Texting Parents about Early Child Development: Behavioral Changes and Unintended Social Effects*

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Abstract

Parenting interventions have the potential to improve early childhood development. Text messages are considered a promising channel to diffuse parenting information at low cost. This paper tests whether sending text messages about parenting practices impacts early childhood development. Households in rural Nicaragua were randomly assigned to receive messages about nutrition, health, stimulation, and the home environment. The intervention led to significant changes in self-reported parenting practices. However, it did not translate into improvements in children's cognitive development. When local opinion leaders were randomly exposed to the same text message intervention, parental investments declined and children's outcomes deteriorated. These negative effects were strongest for children of the least educated caregivers. Since interactions between parents and leaders about child development also decreased, the negative effects may have resulted from a crowding-out of efforts by local leaders.

JEL classification: H23, I15, J13, O15.

Keywords: Early Childhood Development, Parenting, Text Messages, Behavioral Change, Field Experiment.

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1 Introduction

An estimated 250 million children under 5 years old are at risk of not reaching their developmental potential in the developing world (Black et al., 2017). Early childhood development (ECD) is an important predictor of success later in life (Almond et al., 2018). Early childhood interventions can have high returns given the malleability of the brain (Knudsen et al., 2006) and the hypothesized dynamic complementarities in human capital investments (Heckman, 2006). A growing literature provides experimental evidence on the effects of ECD interventions in the short term (on cognitive or socio-emotional outcomes) and the long term (on school performance, wages, or criminality). The evidence has motivated policy responses in both high-income (Currie, 2001; Schweinhart, 2005; Nores et al., 2005) and low- and middle-income countries (LMICs) (Berlinski and Schady, 2015; Black et al., 2023).

Interventions aimed at improving parenting knowledge or skills delivered in-person, for instance through home visiting programs, have been shown to be highly effective at changing practices and improving early childhood cognitive outcomes (Jeong et al., 2018, 2021; Jervis et al., 2023). Building on this evidence, text-messaging interventions are an appealing alternative channel to deliver information on ECD practices due to their low cost, the fast-growing use of mobile phones, and their potential to circumvent quality issues with decentralized service delivery (Carta et al., 2013; Ajzenman and López Bóo, 2019). This is particularly the case in areas with limited accessibility, or contexts where personal interactions are not possible for other reasons, such as during the COVID pandemic or in conflict situations. A growing literature considers the effectiveness of text message interventions in affecting parenting behavior and early childhood outcomes in LMICs, generally finding positive effects on reported caregiver behavior, but with more limited evidence on child ECD outcomes (Richardson et al., 2021).

Text messages are, by design, a light-touch mechanism to convey information, with the recipient in a relatively passive role and little reason to engage. The possibly to increase salience, power, or persuasion through text messages alone may also be limited. Given the broader evidence on the importance of dosage for ECD interventions (Dadisman et al., 2024) this raises questions on whether text messages can be powerful enough on their own. The social transmission of their content by local influencers could be a way of intensifying their reach. In addition, it could help ensure that illiterate caregivers also access the content. This study therefore sets out to test whether information diffusion of text message content through social learning helps to increase intervention "dosage".

As such we build on evidence in the ECD literature showing the importance of social learning (Premand and Barry (2022); Ebert et al. (2024)). A much larger literature in other domains confirms the potential to trigger social learning in rural communities. The potential to amplify the reach of information interventions by targeting messages to key entry points in social networks has been intensively studied in the context of agricultural extension (Beaman et al., 2021). This literature shows that social learning does not automatically occur, and highlights the importance of identifying the right influencers. Farmers appear most convinced by communicators who share common characteristics with them, such as gender, wealth or similar practices and constraints (Kondylis et al., 2017; BenYishay and Mobarak, 2019). The lack of such commonalities can hamper peer learn-

ing (Magruder, 2018). This points to potential trade-offs as more educated people and those with leadership roles may have a greater ability to engage with the messages and possibly more credibility to diffuse them, but they may be perceived differently by low education households. This aligns with recent findings on the importance of the messenger's social proximity for increasing demand for vaccines (Alsan and Eichmeyer (2024); Armand et al. (2024)), and the mixed evidence on influencer-based messaging, with both positive results (Banerjee et al., 2019, 2024; Alatas et al., 2024) and muted or even negative results (Delavande et al., 2026). Finally, social incentives can create a wedge between the intent of external programs and the actual behavior of local delivery agents (Bandiera et al. (2023)). Targeting messages to local leaders therefore does not automatically amplify them, and indeed could lower engagement if it reduces those social incentives.

Building on this literature, we set out to test whether the impact of text messages on parenting behavior and child outcomes differs depending on whether targeted ECD opinion leaders in the village also received the messages. A secondary question of interest is to analyze whether the effects differ by the gender of the opinion leaders. We targeted leadership figures in the villages that were already playing a role in relevant ECD domains, such as community health workers, preschool and primary school teachers as well as village leaders. This choice was motivated by them being considered as natural influencers on ECD. Yet a large literature on community health workers, teachers and other public servants has shown that effort levels and intrinsic motivation can be both positively and negatively affected by outside interventions. The ability of these leaders to amplify messages is hence not automatic. They may perceive the text messages as a form of intrusion in their sphere of influence, and quizzes about the messages as an attempt to monitor their performance. It is possible this adversely affects their intrinsic motivation (e.g. following Bénabou and Tirole (2003); Frey and Jegen (2001)).

This paper provides novel experimental evidence on a text message intervention aiming to improve parenting practices in rural Nicaragua. Our first contribution is to test the direct effect of sending incentivized text messages to caregivers on parenting practices and children's cognitive development. Our second contribution is to test whether impacts vary depending on local opinion leaders' exposure to the text messages. We measure impacts on young children's cognitive and socio-emotional development using a series of age-appropriate tests. We also measure impacts on the practices, beliefs and investments that were promoted by the intervention. This captures intermediary mechanisms through which the text messages intended to affect ECD outcomes. By doing so, we highlight differences between results based on self-reported behaviors and observed final outcomes, showing the importance of not just relying on self-reported data when assessing parenting or behavior change interventions.

The intervention sent daily text messages with advice about parenting practices conducive to early childhood development. The messages covered key risk factors for ECD (Walker et al., 2007b) related to nutrition, health, stimulation and the home environment. They were delivered to randomly selected parents of children between 0 and 6 years of age in 97 villages over a period of approximately 10 months. The text messages mentioned the name of the target child and varied by the age of the child to provide age-appropriate advice. Parents were incentivized to engage with the messages through weekly quizzes, for which they could win airtime. In a random subset of villages, local

opinion leaders (such as community health volunteers, preschool teachers, etc.) who also had children received similar text messages.

Results show that exposure to text messages led to an improvement in reported parenting practices, as well as in observed hygiene. However, no significant effect on children's cognitive or socio-emotional outcomes is found. Reported changes in parenting practices hence were not sufficient to induce gains in cognitive or socio-emotional development, possibly because they were too small or did not reflect actual shifts in parental investment, or because they were offset by other reactions to the intervention.

The analysis then considers how impacts vary depending on local opinion leaders' exposure to the text messages. Results show a significant negative impact of leaders' exposure on cognitive development of children in their village, a finding that goes against our prior when designing the experiment. The negative effects are strongest for children with the least educated caregivers. Leaders' exposure to text messages also reduces a number of intermediary outcomes, including stimulation and nutritional practices. While the experimental design does not allow us to isolate the exact reasons for these negative effects, we discuss several potential mechanisms. Results show that the negative effects are unlikely to be driven by confusion about the messages. The evidence points instead to a crowding-out of local opinion leaders and possibly a form of boycott. In particular, interactions about ECD practices between local leaders and parents decrease in the randomly-selected villages where leaders received the text messages. We speculate that the intervention may have been perceived by local opinion leaders as interfering with their traditional domain of influence, either demotivating them or possibly leading them to try to offset the messages. While we cannot fully disentangle these potential pathways, the negative effects from leaders' exposure to the text messages and the overall lack of impacts on children's cognitive outcomes are robust. This suggests that the roll-out of technology-based solutions requires careful attention to the social spillovers and responses from local leaders they may generate.

The paper contributes to several strands of the literature. While few studies have assessed the effect of providing parenting advice via a text message-only intervention on cognitive outcomes in early childhood in LMICs, the evidence on integrating text messages as a complement to other interventions targeting ECD has been rapidly expanding (Wilton et al., 2023; Smith et al., 2023; Sargsyan et al., 2023; Lenel et al., 2022; Berlanga et al., 2023), often showing positive impacts on parental investments, but limited evidence of effects on direct assessments of children's ECD outcomes (with Hernandez-Agramonte et al. (2024) a notable exception). Relatedly, interactive internet-based information technologies were introduced in various settings during the COVID-19 pandemic, showing mixed results (Dinarte Diaz et al., 2023; Lebedinski et al., 2024), including a negative impact on male caregiver–child interactions in El Salvador (Amaral et al., 2024), as such echoing the negative effects found in our Nicaraguan setting.

Beyond LMICs, evidence on (pre-)kindergarten children in the United States shows that sending text messages to parents can help increase early reading skills (York et al., 2019), with effects varying based on the content, personalization and frequency of the text messages (Cortes et al., 2018; Doss et al., 2019). In an earlier study, Hurwitz et al. (2015) find a positive effect of delivering advice via text messages on parental engagement in learning activities in early childhood. For older school-age children, Bettinger et al. (2020)

find a relatively large impact of text nudges on learning in Brazil. In contrast, Aurino and Wolf (2024) find that text nudges to parents of school children had a net null effect, with significant negative results for low-educated parents, hence resonating with the findings in this paper.

This paper complements a broader literature showing the potential of text messages as information or nudges for health-related behaviors such as prevention and disease management (Cole-Lewis and Kershaw, 2010), treatment adherence (Pop-Eleches et al., 2011), child eating behavior (Chai et al., 2019), vaccination (Kazi et al., 2019; Bahety et al., 2021) or learning (Angrist et al., 2022). The analysis of the effects of sending text messages to local opinion leaders also relates to the literature on the use of technology to support teachers in Africa and Asia (Gaskell and Mills, 2009; Valk et al., 2010; Walsh et al., 2013), with positive effects found on children's literacy and classroom practices in Kenya (Jukes et al., 2017). Finally, it may have implications for the use of text messages for agricultural extension purposes (Fafchamps and Minten, 2012; Fabregas et al., 2025).

The paper also adds to the broader literature analyzing impacts of ECD parenting interventions on children's outcomes in developing countries. Many interventions expose caregivers to parenting advice through other - often more intensive and direct - means. A seminal study in Jamaica shows that children randomly assigned to receive early childhood stimulation through home visits exhibit large improvements in cognitive outcomes in the short term, and some effects remain twenty years after the intervention (Grantham-McGregor et al., 1991; Walker et al., 2007a, 2000; Powell et al., 2004). Experimental evidence from similar interventions, now available for a relatively wide range of LMICs, including Nicaragua, generally confirms positive impacts on early childhood development, though effect sizes vary substantially, and delivering effective interventions at scale has proved challenging (Jeong et al., 2018; Attanasio et al., 2020; J-PAL, 2020; Macours et al., 2015; Arriagada et al., 2018; Jervis et al., 2023).

Cash transfer programs take a different approach to target similar populations with the objective to change parental human capital investments, including in the early years. They have been shown to shift parental investment and improve cognitive development in Nicaragua (Macours et al., 2012), Ecuador (Paxson and Schady, 2010) and Nepal (Levere et al., 2024). Evidence on long run impacts of exposure to cash transfers in early childhood is also growing (Millán et al. (2019)). Experimental studies from interventions focused on behavioral change in nutrition or preventive health practices, with or without cash transfers, also show positive effects on parental investment and nutrition behaviors, but rarely measure impacts on cognition (Fitzsimons et al., 2016; Ahmed et al., 2024; Field and Maffioli, 2024). Recent exceptions include Levere et al. (2024) and Premand and Barry (2022), who find positive effects of behavioral change promotion on parenting practices, but not on cognition.

The rest of the paper proceeds as follows. In the next section, we describe the text message intervention and the data, including ECD measurement. Section 3 presents the empirical strategy. Section 4 presents the main experimental results. Section 5 analyzes potential mechanisms behind the negative impacts of leaders' exposure to text messages. The last section concludes.

2 Intervention, Study Design and Data

2.1 Incentivized Text Message Intervention Design

The design of the intervention was motivated by the literature showing that information on parenting practices can help improve early childhood outcomes. The government of Nicaragua was interested in knowing whether a low-cost intervention could help reduce some of the information asymmetries, and was inspired by simple text message interventions that showed potential elsewhere. While the text-message intervention was not expected to lift all constraints to child investment, the experiment was set up to study whether it could lift at least some information constraints. The intervention was designed to be low-cost, while also introducing various design features aiming to increase the signal strength.

A daily text message with a short practical recommendation about parenting practices was sent to poor households in rural Nicaragua. The messages covered early stimulation, the home environment, nutrition, and preventive health care, focused on the youngest child below 6 years old in the household, and were sent to the child's main caregivers (typically the parents). Messages were age appropriate (with different messages sent to parents of children 0-6 months old, 7-12 months old, 13-24 months old, and older than two years old) and mentioned the name of the target child. They were designed to provide actionable advice based on the government early childhood development curriculum, and built on prior experiences with early childhood development programs in the country.[1]

The daily frequency reflected several design considerations. First, it aimed to maximize informational dosage while staying within plausible attentional bounds. Second, the targeted behaviors (feeding practices, language stimulation, responsive caregiving) are daily parenting decisions, and prior evidence on prompts and reminders (e.g. Pop-Eleches et al. (2011); Karlan et al. (2016)) suggests that cues are most effective when temporally proximate to the moment of choice. Third, the content curriculum covered multiple ECD domains, requiring sufficient cumulative dosage to cover key topics with appropriate spacing repetition.

In an effort to increase engagement with the daily text messages, targeted households had the opportunity to participate in a weekly quiz. They were sent a multiple choice question about one of the parental practices highlighted in earlier messages, and given 24 hours to respond. All individuals who responded correctly entered a lottery to earn free airtime. Every week about 20% of correct answers received 1 US$ airtime, and once a month, winners received 5 US$ airtime (equivalent to 1-2 daily rural wages). The quizzes provided a small incentive for participants to continue reading the text messages. This was considered particularly important as cell phone coverage and electricity access are not universal in the study villages, and receiving text messages at times required walking to a location with signal or charging phones outside of the home. As such, our estimates identify the impact of the text messages along with the quizzes and related incentives. The intervention can be characterized as an incentivized text-message intervention.

[1] Table A1 provides examples of text messages sent to parents of children 7-12 months old. The text message intervention was designed by a Nicaraguan early childhood specialist, in consultation with the Nicaragua Ministry of the Family and with support from the World Bank.

Despite those incentives, a key concern was that the basic text message intervention was too light-touch to meaningfully change behavior. Earlier work in nearby municipalities (Macours and Vakis, 2014, 2017) had demonstrated the role of social interactions with local leaders in influencing behavioral changes for investment in young children's nutrition and health.[2] Baseline data for the current experiment also confirmed that discussions around health, education, nutrition and child development were common in the targeted villages, with half of caregivers indicating discussing these topics with others in the last week. Given this and the broader evidence in the literature on the role of local leaders in information interventions, the text messages were purposely targeted to local leaders in a random subset of villages. This was done to test whether leaders could amplify effectiveness. The leaders considered included community health workers, preschool teachers and other ECD educators, primary school teachers, and community leaders (both current leaders and those that held those positions in the last 10 years). These are all functions in the villages that were integrated within the government administrative system. They were therefore expected to be aware of the national ECD approach, with which the messages had been aligned. With the exception of the community leaders, the topics addressed in the messages are also closely related to their spheres of influence and human capital mandates. Baseline data confirm their potential influence: caregivers reporting social interactions on ECD indicated these occurred with community health workers (22%), preschool teachers or other ECD educators (16%), primary school teachers (7%), and community leaders (10%).

Text messages were targeted to the relevant caregivers based on information collected at baseline. Prior to program implementation, in the Fall of 2014, a baseline survey was conducted in 97 rural villages in four municipalities (Totogalpa, Telpaneca, Yalaguina and Palacaguina). The baseline survey was collected in all households with children 0 to 6 years of age or pregnant women. For each child, the baseline survey collected information on the main female and male caregiver. In 96% of the cases the biological mother lives with the young child, and in the other 4% the female caregiver is a grandmother (and in very few cases a stepmother). Biological fathers are less likely to live with young children, with 25% absent due to migration or other reasons. In those cases, most often a grandfather fulfills the male caregiver role (13% of children) or a stepfather does (less than 1%), with the remaining children having no male caregiver.

Among households with children 0-6 (or pregnant women), the baseline survey also identified all households with local opinion leaders on early childhood practices. In the 97 villages, there were a total 2,899 children 0 to 6 years old, and 3012 households with at least one target child or a pregnant mother, including 406 opinion leaders. Among households with young children, five villages did not have opinion leaders and the remaining 92 villages, on average, had 4.4 leaders.

[2]This earlier evidence was obtained in the context of a conditional cash transfer program. It is therefore possible that it does not directly translate to the current setting as cash transfers can lift broader constraints to ECD investments. Even so, CCTs targeting children in the earliest years of life (including the earlier program in Nicaragua) typically also have an important information and behavioral change component. Moreover the evidence showed that social interactions were maintained after the end of the program. As such, this evidence provided the context-specific motivation for the experimental design.

2.2 Experimental Design

To test the effectiveness of the incentivized text message intervention, a household-level randomization determined which households would receive text messages: for households without leaders, 75% were randomly selected to receive text messages, with the remaining 25% serving as control (see the top part of Figure A1).

Among the 92 villages with at least one opinion leader (among households with young children), a village-level randomization determined whether household with opinion leaders were sent text messages (65 villages) or not (27 villages) (see top part of Figure A2). The village-level randomization of the "leader" treatment was stratified on the average level of education of the main caregiver in households with leaders (specifically a variable capturing the terciles of the education distribution).[3]

Additional (orthogonal) experimental sub-treatment variations were introduced at the household level (see bottom part of Figure A1) to examine whether impacts differed depending on the recipient within the household (female or male caregiver, or both) or the specific risk factors on which the messages focused (nutrition and health, stimulation and the home environment, or both).[4] While we recognize that these sub-treatment variations may raise concerns regarding multiple hypotheses testing (as shown by Young (2019)), these two variations were introduced to learn from a possible null result (given the concern with the intervention being too light-touch), and to provide the most useful policy recommendation, in case the interventions were indeed effective. Specifically, when we designed the experiment, we were aware of evidence in the literature on text message interventions for health and nutrition with positive results, but at the time, text messages focused on stimulation and the home environment were less common. The experimental content variation was designed to test whether text messages are better suited for some domains. The variation in target recipient (female caregiver, male caregiver, or both) was introduced to test whether the intervention could be strengthened by reaching both parents, while acknowledging there could be trade-offs involved as ECD is often considered the mother's sphere of influence, but male caregivers in this context decide on budget allocations for nutrition, health and stimulation material, and often also intervene in disciplining. We report the results from these additional variations in the appendix and only

[3]The villages in which leaders were treated were further randomized to vary the target recipient of text messages in leader household to both the male and female caregivers (27 villages), only the female caregivers (27 villages) or only the male caregivers (11 villages) (see bottom part of Figure A2).

[4]Specifically, we randomly selected whether text messages were sent to (i) the main female caregiver (25 percent of the sample), (ii) the main male caregiver (25 percent of the sample) or (iii) both (25 percent of the sample). Second, treated households were randomly assigned to either receive text messages focused on (i) early childhood stimulation and the home environment; (ii) nutrition and preventive health care; or (iii) a combination of topics. Note that caregivers who received both stimulation and nutrition messages did not receive more messages. They also received one message daily, but the theme of the messages varied. The household level randomization was stratified on the level of education of the main caregiver (in most cases the mother of the child) distinguishing those with less than 4 grades, 4-6 grades and more than primary; and on whether there is a male caregiver (typically the father) in the household. Figure A1 illustrates the household-level randomization design. Note that the number of households in each treatment modality varies slightly due to stratification. Randomization of the content of the messages was also performed among leader households. This was further stratified on access to electricity at home. This is only done for leaders because access to electricity is highly correlated with education among non-leaders.

mention them in the text when noticeable differences arise, which is rarely the case.

The household level randomization by gender of the recipient(s) was also applied for the leader households. As a result, non-leader households face experimental variation as to whether female or male caregivers (or both) in leader households in their close proximity were exposed to the text messages. This allows to test whether the gender of the leader receiving the text message affects the social interaction effects.

After the baseline was collected, a registration assembly was organized in each village in December 2014. All households from the treatment and control groups were invited. They all received a basic cell phone.[5] This was done because a relatively large share of parents did not have cell phones. The cell phones provided were the most basic models available, and at about 16 USD (less than 1% of average national income per capita), do not constitute a big asset or income shock, making it unlikely they induced a change of bargaining power within the household, even if they may have increased access to other information or networks. Cell phones were also distributed to control households in order to rule out any direct effect resulting from an increase in cell phone access.[6] The intervention was presented as a pilot providing access to cell phones and text messages with information about early childhood development. All participants were invited to sign up for the text message intervention and the dynamics and prizes of the quizzes were also explained.[7]

Households assigned to treatment were then assisted to activate the intervention. This was done by sending a text message to a central server, with only treated cell phones able to register. Once activated, cell phones started receiving daily messages. Treatment households that did not participate in the assemblies subsequently received the cell phones at their home, together with information about the program and help with activation. The registration assemblies took a month to complete for all villages, resulting in a take-up (activation) rate of 90%. The intervention cost approximately 50 US$ per household.[8] Implementation lasted from late 2014 to late 2015.

[5]The cell phone was labeled as being assigned to the male or female caregiver of the target child, depending on the household-level randomization. Households randomly assigned to have both the male and female caregiver receive text messages were given two cell phones.

[6]Even so, the distribution of the cell phones needs to be considered to interpret the external validity of the results. Another caveat is that control households were not sent placebo text messages, so that we cannot disentangle the effect of receiving messages with the effect of receiving the specific content. However, the content sub-treatment variations show that parents' self-reported behavior reflects the specificity of the content they received.

[7]The protocol followed during the assemblies explained the objectives of the intervention as being: a) sending information about good parenting practices children in their early years; b) increasing knowledge of parents about good practices in nutrition, health, stimulation and the home environment, so that they themselves can help their sons and daughters develop from an early age; and c) testing a new method of information delivery. The protocol also explained the program was being delivered in collaboration with the Ministry of the Family and other government entities, and was financed by the World Bank.

[8]Total costs included cell phones (50,000 US$), a text messaging distribution platform and incentives (65,000 US$) and field implementation (including registration assemblies) and monitoring (USD 35,000 US$). Given the relatively large fixed costs, costs would be substantially lower at scale.

2.3 Compliance

The text messages were sent from an automated platform managed by a local provider. Administrative data from the provider confirm that all messages were sent. In addition, our field team monitored reception of the text messages on a random subset of phones (with their specific phone numbers not known to the provider), with these phones assigned to the various sub-treatment modalities to monitor that messages were sent consistently and on time. The monitoring data confirms very high compliance. We do not, however, have comprehensive data about whether all messages were received on all phones.

As a further indicator of households' active participation in the text message intervention, we use the weekly information about households' response to the quizzes. While participation in the quizzes is an imperfect measure of exposure, it provides a directly observed proxy of engagement with the intervention at the household level. Figure 1 shows the trivia response rate over time. The response rate peaked at 70 percent about two months after the start of the intervention (i.e. when all registrations were finalized), and then slowly decreased over the year to reach about 25 percent after 10 months.[9] Qualitative field work indicated that this decline reflected three factors. First, some households reported having lost or broken the cellphone or its charger.[10] Second, some households voluntarily stopped using the mobile phone all together (some of the phones were seen being used as toys instead). Third, others kept using the mobile phone but simply stopped responding to quizzes out of lack of interest or motivation to search for phone signal.[11]

2.4 Data

Baseline data were collected in the Fall of 2014 using a short household survey instrument. It captured information on household composition, socio-economic status, cell phone usage, social interactions and economic activities, as well as child-specific information regarding health practices, preschool participation, nutritional intake, early childhood practices and attitudes. As noted above, the baseline was also used to identify the main female and male caregiver for each child, i.e. the child's biological mother and father, or in their absence, the individuals with similar caregiving roles, as defined by the household.

A follow-up survey was implemented in July and August 2015, approximately nine months after households had started receiving the text messages. The duration of exposure is similar to other early childhood interventions where impacts on ECD outcomes were found in nearby municipalities in Nicaragua (Macours et al., 2012).[12] The follow-up

[9]This percentage is computed over all the cell phone numbers distributed to treatment households, including leaders and non-leaders. Cell phone numbers distributed to control households did not receive the quizzes.

[10]Cell phones for which issues were reported in the first months of the intervention were replaced.

[11]Figures A3 – A6 show that the evolution of the number of treated individuals participating in weekly quizzes is broadly similar for caregivers with different education levels and for the different experimental variations.

[12]The follow-up survey was fielded a bit before the end of the text message intervention so that data collection could take place before the rainy season, when accessibility can be challenging. That said, about

survey targeted children in sample households, as well as the main caregiver. We limit the analysis to children under 7 years of age at follow-up, in order to use the full battery of tests, as detailed below.[13] Questions on early childhood practices and attitudes were asked separately to female and male caregivers.

The child-level follow-up instrument includes a number of tests to assess early childhood development. First, the four sub-scales of the Denver Developmental Screening Test (Frankenburg and Dodds (1967)) were used to assess social-personal, language, fine motor, and gross motor skills for all children between 12 and 84 months of age. We use a modified version of the Denver previously used as part of a national early childhood stimulation program in Nicaragua.

Three additional tests were conducted for children between 36 and 84 months old: 1) The TVIP, the Spanish-speaking version of the Peabody Picture Vocabulary Test (PPVT) (Dunn et al., 2006); 2) The digit span, an associative numeric memory test; and 3) A version of the marshmallow test to measure self-control.[14] The test was adapted to the local (humid) survey context by using hard red candy instead of a marshmallow.

The tests have been applied to similar populations in Latin America, including in previous studies in Nicaragua (Macours et al. (2012) and Barham et al. (2013)), Ecuador (Paxson and Schady (2007) and Paxson and Schady (2010)) and Mexico (Fernald et al. (2008)). All tests were extensively piloted in the field and adjusted when necessary. Test administrators were selected based on their background (trained as psychologists, social workers, or similar fields) and for their ability to quickly establish a rapport with young children. They were intensively trained on the standardized application of the tests, as well as on putting children at ease. Tests were administered at home. The privacy of the test-taker and the confidentiality of the results were ensured throughout the process. Test administrators were randomly assigned to households. The quality and standardized application of the tests was closely monitored in the field. A key advantage of the tests is that they provide observed and objective measures of child development, rather than parent-reported measures that may suffer from reporting biases.[15]

The test scores are aggregated using principal component analysis to determine factor weights in the control group. We retain the first principal component as a summary indicator of early childhood cognitive development. The first component accounts for 32% of the overall variation in the 7 tests, and for 35% of the overall variation in the 4 subcomponents of the Denver. Table A2 reports the factor weights, showing that the cognitive development tests all have relatively high weights (Denver language, TVIP, memory, fine motor skills).[16]

2 percent of observations was collected later, during a short tracking phase in May 2016 when missing households were re-visited.

[13] By the time of the endline, 209 children who were tested at baseline were older than 7 and had aged out of taking the Denver test. Vice versa, 114 newborn children were added to the sample.

[14] The marshmallow test is a well-known test of delayed gratification, evaluating preschool-age children's ability to wait before eating a marshmallow in exchange for being rewarded an additional one. Mischel et al. (1989) show that the test predicts outcomes later in life.

[15] Only a few items of the Denver are reported by caregivers.

[16] Although these tests do not capture all domains of broader cognitive ability, they have been shown to be malleable to investments in ECD in this context, without subjecting the young children to a long direct assessment protocol.

The aggregate cognitive score constitutes our main ECD outcome. In addition, socio-emotional skills are measured using the Strength and Difficulties questionnaire (SDQ) and a behavioral screening test consisting of questions to caregivers about a set of positive and negative behaviors for children 36 to 83 months old. These scales were complemented with questions on inhibitory control and positive demeanor. Another standardized set of age-appropriate behaviors was asked for children aged 18 to 35 months old. We consider socio-emotional measures as a secondary outcome. We analyze it separately because information self-reported by caregivers is sensitive to potential reporting biases, which may be influenced by the text message intervention. As for the cognitive score, we construct an aggregate index across the various socio-emotional development subscales. We use principal component analysis to determine factor weights in the control group (see Table A3).[17]

The text message intervention aimed to improve early childhood cognitive and socio-emotional development by changing parental investment behavior and attitudes linked to ECD risk factors. To measure intermediate outcomes related to parenting practices, we construct seven indices for parental investments in nutrition, protein intake, micro-nutrient intake, stimulation, health, and indices for caregiver attitudes regarding ECD, and hygiene. Each index is constructed using a set of questions about parental behaviors, ECD risk factors, and attitudes. The nutrition index is based on a set of questions measuring the number of days the child receives nutritious food during the week before the survey. The stimulation index aggregates questions on whether the caregiver gives toys to the child, reads or tells stories to the child, and whether there is pen and paper in the house for the child to draw. The health index is based on twenty questions related to preventive health behaviors, including tooth brushing, hand washing, use of mosquito nets, vaccination, boiling water etc. The micro-nutrient index is based on three variables measuring whether the child received vitamin A, ferrous sulfate, or de-worming medicine during the last six months. The animal protein index measures consumption of proteins (milk, eggs, cheese, meat) during the last week. The attitudes index is based on variables measuring the caregiver's opinion about ECD and stimulation practices. Finally, the hygiene index captures the condition of the child during the interview. In contrast with other intermediate outcomes, the hygiene index is directly observed by the enumerator. Each index score is standardized using the mean and standard deviation in the control group.

We note that any information intervention (and possibly in particular a high-frequency messaging intervention) can inflate self-reported practices through experimenter demand without changing actual behavior. This is why we consider the direct assessment of children's cognitive skills as the main outcome. It provides an objective measure and cannot be inflated by parents' desire to provide socially desirable responses. We nevertheless consider information on the self-reported practices useful, as they can indicate that parents, at the very least, understood and remembered the messages.

[17]While some of the subscales have low or even negative weights, we restrict the analysis to the first principal component as for the cognitive outcome. For comparability, we also restrict the analysis to the sample of children with cognitive tests.

2.5 Balance and Attrition

The sample is balanced on baseline characteristics between treatment and control households (Table 1). It is also balanced between villages with and without opinion leaders assigned to treatment (Table 2).[18] Table 1 provides relevant contextual information about the study setting. Both fathers and mothers have low levels of education, with mothers having completed 6 years of education on average, and fathers 5 years. 75% of target children live with their father at baseline, and 96% with their mother. We therefore also consider education levels of the female and male caregivers, i.e. the individuals targeted by the text messages. 87% of female caregivers and 79% of male caregivers are literate, indicating that the large majority of caregivers should have been able to read the text messages themselves. That said, 66% of female caregivers and 81% of male caregivers in treated households have not gone beyond primary school. Children on average consume meat and vegetables one to two days per week, and fruit and eggs about 3 days per week. By contrast, children's coffee consumption is high (four days per week). Only 22% of children had an adult read to them in the month before the baseline survey.

The baseline data further illustrate that leader and non-leader households differ both in terms of education and early childhood practices (Table A6). Leaders generally have higher education levels and literacy. For instance, 95% of female caregivers in leader households are able to read and write compared to 86% in non-leader households, while 57% of leaders have gone to secondary school (compared to 31% among non-leaders). More positive parenting practices are also observed in leader households, with more time spent reading to children, children more likely to receive nutritional supplements (vitamins), and children consuming fruit and vegetables more frequently. The higher level of education of leaders implies they were, a priori, well placed to help with outreach to less literate caregivers in other households. And given the leaders' baseline parenting practices, they were expected to be effective transmitters of the content of the text messages.

Attrition at follow-up is 10 percent for tests administered to the target child, 8 percent for questions asked to the child's main caregiver at endline, 12 percent for the questions to be asked to the baseline female caregiver, and 21 percent for questions to be asked to the baseline male caregiver.[19] Attrition is balanced between treatment and control groups (Table A7). Baseline observables are similar for attrited observations in the treatment and control groups (Table A8), suggesting that the profile of children and parents lost due to attrition are similar between groups. Moreover, attrition is also balanced between villages with and without opinion leaders assigned to receive the text messages. Indeed, the coefficients for child and household level attrition in panel B of Table A7 are close to zero, suggesting attrition is not likely to bias the estimated effects of leaders' assignment to the text message intervention.

[18] Tables A4 and A5 documents baseline balance for the randomization of text message content (on nutrition, stimulation, or both nutrition and stimulation) and target recipient (female caregiver, male caregiver or both) at the household level. In each case, the experimental design achieved balance.

[19] We do not use the male caregiver-specific questions given the relatively high attrition.

3 Empirical Specification

We estimate the following child-level intent-to-treat regression:

$$Y_{iv} = \alpha Text_i + \beta X_i + \delta_v + v_{iv} \quad (1)$$

where Y_{iv} is the outcome for child i in village v; *Text* is an indicator denoting treatment assignment, which takes the value of one for children in households randomly assigned to receive the text message intervention; X is a set of control variables, including the stratification variables[20] as well three-monthly age dummies, the gender of the child, and test administrator fixed effects. We also include a binary variable indicating whether data were collected during a tracking phase.[21] δ_v is a village fixed effect, which controls for the village-level assignment of the leader treatment.

The household-level randomization design identifies treatment effects net of spillovers between households within villages. To capture spillovers directly, we estimate the effects from opinion leaders' exposure to the text message intervention through the following regression:

$$Y_{iv} = \beta_1 Leader_v + \delta Text_i + \beta_2 X_i + \epsilon_{iv} \quad (2)$$

Y_{iv} is the outcome for child i in village v. $Leader_v$ takes the value of 1 in villages where opinion leaders were randomly assigned to receive text messages. Controls include the stratification variables used for the leader randomization (the level of education of the leader) and other household-level controls as in specification 1. To isolate spillover effects, equation 2 is estimated by excluding the households of the opinion leaders themselves. The coefficient of interest (β_1) captures the spillover effects of being in a village where leaders were exposed to text messages. Randomization took place at the village level and we also cluster standard errors at that level.

Figures A1 and A2 illustrate the experimental design. Equation 1 refers to the first (top) level of randomization in Figure A1 (households targeted with text messages versus control households), while equation 2 refers to the first (top) level of randomization in Figure A2 (villages in which the leaders were targeted with text messages versus villages in which the leaders were not targeted).

To address concerns about multiple hypotheses testing, we focus only on two main outcomes. Cognitive development is the primary outcome, and socio-emotional development the secondary outcome. As discussed in Section 2.4, we create an index for each outcome by aggregating related measures. We also test for impacts on intermediate outcomes capturing parenting practices, which are also aggregated by domain.[22]

[20] The stratification variables include: the level of education of the main caregiver, whether there is a male caregiver in the household, whether it is a leader household, and whether it is a leader household with access to electricity.

[21] As indicated above, in May 2016 the data collection team tracked 63 households that were not found during the initial visit. The control variable accounts for the fact that the intervention had ended by then, and for the age-sensitivity of the tests.

[22] For completeness, we also run an intent-to-treat regression to estimate the effects of the sub-treatment variations randomized at the household level:

Appendix A1.3 (and Table A39) provides more information about the statistical power of the experiment. The minimum detectable effects are 0.125 SD for sending text messages to households (first level of randomization in Figure A1, equation 1), between 0.13 and 0.22 SD for the leaders' exposure to text message (village-level randomization in figure A2, equation 2), and approximately 0.15 for the sub-treatment variations randomized at the household level (second level of randomization in figure A1, equation 3). Overall, these detectable effect sizes are within the range of policy-relevant effects documented in the early childhood literature.

4 Results

4.1 Direct Effects of Text Message Intervention

The main results on the effects of the text message intervention on early childhood development are reported in Table 3. Panel A reports ITT estimates for the aggregate cognitive development index for all children age 1-7 years at endline (column 1), as well as separately for children age 1-3 years (column 2), and 3-7 years (column 3). The estimated impact on early childhood development is very small and not significantly different from zero. This result holds for the different age groups. Table A9 in the appendix shows similar findings for the individual tests when they are analyzed separately.[23] The top panels of Tables A11 and A12 further show that there is no statistically significant effect on the overall behavioral (socio-emotional) index (column 1), which holds for most of its individual components.

Table 4 shows results for intermediate outcomes for all children between 1 and 7 years old. Positive ITT estimates are found for all intermediate outcome indices, with small magnitudes between 0.06 to 0.16 standard deviation.[24] Results for individual questions

$$Y_{iv} = \alpha_1 Text_{1i} + \alpha_2 Text_{2i} + \alpha_3 Text_{3i} + \beta X_i + \delta_v + v_{iv} \quad (3)$$

where $Text_1$, $Text_2$, and $Text_3$ are indicators denoting children whose parents were randomized to receive text message variations focused on nutrition, stimulation, or both nutrition and stimulation. We use a similar specification to estimate treatment effects on children's outcomes depending on whether the mother, the father or both parents were randomly selected to receive the text messages. These results are presented in annex, and only mentioned in the text when noticeable differences arise.

[23]Table A10 shows consistent results across the treatment variations focusing on nutrition, stimulation or both, as well as depending on whether the intervention targets the female caregiver, male caregiver, or both in the household. We also tested heterogeneity of impacts by the coverage of the government early childhood development program based on which the content of the text messages were derived. Few households from the communities report participating in the national program, with 2 households in the median village. We do not find evidence of complementarities: there is no significant heterogeneity by coverage of the national program (p=0.29), and we cannot reject that the treatment effects are zero villages with higher coverage either (p=0.8).

[24]Table A15 reports estimated effects on the 7 intermediate outcome indices, separately for each (randomized) variation in the content of messages. The impacts on the indices for nutrition, micro-nutrients intake, proteins and hygiene are larger for households assigned to the nutrition and preventive health messages (though not significantly so). Impacts on stimulation and caregivers' attitudes toward ECD are significantly larger for those assigned to the stimulation and home environment messages.

used to construct the indices are reported in Tables A16, A17, and A18.[25] Importantly, these results show that changes in reported parental investments and practices broadly reflect the content of the text messages that caregivers received.

Since most of the intermediate outcomes measure parenting behavior as reported by the child's main caregiver, it is possible that these results capture parents increased knowledge and awareness about these practices, rather than actual shifts in behavior (e.g. if social desirability bias makes parents that were exposed to text messages feel more compelled to say they implement certain practices even if they do not). The possibility of such experimenter demand effects highlights the importance of analyzing not only self-reported behaviors, but also observed outcomes. In this case, and importantly, the hygiene index is based on direct observations by the enumerators, and also shows a significant improvement.

Finding positive results on intermediate outcomes but not on final ones could simply be because the shifts in behavior were too small to translate into cognitive or socio-emotional gains. And while positive spillovers between treatment and control households due to information sharing could lead to an underestimation of impacts, it likely cannot explain why estimates show impacts on intermediate outcomes but not on final ECD outcomes.

Panel B of Table 3 reports ITT estimates by level of education of the main caregiver. This shows a negative coefficient of -0.12 standard deviation among children of the least educated caregivers (those with 3 or less years of education), significant at the 5% level (column 1). In contrast, interaction terms are positive for children whose caregivers have 4 years of education or more. But this does not result in an overall positive effect, except for the youngest children whose caregivers have completed more than primary school (significant at the 10% level with an effect size of 0.16 standard deviation). Results show no heterogeneity by education level for older children, for whom there is little impact overall. The second panel of Table 4 shows that changes in reported parenting practices appear more muted (and are not statistically significant) for households with caregivers who have lower levels of education.

Overall the results suggest that caregivers' ability to read and understand the messages could (logically) be important for the messages to be effective.[26] Even so, the deterioration of cognitive outcomes suggested by the negative coefficient for the least educated (as opposed to a 0 effect) cannot be explained by limited ability to read alone. We turn to possible additional reasons next.

[25]The mean values of the control households document the state of parents' knowledge and beliefs. While 33% of caregivers do not believe that early language development can result from parents talking to their child, there is general broad awareness about the importance of ECD practices (with 87% confirming it is important to answer a child's questions, and 86% reporting children's brain develops from the early years.) There seems to be less awareness about the importance of nutrition and health, with control parents reporting only a limited set of health or nutrition practices parents can undertake to avoid children getting sick. Relatedly, at baseline only 5% of parents reported investments in nutrition can help brain development.

[26]In line with this result, caregivers with the lowest level of education also show less engagement with the weekly quizzes, when compared to the medium levels (Figure A3). Engagement is however also lower among caregivers who completed primary school.

4.2 Impact of Opinion Leaders' Exposure to Text Message Intervention

Table 5 reports the estimated β_1 coefficients from equation 2 on the main outcome. Panel A shows the estimated effect of leaders' exposure to text messages on Early Childhood Development.[27] It shows that sending messages to opinion leaders has a negative spillover effects on cognitive outcomes of children from other (nonleader) households in the same village. Children living in villages where leaders were assigned to treatment have a score on average 0.11 standard deviation lower than children from households in villages where leaders were not treated (column 1). While the spillover coefficient is very small and insignificant for the younger children, it is negative and highly significant for children between 3 and 7 years old (-0.14 standard deviation). When considering impacts on individual tests, Table A19 shows that the negative results are strongest for the two language scores (Denver language and the receptive vocabulary test), which are considered good proxies for cognition. On the other hand, Panel A of Tables A20 and A21 show no significant impact of the leader treatment on socio-emotional outcomes.

Panel B of Table 5 reports the leader spillover effects on cognitive outcomes distinguishing by caregivers' level of education. Results show the strongest negative spillover effect from leaders' exposure to text messages among children whose caregivers have fewer than 4 years of schooling. Recall that text messages also had a negative effect for young children in low-education households (Table 3, Panel B). Since the results in Table 5 show that children with the least educated parents are also the most affected by negative spillovers from leaders, they suggest that negative influences of others is a potential explanation for the deterioration of outcomes of children in low-education households. For older children, and for all children together, the effect of leader exposure is also negative for those whose parents completed primary education. (The p-values for the joint significance test for the high-education group are 0.05 and 0.03). Similarly, when distinguishing by education levels of the leaders, Table A22 shows that negative effects are found for leaders with the lowest education levels.

Exposure of opinion leaders to parenting text messages leads to a deterioration of early childhood outcomes among children in their village. As such, the effects of opinion leaders' exposure to text messages go in the opposite direction than anticipated, and suggest a possible negative influence of these opinion leaders. Before delving into possible mechanisms, we first use an alternative specification to test the robustness of this unanticipated effect. We define a variable measuring the number of dwellings between each household and the closest opinion leader. The variable captures physical distance to opinion leaders, which can be used to test whether the negative leader effects are driven by households that are closer to the leaders. The interaction effect in Table 6 (panel A) shows that the negative leader effect is indeed stronger for households living close to the leaders, and weakens as distance increases (column 1). This effect is particularly strong for younger children (column 2). For them, the significant interaction term indicates that the negative leader spillover effect disappears for households living 6 or more dwellings away from the leader's house.

A possible caveat to the interpretation of this alternative specification is that the dis-

[27] Recall that we only consider social interaction effects with opinion leaders who themselves have young children. The intervention delivered text messages that were tailored to the age of recipient's own children.

tance variable could capture remoteness more generally (if opinion leaders live in more central locations), or social distance (if, for instance, members of the same extended families live closer to each other), among other factors. Even so, the interaction effect between the distance variable and the leader treatment provides a useful check about the plausibility that the negative experimental leader effects comes from exposure to those opinion leaders. We further test whether the effects are driven by network size, following the approach in Cai et al. (2015). We construct a proxy for network size by considering the total the number of households within each community. Table A23 shows that the main results in the proximity regressions remain unchanged when controlling for this proxy of network size : households closer to leaders are significantly more impacted by spillovers. This strengthens our interpretation that the observed proximity effects reflect leader influence rather than simply remoteness.

Panel B of Table 6 shows that the negative leader effect is overall not significantly different between households who received the text messages and those who did not. That said, for older children, the interaction between the household-level treatment and leader spillover is positive and significant at 10%, suggesting that negative effects of leaders' exposure may be weaker for those receiving text messages. Nevertheless, the joint significance test reported at the bottom of the table shows that the negative leader effect is also significant for households who received the text messages. For younger children, results suggest no significant difference in the leader effects between treatment and control households.

Table 7 (panel A) reports estimated coefficients from equation 2 for the seven intermediate outcome indices. Negative leader effects are found for several of the indices and related ECD risk factors, specifically in the domains of nutrition, micronutrients and proteins (columns 1, 4, 5). Here too, the significant negative effect on observed hygiene (column 7) offers some assurance that the results on the other intermediate outcomes are not solely the result of reporting biases. Together, these results highlight a likely channel through which leaders' exposure can negatively influence parenting practices and contribute to negative impacts on ECD outcomes. Table 7 (panel B) reports results on the same outcomes by the caregivers' education level but shows no clear pattern of heterogeneity.[28]

Table A28 shows that we do not observe any significant negative effect of text messages in villages when the leaders are not treated. We re-estimated our main ITT specification excluding all villages in which a leader was treated, i.e. restricting the sample to villages where leaders did not receive text messages. The estimated impacts of the text message intervention are small and statistically indistinguishable from zero across all caregiver education groups when leaders are not treated. These results suggest that the finding of negative impacts of the text messages on the lowest education households are driven by leader interactions in villages randomly exposed to the leader treatment.

Finally, the evidence on spillovers of leaders naturally raise the possibility that there are also spillovers between non-leader households. A priori, those could be positive or

[28]Tables A24 and A25 show no clear differences in impacts on cognitive or intermediate outcomes depending on whether female caregivers, male caregivers, or both received the text messages in leader households.

negative. Households may have discussed the text messages or how to respond to the quizzes, for instance, and by doing so may have increased learning or, alternatively, confusion. To explore this, we use an approach similar to our analysis of "distance to leaders" above, by considering the share of non-leader treated households within a window of $2, 4, 6$ or 8 neighbors from any given household. We then interact this variable with the treatment to assess whether there are spillovers between non-leader households. Results in Table A29 do not show evidence of such spillovers. Neither the share of treated neighbors, nor the interaction between the treatment and the share of treated neighbors are statistically significant in any of the specifications. This suggests that the diffusion of information between neighbors did not generate detectable spillovers on children's outcomes. This could be either because interactions about the text messages between households was limited, or because any possible positive and negative learning spillovers offset each other.

5 Mechanisms

The negative effect of opinion leaders' exposure to the text message intervention on young children's development outcomes and (some) parental practices goes against the initial hypothesis motivating this experimental variation. The experimental design does not allow to causally identify a specific underlying mechanism. Still, given its potential relevance for the design of similar information interventions, we attempt to further unpack this result, acknowledging that the analysis is more speculative in nature. This section considers a number of possible explanations: confusion, competition, boycott and crowding out.

5.1 Confusion

Because the experimental design includes age-specific messages and randomized content variations, households within each village receive various types of text messages. Leaders also receive different text messages than many of the other parents close to them.[29] To the extent that opinion leaders engage with households in their villages based on the messages they receive, this could have caused confusion, especially among the least educated parents. We investigate this hypothesis by analyzing whether ECD outcomes improve when parents and the closest leader receive the same message (compared to those who receive a different message). The point estimate of the difference between those two groups is very small, -0.00 (s.e. 0.09), hence providing no evidence in support of the confusion hypothesis. Note, however, that given the large number of potential combinations of text messages between leader and non-leader households, there are relatively few pairs of leader and non-leader households who receive the same text message (80 of a total 1,004 pairs), so that the comparison may be underpowered. Even so, the precisely

[29]For instance, on a given day, an opinion leader may receive a text message about nutrition of her 12 month old child, while a household in her proximity receives a message on stimulation of her 4 year old child.

estimated zero suggests that confusion is unlikely to be a major driver of the negative leader results.[30]

5.2 Competition

Another possibility is that the intervention triggers competitive dynamics. Leaders receiving text messages could favor advancing children within their close social networks, including their own children, at the expense of others. For instance, they could reallocate resources (such as time) to some children at the cost of others or of their broader responsibilities in the community. Recall, however, that negative effects are stronger for children living close to leaders, which would seem to go against leaders favoring children in their social network. To further analyze whether competitive motives contribute to the observed negative effects, we analyze treatment effects on leaders' own children.[31] Table A30 shows that there is no significant treatment effect on leaders' children. Changes in intermediate outcomes are not significantly different between leader and non-leader households either (Table A31).[32] Overall, changes in behavior appear more limited for leaders, possibly because leaders engage more in some of the practices irrespective of the intervention. While these results are an imperfect test of the competition hypothesis, the lack of impact on leaders' practices and their children's outcomes suggests that leaders exposed to text messages do not increase investments in their own children. This makes it unlikely that the negative effect on non-leaders' children resulted from a deliberate effort by leaders to favor their own children.

5.3 Boycott

A third potential explanation for the negative leader effect is that opinion leaders have strong prior beliefs about parenting practices, and may tell people not to believe messages that go against their own beliefs or otherwise spread misinformation. Qualitative interviews indeed suggested that some text messages promoted practices diverging from traditional beliefs.[33] Further quantitative analyses provides mixed evidence on this mechanism, however.

First, we do not see that leaders directly discourage engagement with the program.[34] Second, to test the potential role of leaders' beliefs more directly, we use leaders' answers to a set of five baseline questions about caregivers' beliefs regarding early childhood de-

[30] Also recall that the negative leader effect is observed for children from households that do not receive text messages.

[31] In absence of the intervention, leaders' children have better ECD outcomes (Table A30). This is in line with the higher education levels and general status of opinion leaders in the communities.

[32] Proteins are an exception, with a negative and significant interaction between the treatment and leaders.

[33] For example, several households said they had learned they could give eggs to small children, while before they thought this would hurt them. Other examples include parents stopping to give coffee to kids, abandoning harsh disciplining practices, or letting girls play with toys traditionally considered to be for boys.

[34] Figure A4 shows that participation in the weekly quizzes is in fact slightly higher in villages with treated leaders than villages without treated leaders.

velopment, in particular on stimulation and the home environment.[35] The answers show that half the leaders disagree with 2 or more of the 5 messages about attitudes toward early childhood development. Tables A32 and A33 test for heterogeneity in the leader effect based on the baseline attitudes toward ECD of the closest leader. The results do not provide evidence that treatment effects are significantly larger when households are exposed to "agreeing" leaders who have prior opinions more aligned with the text messages and may be less likely to spread misinformation.[36]

Third, we explore whether the negative opinion leader effect varies by leaders' commitment or engagement with the text message intervention. We use the frequency of leaders' participation in the quizzes as a proxy for leaders' interest in the text message intervention.[37] As we do not have such a proxy for leaders in the control group, we predict the frequency of quiz participation for leaders randomly assigned to treatment, using Lasso to select baseline observables.[38] We obtain a relatively precise prediction (with a R^2 of 0.65) and define "committed" leaders as those who are predicted to be in the top 20% of quiz participation. This threshold corresponds to leaders participating approximately half of the time. We can then analyze whether the leader effect differs depending on the predicted commitment of the closest leader to each non-leader household.[39]

Table A34 shows that negative leader effects in columns 1 and 3 are somewhat attenuated for children from households in proximity of committed leaders. Although the interaction term is not significant, the overall leader effect on ECD outcomes for those children is not significantly different from zero (bottom row of the table). This pattern is confirmed in Table A35, which shows the same specification for the intermediate outcomes. There is no significant leader effects for households in proximity of committed leaders for 6 of the 7 outcomes (the micro-nutrient index being an exception). Moreover the point estimates indicate that the leader effects for households whose closest leader is predicted to be committed to the program are positive for stimulation, health, and attitudes, though none of these effects are significant.[40] While a high predicted program participation may be capturing many different characteristics of the leaders (and those living in their proximity), this heterogeneity analysis provides suggestive evidence that the negative effects of opinion leaders are driven by leaders that were less likely to actively engage with the

[35]The baseline questions about beliefs are similar to those used at follow-up to capture attitudes toward early childhood development.

[36]The interaction term indicates whether the leader effect is different for households living close to leaders whose prior opinions were largely in line with the stimulation and home environment text messages (i.e. they agreed with 4 out of 5 promoted messages, and we hence label them as being "agreeing" leaders). With the exception of the intermediary outcome on micro-nutrients, interaction effects are not significant. For the early childhood development outcomes, they go in the direction of the boycott hypothesis for the younger children, but not for the older ones. Unfortunately, there are no baseline measures of leaders' beliefs about nutrition and health practices, which are the risk factors where the negative leader effects appear to be the strongest (in Table 7).

[37]By this measure, opinion leaders do not appear to be more (or less) committed to the intervention than other households: there is no significant difference in the number of quizzes that leader households responded to (22 quizzes) compared to households without leaders (21 quizzes).

[38]See appendix A1.4 for details, including a list of covariates used in the prediction model.

[39]We consider heterogeneity based on the closest leader as the prediction is done for each leader separately (and hence varies within a community). The closest leader is defined as in section 4.2.

[40]Appendix Table A36 and A37 show results for each quintile of predicted participation.

program. This result could be seen as consistent with the boycott hypothesis. It is also consistent with a de-legitimization or demotivation inducing a crowding-out of interaction with leaders, a mechanism we consider in more detail next.

5.4 Crowding Out

A fourth potential mechanism is that the text message intervention crowds out local leaders. On the one hand, the text message intervention may be perceived by local opinion leaders as demotivating or de-legitimizing because it directly interferes with their sphere of influence. If this reduces interactions between parents and local opinion leaders, parents may miss out on personal advice tailored to the specific needs of their children. This may contribute to the negative effects observed in Table 5, and is possibly more important for less educated parents, for whom the text messages themselves were less useful. By demotivating providers, the text messages may also lower the quality of education or basic health services in the community. Opinion leaders might feel burdened by the volume of messages, or perceive the intervention as an additional workload, which could further contribute to their disengagement. On the other hand, the direct provision of information to parents may decrease the need for parents to seek guidance from local leaders through direct interactions with them.

Table 8 shows that leaders' randomized exposure to text messages significantly reduces the interactions about ECD practices that parents report having with the different opinion leaders. Importantly, there is no effect of direct exposure to the text messages on reported interactions between caregivers and leaders. This indicates that caregivers themselves did not decrease their consultations with local leaders as a response to receiving parenting information through text messages. Instead, results suggest that certain leaders, when they receive the text messages, reduced interactions about ECD with parents. This may occur because leaders learn that what they previously told parents is not consistent with the content of the government-endorsed text messages. Or alternatively they may feel there is no longer a need for them to talk about certain issues as parents now have access to the relevant content from the text messages. We cannot disentangle these closely related reasons other than possibly distinguishing between the type of leaders (columns 2 to 7). The negative effects are significant for primary school teachers, other educators and community leaders. This is broadly consistent with the results indicating that the negative leader effects is also observed for the most educated leaders, who may be expected to be more familiar with the government curriculum. Table A38 further shows that these results are not driven by a more general reduction in social interactions in the village, as there is no significant reduction in social interactions about ECD practices with family or neighbors, and possibly even a slight increase in interactions with religious leaders.[41]

[41] Tables A26 and A27 further test whether the negative leader effects on cognitive outcomes are stronger for households who had more social interactions about parenting practices at baseline. At baseline, households were asked whether they had talked to different types of members in the community in the last 7 days about ECD practices. We measured in particular whether anybody in the household had any interaction about ECD practices with the health promoter, pre-school teacher, primary school teacher, other teachers, family members, neighbors, or elected leaders in the village. About half of the households had talked to at

While the data do not allow us to analyze local service delivery or the nature of interactions between leaders and parents in more detail, overall these results suggest that opinion leaders' exposure to the text messages leads to a crowding out of their direct interactions with parents of young children in the community. The evidence in particular points to the decrease of interaction originating from leaders rather than caregivers.

6 Discussion and Conclusion

A large number of children in developing countries suffer from cognitive delays, which start at a very young age and affect their lifelong prospects. Experimental evidence has shown that interventions aiming to improve parental investments and practices can positively impact cognitive and socio-emotional development in early childhood. Growing evidence has also demonstrated that early investments can lead to longer-term gains in education, earnings and social outcomes. In light of this evidence, there is growing interest in low-cost interventions to improve parenting practices. Text message interventions offer an alternative to more intensive approaches such as home visiting programs, especially in contexts when personal interactions are not possible due to limited accessibility or social distancing requirements, as was the case during the COVID pandemic. Together with other recent work, this paper shows, however, that they can have important limitations.

We present results from the RCT of an incentivized intervention sending daily text messages on parenting practices to caregivers in poor households in rural Nicaragua. The program enhanced knowledge and improved reported parental practices associated to nutrition and stimulation. However, no improvements were found on children's cognitive or socio-emotional outcomes. These results highlight the importance of going beyond measuring (self-reported) behaviors and to directly assess children's outcomes. The findings contrast with those from more intensive interventions improving parental investment and early child development in Nicaragua and elsewhere in the developing world.

The second main result of this paper is that opinion leaders' randomized exposure to the text messages led to a significant decline in cognitive outcomes among children from non-leader households. These spillover effects are stronger for children of the least educated parents, and for those living closest to the local opinion leaders. We explore potential mechanisms that may explain this negative effect. Leaders' exposure to text messages led to a decrease in interactions about ECD practices between leaders and parents, suggesting a crowding out effect. Possibly the text messages led to demotivation or de-legitimization of local opinion leaders, with a reduction of their efforts in the provision of ECD information or services.

The results in this paper contrast with those of a CCT program in a nearby region of Nicaragua in two dimensions. First, while both interventions led to significant changes in reported parenting practices, the text messages did not result in improvements in ECD outcomes, while the CCT program did (Macours et al., 2012). Possibly the changes in

least one other community member about ECD practices. Results in Tables A26 and A27 show that there is no clear heterogeneity by this indicator of baseline social interactions.

knowledge and practices resulting from the text messages (3-4 times smaller than those obtained with the CCT) were simply too small to translate into changes in final ECD outcomes. Second, Macours and Vakis (2014, 2017) show that the CCT impacts were in part induced by an increase in social interactions with local leaders, while this paper shows negative spillovers and a potential crowding-out of local leaders. While the CCT program gave local leaders an explicit recognized role in the information dissemination and mobilization around the intervention, there was no active role for local leaders in the text message intervention, which can help explain these contrasting findings. Indeed, this suggests that the possibility of negative spillovers through opinion leaders may be mitigated when leaders are formally integrated into the design and delivery of the intervention. More generally, the contrasting results also point to a need to better understand how to leverage social interactions to enhance positive behavioral change.

The results are based on short-term outcomes measured approximately 9 months since the beginning of the text message campaign. This is a similar time frame for which impacts of the CCT on ECD outcomes were observed in the nearby region in earlier work. Given that the text message intervention mostly address information constrains and can be considered lower intensity, it is possible that a much longer exposure could lead to different results. As such, the relatively short time frame of this study implies an important caveat. Even so, as engagement with the text messages decreases over time, and given the overall direction of the results, the 9-month results are informative. Similarly, we cannot exclude that the negative spillovers from leaders would evolve and dissipate over time.

Importantly, the results are obtained in a context where cell phone coverage and access to electricity was far from universal, where low levels of education may have limited some parents' ability to fully internalize the text messages and where few households were reached by a government-led ECD program. These contextual factors can help explain the lack of more positive results, and are worth considering when contemplating the external validity of our findings. For instance, contexts where cell phone and network coverage are near universal may make it easier to deliver text message interventions. Yet the information or attention paid by targeted populations to those text messages might also be diluted, making it unclear whether results would be expected to be stronger. We also note that lack of electricity, limited cell phone ownership, low coverage of ECD programs, and low literacy are still common in a number of low- and low-middle income countries.

Overall, the lack of impacts of text messages to parents on ECD outcomes and the negative effects of leaders' exposure to the text messages call for caution before advocating for the large-scale roll-out of text message parenting interventions in high-poverty settings with low levels of education. Such interventions may need to be complemented with personal interactions and other types of ECD programs. And they may need to explicitly incorporate strategies to crowd-in efforts by local opinion leaders, for instance by empowering them with a specific role during implementation. Beyond ECD, and given the large policy interest in using text messages and broader information technology to reach poor rural households in remote settings for various objectives ranging from agricultural extension to foundational skill learning, the findings in this paper thus point to open questions for program design as well as future research.

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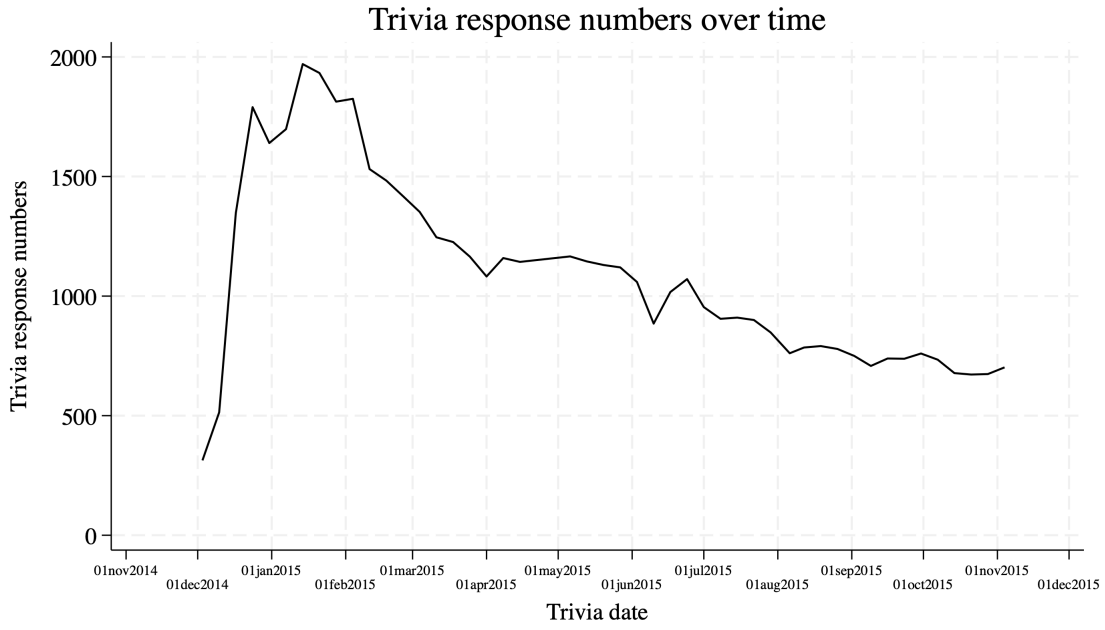
7 Figures and Tables

FIGURE 1: Number of treated individuals participating in weekly quizzes over time



Note: Data from weekly responses to quizzes as received from the text messaging platform provider. To enhance readability, the graph was smoothed for the last two weeks of April, when there was a large temporary drop in data received, likely due to problems with cellphone coverage because of cell phone tower signal issues or weather conditions.

TABLE 1: Baseline balance: text message treatment and control households

	N	Control	Treatment	P-values with **stratification** (T - C)	P-Values **Unconditional** (T - C)
Child-specific characteristics					
Age at baseline	2,899	2.44	2.52	0.336	0.273
Mother lived in household at baseline	2,899	0.96	0.96	0.858	0.963
Father lived in household at baseline	2,899	0.77	0.75	0.248	0.205
Mother's years of education	2,897	6.15	5.97	0.662	0.274
Father's years of education	2,747	5.33	5.15	0.336	0.307
Mother with no education	2,897	0.13	0.11	0.017	0.099
Father with no education	2,747	0.17	0.15	0.110	0.174
Mother with primary education at most	2,897	0.63	0.66	0.226	0.186
Father with primary education at most	2,747	0.72	0.74	0.278	0.269
Mother can read and write	2,899	0.86	0.87	0.101	0.313
Father can read and write	2,899	0.81	0.83	0.143	0.238
Education of text message recipient caregiver					
Female caregiver's years of education	2,892	6.07	5.87	0.510	0.209
Male caregiver's years of education	2,620	4.48	4.34	0.376	0.370
Female caregiver with no education	2,892	0.13	0.11	0.058	0.224
Male caregiver with no education	2,620	0.20	0.19	0.288	0.351
Female caregiver with primary education at most	2,892	0.64	0.66	.	0.264
Male caregiver with primary education at most	2,620	0.79	0.81	0.325	0.334
Female caregiver can read and write	2,894	0.86	0.87	0.357	0.683
Male caregiver can read and write	2,632	0.78	0.79	0.280	0.353
Health and Nutrition					
# Days sick (in bed) in last month	2,899	0.18	0.21	0.613	0.608
Received deworming in last 6 months	2,899	0.41	0.40	0.720	0.762
Received vitamins in last 6 months	2,899	0.40	0.39	0.439	0.429
# Days child had vegetables (last week)	2,898	1.74	1.86	0.123	0.174
# Days child had fruit (last week)	2,898	2.89	3.00	0.246	0.328
# Days child had meat (last week)	2,898	1.22	1.20	0.699	0.705
# Days child had eggs (last week)	2,897	2.72	2.67	0.638	0.638
# Days child had breast milk (last week)	2,897	2.34	2.27	0.771	0.638
# Days child had coffee (last week)	2,897	4.38	4.18	0.118	0.159
# Days child had soup (last week)	2,898	0.52	0.60	0.199	0.156
# Days someone read to child (last week)	2,898	0.76	0.68	0.386	0.251
Someone read to child (last month)	2,898	0.22	0.22	0.697	0.892
Household-level characteristics					
Male household head	3,012	0.86	0.86	0.515	0.994
Household head's age	3,012	41.36	41.50	0.404	0.823
Household head can read and write	3,012	0.74	0.74	0.763	0.898
Number of men in household	3,012	1.57	1.57	0.560	0.941
Number of women in household	3,012	1.63	1.61	0.741	0.509
Number of boys (age 7-15) in household	3,012	0.57	0.52	0.166	0.167
Number of girls (age 7-15) in household	3,012	0.48	0.48	0.872	0.953
Number of young boys (age 0-6) in household	3,012	0.65	0.63	0.174	0.604
Number of young girls (age 0-6) in household	3,012	0.59	0.57	0.634	0.513
Number of rooms in house	3,011	1.90	1.83	0.085	0.059
Network					
Distance (in min) to closest cellphone signal	3,004	30.96	29.44	0.637	0.483
Distance (meters) to closest cellphone signal	2,814	2,040.72	1,906.83	0.815	0.441

Note: Baseline survey characteristics of all children and households (including households with pregnant women). Children born after the baseline are not included. P-values for test of difference between control and treatment, after controlling for stratification variables (column before last), or without any controls (i.e. unconditional, last column). The conditional p-value for "Female caregiver with primary education at most" is omitted because this variable is perfectly collinear with a stratification variable. P-values based on standard errors clustered by community.

TABLE 2: Baseline balance for villages with leader treatment and control

	N	Control	Treatment	P-Values (T - C)
Village characteristics				
Average number of leaders	92	4.59	4.23	0.557
Average number of households	92	34.81	30.22	0.277
Average age of targeted children	92	2.36	2.41	0.509
% of households with mother present	92	0.94	0.93	0.459
% of households with father present	92	0.74	0.73	0.846
Share of households in the government's ECD program	92	4.78	4.69	0.952
Share of households with access to electricity	92	19.41	15.69	0.457
Average years of education Mother	92	5.75	5.53	0.566
Average years of education Father	92	4.91	4.41	0.165

Note: Treated villages were randomly assigned to have leader sent text messages, whereas leaders in control villages were assigned not to receive text messages. Villages without leaders are excluded from this table.

TABLE 3: Impact of text messages on Early Childhood Development

	(1) ECD full sample	(2) ECD young	(3) ECD old
Panel A: Text messages sent			
Text	0.00	-0.01	0.00
	(0.03)	(0.06)	(0.04)
Panel B: Heterogeneity by caregiver education			
Text	-0.12**	-0.24*	-0.07
	(0.06)	(0.13)	(0.07)
Text X Medium educ (4-6 years of education)	0.17**	0.18	0.13
	(0.08)	(0.16)	(0.09)
Text X High educ (more than primary education)	0.18**	0.41***	0.04
	(0.08)	(0.15)	(0.09)
Observations	2485	774	1711
P-values (joint significance test)			
Text + Text X Medium educ = 0	0.35	0.48	0.22
Text + Text X High educ = 0	0.27	0.07	0.74

Note: All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old, and the first principal component of all 7 tests for children 36-84 months old. In column 2, the dependent variable is the principal component for the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, and a dummy variable for a set of households surveyed in 2016, as well as village fixed effects. Standard errors reported in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE 4: Impact of text messages on intermediate outcomes

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Panel A. Text messages sent							
Text	0.06	0.16***	0.07*	0.08*	0.06	0.11**	0.09**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Panel B. Heterogeneity by caregiver education							
Text	0.02	0.11	-0.01	0.06	0.03	0.06	-0.01
	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.08)	(0.08)
Text × Medium education	0.07	0.14	0.12	-0.00	0.05	0.11	0.17*
	(0.10)	(0.10)	(0.10)	(0.11)	(0.09)	(0.11)	(0.10)
Text × High education	0.05	-0.02	0.12	0.05	0.03	0.03	0.10
	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)	(0.11)	(0.10)
Observations	2500	2501	2512	2495	2501	2396	2506
P-values: joint significance tests							
Text + Text × Medium education = 0	0.17	0.00	0.11	0.34	0.17	0.02	0.01
Text + Text × High education = 0	0.32	0.21	0.11	0.12	0.37	0.24	0.18

Notes: All outcome variables are standardized using the mean and standard deviation of control households. The first six columns show estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. Impacts on each of the individual items used to construct the indices are reported in Tables A16, A17, and A18. All regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variable for the set of households surveyed in 2016, and village fixed effects. Sample restricted to children under 84 months. Panel B interacts the treatment with caregiver education categories: *Medium education* denotes 4–6 years of schooling (completed primary); *High education* denotes more than primary schooling; the omitted category is less than 4 years of schooling. Standard errors reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE 5: Impact of leaders' exposure to text messages on Early Childhood Development

	(1) ECD full sample	(2) ECD young	(3) ECD old
Panel A: Leader exposure to text messages			
Leader	-0.11***	-0.02	-0.14***
	(0.04)	(0.05)	(0.05)
Panel B: Heterogeneity by caregiver education			
Leader	-0.20***	-0.22*	-0.18***
	(0.06)	(0.12)	(0.07)
Leader X Medium educ (4-6 years of education)	0.17**	0.34**	0.09
	(0.07)	(0.16)	(0.08)
Leader X High educ (more than primary education)	0.07	0.17	0.01
	(0.07)	(0.14)	(0.10)
Observations	2051	624	1427
P-values (joint significance test)			
Leader + Leader X Medium educ = 0	0,58	0,20	0,13
Leader + Leader X High educ = 0	0,03	0,49	0,05

Note: The sample includes only non-leader households in 92 villages with opinion leaders. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), as well as the level of education of the main caregiver, whether there is a male caregiver in the household, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE 6: Impact of leaders' exposure to text messages, by distance to closest leader's dwelling

	(1) ECD full sample	(2) ECD young	(3) ECD old
Panel A: Leader exposure interacted with distance from closest leader			
Leader	-0.167***	-0.125*	-0.193***
	(0.05)	(0.07)	(0.07)
Distance from closest leader	-0.009***	-0.017***	-0.006
	(0.00)	(0.00)	(0.00)
Leader X distance from closest leader	0.012***	0.022***	0.009
	(0.00)	(0.01)	(0.01)
Panel B: Leader exposure interacted with household treatment status			
Text	-0.046	0.036	-0.112*
	(0.06)	(0.13)	(0.06)
Leader	-0.151**	0.029	-0.251***
	(0.06)	(0.13)	(0.07)
Text X Leader	0.060	-0.071	0.150*
	(0.07)	(0.15)	(0.08)
Observations	2051	624	1427
P-values (joint significance test)			
Leader + Text X Leader	0,04	0,51	0,07

Note: The distance from closest leader is measured by the number of houses between the household and the closest household with an opinion leader. The sample includes only non-leader households in the 92 villages with opinion leaders. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE 7: Impact of leaders' exposure to text messages on intermediate outcomes

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Panel A: Leader exposure to text messages							
Leader	-0,14*	0,02	-0,00	-0,16**	-0,23**	-0,00	-0,11*
	(0,08)	(0,06)	(0,04)	(0,06)	(0,09)	(0,06)	(0,06)
Panel B: Heterogeneity by caregiver education							
Leader	-0,01	0,10	-0,01	-0,23***	-0,18*	0,00	-0,08
	(0,12)	(0,11)	(0,07)	(0,09)	(0,09)	(0,10)	(0,09)
Leader X Medium educ (4-6 years of education)	-0,04	-0,04	-0,01	0,08	0,03	0,04	-0,05
	(0,10)	(0,12)	(0,08)	(0,09)	(0,09)	(0,11)	(0,10)
Leader X High educ (more than primary education)	-0,34***	-0,21	0,04	0,10	-0,20	-0,06	-0,04
	(0,13)	(0,13)	(0,10)	(0,10)	(0,12)	(0,13)	(0,10)
Observations	2062	2062	2073	2059	2062	1970	2068
P-values (Joint significance test)							
Leader + Leader X Medium Educ	0,58	0,46	0,66	0,08	0,12	0,61	0,16
Leader + Leader X High Educ	0,00	0,12	0,67	0,16	0,01	0,60	0,13

Note: The sample includes only non-leader households in the 92 villages with opinion leaders. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of the control household. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE 8: Impacts on social interactions about ECD with targeted leaders

	(1) # leaders	(2) Health promotor	(3) Pre-sch Teacher	(4) Primary Teacher	(5) Other Educator	(6) Local leader	(7) Other com. leader
Text	-0.01	0.02	-0.04	-0.01	-0.01	0.01	0.00
	(0.05)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Leader	-0.18**	-0.03	-0.03	-0.07***	-0.02**	-0.02	-0.02**
	(0.07)	(0.03)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)
Observations	2073	2073	2073	2073	2073	2073	2073
Mean Control	0.89	0.13	0.33	0.24	0.05	0.10	0.03

Note: The dependent variables captures social interactions between the household and targeted opinion leaders during the previous week. Column 1 is an index accounting for the number of social interaction between the household and health promoters, preschool-teachers, primary school teachers, other teachers, the local leader or other community leader. The dependent variables in the remaining columns are binary and indicate whether the household had at least one interactions with each type of leader during the previous week. All regressions include controls for the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects, and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

A1 Online Appendix

A1.1 Supplementary figures

FIGURE A1: Household-level randomization

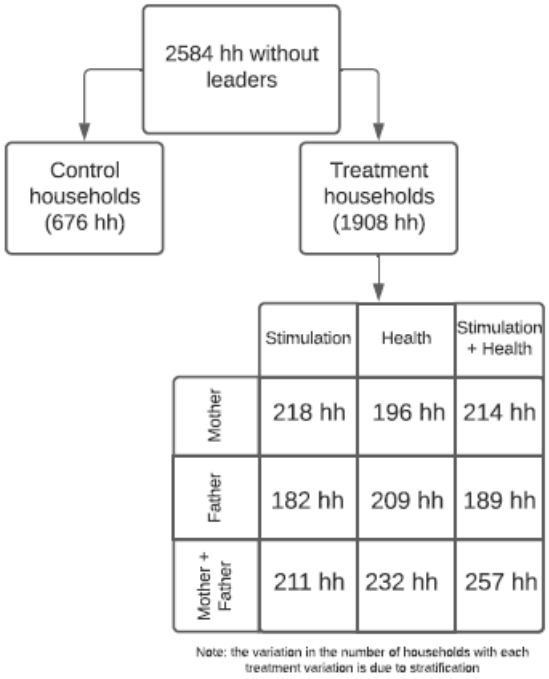


FIGURE A2: Village-level randomization

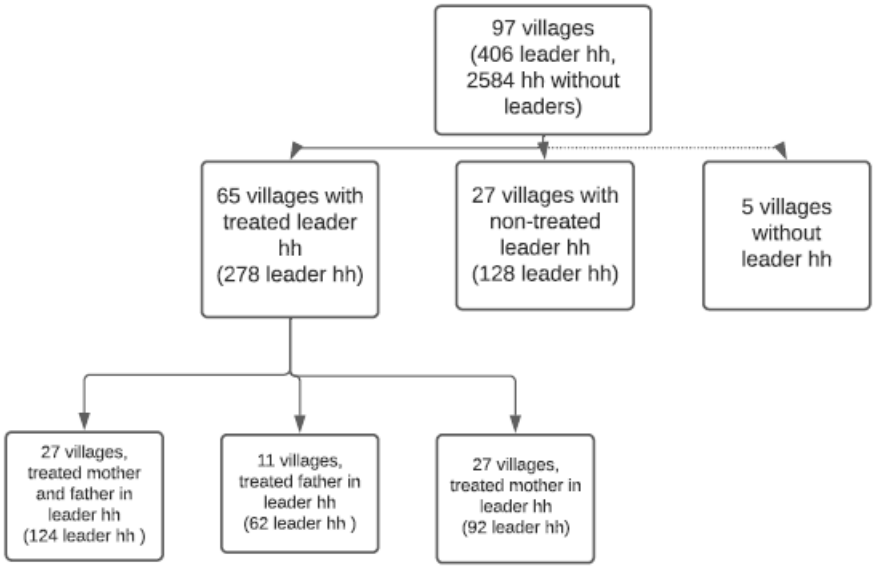
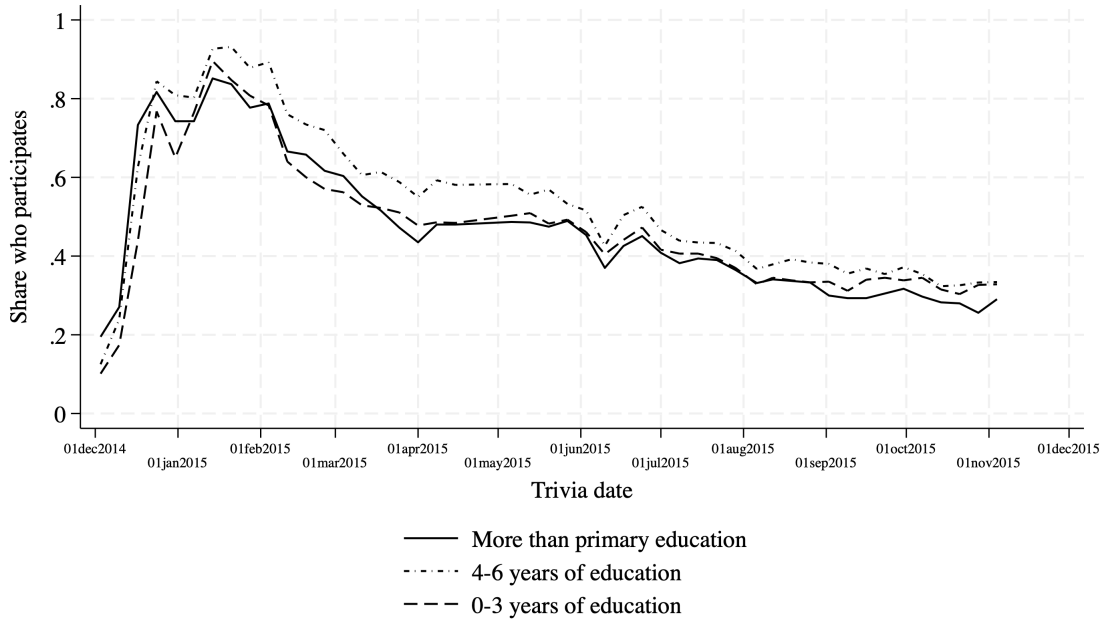
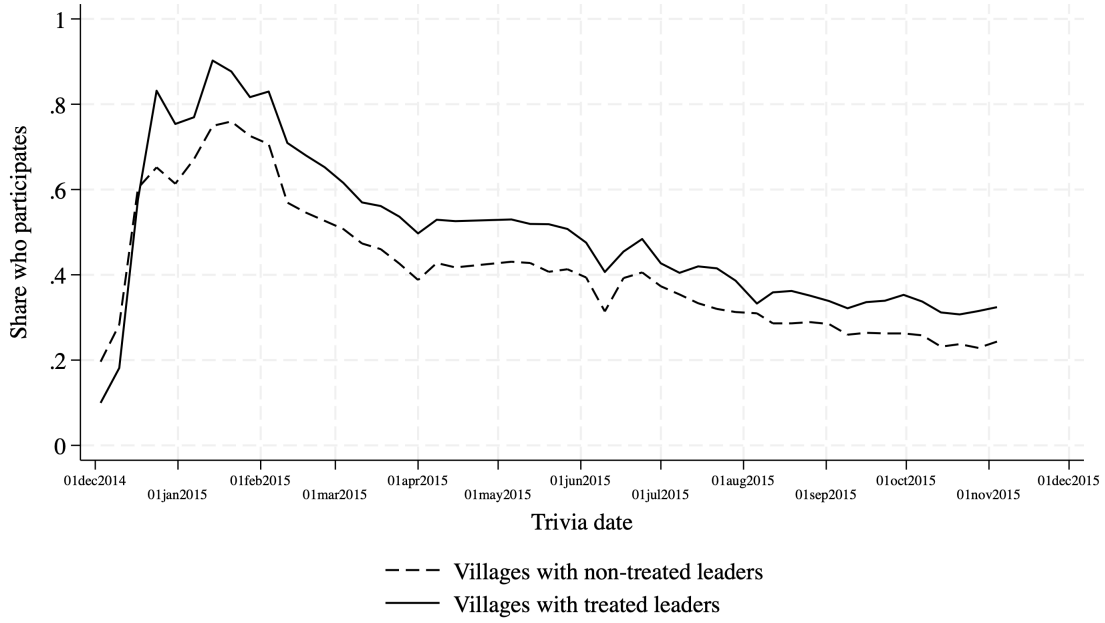


FIGURE A3: Quiz participation by caregiver education level



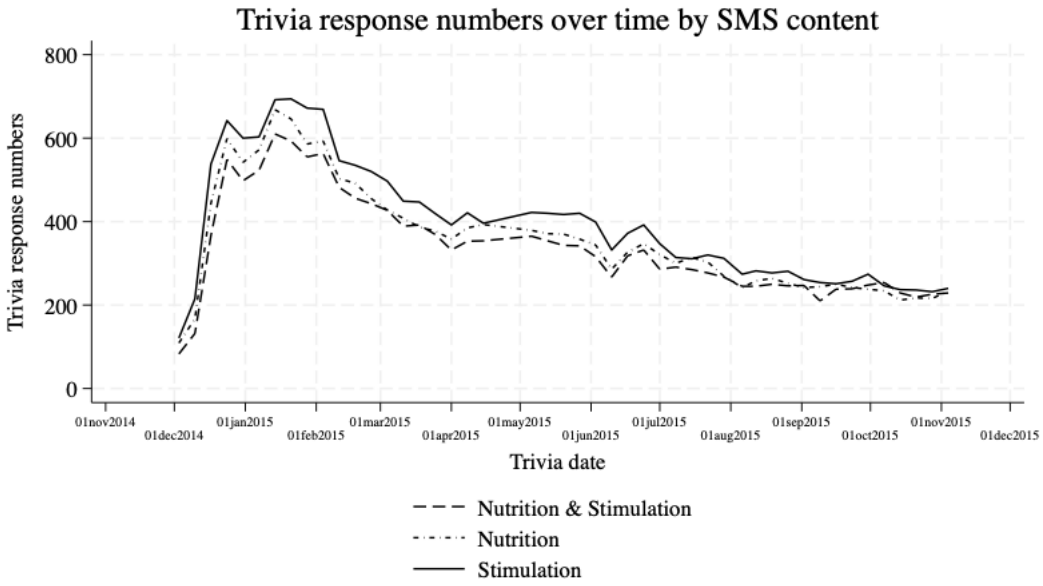
Note: Data from weekly responses to quizzes as received from the text messaging platform provider. As in Figure 1, the graph was smoothed for the last two weeks of April to enhance readability.

FIGURE A4: Quiz participation for villages with or without treated leaders



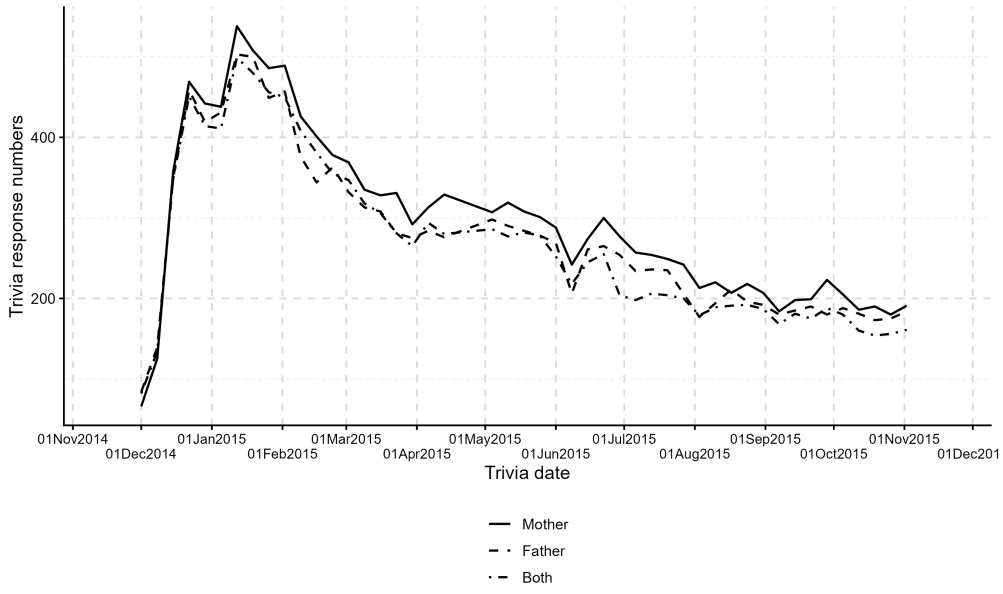
Note: Data from weekly responses to quizzes as received from the text messaging platform provider. As in Figure 1, the graph was smoothed for the last two weeks of April to enhance readability. This Figure includes the 92 villages with leaders.

FIGURE A5: Quiz participation by content of messages



Note: Data from weekly responses to quizzes as received from the text messaging platform provider. Lines show weekly counts of quiz responses for treated households by randomized content of the messages - Nutrition, Stimulation and the combination of both. As in Figure 1, the graph was smoothed for the last two weeks of April to enhance readability.

FIGURE A6: Quiz participation by text message target recipient



Note: Data from weekly responses to quizzes received from the text-messaging platform provider. Lines show weekly counts of quiz responses for treated households for whom the target recipient was a female caregiver (mother), male caregiver(father), or both. As in Figure 1, the graph was smoothed for the last two weeks of April to enhance readability.

A1.2 Supplementary tables

TABLE A1: Example of text messages, by content, for children 7-12 months old

Content	Message
Nutrition and Health	Take NAME to her check-ups every two months on time
	After 6 months, start feeding NAME little by little
	Vaccine NAME against dangerous diseases so that she grows healthy
	Give NAME mashed vegetables after 6 months
	Bathe NAME daily. Keep him / her clean so he/she doesn't get sick
	Breastfeed NAME in addition to giving her other foods until she is at least 2 years old
	Take care of NAME if she has a cough. A cough that lasts is dangerous
	Give NAME mashed vegetables (pipian, chayote, carrot, squash,...)
	Teach NAME to brush her teeth so they are always clean and healthy
	Give NAME vegetables, they have a lot of vitamins and are nutritious
	Put slippers or shoes on NAME so worms don't bother her
	Give NAME fruits in small pieces to help him grow healthy
	Wash NAME's hands often so she doesn't get sick
	Protect NAME from malaria and dengue by sleeping under a mosquito net
	Give NAME a well cut or cooked tomato, it is good for her to grow well
	Let your house be fumigated so there are no mosquitoes
	After 6 months, give NAME mashed fruits, papaya and mango
	Don't cook with wood near NAME. The smoke makes the lungs sick
	Do not give NAME candy and chips, they are junk food that does not feed him
	Keep NAME clean so she doesn't get sick
	Wash NAME's clothes well so that he is clean and healthy
	Don't give NAME soda or packaged juices, they are not good for her
	After 6 months, you can already give NAME beans
	Wash NAME's hands several times a day
	Give NAME your milk and about 12 tablespoons of mashed food 3 to 4 times a day
	Don't smoke near NAME, it hurts her
	Feed NAME vegetables and leafy greens: they are very nutritious
	Protect NAME from flies, they transmit diseases
	Feed NAME cabbage, spinach and lettuce, they have iron and they are good
	After 6 months, give NAME other mashed foods
Stimulation and Home Environment	Speak with affection to NAME
	Give NAME hugs, children need a lot of affection
	Put NAME with his hands together and play with him to try to separate them
	Do not mistreat NAME so that he can love you and grow up healthy and happy
	Read stories to NAME
	Don't yell at NAME, the screams hurt
	Make simple toys for NAME to push or drag using what you have at home
	After 11 months, help NAME to start walking
	Do not compare NAME with other children. All children are different
	Take NAME for a walk and lovingly show him different things
	Do not say ugly names or curse NAME. That hurts more than a blow
	Tell stories to NAME
	While you work around the house put NAME in a safe place
	Make toys for NAME. A tin with stones inside is good for playing
	Make NAME her little corner in the house so she has her toys in order
	Let NAME touch, hear and observe different things and situations
	Curiosity is good for learning and developing
	Keep a place in the house clear of furniture so that NAME can crawl and walk
	Make NAME listen to different sounds and tell him where each sound comes from
	Smile at NAME, this way she will be happier
	Caress NAME, touch her arms, head and legs gently, massage her back so that she feels loved
	Give NAME tenderness so that he grows up feeling safe
	Take NAME to see the sun when it rises or sets. Explain what the sun is for
	Please bear with NAME when she cries. Remember that he can't say what he wants
	Make NAME touch different things to make him feel how they are
	Explain to NAME what the things he touches are for. It educates him
	Don't let animals stay where NAME plays so she doesn't get sick
	Keep the places where NAME spends the most time clean
	Make simple toys for NAME with whatever you have on hand

Note: Translated from Spanish.

TABLE A2: Principal component analysis: ECD (cognitive) outcomes

	(1) Variance	(2) Proportion	(3) Factor loadings
Denver subcomponents (used for children 1-3 years old)	1.390	0.3476	
Personal - Social			0.386
Language			0.651
Fine Motor			0.675
Gross Motor			0.601
All tests together (used for children 3-7 years old)	2.268	0.324	
Denver Personal - Social			0.055
Denver Language			0.745
Denver Fine Motor			0.595
Denver Gross Motor			0.487
Vocabulary (TVIP)			0.754
Memory			0.735
Self-control			0.100

Note: Column 1 reports the eigenvalue of the first principal component. Column 2 reports the proportion of variance accounted for by the first principal component. Column 3 reports the principal component factor loadings, which show the correlation between the variables and the first principal component.

TABLE A3: Principal component analysis: socio-emotional outcomes

	(1) Variance	(2) Proportion	(3) Factor loadings
Behavioral (used for children 1-3 years old)	1.320	0.440	
Control			0.505
Affect			0.761
Ability			0.697
Strengths and Difficulties (used for children 3-7 years old)	1.718	0.245	
Emotional			0.688
Conduct			0.783
Hyperactivity			0.120
Peer			0.733
Pro-social			-0.077
Control			0.262
Laugh			-0.060

Note: Column 1 reports the eigenvalue of the first principal component. Column 2 reports the proportion of variance accounted for by the first principal component. Column 3 reports the principal component factor loadings, which show the correlation between the variables and the first principal component.

TABLE A4: Balancing test across randomized groups – by content variation

	Mean of variable by group				P-value
	Control	Nut-Stim	Nutrition	Stim	Joint F test Equality of Means
	(1)	(2)	(3)	(4)	(5)
Child-specific characteristics					
Age at baseline	2.44	2.51	2.49	2.57	0.613
Father lived in household at baseline	0.77	0.74	0.74	0.77	0.964
Mother lived in household at baseline	0.96	0.96	0.96	0.96	0.734
Mother's years of education	6.16	6.17	5.99	5.77	0.553
Father's years of education	5.36	5.35	5.10	5.06	0.509
Mother with no education	0.13	0.09	0.12	0.11	0.139
Father with no education	0.17	0.15	0.15	0.14	0.366
Mother with primary education at most	0.63	0.65	0.64	0.68	0.238
Father with primary education at most	0.72	0.71	0.75	0.75	0.177
Mother can read and write	0.86	0.89	0.86	0.88	0.066
Father can read and write	0.82	0.83	0.83	0.85	0.213
Education of SMS-recipient caregiver					
Female caregiver's years of education	6.14	6.13	5.93	5.72	0.288
Male caregiver's years of education	4.56	4.51	4.33	4.42	0.582
Female caregiver with no education	0.13	0.10	0.13	0.11	0.061
Male caregiver with no education	0.20	0.18	0.20	0.17	0.208
Female caregiver with primary education at most	0.64	0.64	0.64	0.68	.
Male caregiver with primary education at most	0.78	0.78	0.81	0.80	0.431
Female caregiver can read and write	0.87	0.88	0.86	0.88	0.059
Male caregiver can read and write	0.78	0.80	0.79	0.81	0.356
Health and Nutrition					
# Days sick (in bed) in last month	0.20	0.26	0.16	0.22	0.278
Received deworming drugs in last 6 months	0.40	0.42	0.39	0.38	0.570
Received vitamins in last 6 months	0.40	0.39	0.38	0.38	0.910
# Days child had vegetables (last week)	1.75	1.91	1.80	1.90	0.538
# Days child had fruit (last week)	2.89	2.95	3.00	3.05	0.771
# Days child had meat (last week)	1.23	1.26	1.20	1.14	0.868
# Days child had eggs (last week)	2.71	2.73	2.67	2.63	0.729
# Days child had breast milk (last week)	2.33	2.26	2.35	2.18	0.493
# Days child had coffee (last week)	4.35	4.05	4.13	4.35	0.334
# Days child had soup (last week)	0.52	0.61	0.60	0.55	0.593
# Days someone read to child (last week)	0.75	0.70	0.62	0.72	0.409
Someone read to child (last month)	0.22	0.22	0.21	0.23	0.636
Household-level characteristics					
Male household head	0.86	0.85	0.86	0.88	0.928
Household head's age	41.21	41.17	41.75	41.15	0.738
Household head can read and write	0.74	0.76	0.72	0.75	0.167
Number of men in household	1.57	1.57	1.58	1.56	0.569
Number of women in household	1.62	1.59	1.65	1.55	0.209
Number of boys (age 7-15) in household	0.56	0.49	0.54	0.53	0.696
Number of girls (age 7-15) in household	0.47	0.46	0.45	0.51	0.389
Number of young boys (age 0-6) in household	0.64	0.62	0.65	0.62	0.753
Number of young girls (age 0-6) in household	0.59	0.57	0.56	0.58	0.679
Number of rooms in house	1.90	1.82	1.81	1.83	0.451
Network					
Distance (in min) to closest cellphone signal	30.88	25.62	31.65	31.00	0.273
Distance (meters) to closest cellphone signal	2,051.92	1,479.26	2,204.95	2,060.38	0.013

Note: Baseline survey characteristics of all baseline children and households (including households with pregnant women). Children born after the baseline are not included. This table reports baseline balance between (1) control and treatment groups randomized to receive messages focused (2) only on nutrition and health, (3) only on stimulation and the home environment, and (4) a combination of both. The first four columns present mean values by group, and column 5 reports the p-value of an F-test for equality of means across groups.

TABLE A5: Balancing test across randomized groups – by target recipient

	Mean of variable by treatment				P-value
	Control	Mother	Father	Both	Joint F test of Equality of Means
	(1)	(2)	(3)	(4)	(5)
Child-specific characteristics					
Age at baseline	2.44	2.61	2.47	2.48	0.179
Father lived in household at baseline	0.77	0.75	0.75	0.76	0.651
Mother lived in household at baseline	0.96	0.96	0.97	0.95	0.036
Mother's years of education	6.16	5.96	5.79	6.18	0.852
Father's years of education	5.36	5.15	4.96	5.41	0.614
Mother with no education	0.13	0.10	0.12	0.10	0.640
Father with no education	0.17	0.13	0.16	0.15	0.361
Mother with primary education at most	0.63	0.66	0.66	0.64	0.994
Father with primary education at most	0.72	0.75	0.77	0.70	0.048
Mother can read and write	0.86	0.88	0.86	0.89	0.915
Father can read and write	0.82	0.84	0.82	0.84	0.720
Education of SMS-recipient caregiver					
Female caregiver's years of education	6.14	5.89	5.79	6.10	0.991
Male caregiver's years of education	4.56	4.49	4.10	4.66	0.056
Female caregiver with no education	0.13	0.10	0.12	0.11	0.603
Male caregiver with no education	0.20	0.17	0.21	0.17	0.207
Female caregiver with primary education at most	0.64	0.67	0.66	0.64	.
Male caregiver with primary education at most	0.78	0.81	0.84	0.76	0.006
Female caregiver can read and write	0.87	0.88	0.86	0.88	0.925
Male caregiver can read and write	0.78	0.80	0.77	0.82	0.376
Health and Nutrition					
# Days sick (in bed) in last month	0.20	0.24	0.20	0.21	0.779
Received deworming drugs in last 6 months	0.40	0.42	0.37	0.39	0.177
Received vitamins in last 6 months	0.40	0.38	0.37	0.40	0.849
# Days child had vegetables (last week)	1.75	1.79	1.78	2.03	0.027
# Days child had fruit (last week)	2.89	2.89	3.01	3.09	0.342
# Days child had meat (last week)	1.23	1.15	1.12	1.33	0.187
# Days child had eggs (last week)	2.71	2.68	2.63	2.73	0.793
# Days child had breast milk (last week)	2.33	2.25	2.24	2.30	0.793
# Days child had coffee (last week)	4.35	4.15	4.24	4.14	0.910
# Days child had soup (last week)	0.52	0.57	0.57	0.63	0.608
# Days someone read to child (last week)	0.75	0.74	0.61	0.69	0.329
Someone read to child (last month)	0.22	0.24	0.20	0.23	0.166
Household-level characteristics					
Male household head	0.86	0.87	0.87	0.86	0.296
Household head's age	41.21	40.77	42.35	41.01	0.173
Household head can read and write	0.74	0.76	0.71	0.76	0.225
Number of men in household	1.57	1.58	1.59	1.54	0.781
Number of women in household	1.62	1.58	1.63	1.59	0.619
Number of boys (age 7-15) in household	0.56	0.56	0.50	0.50	0.238
Number of girls (age 7-15) in household	0.47	0.48	0.50	0.43	0.544
Number of young boys (age 0-6) in household	0.64	0.61	0.65	0.62	0.158
Number of young girls (age 0-6) in household	0.59	0.58	0.55	0.57	0.537
Number of rooms in house	1.90	1.85	1.78	1.84	0.494
Network					
Distance (in min) to closest cellphone signal	30.88	30.75	33.11	24.60	0.372
Distance (meters) to closest cellphone signal	2,051.92	2,202.03	1,904.90	1,634.30	0.078

Note: Baseline survey characteristics of all baseline children and households (including households with pregnant women). Children born after the baseline are not included. This table reports balancing tests across sub-treatment groups defined by the text message target recipient. Among treated households, one-third had text messages targeted to the mother, one-third to the father, and the remaining third to both parents. The first four columns present mean values by randomized groups, and the last columns report the p-value of an F-test for equality of means across groups.

TABLE A6: Baseline characteristics of leaders vs non-leaders

	Leaders	Obs	Non-Leaders	Obs	P-Values Leaders - Non Leaders hh
Child-specific characteristics					
Age at baseline	2.46	389	2.50	2,510	0.103
Mother lived in household at baseline	0.96	389	0.96	2,510	0.967
Father lived in household at baseline	0.68	389	0.77	2,510	0.000
Mother's years of education	8.33	389	5.66	2,508	0.000
Father's years of education	6.67	366	4.97	2,381	0.000
Mother with no education	0.04	389	0.13	2,508	0.000
Father with no education	0.07	366	0.17	2,381	0.000
Mother with primary education at most	0.41	389	0.68	2,508	0.000
Father with primary education at most	0.63	366	0.75	2,381	0.000
Mother can read and write	0.95	389	0.86	2,510	0.000
Father can read and write	0.91	389	0.82	2,510	0.000
Education of SMS-recipient caregiver					
Female caregiver's years of education	8.17	389	5.57	2,503	0.000
Male caregiver's years of education	5.22	348	4.25	2,272	0.000
Female caregiver with no education	0.04	389	0.13	2,503	0.000
Male caregiver with no education	0.11	348	0.20	2,272	0.000
Female caregiver with primary education at most	0.43	389	0.69	2,503	0.000
Male caregiver with primary education at most	0.76	348	0.81	2,272	0.011
Female caregiver can read and write	0.95	389	0.86	2,505	0.000
Male caregiver can read and write	0.88	350	0.78	2,282	0.000
Health and Nutrition					
# Days sick (in bed) in last month	0.21	389	0.20	2,510	0.998
Received deworming in last 6 months	0.42	389	0.40	2,510	0.415
Received vitamins in last 6 months	0.43	389	0.38	2,510	0.014
# Days child had vegetables (last week)	2.16	389	1.78	2,509	0.089
# Days child had fruit (last week)	3.44	389	2.90	2,509	0.003
# Days child had meat (last week)	1.31	389	1.19	2,509	0.011
# Days child had eggs (last week)	2.64	389	2.69	2,508	0.897
# Days child had breast milk (last week)	2.57	389	2.25	2,508	0.076
# Days child had coffee (last week)	3.90	389	4.29	2,508	0.005
# Days child had soup (last week)	0.43	389	0.60	2,509	0.088
# Days someone read to child (last week)	1.14	389	0.63	2,509	0.000
Someone read to child (last month)	0.31	389	0.21	2,509	0.000
Household-level characteristics					
Male household head	0.84	402	0.87	2,610	0.667
Household head's age	46.92	402	40.62	2,610	0.000
Household head can read and write	0.81	402	0.73	2,610	0.001
Number of men in household	1.90	402	1.52	2,610	0.000
Number of women in household	1.99	402	1.56	2,610	0.000
Number of boys (age 7-15) in household	0.60	402	0.53	2,610	0.615
Number of girls (age 7-15) in household	0.47	402	0.48	2,610	0.253
Number of young boys (age 0-6) in household	0.67	402	0.63	2,610	0.186
Number of young girls (age 0-6) in household	0.55	402	0.58	2,610	0.233
Number of rooms in house	2.11	402	1.80	2,609	0.000
Network					
Distance (in min) to closest cellphone signal	38.18	402	28.56	2,602	0.287
Distance (meters) to closest cellphone signal	2,740.79	383	1,817.58	2,431	0.062

Note: Baseline survey characteristics of all baseline children and households (including households with pregnant women). Children born after the baseline are not included. p-values for test of difference between households with at least one member in a leadership position and households without leaders, controlling for commune fixed effects. P-values based on standard errors clustered by community.

TABLE A7: Attrition and treatment (for baseline sample)

	(1) Child	(2) Household	(3) Mother	(4) Father
Panel A : Text messages sent				
Text	0.021	0.013	0.008	0.015
	(0.013)	(0.012)	(0.014)	(0.015)
Observations	2690	2690	2690	2690
Mean control	0.087	0.070	0.116	0.198
Panel B : Leader exposure to text messages				
Leader	-0.003	0.000	-0.009	-0.016
	(0.017)	(0.015)	(0.021)	(0.016)
Observations	2238	2238	2238	2238
Mean control	0.104	0.080	0.125	0.219
Panel C : Text message content variation				
Nutrition & Stimulation	0.014	0.007	-0.006	-0.003
	(0.017)	(0.015)	(0.018)	(0.019)
Nutrition	0.043**	0.028*	0.032*	0.041**
	(0.017)	(0.015)	(0.018)	(0.019)
Stimulation	0.014	0.007	0.012	0.024
	(0.017)	(0.015)	(0.019)	(0.020)
Observations	2690	2690	2690	2690
Mean control	0.087	0.070	0.116	0.198
P-values				
Nutrition & Stimulation = Nutrition	0.118	0.185	0.053	0.035
Nutrition & Stimulation = Stimulation	0.981	0.974	0.363	0.210
Nutrition = Stimulation	0.133	0.207	0.329	0.420

Note: The dependent variable captures attrition for children's test outcomes (column 1), and information from the main caregiver (2), mother (female caregiver) (3) and father (male caregiver (4). Coefficients in panel A and C are estimated for the full sample of children less than 7 years old at baseline using equation 1 and equation 3 (including controls for the stratification variables, child age and gender, enumerator fixed effects, and village fixed effects). Coefficients in panel B are estimated for children less than 7 years old from non-leader households using equation 2 (including controls for the household-level treatment, the average level of education of the leaders, the level of education of the main caregiver, whether there is a male caregiver in the household, the child age and gender, and enumerator fixed effects). The standard errors (in parentheses) are clustered at village level. * p<0.1, ** p<0.05, *** p<0.01

TABLE A8: Balancing test on attrited observations

	N	Control	Treatment	P-values with stratification (T - C) with controls	P-Values Unconditional (T - C)
Children without test results at follow-up					
Age at baseline	274	2.23	2.09	0.228	0.464
# Days in bed over last month	274	0.17	0.13	0.430	0.678
Received deworming drugs over last 6 months	274	0.45	0.38	0.545	0.303
Received vitamins over last 6 months	274	0.52	0.38	0.033	0.056
# Days child had vegetables (last week)	274	1.81	1.60	0.317	0.483
# Days child had fruit (last week)	274	2.77	2.69	0.962	0.842
# Days child had meat (last week)	274	1.36	1.31	0.738	0.832
# Days child had eggs (last week)	274	2.42	2.66	0.632	0.507
# Days child was breastfed (last week)	274	2.53	2.43	0.475	0.838
# child had coffee (last week)	274	3.52	4.00	0.329	0.313
# Days child had soup (last week)	274	0.77	0.47	0.025	0.057
# Days someone read to child (last week)	274	0.88	0.59	0.248	0.190
Someone read to child in (last month)	274	0.22	0.21	0.877	0.875
Attrited households					
Male household head	223	0.93	0.88	0.949	0.363
Household head's age	223	41.33	41.18	0.980	0.953
Household head can read and write	223	0.78	0.76	0.714	0.828
Number of men in household	223	1.56	1.59	0.657	0.826
Number of women in household	223	1.63	1.64	0.894	0.947
Number of boys (age 7-14) in household	223	0.31	0.46	0.283	0.159
Number of girls (age 7-14) in household	223	0.43	0.43	0.693	0.999
Number of young boys (age 0-6) in household	223	0.59	0.62	0.662	0.797
Number of young girls (age 0-6) in household	223	0.50	0.59	0.886	0.360
Number of rooms in the house	223	2.07	1.69	0.086	0.010
Attrited female caregivers					
Mother lived in household at baseline	340	0.95	0.97	0.886	0.421
Mother's years of education	340	7.43	6.60	0.812	0.093
Male household head	340	0.89	0.84	0.602	0.268
Household head's age	340	43.73	42.31	0.355	0.477
Household head can read and write	340	0.75	0.76	0.282	0.882
Number of males in household	340	1.64	1.57	0.493	0.628
Number of women in household	340	1.76	1.75	0.445	0.906
Number of boys (7-14) in household	340	0.44	0.43	0.733	0.901
Number of girls (7-14) in household	340	0.44	0.39	0.239	0.519
Number of young boys (0-6) in household	340	0.73	0.66	0.697	0.386
Number of young girls (0-6) in household	340	0.49	0.56	0.884	0.334
Number of rooms in house	340	2.11	1.79	0.048	0.012
Attrited male caregivers					
Father lived in household at baseline	588	0.47	0.47	0.906	0.972
Father's year of education	569	6.54	6.06	0.704	0.235
Male household head	620	0.59	0.63	0.184	0.455
Household head's age	620	43.13	43.93	0.682	0.594
Household head can read and write	620	0.74	0.74	0.246	0.910
Number of men in household	620	1.39	1.40	0.701	0.884
Number of women in household	620	1.82	1.88	0.766	0.559
Number of boys (age 7-14) in household	620	0.52	0.49	0.399	0.625
Number of girls (age 7-14) in household	620	0.37	0.46	0.448	0.141
Number of young boys (age 0-6) in household	620	0.73	0.68	0.120	0.398
Number of young girls (age 0-6) in household	620	0.52	0.56	0.815	0.473
Number of rooms in house	620	2.13	1.81	0.017	0.001

Note: All data from 2014 baseline survey. P-values based on standard errors clustered by community. The number of observations (N) indicating child-level attrition is the difference between the number of baseline households and the number of children for whom the Denver test was completed; N for household-level attrition is the number of baseline households for whom no follow up household survey was collected; and N for female (male) caregiver is the number of baseline households for whom the female (male) caregiver could not be interviewed at follow-up.

TABLE A9: Impact of text messages on ECD tests

	Text	**S.e**	**P-Value**	**Obs**
	(1)	(2)	(3)	(4)
Younger children (12 - 36 months)				
ECD index (first principal component)	-0.01	(0.06)	0.87	774
Denver Personal-social	0.02	(0.08)	0.82	790
Denver Language	0.04	(0.05)	0.39	784
Denver Fine Motor	0.01	(0.07)	0.87	781
Denver Gross Motor	-0.13	(0.10)	0.17	779
Older children (37 - 84 months)				
ECD index (first principal component)	0.00	(0.04)	0.95	1,711
Denver Personal-social	0.01	(0.04)	0.81	1,757
Denver Language	0.06	(0.04)	0.81	1,753
Denver Fine Motor	0.04	(0.05)	0.37	1,746
Denver Gross Motor	-0.01	(0.05)	0.80	1,742
Memory	-0.05	(0.04)	0.21	1,927
TVIP (Vocabulary)	-0.03	(0.04)	0.41	1,757
Self control	0.00	(0.05)	0.93	1,713

Note: Each row corresponds to a separate estimation (using equation 1). All outcome variables are standardized using the mean and standard deviation of control households. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variables for a set of households surveyed in 2016, and community fixed effects. Standard errors reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01

TABLE A10: Impacts of text messages on ECD, by treatment variations

	(1) ECD full sample	(2) ECD young	(3) ECD old
Panel A: By text message content variation			
Nutrition & Stimulation	-0,00	-0,05	0,02
	(0,04)	(0,07)	(0,05)
Nutrition	-0,02	0,02	-0,05
	(0,04)	(0,08)	(0,05)
Stimulation	0,02	0,00	0,02
	(0,04)	(0,08)	(0,05)
Observations	2485	774	1711
Panel B: By text message target recipient			
Mother	0,03	0,05	0,02
	(0,04)	(0,08)	(0,05)
Father	-0,01	-0,01	-0,01
	(0,04)	(0,08)	(0,05)
Mother and Father	-0,02	-0,06	-0,02
	(0,04)	(0,07)	(0,05)
Observations	2485	774	1711

Note: All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months and the first principal component of all 7 tests for children 36-84 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variable for a set of households surveyed in 2016, and village fixed effects. Standard errors reported in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A11: Impacts of text messages on socio-emotional outcomes (children age 3-7 years)

	(1) Behavioral Index	(2) Emotional	(3) Conduct	(4) Hyperactive	(5) Peer	(6) Pro Social	(7) Control	(8) Laugh and Smile
Panel A: Text messages sent								
Text	- 0.02	0.08	-0.10*	0.10*	0.00	-0.01	-0.03	0.02
	(0.05)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.05)
Observations	1723	1723	1723	1723	1723	1723	1723	1723
Panel B: Heterogeneity by caregiver education								
Text	0.05	0.16	-0.08	0.17	0.04	-0.23**	-0.04	0.11
	(0.10)	(0.10)	(0.10)	(0.11)	(0.10)	(0.09)	(0.11)	(0.10)
Text X Medium education	0.01	-0.02	0.07	-0.08	0.00	0.31**	-0.04	-0.08
	(0.13)	(0.13)	(0.14)	(0.14)	(0.13)	(0.12)	(0.14)	(0.13)
Text X High education	-0.22	-0.24*	-0.16	-0.12	-0.14	0.32**	0.10	-0.17
	(0.14)	(0.14)	(0.15)	(0.15)	(0.14)	(0.13)	(0.15)	(0.14)
Observations	1723	1723	1723	1723	1723	1723	1723	1723
P-values: joint significance tests								
Text + Text X Medium education	0.53	0.11	0.86	0.34	0.58	0.30	0.34	0.77
Text + Text X High education	0.08	0.41	0.02	0.64	0.32	0.32	0.58	0.50

Note: The dependent variable in the first column is the first principal component of the 5 subscales of the "Strengths and difficulties" questionnaire, and modules measuring inhibitory control and positive demeanor (Laugh and Smile). Controls as in Table 3. Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A12: Impacts of text messages on socio-emotional outcomes (children age 1-3 years)

	(1) Behavioral index	(2) Control	(3) Affect	(4) Ability
Panel A: Text messages sent				
Text	0.02	-0.14	0.04	0.09
	(0.08)	(0.09)	(0.09)	(0.09)
Observations	717	717	717	717
Panel B: Heterogeneity by caregiver education				
Text	-0.14	-0.39**	-0.05	0.06
	(0.18)	(0.18)	(0.18)	(0.18)
Text X Medium education	0.11	0.27	0.01	-0.01
	(0.23)	(0.23)	(0.23)	(0.24)
Text X High education	0.31	0.37*	0.20	0.09
	(0.22)	(0.22)	(0.22)	(0.23)
Observations	717	717	717	717
P-values: joint significance tests				
Text + Text × Medium education = 0	0.79	0.44	0.80	0.74
Text + Text × High education = 0	0.21	0.90	0.24	0.26

Note: The dependent variable in the first column is the first principal component of 3 sub-scales of the early childhood behavior questionnaire: effortful control (column 2), negative affectivity (column 3) and sociability (or extraversion, column 4). Controls as in Table 3. Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A13: Impacts of text messages on socio-emotional outcomes by content and recipient (children age 3-7 years)

	(1) Behavioral Index	(2) Emotional	(3) Conduct	(4) Hyperactive	(5) Peer	(6) Pro Social	(7) Control	(8) Laugh and Smile
Panel A: : Treatment (content) variation								
Nutrition & Stimulation	0.04	0.16**	-0.03	0.13*	-0.02	0.01	0.00	0.06
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.06)	(0.07)	(0.07)
Nutrition	-0.03	0.04	-0.11	0.05	0.04	-0.03	-0.09	0.00
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Stimulation	-0.03	0.07	-0.16**	0.09	0.02	0.00	-0.00	-0.00
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Observations	1723	1723	1723	1723	1723	1723	1723	1723
Panel B: Treatment (recipient) variation								
Mother	0.02	0.10	-0.09	0.15*	0.04	-0.02	-0.03	0.01
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.08)	(0.07)
Father	-0.00	0.11	-0.10	0.14*	0.01	0.01	-0.06	0.03
	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)
Mother and Father	-0.04	0.06	-0.11	-0.00	-0.02	-0.01	-0.01	0.02
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.07)	(0.07)
Observations	1723	1723	1723	1723	1723	1723	1723	1723

Note: The dependent variable in the first column is the first principal component of the 5 subscales of the "Strengths and difficulties" questionnaire, and modules measuring inhibitory control and positive demeanor (Laugh and Smile) Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A14: Impacts of text messages on socio-emotional outcomes by content and recipient (children aged 1-3 years)

	(1) Behavioral index	(2) Control	(3) Affect	(4) Ability
Panel A: Treatment (content) variation				
Nutrition & Stimulation	-0.01	-0.16	0.01	0.10
	(0.11)	(0.11)	(0.11)	(0.11)
Nutrition	0.07	-0.27**	0.11	0.22**
	(0.11)	(0.11)	(0.11)	(0.11)
Stimulation	0.02	0.05	-0.00	0.01
	(0.11)	(0.11)	(0.11)	(0.11)
Observations	717	717	717	717
Panel B: Treatment (recipient) variation				
Mother	0.08	-0.24**	0.11	0.20*
	(0.11)	(0.11)	(0.11)	(0.11)
Father	0.03	-0.13	0.04	0.11
	(0.11)	(0.11)	(0.11)	(0.11)
Mother and Father	-0.01	-0.05	-0.02	0.04
	(0.10)	(0.11)	(0.11)	(0.11)
Observations	717	717	717	717

Note: The dependent variable in the first column is the first principal component of 3 sub-scales of the early childhood behavior questionnaire: effortful control (column 2), negative affectivity (column 3) and sociability (or extraversion, column 4). Standard errors in parentheses. * p<0.1, ** p<0.05, *** p<0.01

TABLE A15: Impact of text messages on intermediate outcomes, by content variation

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Nutrition & Stimulation	0.01	0.20***	0.11**	0.05	0.04	0.16***	0.08
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)
Nutrition	0.10**	0.05	0.00	0.13**	0.07	-0.02	0.09*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)
Stimulation	0.08	0.23***	0.08	0.03	0.06	0.19***	0.10*
	(0.05)	(0.05)	(0.05)	(0.06)	(0.05)	(0.06)	(0.05)
Observations	2500	2501	2512	2495	2501	2396	2506
P-values: joint significance tests							
Nutrition & Stimulation = Nutrition	0.09	0.01	0.04	0.20	0.51	0.00	0.89
Nutrition & Stimulation = Stimulation	0.20	0.58	0.59	0.73	0.69	0.59	0.75
Stimulation = Nutrition	0.70	0.00	0.15	0.11	0.80	0.00	0.85

Notes: All outcome variables are standardized using the mean and standard deviation of control households. The first six columns show estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variable for the set of households surveyed in 2016, and village fixed effects. Sample restricted to children under 84 months. Standard errors reported in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

TABLE A16: Impact of text messages on intermediary outcomes: nutrition and stimulation

	Text	S.e	P-Value	Mean Control	Obs
	(1)	(2)	(3)	(4)	(5)
Nutrition					
Nutrition index	0,06	(0,04)	0,12	0,00	2.500
Beverages and soups					
Soy Milk	0,06	(0,06)	0,33	0,37	2.501
Juice	0,16	(0,11)	0,15	3,72	2.501
Soup	0,00	(0,06)	0,96	0,71	2.501
Vegetables					
Salad	-0,13	(0,09)	0,17	0,34	2.501
Potatoes	0,10	(0,07)	0,18	1,08	2.501
Tomatoes	0,06	(0,12)	0,58	2,97	2.501
Onion	0,22	(0,13)	0,10	1,98	2.501
Other vegetables	-0,02	(0,09)	0,85	1,69	2.501
Staples					
Rice	0,03	(0,08)	0,73	5,85	2.500
Beans	-0,06	(0,09)	0,49	6,09	2.501
Bread	-0,02	(0,12)	0,85	4,12	2.501
Tortilla	0,11	(0,10)	0,28	5,82	2.499
Cookies	0,13	(0,09)	0,16	1,28	2.501
Proteins					
Protein index	0,06	(0,04)	0,11	0,00	2.501
Milk	-0,04	(0,11)	0,74	1,76	2.501
Eggs	0,30	(0,09)	0,00	1,72	2.501
Cheese	-0,00	(0,10)	0,98	2,17	2.500
Meat	-0,00	(0,06)	0,98	1,22	2.501
Breast milk	0,22	(0,25)	0,38	3,15	802
Stimulation					
Stimulation index	0,16	(0,04)	0,00	0,00	2.501
Buy toys for the child	0,03	(0,01)	0,01	0,86	2.501
Tell tales to the child	0,04	(0,02)	0,02	0,79	2.501
Read books to child	0,04	(0,02)	0,05	0,27	2.501
Have pen and paper	0,02	(0,02)	0,12	0,84	2.501

Note: Each row corresponds to a separate estimation (equation 1) and shows the ITT estimates on aggregate indices or individual questions measuring investments in nutrition or stimulation as reported by the caregiver. Questions on food items measure how many days in the last 7 days the child was given the specific item. The nutrition index was calculated by summing the days over all food items. The protein index was calculated by summing the days over all protein items. The individual items about stimulation are answers to yes/no questions, and the index is obtained by summing over yes answers. The nutrition, protein, and stimulation indices are standardized using the mean and standard deviation for control households. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variable for a set of households surveyed in 2016, as well as village fixed effects. Standard errors reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01.

TABLE A17: Impact of text messages on intermediary outcomes: preventive health

	Text	S.e	P-Value	Mean Control	Obs
	(1)	(2)	(3)	(4)	(5)
Health					
Health index	0,07	(0,04)	0,07	0,00	2.512
Insist on brushing teeth	0,01	(0,01)	0,41	0,02	2.512
Ensure a healthy diet	0,03	(0,01)	0,02	0,06	2.512
Keep child away from stove	-0,00	(0,00)	0,93	0,00	2.512
Ensure child's good hygiene	-0,01	(0,02)	0,46	0,21	2.512
Wash child's clothes properly	0,01	(0,02)	0,60	0,12	2.512
Avoid giving coffee	-0,00	(0,00)	0,32	0,00	2.512
Make child wash hands	0,00	(0,02)	0,86	0,27	2.512
Smoke at a distance from child	-0,00	(0,00)	0,74	0,00	2.512
Do not give child unhealthy snacks	0,00	(0,01)	0,49	0,01	2.512
Cover fresh food	0,00	(0,02)	0,78	0,13	2.512
Teach child to chew slowly	-0,00	(0,00)	0,61	0,00	2.512
Prevent child from catching the flu	0,00	(0,01)	0,80	0,06	2.512
Boil or chlorinate the water	0,01	(0,01)	0,13	0,02	2.512
Ensure that child vaccines are up-to-date	0,02	(0,01)	0,23	0,07	2.512
Use a mosquito net	-0,00	(0,01)	0,71	0,01	2.512
Insist child wears shoes	0,01	(0,01)	0,56	0,03	2.512
Make sure child eats regularly	0,00	(0,00)	0,25	0,00	2.512
Keep child away from dangerous products	0,00	(0,00)	0,75	0,00	2.512
Show child affection	-0,01	(0,00)	0,09	0,01	2.512
Other	-0,00	(0,02)	0,97	0,17	2.512

Note: Each row corresponds to a separate estimation (equation 1) and shows the ITT estimates on the aggregate health index or on individual questions measuring whether the caregiver reported a given practice when asked how to avoid their young child getting sick. The health index is calculated based on the number of different preventive health practices. The index is standardized using the mean and standard deviation of the control households. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, and a dummy variable for a set of households surveyed in 2016, as well as village fixed effects. Standard errors reported in parentheses.* p<0.1, ** p<0.05, *** p<0.01.

TABLE A18: Impact of text messages on intermediary outcomes: micronutrients, ECD attitudes and observed hygiene

	Text	S.e	P-Value	Mean Control	Obs
	(1)	(2)	(3)	(4)	(5)
Micronutrients					
Micronutrients index	0.08	(0.04)	0.06	-0.00	2,495
Received Vitamin A	0.02	(0.02)	0.21	0.73	2,495
Received deworming medecine	0.02	(0.02)	0.37	0.76	2,495
Received iron supplementation	0.04	(0.02)	0.07	0.49	2,495
ECD Attitudes of main caregiver					
Attitudes index	0.11	(0.04)	0.01	0.00	2,396
Should always answer child's questions	0.02	(0.02)	0.28	0.87	2,396
Boys can play with dolls	0.07	(0.02)	0.00	0.36	2,396
Girls can play with cars	0.04	(0.02)	0.04	0.51	2,396
Early language develops from stimulation	-0.00	(0.02)	0.87	0.67	2,396
Brain develops from very early on	0.01	(0.02)	0.51	0.86	2,396
Hygiene (observed by test administrator)					
Hygiene index	0.09	(0.04)	0.03	0.00	2,506
Child has clean face	0.03	(0.02)	0.09	0.67	2,506
Child has clean hair	-0.00	(0.02)	0.83	0.80	2,506
Child has clean hands	0.06	(0.02)	0.00	0.56	2,506
Child has clean clothes	0.07	(0.02)	0.00	0.56	2,506
Child is wearing shoes	-0.04	(0.02)	0.05	0.33	2,506
Child does not cough	-0.01	(0.02)	0.40	0.85	2,506
Child has clean nose	0.00	(0.02)	0.99	0.84	2,506
Child does not have skin problems	0.00	(0.01)	0.83	0.93	2,505

Note: Each row corresponds to a separate estimation (equation 1). The vitamin index is based on three variables: the child has received vitamin A, ferrous sulfate and deworming medicine during the last six months (yes/no questions). The hygiene index captures the hygienic condition of the child observed by the test administrator. The Attitudes index is calculated based on answers by the caregiver to the following questions: 1. Do you answer your child's questions? 2. Do you think boys can play with dolls? 3. Do you think girls can play with cars? 4. Do you think children start talking by nature? 5. Does the child's brain develop from gestation or when the child starts going to school? Each outcome variable is standardized using the mean and standard deviation for control households. The rows shows ITT estimates. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, and dummy variable for a set of households surveyed in 2016, as well as village fixed effect. Standard errors reported in parentheses. p<0.1, p<0.05, p<0.01

TABLE A19: Impact of leader's exposure to text messages on ECD tests

	Leader	**S.e**	**P-Value**	**Obs**
	(1)	(2)	(3)	(4)
Younger children (12 - 36 months)				
ECD index (first principal component)	-0.02	(0.05)	0.68	624
Denver Personal-social	-0.03	(0.07)	0.70	639
Denver Language	0.03	(0.06)	0.56	633
Denver Fine Motor	-0.05	(0.08)	0.49	630
Denver Gross Motor	-0.06	(0.07)	0.42	629
Older children (37 - 84 months)				
ECD index (first principal component)	-0.14	(0.05)	0.01	1,427
Denver Personal-social	-0.02	(0.05)	0.72	1,449
Denver Language	-0.14	(0.05)	0.01	1,449
Denver Fine Motor	-0.01	(0.05)	0.85	1,449
Denver Gross Motor	-0.09	(0.06)	0.15	1,449
Memory	-0.07	(0.05)	0.19	1,449
TVIP (Vocabulary)	-0.13	(0.05)	0.02	1,449
Self control	-0.08	(0.06)	0.17	1,427

Note: Each row corresponds to a separate estimation (equation 2). All outcome variables are standardized using the mean and standard deviation of control households. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variables for a set of households surveyed in 2016, as well as community fixed effects. Standard errors reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01

TABLE A20: Impacts of leaders' exposure to text messages on socio-emotional outcomes (children age 3-7 years)

	(1) Behavioral Index	(2) Emotional	(3) Conduct	(4) Hyperactive	(5) Peer	(6) Pro Social	(7) Control	(8) Laugh and Smile
	(0.13)	(0.13)	(0.14)	(0.14)	(0.13)	(0.12)	(0.14)	(0.13)
	(0.14)	(0.14)	(0.15)	(0.15)	(0.14)	(0.13)	(0.15)	(0.14)
Panel A: Leader exposure to text messages								
Leader	-0.05	-0.00	-0.05	0.02	-0.06	-0.00	-0.03	-0.13**
	(0.06)	(0.05)	(0.07)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)
Observations	1438	1438	1438	1438	1438	1438	1438	1438
Panel B: Leader Heterogeneity by caregiver education								
Leader	0.11	0.11	0.05	0.06	0.05	-0.04	0.08	-0.31***
	(0.09)	(0.10)	(0.10)	(0.15)	(0.10)	(0.12)	(0.11)	(0.11)
Lead X Medium education	-0.25*	-0.22	-0.11	-0.07	-0.14	0.03	-0.21	0.32**
	(0.13)	(0.15)	(0.12)	(0.15)	(0.14)	(0.16)	(0.13)	(0.13)
Lead X high education	-0.23	-0.08	-0.22	-0.06	-0.17	0.09	-0.10	0.17
	(0.14)	(0.13)	(0.14)	(0.19)	(0.19)	(0.13)	(0.15)	(0.13)
Observations	1438	1438	1438	1438	1438	1438	1438	1438
P-values: joint significance tests								
Leader + Leader× educ = 0	0.15	0.23	0.55	0.95	0.28	0.93	0.18	0.90
Leader + Leader× educ = 0	0.28	0.76	0.15	0.97	0.42	0.56	0.88	0.14

Note: The dependent variable in the first column is the first principal component of the 5 subscales of the "Strengths and difficulties" questionnaire, and modules measuring inhibitory control and positive demeanor (Laugh and Smile). Controls as in Table 5. Panel A interacts the treatment with caregiver education categories: *Medium education* denotes 4–6 years of schooling (completed primary); *High education* denotes more than primary schooling; the omitted category is less than 4 years of schooling. Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A21: Impacts of leaders' exposure to text messages on socio-emotional outcomes (children age 1-3 years)

	(1) Behavioral index	(2) Control	(3) Affect	(4) Ability
Panel A: Leader exposure to text messages				
Leader	0.02	-0.01	0.04	0.00
	(0.10)	(0.09)	(0.09)	(0.11)
Observations	577	577	577	577
Panel B: Leader Heterogeneity by caregiver education				
Leader	0.17	0.17	0.21	-0.04
	(0.23)	(0.17)	(0.25)	(0.25)
Leader X Medium education	-0.15	-0.22	-0.21	0.09
	(0.30)	(0.25)	(0.31)	(0.28)
Leader X High education	-0.25	-0.29	-0.25	0.01
	(0.25)	(0.21)	(0.26)	(0.29)
Observations	577	577	577	577
P-values: joint significance tests				
Leader + Leader× educ = 0	0.93	0.81	0.98	0.72
Leader + Leader× educ = 0	0.46	0.30	0.64	0.85

Note: The dependent variable in the first column is the first principal component of 3 sub-scales of the early childhood behavior questionnaire: effortful control (column 2), negative affectivity (column 3) and sociability (or extraversion, column 4). Controls as in Table 5. Panel A interacts the treatment with caregiver education categories: *Medium education* denotes 4–6 years of schooling (completed primary); *High education* denotes more than primary schooling; the omitted category is less than 4 years of schooling. Standard errors in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A22: Impact of leaders' exposure to text messages on ECD, by leaders' education levels

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0,14**	-0,01	-0,18***
	(0,05)	(0,09)	(0,06)
Leader X Leaders medium educ	0,12	-0,03	0,18*
	(0,08)	(0,14)	(0,10)
Leader X Leaders high educ	-0,03	-0,00	-0,06
	(0,09)	(0,13)	(0,11)
Observations	2051	624	1427
Leader + Leader X Leaders medium educ	0,79	0,69	0,98
Leader + Leader X Leaders high educ	0,02	0,89	0,01

Note: All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level. * p<0.1, ** p<0.05, *** p<0.01

TABLE A23: Impact of leaders' exposure to text messages by distance to the closest leader's dwelling, controlling for network size

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0.161***	-0.122*	-0.184***
	(0.04)	(0.07)	(0.06)
Distance from leader	-0.010***	-0.018***	-0.008*
	(0.00)	(0.00)	(0.00)
Leader X distance	0.012***	0.023***	0.009
	(0.00)	(0.01)	(0.01)
Log network size	0.053	0.029	0.073*
	(0.03)	(0.04)	(0.04)
Observations	2051	624	1427

Note: Distance from leader is measured by the number of houses between the household and the closest household with an opinion leader. The sample includes only non-leader households in the 92 villages with opinion leaders. It also includes the log of community population as a proxy for network size. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A24: Impacts of leaders' exposure to text messages on ECD, by target recipient in leader households

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader exposure targeting women and men in leader hh	-0.13**	0.02	-0.20***
	(0.05)	(0.07)	(0.06)
Leader exposure targeting women in leader hh	-0.09*	-0.06	-0.10
	(0.05)	(0.08)	(0.06)
Leader exposure targeting men in leader hh	-0.10	-0.05	-0.11
	(0.07)	(0.09)	(0.09)
Observations	2051	624	1427
Men & women target recipient = women target recipient	0.50	0.37	0.14
Men & women target recipient = men target recipient	0.77	0.48	0.35
Men target recipient = women target recipient	0.83	0.93	0.89

Note: The estimation corresponds to the leader effect, with three sub-treatment arms: (i) villages where both men and women in the leader households were targeted with text messages, (ii) villages where only women in the leader households were targeted with text messages, and (iii) villages where only men in the leader households were targeted with text messages. The sample includes only non-leader households in the 92 villages with opinion leaders. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A25: Impacts of leaders' exposure to text messages on intermediate outcomes, by target recipient in leader households

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Leader exposure targeting women and men in leader hh	-0.06	0.03	0.03	-0.20***	-0.22**	-0.08	-0.08
	(0.10)	(0.06)	(0.05)	(0.07)	(0.10)	(0.07)	(0.08)
Leader exposure targeting women in leader hh	-0.24**	-0.04	-0.01	-0.13	-0.23**	0.03	-0.10
	(0.09)	(0.08)	(0.05)	(0.08)	(0.11)	(0.07)	(0.07)
Leader exposure targeting men in leader hh	-0.10	0.09	-0.06	-0.14	-0.26**	0.09	-0.19**
	(0.09)	(0.09)	(0.05)	(0.10)	(0.12)	(0.13)	(0.09)
Observations	2062	2062	2073	2059	2062	1970	2068
Men & women target recipient = women target recipient	0.06	0.32	0.52	0.40	0.98	0.14	0.76
Men & women target recipient = men target recipient	0.60	0.46	0.10	0.53	0.76	0.19	0.21
Men target recipient = women target recipient	0.11	0.16	0.30	0.92	0.78	0.65	0.31

Note: The estimation corresponds to the leader effect, with three sub-treatment arms: (i) villages where both men and women in the leader households were targeted with text messages, (ii) villages where only women in the leader households were targeted with text messages, and (iii) villages where only men in the leader households were targeted with text messages. The sample includes only non-leader households in the 92 villages with opinion leaders. Five villages without leaders are excluded from the estimation. All outcome variables are standardized using the mean and standard deviation of control households. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A26: Impact of leaders' exposure to text messages on ECD, by baseline social interactions about ECD

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0,10**	-0,08	-0,11**
	(0,04)	(0,08)	(0,06)
Social (Had interactions about ECD at baseline)	0,02	-0,08	0,05
	(0,07)	(0,09)	(0,09)
Leader X Social	-0,02	0,14	-0,06
	(0,08)	(0,12)	(0,10)
Observations	2051	624	1427
Leader + Leader X Social	0,07	0,48	0,04

Note: Social is a binary variable indicating that the household had talked to at least one other community member about ECD in the week before the baseline survey. At baseline, households were asked whether they had talked to other community members about ECD practices in the last 7 days. This includes interaction about ECD practices with the health promoter, pre-school teacher, primary school teacher, other teachers, family members, neighbours, or elected leaders in the village. About half of the households had talked to at least one other community member about ECD practices. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old, and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A27: Impact of leaders' exposure to text messages on intermediary outcomes, by baseline social interactions about ECD

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Leader	-0.14	-0.05	-0.06	-0.19**	-0.24***	-0.08	-0.14*
	(0.10)	(0.07)	(0.06)	(0.08)	(0.09)	(0.07)	(0.08)
Social (Had interactions about ECD at baseline)	0.05	-0.06	-0.00	0.03	-0.03	0.06	0.02
	(0.08)	(0.09)	(0.08)	(0.07)	(0.10)	(0.09)	(0.08)
Leader X Social	0.01	0.13	0.13	0.06	0.01	0.18*	0.06
	(0.10)	(0.11)	(0.09)	(0.09)	(0.11)	(0.10)	(0.09)
Observations	2062	2062	2073	2059	2062	1970	2068
Leader + Leader X Social	0.13	0.35	0.21	0.10	0.07	0.29	0.34

Note: Social is a binary variable indicating that the household had talked to at least one other community member about ECD in the week before the baseline survey. At baseline, households were asked whether they had talked to other community members about ECD practices in the last 7 days. This includes interaction about ECD practices with the health promoter, pre-school teacher, primary school teacher, other teachers, family members, neighbours, or elected leaders in the village. About half of the households had talked to at least one other community member about ECD practices. All outcome variables are standardized using the mean and standard deviation of control households. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A28: Impact of text messages on Early Childhood Development, in villages without treated leaders

	(1) ECD full sample	(2) ECD young	(3) ECD old
Panel A: Text messages sent			
Text	-0.03	0.06	-0.06
	(0.05)	(0.11)	(0.06)
Panel B: Heterogeneity by caregiver education			
Text	-0.05	-0.08	-0.09
	(0.10)	(0.26)	(0.11)
Text X Medium educ (4-6 years of education)	-0.02	0.02	0.07
	(0.13)	(0.30)	(0.15)
Text X High educ (more than primary education)	0.06	0.28	-0.02
	(0.13)	(0.29)	(0.15)
Observations	868	278	590
P-values joint significance test			
Text + Text X Medium educ = 0	0.42	0.69	0.86
Text + Text X High educ = 0	0.87	0.18	0.34

Note: All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old, and the first principal component of all 7 tests for children 36-84 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All the regressions include controls for the stratification variables, the child age and gender, enumerator fixed effects, a dummy variable for a set of households surveyed in 2016, and village fixed effects. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A29: Spillovers by share of nearby treated households (considering 2, 4, 6 and 8 neighbor households)

	(1) ECD full Sample	(2) ECD full Sample	(3) ECD full sample	(4) ECD full sample
		Share of treated non-leader neighbors		
	(2 closest hh)	(4 closest hh)	(6 closest hh)	(8 closest hh)
Text	-0.045	-0.040	-0.120	-0.098
	(0.08)	(0.09)	(0.12)	(0.16)
Share treated	-0.037	-0.014	-0.084	-0.072
	(0.08)	(0.10)	(0.13)	(0.17)
Text × Share	0.043	0.049	0.154	0.124
	(0.10)	(0.11)	(0.16)	(0.20)
Observations	1940	2024	2036	2036
Adjusted R^2	0.449	0.448	0.450	0.449
p(Text + Text×Share = 0)	0.964	0.848	0.502	0.648

Notes: This table examines spillover effects between non-leader households by interacting treatment with the share of treated neighbors, defined over the dwelling sequence within the same community. Leader households are excluded from the calculation of the share. Columns (1)–(4) use the 2, 4, 6, and 8 closest non-leader households, respectively. The dependent variable is the first principal component of the child development test scores, standardized using the mean and standard deviation of control households (based on the four Denver sub-components for children aged 12–35 months and all seven tests for children aged 36–83 months). *Share treated* captures how outcomes vary with local treatment density among control households; *Text + Text × Share* captures the spillover effect on treated households. All regressions include controls for the household-level treatment assignment, the average level of education of leaders (the stratification variable for village-level leader randomization), the education of the main caregiver, the presence of a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects, and an indicator for data collected in 2016. Standard errors are clustered at the village level and reported in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

TABLE A30: Impact of text messages on ECD for children of leaders versus non-leaders

	(1) ECD full sample	(2) ECD young	(3) ECD old
Text	-0.01	-0.02	-0.01
	(0.03)	(0.07)	(0.04)
Child of Leader	0.10	0.24*	0.03
	(0.07)	(0.12)	(0.08)
Text X Child of Leader	-0.06	-0.02	-0.08
	(0.08)	(0.13)	(0.10)
Observations	2393	747	1646
Text + Text X Child of Leader =0	0.39	0.73	0.32

Note: All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old, and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All the regressions include controls for the stratification variables, child age and gender, enumerator fixed effects, a dummy variable for a set of households surveyed in 2016, and village fixed effects. Five villages without leaders are excluded from the sample. Standard errors reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01

TABLE A31: Impact of text messages on intermediary outcomes for children of leaders versus non-leaders

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Text	0.08	0.19***	0.04	0.07	0.06	0.12**	0.09*
	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.05)
Child of Leader	-0.14	0.31***	-0.04	0.21*	-0.03	0.21*	0.05
	(0.11)	(0.11)	(0.10)	(0.11)	(0.10)	(0.11)	(0.11)
Text X Child of Leader	-0.09	-0.16	0.15	-0.11	-0.24**	0.06	-0.07
	(0.12)	(0.12)	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)
Observations	2407	2408	2419	2403	2408	2303	2413
Text + Text X Child of Leader = 0	0.88	0.82	0.06	0.71	0.09	0.12	0.91

Note: All outcome variables are standardized using the mean and standard deviation of control households. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All the regressions include controls for the stratification variables, the child age and gender, enumerator fixed effects, a dummy variable for a set of households surveyed in 2016, and village fixed effects. Five villages without leaders were excluded from the sample. Standard errors reported in parentheses.* p<0.1, ** p<0.05, *** p<0.01

TABLE A32: Impact of leaders' exposure to text messages on ECD outcomes, by leaders' prior beliefs

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0.08*	-0.09	-0.08
	(0.05)	(0.06)	(0.05)
Agreeing leader	0.07	-0.10	0.15*
	(0.07)	(0.09)	(0.08)
Leader X Agreeing leader	-0.06	0.16	-0.16
	(0.08)	(0.11)	(0.10)
Observations	2051	624	1427
Leader + Leader X Agreeing leader = 0	0.04	0.44	0.01

Note: An agreeing leader is defined as a binary variable indicating that the closest leader agreed with at least 4 out of 5 program messages on parenting practices at baseline. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months old, and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 to 35 months. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, Memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level. * p<0.1, ** p<0.05, *** p<0.01

TABLE A33: Impact of leaders' exposure to text messages on intermediary outcomes, by leaders' prior beliefs

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Leader	-0.12	0.06	-0.01	-0.25***	-0.25***	0.01	-0.10
	(0.09)	(0.06)	(0.04)	(0.07)	(0.09)	(0.07)	(0.08)
Agreeing leader	0.09	0.11	0.07	-0.11	0.06	0.01	0.06
	(0.09)	(0.09)	(0.06)	(0.10)	(0.10)	(0.08)	(0.10)
Leader X Agreeing leader	-0.04	-0.12	0.01	0.22*	0.05	-0.03	-0.02
	(0.11)	(0.11)	(0.07)	(0.12)	(0.12)	(0.10)	(0.12)
Observations	2062	2062	2073	2059	2062	1970	2068
Leader + Leader X Agreeing leader = 0	0.12	0.58	1.00	0.77	0.11	0.82	0.20

Note: An agreeing leader is defined as a binary variable indicating that the closest leader agreed with at least 4 out of 5 program messages on parenting practices at baseline. All outcome variables are standardized using the mean and standard deviation of the control household. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level. * p<0.1, ** p<0.05, *** p<0.01

TABLE A34: Impact of leaders' exposure to text messages on ECD outcomes, by closest leader's commitment

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0,11**	-0,01	-0,15***
	(0,04)	(0,06)	(0,06)
Committed leader	-0,00	0,03	-0,01
	(0,06)	(0,15)	(0,06)
Leader X Committed leader	0,01	-0,05	0,04
	(0,09)	(0,20)	(0,10)
Observations	2051	624	1427
Leader + Leader X Committed leader	0,24	0,71	0,20

Note: A committed leader is defined as a leader predicted to be in the top quintile of leaders with highest participation in the quizzes. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 and 35 month. In column 3, the dependent variables is the first principal component of all 7 tests (4 Denver sub-components,TVIP, memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A35: Impact of leaders' exposure to text messages on intermediary outcomes, by closest leader's commitment

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Leader	-0.16*	-0.01	-0.02	-0.13*	-0.25**	-0.05	-0.13*
	(0.08)	(0.06)	(0.04)	(0.07)	(0.10)	(0.06)	(0.07)
Committed leader	-0.14	-0.15	-0.05	0.19**	-0.10	-0.26***	-0.14
	(0.12)	(0.11)	(0.07)	(0.08)	(0.10)	(0.08)	(0.13)
Leader X Committed leader	0.08	0.07	0.09	-0.11	0.11	0.24*	0.06
	(0.17)	(0.14)	(0.09)	(0.11)	(0.14)	(0.12)	(0.14)
Observations	2062	2062	2073	2059	2062	1970	2068
Leader + Leader X Committed leader	0.63	0.62	0.42	0.02	0.25	0.13	0.63

Note: A committed leader is defined as a leader predicted to be in the top quintile of leaders with highest participation in the quizzes. All outcome variables are standardized using the mean and standard deviation of control households. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A36: Impact of leaders' exposure to text messages on ECD outcomes, by closest leader's predicted commitment

	(1) ECD full sample	(2) ECD young	(3) ECD old
Leader	-0.05	-0.04	-0.05
	(0.09)	(0.18)	(0.09)
Leader X low commitment	-0.14	-0.06	-0.20*
	(0.11)	(0.18)	(0.12)
Leader X medium commitment	-0.16	-0.12	-0.19
	(0.12)	(0.24)	(0.12)
Leader X high commitment	0.08	0.30	-0.01
	(0.11)	(0.20)	(0.13)
Leader X very high commitment	-0.06	-0.02	-0.08
	(0.12)	(0.28)	(0.12)
Observations	2051	624	1427
Leader + Leader X low commitment = 0	0,01	0.33	0,01
Leader + Leader X medium commitment = 0	0.01	0.20	0.01
Leader + Leader X high commitment = 0	0.71	0,02	0.59
Leader + Leader X very high commitment = 0	0.21	0.74	0.16

Note: Low, medium, high and very high commitment indicates whether leader is predicted to be in the 2nd, 3rd, 4th, or top quintile of leaders with highest participation in the quizzes. All outcome variables are standardized using the mean and standard deviation of control households. In column 1, the dependent variable is the first principal component of the 4 Denver sub-components for children below 36 months and the first principal component of all 7 tests for children 36-83 months old. In column 2, the dependent variable is the principal component of the four Denver sub-components for children aged 12 and 35 month. In column 3, the dependent variable is the first principal component of all 7 tests (4 Denver sub-components, TVIP, memory and self-control) for children aged 36 to 83 months. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level. * p<0.1, ** p<0.05, *** p<0.01

TABLE A37: Impact of leaders' exposure to text messages on intermediary outcomes, by closest leader's predicted commitment

	(1) Nutrition	(2) Stimulation	(3) Health	(4) Micronutrients	(5) Proteins	(6) Attitudes	(7) Hygiene
Leader	-0.08	0.06	0.03	-0.07	-0.01	0.04	-0.04
	(0.15)	(0.09)	(0.10)	(0.12)	(0.14)	(0.10)	(0.11)
Leader X low commitment	-0.13	-0.07	-0.07	-0.20	-0.31*	-0.02	-0.21
	(0.16)	(0.15)	(0.15)	(0.16)	(0.18)	(0.15)	(0.15)
Leader X medium commitment	-0.18	-0.16	-0.21	-0.16	-0.36*	-0.14	-0.14
	(0.20)	(0.15)	(0.13)	(0.15)	(0.21)	(0.15)	(0.15)
LeaderL X high commitment	0.03	0.01	0.08	0.12	-0.27	-0.20	0.03
	(0.20)	(0.14)	(0.14)	(0.17)	(0.19)	(0.16)	(0.15)
Leader X very high commitment	-0.01	0.00	0.03	-0.18	-0.16	0.15	-0.03
	(0.22)	(0.15)	(0.13)	(0.16)	(0.19)	(0.16)	(0.18)
Observations	2062	2062	2073	2059	2062	1970	2068
Leader + Leader X low committed = 0	0.01	0.89	0.73	0.02	0.04	0.85	0.04
Leader + Leader X medium committed = 0	0.08	0.34	0.05	0.02	0.03	0.39	0.14
Leader + Leader X high committed = 0	0.70	0.53	0.15	0.71	0.05	0.22	0.96
Leader + Leader X very high committed = 0	0.59	0.65	0.46	0.02	0.19	0.12	0.62

Note: Low, medium, high and very high commitment indicates whether leader is predicted to be in the 2nd, 3rd, 4th, or top quintile of leaders with highest participation in the quizzes. All outcome variables are standardized using the mean and standard deviation of the control household. The first 6 columns show ITT estimates on indices aggregating information regarding early childhood investments, as reported by the caregiver. Column 7 aggregates information regarding hygiene of the child, as observed by the enumerator. All regressions include controls for the household-level treatment, the average level of education of the leaders (the stratification variable for village level leader randomization), the level of education of the main caregiver, whether there is a male caregiver in the household, whether the leader household had access to electricity, the child age and gender, test-administrator fixed effects and a binary indicator indicating the data was collected in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

TABLE A38: Impacts on social interactions about ECD with other members of the community

	(1) # other members	(2) Relatives	(3) Neighbors	(4) Religious leader
Text	0.05	0.03	0.03	-0.01
	(0.04)	(0.02)	(0.02)	(0.02)
Leader	0.04	-0.01	0.02	0.03*
	(0.05)	(0.02)	(0.03)	(0.02)
Observations	2073	2073	2073	2073
Mean Control	0.95	0.40	0.36	0.19

Note: The dependent variables capture social interactions between the head of the household and social leaders during the previous week. Column 1 is an index accounting for the number of interaction with relatives, neighbors and religious leaders. The remaining columns are dummies indicating whether the household head had at least one interaction with the respective leader during the previous week. All regressions include controls for the stratification variables: education of the household, titular of the household is male, whether the leader has access to electricity, the child age and sex, enumerator and a binary variable for households surveyed in 2016. The standard errors (in parentheses) are clustered at village level.* p<0.1, ** p<0.05, *** p<0.01

A1.3 Statistical Power

Text messages were randomized at the household level. Recall that our design includes 2,584 households without leaders, of which 676 were controls. This implies a MDE of 0.125 for the first level of randomization in Figure A1 (equation 1). Table A39 shows that the experiment is powered to detect changes in the order of 0.15 standard deviations for the variation in content as well as for the variation in the gender of the target recipients. These MDEs are in line with those used in the early childhood development literature and imply that the experiment was sufficiently powered to detect modest but policy-relevant effects.

As for the power analysis for the village-level leader randomization (figure A2, equation 2), given that leader treatment was randomized at the village level, power depends on the number of clusters as well as the intra-cluster correlation (ICC). With 97 villages (65 treated, 27 control and 5 without leaders) and an average of about 27 non-leader households per village, the minimum detectable effect (MDE) is between 0.13 and 0.22 SD depending on the ICC (0.14 SD at ICC = 0.02). For the leader target sub-arms, the MDE is 0.17–0.27 SD when 27 villages are treated (Mother+Father, or Mother only) and 0.23-0.36 SD when 11 villages are treated (Father only).

Overall, these detectable effect sizes are within the range of policy-relevant effects documented in the early childhood literature.

Finally, the variation in sub-treatments were not designed to study the interactions between them, and we are not powered to study the cross-randomization design.

TABLE A39: Minimum Detectable Effects (MDE) for Treatment Arms vs. Control (Power = 0.80, $\alpha = 0.05$)

Panel A. Any text-message treated vs. Control			
Arm	N_t	N_c	MDE (SD)
Text messages sent	1,908	676	0.125
Panel B. By content variation vs. Control, $N_c = 676$**)**			
Arm	N_t	N_c	MDE (SD)
Stimulation only	611	676	0.157
Health only	637	676	0.155
Stimulation + Health	660	676	0.153
Panel C. By target recipient vs. Control, $N_c = 676$**)**			
Arm	N_t	N_c	MDE (SD)
Mother	628	676	0.155
Father	580	676	0.159
Mother and Father	700	676	0.151

Notes: MDEs are standardized effect sizes (Cohen's d) for two-sided tests with $\alpha = 0.05$ and power $= 0.80$, comparing each treatment arm to the control group. Outcomes are standardized, so effects are in SD units. Calculations assume independent observations and no clustering adjustment; covariate adjustment in the main regressions would typically *reduce* the MDEs, while clustering would *increase* them.

A1.4 Lasso prediction of quiz participation

Information on quiz participation can be seen as a measure of engagement with the text message intervention. As the control group did not received text messages, they did not participate in the quiz. We therefore use baseline observables to predict the frequency of participation in the quiz for each leader household, using Lasso (Tibshirani (1996)).

We minimize the sum of the square residuals (SSR) correcting with a Lasso regression penalty given by the following expression:

$$SSR + \lambda * (\mid \beta_1 + \beta_2 + \beta_3 + ... + \beta_k \mid)$$

where λ is the penalized Lasso parameter, and β_k are the OLS parameters for the variables k, excluding the intercept.

When $\lambda = 0$ the Lasso prediction will be the same as the OLS prediction. But as λ increases, Lasso will shrink the slope of a subset of parameters to 0, reducing the number of covariates used for the prediction.

The Lasso regression has more bias than OLS, but it has lower variance of the predicted values and hence improve the overall prediction accuracy.

To obtain the predictive model, we start from 145 baseline variables, including questions on parental practices, nutrition and stimulation of the child, household economic activity, migrant status, social interactions with the rest of the community, labor supply of all household members, as well as a demographic characteristics of the household head and targeted child. We also include questions on education and health. We force the model to keep all stratification variables.

By setting $\lambda = 10$, we can explain 65% of the variation keeping the following 22 variables: caregiver's assessment of child's' fine motor skills, household is engaged in agriculture activity, has livestock activities, and has private wage job activities, the head of the household has a small manufacturing business activity, someone in household has migrated to work as a nanny, someone in the household has received training on ECD, the household has had social interactions with the health promoter, with the primary school teacher and a local political leader, the caregiver considers that hitting a child is a good parenting practice, the caregiver considers that playing games and giving affection is good parenting practice, someone in the household sometimes threatens the child by saying that a monkey may take him away, someone in the household sometimes uses a phone in other households, someone in household has a cell phone with Movistar coverage, the household has Movistar network coverage at home, the child drank milk during the previous week, number of days that the child consumed fruit in previous week, at least one child has a caregiver other than his/her mother, household size, number of adults in the household who have migrated temporarily over last 12 months, household has access to electricity, and presence of a male caregiver.