Mobile Technology
to Improve Early Childhood Development
in Remote Areas:
Evidence from Côte d'Ivoire

Samuel Kembou Nzale,[†] Bastien Michel,[‡][*] Joanna Murray[§]

[†] University of Lausanne, Swiss Graduate School of Public Administration
Bâtiment IDHEAP, Quartier Mouline, CH-1015 Lausanne, Switzerland
[‡] Paris School of Economics
48 boulebard Jourdan, Paris, France
[§] Development Media International
Unit R, Reliance Wharf, Hertford Road, London, N1 5EW, UK

*To whom correspondence should be addressed: bastien.michel@psemail.eu

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Abstract

In low-income and middle-income countries, 250 million children under 5 years of age are at risk of not reaching their developmental potential, with substantial adverse consequences in the long-term. Investing in child development has the potential to set them on a trajectory towards a better equilibrium. Yet, there are currently few tested models for taking early childhood development interventions to scale and guidance remains limited for policymakers operating under budget and human capital constraints. In this study, we implement a randomized controlled trial designed to measure the impact of a cheap and easily scalable information campaign implemented in rural Côte d'Ivoire. It uses a series of 9 short and culturally adapted videos saved on mobile phone memory cards to foster good parenting practices. We measure the impact of the videos on parenting knowledge and practices (main outcomes), and child development (secondary outcome), as well as the reach of the information campaign.

Proposed timeline

Period	Activities
November, 2019	Selection of villages to be included in the study sample
January, 2020	Baseline survey
February, 2020	Randomization
From December, 2020 to April, 2021	Program implementation
April, 2021	Endline survey
June, 2021	Completion of data analysis
September, 2021	Submission of Stage 2 manuscript

We conducted our baseline survey in January 2020 and randomly assigned villages to treatment and control in February 2020. The intervention is scheduled to start in December 2020 and run for 3 months before we collect endline data. This schedule may be subject to change depending on the evolution of the Covid-19 and political situation in the country. However, it should be noted that this timetable was agreed by all stakeholders on November 26, 2020 (including the government, the midwives' association and donors). Face-to-face data collection is currently allowed in Côte d'Ivoire provided that researchers comply with government Covid-19 precautions.

1. Introduction

In low-income and middle-income countries, 250 million children under 5 years of age are at risk of not reaching their developmental potential (Black et al., 2017). Among other key risk factors, low levels of cognitive stimulation, dietary deficiencies, chronic infections, and even excessive exposure to stress can affect the structure and functioning of the brain, and subsequent child development (Walker et al., 2011). Affected children are likely to do poorly in school and subsequently have low incomes, high fertility, and provide poor care for their children, thus contributing to the intergenerational transmission of poverty (Grantham-McGregor et al., 2007).

Effective investments in the development of a child in their first years (for instance, taking the forms of parent-support or preschool education programs) have the potential to set them on a trajectory towards a better equilibrium (Engle et al., 2011). In fact, Gertler et al. (2014) found that, twenty years after a parent-support intervention was implemented in Jamaica, the earnings of the children who benefitted from the intervention were 25% higher than those of the children who did not. The intervention consisted of weekly visits from community health workers over a 2-year period that taught parenting skills and encouraged mothers and children to interact in ways that develop cognitive and socioemotional skills. Yet, there are currently few tested models for taking early childhood interventions to scale and guidance remains limited for policymakers operating under budget and human capital constraints.

In order to remedy this, we propose to study the impact of a cheap and easily scalable information campaign targeting parenting practices to improve early childhood stimulation and designed to reach remote communities. A series of short videos saved on mobile phone memory cards will be disseminated, with the aim of encouraging simple parenting behaviors that promote child development. Taking the form of a mini-series mixing entertainment and education, the videos tell the story of a father who, following the advice of his brother, changes his parenting practices to

promote his children's development and marvels at the progress they make. Videos are made available to the public in multiple languages to engage viewers and increase buy-in to the conveyed messages. In order to reach as many people as possible, the intervention will take advantage of the high mobile penetration rates and the fact that mobile phone memory cards allow one to exchange music and videos – a practice that is particularly common in West Africa.

As part of this project, we set ourselves to answer two main research questions:

Question 1: What is the impact of the videos on parenting knowledge and practices, as well as on child development? With this first question, we want to study the effectiveness of the videos as a factor of change.

Question 2: To what extent are the messages conveyed by the information campaign using memory cards to disseminate the videos getting through to the targeted populations? With this second question, we want to study the effectiveness of the memory cards as a means of disseminating information to remote communities.

To answer these two questions, we implement a randomized controlled trial in 200 rural villages of Côte d'Ivoire, which were randomly selected from a large area representing 16.0% of the country's population. Memory cards containing the videos will be distributed to key individuals at the village level (community leaders and local health workers) in 100 randomly selected treatment villages. Then, these key individuals will be responsible for distributing the SD cards or sharing videos directly with other village members. Given that most media programs have a low take-up, we propose to answer these two questions separately using a two-sample design, as part of which two distinct sub-samples of households will be constituted in each village for the purpose of answering our two different research questions. To answer *research question #1*, a first subsample of households will be handed over memory cards containing the videos and encouraged to watch them. In doing so, we fall

in with the experimental literature on media programs, which studies their impact in controlled settings. To answer *research question #2*, we will use a distinct subset of households who will not be handed over the memory cards but might receive them from community leaders, local health workers, or friends and family in the village.

In answering these questions, we hope to contribute to two different strands of literature. First, we hope to contribute to the one on early childhood development by providing an example of a cheap early childhood stimulation (ECS) program that can be easily scaled up in low-income countries (see J-PAL (2020) for a review for a review of studies on interventions promoting ECS by parents and caregivers to improve child development). While promoting psychosocial stimulation between caregivers and children has already found to be effective at improving child development (Walker et al., 2011; Gertler et al., 2014; Singla et al., 2015; Attanasio et al., 2020), several questions remain. The few tested interventions are all based on meetings with trained individuals, which can be both expensive and difficult to take to scale for governments operating under budget and human capital constraints. In fact, the few scale-up experiences that have been evaluated have demonstrated systematic problems in program implementation and, ultimately, a more modest impact (Fernald et al., 2017; Andrew et al., 2018; Attanasio et al., 2018).

We also add to the experimental literature on the impact of media programs (DellaVigna and La Ferrara, 2015) by studying jointly the effect of media content and a scalable way to share it with a population of interest. So far, experimental studies on the impact of media programs (and, in particular, videos) have focused on answering the first question in controlled settings using one of two means to increase respondents' exposure to their program: a) organizing screening sessions in treatment villages (e.g. Bernard et al., 2014; Ravallion et al., 2015; Banerjee et al., 2019a; Banerjee et al., 2019b); or b) offering financial incentives to treatment respondents (Berg and Zia, 2017; Bjorvatn et al., 2019). However, the second question has been eluded from most experimental studies

despite the fact it is essential to estimating the impact a program would have if it was to be scaled up. A notable exception is Barsoum et al. (2020) who measured the impact of a program broadcast on national television using an encouragement design relying solely on text messages.

2. Research design

2.1. Context

The intervention will be implemented in villages located in Côte d'Ivoire, a lower middle-income country of 25.07 million inhabitants.

In Côte d'Ivoire, as in many other countries, a large share of children are not getting enough stimulation in their early childhood to reach their developmental potential. There are several reasons for this. For instance, knowledge about the importance of early childhood stimulation for children's development is limited and, as a consequence, parents do not always carry out stimulating activities (*e.g.* playing, reading, and singing) as often as they should. Gendered norms also often lead fathers to see it as the responsibility of mothers to play and talk with young children. Moreover, the time that parents can devote to these activities is even more limited in rural settings given the significant amount of time parents spend working in the fields, etc. Finally, certain parenting practices that are detrimental to child development remain the norm, with nearly nine out of ten children (86.5%) being subjected to violent disciplinary methods at an early age, and the majority of them experiencing physical, emotional, or sexual abuse during childhood (UNICEF, 2019).[1]

Traditional media programs (*i.e.* the internet, newspapers, radio, and television) have been shown to be important vectors of societal changes in various settings (DellaVigna and La Ferrara, 2015) and offer promising avenues for conveying information on the benefits of early childhood stimulation to

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[1] Note that the welfare state is currently too underdeveloped to help children on a large scale. For instance, less than 10% for children aged 36-59 months are currently enrolled in early childhood education programs.

a large audience at a low cost. However, in Côte d'Ivoire as elsewhere, their effectiveness is often hampered by several factors. First, access to traditional media is limited. In Côte d'Ivoire, only 48.6% of the households owned a television set and 51.6% owned a radio (DHS, 2016). Moreover, the literacy rate of individuals aged 15 and above was at 47.2% in 2018 according the UNESCO and only 37.5% were using the internet in the same year according to the International Telecommunication Union. These figures tend to decrease with the degree of remoteness of the populations, indicating that traditional media have a considerably lower reach in more rural areas.

Second, many countries have a fragmented linguistic environment, which diminishes the effectiveness of uniform communication, often a prerequisite of traditional media, among a heterogeneous population. In Côte d'Ivoire, 78 indigenous languages coming from five different branches of the Congo-Niger language family are currently being spoken. Moreover, although other languages (*e.g.* Dioula) are also commonly used to communicate between members of different linguistic groups, French remains the official language and is the *lingua franca*. It is also by far the main language used by the media. Unfortunately, only 31.1% of the population understands it – again, figures are lower in rural areas.[2]

2.2. Intervention

It is in this context that Development Media International (DMI)[3] designed an innovative intervention to reach remote communities. It is based on two key elements: a) its media content, *i.e.* the videos using entertaining stories to promote ECS, and b) its means of distribution to the population, *i.e.* via

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[2] This figure is based on population estimates from the 2014 census and on the number of Francophones in Côte d'Ivoire in 2014 available on the following webpage: http://observatoire.francophonie.org/qui-parle-francais-dans-le-monde/ (accessed in September, 2020).

[3] Development Media International is a non-governmental organization with both non-profit and for-profit arms that "use[s] scientific modelling combined with mass media campaigns in order to save the greatest number of lives in the most cost-effective way." More information on the organization can be found on their website: https://www.developmentmedia.net/

mobile phone memory cards distributed via key individuals at the village level (community leaders and local health workers).

Content of the videos

The videos consist of a mini-series of 9 short videos (2-3 minutes) designed to encourage simple but effective parenting practices to foster childhood stimulation. The entertaining videos tell the story of a father who, following the advice of his brother, begins to play and interact with their children in a stimulating way and marvels at the progress they make.

As displayed in *Table 1* below, the messages conveyed by the videos encourage parents to praise and encourage their children, speak to them, and play with them from an early age to foster their development. The videos aim to address beliefs that were identified through qualitative formative research, as being barriers to parental investment in stimulating activities. For example, the videos aim to correct the idea that mothers have sole responsibility for raising children, that praising children will make them vain and disrespectful, and that stimulating children is only important if they can talk.

Table 1: Key messages conveyed by the videos

Episode	Key message(s)
1	Talk to your children, it awakens their consciousness and develops their intelligence.
2	When your children are unable to do something, encourage them, do not get angry at them.
3	Your children learn by playing. You can encourage play activities by making toys for them from scratch or by using what you find at home, as long as it is safe for them.
4	Stimulate your children from an early age, even before they can speak. Babies can understand long before they can talk.
5	Playing with your children promotes their development. It is also the responsibility of fathers to do so, not just mothers.
6	Praising your children will not make them vain and disrespectful, but will promote their development.

7	If you are too busy with daily chores to play with your children, you can get them involved in some of your activities (to the extent of their abilities). It allows you to accomplish your tasks while promoting your children's learning.
8	Use positive discipline rather than negative discipline.
9	Encouraging children, talking to them, playing with them, fosters their development. This is everyone's responsibility.

To engage viewers and increase buy-in to the conveyed messages, the videos are made available to the public in French, as well as in the most common local languages of the area where the intervention will be implemented: Baoulé, Bété, Guéré, Malinké, Moré, Wobé, and Yacouba.

Means of distribution for the videos

An innovative feature of this information campaign lies in how these videos will be shared with the population: they will be saved on mobile phone memory cards (SD cards) and distributed via key individuals at the village level (community leaders and local health workers). This delivery method takes advantage of the high mobile penetration rates and the fact that memory cards are commonly used to exchange music and videos in West Africa.[4] As discussed in the previous sub-section, this way of disseminating the videos is particularly interesting in a disadvantaged and linguistically fragmented context where access to traditional media content (*i.e.* the internet, newspapers, radio, and television) is limited by lack of availability, human capital and financial constraints, as well as linguistic barriers.

Midwives will be responsible for supplying key individuals at the village level (community leaders and local health workers) with memory cards containing the videos. Then, these key individuals will be instructed to share the memory cards and/or the videos (either by physically copying them from

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[4] In Côte d'Ivoire, the mobile penetration rate is estimated to be as high as 113.32%. At the end of 2016, the country's agency of telecommunications regulation (ARTCI) estimated that there were over 27.5 million mobile phone subscribers using one or multiple sim cards in Côte d'Ivoire. Most users continue to use simple handsets that can usually show video but have limited internet connectivity. These phones are available from as little as USD$5-$10. Videos are produced for very small screens so that they can be watched on low-cost feature phones that are video enabled.

one phone to another or via Bluetooth and WhatsApp) with other village members with young children. In order to foster dissemination, letters of support were obtained from the government, all stakeholders who will be requested to log the names of the individuals they share the cards and/or the videos with, and DMI will monitor the work of the midwives, who in turn will monitor the work of the others key individuals.

2.3. Sampling strategy

We will measure the impact of the intervention on a subset of villages located in the cocoa-growing region, which is a particularly disadvantaged area of Côte d'Ivoire. As the intervention primarily targets men, for whom there is likely to be more room for improvement in interactions with children, our study focuses on primary male caregivers.

Selection of villages

We used data from the 2014 census (Recensement Général de la population et de l'Habitat) to constitute our sample of villages. The census provides the name of each of the Ivorian localities, as well as their number of inhabitants. It also provides whether or not a locality is located in the communal area of the administrative town to which it is attached.

We restricted our focus to villages located in the following five districts of the cocoa-growing regions: Bas-Sassandra (Nawa region), Goh-Djiboua (Goh region), Montagnes (Guémon region), Sassandra Marahoué (départements of Issia and Sinfra), and Yamoussoukro. This area represents a large corridor of 3.6 million inhabitants extending from the center of the country to its western borders – 16.0% of the country's population and 10.4% of its total area. Among these, we have further restricted our attention to medium-sized localities, in which between 500 and 2,000 inhabitants reside, and those located outside the communal area of the administrative city to which it is attached, so as to exclude urban localities.

From the eligible villages, we randomly selected 200 villages to be included in our sample.

Selection of households

In each selected village, households were approached using a random walk methodology and 15 households meeting the following two eligibility criteria were selected: 1) household has at least a child under 24 months of age; 2) household members own at least one mobile phone on which they can watch videos.

We will measure the impact of the intervention on primary male caregivers and children under 2 years of age at baseline. When more than one child under 2 years of age was living in the household at the time of the baseline survey, a random draw was held to determine which child would be selected for the study.

In January 2020, we found and selected an average of 14.5 households in each village, for a total of 2,901 households and children.

2.4. Identification strategy

As displayed in *Figure 1,* the design of our randomized controlled trial is based on two key features which allow us to answer separately the two research questions we are interested in.

First, we created two subsamples of households in each of the 200 villages. We did so by randomly splitting the 15 selected households in two groups of sizes 10 and 5. Groups of 10 (referred to as "*type 1* respondents" hereafter) will be used to measure the impact of the intervention on parenting knowledge and practices, and child development (*research question #1*). Groups of 5 (referred to as "*type 2* respondents" hereafter) will be used to study the reach of the information campaign (*research question #2*). In total, our sample includes 1,953 type 1 respondents and 948 type 2 respondents.

Second, we randomly selected 100 villages in which memory cards containing the videos will be handed out to key individuals at the village level (community leaders and local health workers) for distribution.[5] In treatment villages, memory cards will be handed over to type 1 respondents (not type 2) by midwives. Whenever necessary, they will teach beneficiaries how to watch the videos on their phones. After a month, a follow-up visit will be organized to make sure that selected households have watched the videos. Note that midwives will not provide any information other than technical assistance to help households play the videos on their cell phones, to ensure that our estimates reflect only the effect of the videos – not a combination of the videos and the midwives' actions. Finally, type 1 respondents will be asked to keep their memory card and its contents private to avoid any spillover effect on type 2 respondents, who will not receive a memory card.

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[5] The draw was stratified by region, which, in the administrative divisions of Côte d'Ivoire, is under the district and above the *département*.
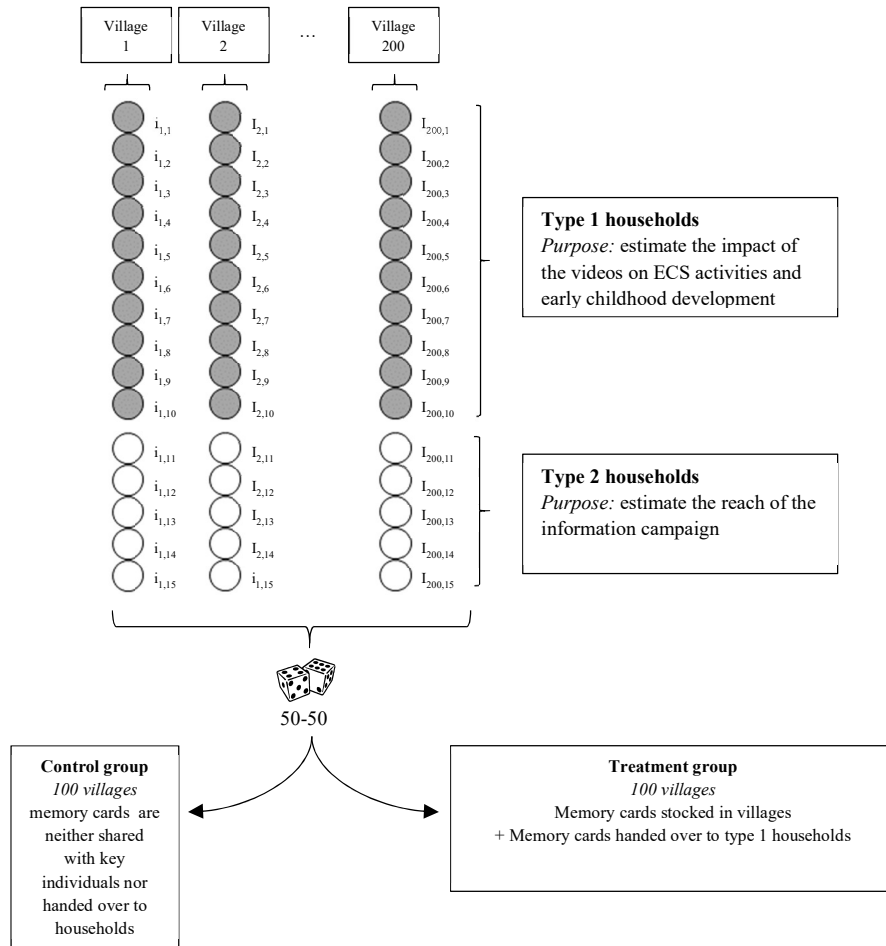
Village 1 | Village 2 | ... | Village 200

$i_{1,1}$ | $I_{2,1}$ | $I_{200,1}$
$i_{1,2}$ | $I_{2,2}$ | $I_{200,2}$
$i_{1,3}$ | $I_{2,3}$ | $I_{200,3}$
$i_{1,4}$ | $I_{2,4}$ | $I_{200,4}$
$i_{1,5}$ | $I_{2,5}$ | $I_{200,5}$
$i_{1,6}$ | $I_{2,6}$ | $I_{200,6}$
$i_{1,7}$ | $I_{2,7}$ | $I_{200,7}$
$i_{1,8}$ | $I_{2,8}$ | $I_{200,8}$
$i_{1,9}$ | $I_{2,9}$ | $I_{200,9}$
$i_{1,10}$ | $I_{2,10}$ | $I_{200,10}$

Type 1 households
Purpose: estimate the impact of the videos on ECS activities and early childhood development

$i_{1,11}$ | $I_{2,11}$ | $I_{200,11}$
$i_{1,12}$ | $I_{2,12}$ | $I_{200,12}$
$i_{1,13}$ | $I_{2,13}$ | $I_{200,13}$
$i_{1,14}$ | $I_{2,14}$ | $I_{200,14}$
$i_{1,15}$ | $i_{1,15}$ | $I_{200,15}$

Type 2 households
Purpose: estimate the reach of the information campaign

50-50

Control group
100 villages
memory cards are neither shared with key individuals nor handed over to households

Treatment group
100 villages
Memory cards stocked in villages
+ Memory cards handed over to type 1 households

Fig. 1: Experimental design

We map the location of control villages (in white) and treatment villages (in blue) in *Figure 2*.
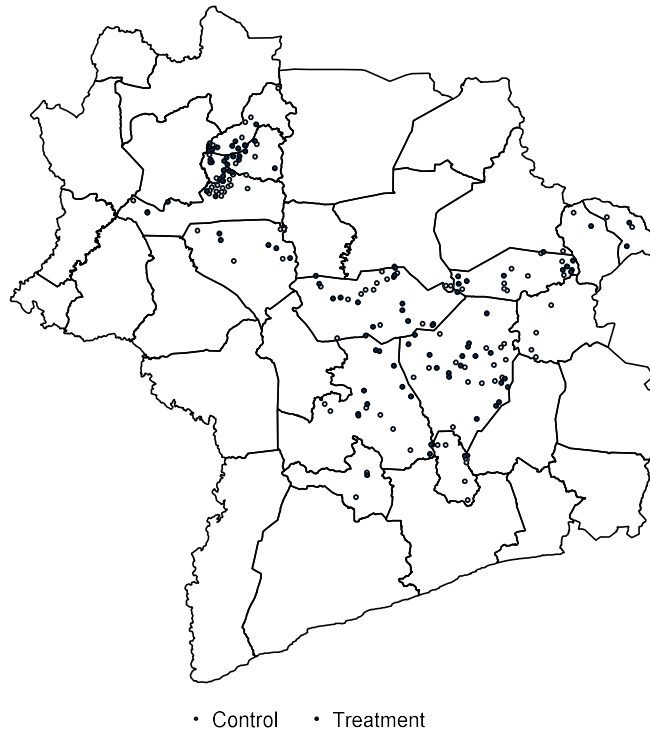

· Control   · Treatment

Fig. 2: Location of sampled villages

2.5. Sample description and balance checks

In January 2020, we carried out our baseline survey. While type 1 households answered a full baseline survey, type 2 households simply answered a short version of the questionnaire which was merely designed to collect basic background information on each of the household members (gender, age, highest level of education, etc.).

In *Table 2*, we describe the average baseline characteristics of the individuals surveyed at baseline and those of their child we selected. As we focus on male caregivers, 95% of the respondents to the initial survey were men – the remaining 5% were the result of sampling errors. The average age is 38 years old and average household size is 6.4. The level of education is relatively low as 27.2% of our respondents have no education at all and 36.9% have only been through primary education. Almost all respondents live with a partner in a monogamous marriage (46.8%), a polygamous one (8.4%), or

without being married (38.0%). Half of the children included in our sample are boys (50.0%) and are on average 11 months old. Most of the children live in the same household as their biological mother (97.4%) and father (87.6%).

Table 2: Sample description

Variables	N	Mean	Sd
Panel A: Selected adults			
Male	2,901	0.948	0.221
Age	2,901	38.457	11.134
Household size	2,901	6.371	2.580
Highest level of education			
None	2,901	0.272	0.445
Primary	2,901	0.369	0.483
Higher	2,901	0.359	0.480
Has an income-generating activity	2,901	0.925	0.263
Marital status			
Monogamous marriage	2,901	0.468	0.499
Polygamous marriage	2,901	0.084	0.278
Cohabitation	2,901	0.380	0.485
Single	2,901	0.041	0.198
Other	2,901	0.028	0.164
Panel B: Selected children			
Male	2,901	0.499	0.500
Age (in months)	2,900	11.031	6.658
Bio. father lives in the household	2,901	0.876	0.330
Bio. mother lives in the household	2,901	0.974	0.161

Notes: In the table, we provide the average characteristics of the primary male caregivers included in our sample (Panel A). We also provide a description of the child who, in each household, was randomly selected for the purpose of this experiment (Panel B).

Data collected from type 1 respondents is displayed in *Table 3* convey some other important information. First, investigating household assets, we find that they own an average of 2.3 mobile phones. In contrast, only 41.4% have a radio and 34.1% have a TV set. Cause and consequence of the widespread use of cell phones, 72.6% of the households own a mobile money account when only 10.1% of the respondents have a traditional bank account. Second, as expected, exposure to traditional media programs is limited. On average, respondents report listening to radio in 53.1% of cases and television in 48.1% of cases. They more rarely read newspapers and use the Internet. Third, we observe that it seems possible to significantly improve child development by promoting adequate parenting, as households score 2.3 out of 5 on the *Support for Learning* index, which indicates the

extent to which household members are engaged in childhood stimulation, and 0.4 out of 2 on the

Learning Materials index, which indicates the availability of learning materials.

Table 3: Balance checks

	Type 1 respondents						Type 2 respondents					
	Sample description			*Balance checks*			*Sample description*			*Balance checks*		
Variables	**N**	**Mean**	**Sd**	**Coeff.**	**P-value**	**Sig.**	**N**	**Mean**	**Sd**	**Coeff.**	**P-value**	**Sig.**
Panel A: Selected adults												
Male	1,953	0.963	0.190	0.025	0.015		948	0.919	0.273	0.020	0.025	
Age	1,953	38.580	11.065	-0.057	0.540		948	38.204	11.276	-0.521	0.803	
Household size	1,953	6.400	2.595	0.059	0.149		948	6.309	2.550	-0.010	0.188	
Highest level of education												
None	1,953	0.247	0.432	-0.029	0.026		948	0.323	0.468	-0.024	0.037	
Primary	1,953	0.369	0.483	-0.006	0.024		948	0.369	0.483	0.050	0.032	
Higher	1,953	0.384	0.486	0.035	0.026		948	0.307	0.461	-0.028	0.033	
Has an income-generating activity	1,953	0.931	0.253	0.006	0.014		948	0.914	0.281	0.021	0.020	
Marital status												
Monogamous marriage	1,953	0.478	0.500	0.016	0.041		948	0.447	0.497	0.049	0.042	
Polygamous marriage	1,953	0.073	0.260	-0.002	0.014		948	0.108	0.310	-0.014	0.022	
Cohabitation	1,953	0.384	0.486	-0.024	0.040		948	0.371	0.483	-0.039	0.043	
Single	1,953	0.040	0.196	-0.001	0.010		948	0.042	0.201	-0.005	0.014	
Other	1,953	0.026	0.158	0.011	0.010		948	0.032	0.175	0.008	0.012	
Asset owned:												
#Mobile phones	1,953	2.269	1.329	0.070	0.074							
#Radios	1,953	0.414	0.535	-0.015	0.026							
#TVs	1,953	0.341	0.511	0.011	0.029							
Bank account	1,953	0.101	0.301	0.002	0.016							
Mobile money account	1,953	0.726	0.446	0.001	0.025							
Use of media												
Newspapers	1,953	0.173	0.378	0.023	0.023							
Radio	1,953	0.531	0.499	0.053	0.033							
TV	1,953	0.481	0.500	0.029	0.032							
Internet	1,953	0.175	0.380	0.033	0.022							
Parenting practices												
Support for learning (0 to 5)	1,933	2.342	1.133	0.057	0.085							
Learning material (0 to 2)	1,945	0.544	0.514	-0.005	0.028							
Inadequate care (0 to 1)	1,953	0.171	0.377	-0.003	0.022							
Panel B: Selected children												
Male	1,953	0.506	0.500	0.004	0.022		948	0.484	0.500	-0.004	0.032	
Age (in months)	1,953	10.928	6.657	-0.398	0.328		947	11.245	6.658	-0.665	0.430	
Bio. father lives in the household	1,953	0.879	0.326	0.027	0.017		948	0.869	0.337	0.030	0.023	
Bio. mother lives in the household	1,953	0.971	0.167	0.004	0.008		948	0.978	0.147	-0.002	0.009	

Notes: In the table, we provide the average characteristics of the type 1 and type 2 respondents who completed our baseline questionnaire (Panel A). We also provide a description of the child who, in each household, was randomly selected for the purpose of this experiment (Panel B). For both types of respondents, we compare the characteristics of the control and treatment respondents. In order to do so, equation (1) is estimated for each variable displayed in the left column. Equations are estimated separately for type 1 and type 2 respondents. Note that the amount of information available for type 2 respondents is more limited because they were not requested to answer the whole baseline questionnaire and only basic information on each household member was collected . Standard errors are clustered at the group of friends level. *, **, *** denote significance at the 10, 5 and 1 percent levels respectively.

As expected due to randomization, the characteristics of type 1 and type 2 respondents are

uncorrelated with whether or not the village in which they live was selected to benefit from the

intervention, as also displayed in *Table 3*. Coefficients displayed in the *Balance checks* columns are obtained by regressing successively each of the baseline characteristics displayed in the left column of the table on a dummy variable indicating whether or not a respondent i lives in a treatment village and a vector of region fixed effects. We do this separately for type 1 and type 2 respondents. The point estimates associated with the treatment variable remain small and non-significant at the 10% level, suggesting again that respondents' treatment status is uncorrelated with their baseline characteristics.

2.6.   Theories of change, outcomes, and statistical power

Research question #1. *What is the impact of the videos on parenting knowledge and practices, as well as on child development?*

As mentioned above, our first objective is to measure the impact of the videos on parenting knowledge and practices, as well as on child development (*research question #1*). Our primary outcomes are parents' knowledge and practices. Our secondary outcome is child development.

a. Theory of change

In order to answer *research question #1*, we will collect information to test the following sequence of the hypotheses:

Hypothesis 1. *Respondents will watch the videos*

Rationale: Exposure to videos is a prerequisite for them to have any impact.

Outcomes: Respondents will be asked whether they received a mobile phone memory card, whether they watched at least one of the videos contained on the memory card and, if so, the number of videos they watched and the number of times they watched them.

Hypothesis 2. *Videos will modify respondents' knowledge about parenting practices and child development*

Rationale: We will study parenting knowledge as a determinant of parenting practices.

Outcomes: Parenting knowledge will be measured with the help of the Parent Knowledge Scale developed by Powell et al. (2004) and used in other subsequent studies – *e.g.* Chang et al. (2015) and Hamadani et al. (2019). Parents will be asked to indicate if they agree completely, agree a little bit, disagree a little bit, or disagree completely with a series of statements, such as "Too much love and attention will spoil a child," "There is no need to give toys to children < 1 year old," "Children should not be given crayons until they are ready to learn to write," etc.

Hypothesis 3. *Respondents will modify their parenting practices to promote stimulating activities and limit their use of violent discipline.*

Rationale: We will study two dimensions of parenting practices, which were shown to be highly correlated with child development.

Outcomes: On the one hand, we will measure the extent to which parents engage in early childhood stimulation (Bradley and Corwyn, 2005; Kariger et al., 2012; Hamadani et al., 2006) with the help of the Family Care Indicators developed by the UNICEF as part of the Multiple Indicator Cluster Survey (MICS) (Kariger et al., 2012). The indicators assess the availability of books and play materials along with the occurrence of different activities between an adult and a child, including reading books, singing songs, telling stories, playing, teaching about letters, numbers, and concepts, and going on outings that take the child outside the home. Indicators will be combined into three indexes capturing a) the extent to which household members engage in childhood stimulation (*Support for Learning*

index), b) learning materials availability (*Learning Materials* index), and c) inadequate supervision (*Inadequate Supervision* index). To do so, we will follow UNICEF's guidelines.[6]

On the other hand, we will measure the extent to which parents resort to violent discipline (verbal or physical) (Teicher et al., 2006; Hillis et al., 2016) with the help of the Dimensions of Discipline Inventory (DDI). The DDI provides information on 26 of the most frequently used discipline behaviors of parents, such as explaining, rewarding, deprivation of privileges, and spanking (Strauss and Fauchier, 2007). The DDI items can be used to create nine sub-indexes indicating the frequency with which parents use the following discipline method: a) corporal punishment; b) deprivation of privileges; c) psychological aggression; d) penalty tasks and restorative behavior; e) diversion; f) explain/teach; g) ignore misbehavior; h) rewards; and i) monitoring.[7] We will create two different sub-indexes capturing violent and non-violent disciplines (the former including items falling in sub-indexes a) and c)).

***Hypothesis 4.** Child development will improve*

Outcomes: Our secondary outcome is child development, which will be assessed using different adults' reports. It will be measured using the long-form of the Caregiver Reported Early Childhood Development Instrument (CREDI), which asks caregivers whether a child can or cannot do a series of tasks.[8] CREDI data will be collected from caregivers as well as from another household member aged above 18, who will be randomly selected out of the list of members identified at baseline. Collecting these two pieces of information will allow us to determine whether caregiver assessments are likely to overestimate the true impact of the intervention when it is likely to affect the extent to

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[6] They can be found in the *Tabulation Plan* available on the following webpage: https://mics.unicef.org/tools#analysis
[7] Discipline methods a) to d) can be thought of as punitive or partly punitive methods and e) to i) as non-punitive ones.
[8] More information on the tool is available on the project's webpage: https://sites.sph.harvard.edu/credi

which caregivers pay attention to their child and, therefore, the extent to which they are likely to see and report when a child is able to perform a new task.

Table 4: Primary and secondary outcomes

Hypothesis	Outcome	Tool	Definition	Collected at baseline	Type
H1	Exposure to the videos	N.A.	Whether or not respondents watched at least one video; Number of videos watched	No	Intermediate
H2	Parenting knowledge	Parent Knowledge Scale		No	Primary
H3a	Parenting practices, early childhood stimulation activities carried out	Family Care Indicators	Support for learning index Learning materials index Inadequate supervision index	Yes	Primary
H3b	Parenting practices, use of violent discipline	Dimensions of Discipline Inventory	Violent discipline index	No	Primary
H4	Early childhood development	CREDI	CREDI score	No	Secondary

b. Minimum detectable effects (MDE)

As mentioned above, we use a sample of 200 villages, containing on average 10 households each, to answer our first research question. To calculate MDE, we use a type I error of 5% and a type II error of 80%.

Intra-cluster correlations (ICC): We compute ICCs using data collected at baseline. It should be noted that, after careful analysis of the baseline data, we decided to replace some of the tools used at baseline with those just described, which we now consider more appropriate (as displayed in *Table 4*). As reported in *Table 5*, we found ICCs of 0.09 for parenting knowledge, 0.20 for the *Support for Learning* index, 0.04 for the *Learning Materials* index, 0.09 for the *Inadequate Supervision* index,

0.07 for violent discipline, and 0.04 for early childhood development. Note that the ICC found for early childhood development is similar to what was found in other settings – Andrew et al. (2018) and Macours et al. (2008) both found an ICC below 0.05 for early childhood development.

Compliance: We estimate the compliance rate at 90%. We believe that the fact that memory cards will be handed over by midwives combined with the novelty of the intervention, using videos dubbed in local languages, should guarantee a high compliance rate. Furthermore, midwives will also be instructed to make sure that treatment respondents watch the videos. Finally, as the study area is vast, we expect a contamination rate close to 0 in the control villages. We discuss this further in the next subsection.

Attrition: As our study focuses on villages located in rural areas where geographic mobility is more limited, we believe it is reasonable to estimate that the attrition rate will not exceed 20%. In order to limit this rate as much as possible, a lot of information (topographical landmarks, telephone numbers, GPS coordinates, etc.) was collected at baseline in order to increase our chances of finding our respondents at the time of the follow-up survey. Finally, the endline survey will be conducted by Innovations for Poverty Action, which has extensive experience in tracking and surveying households in Cote d'Ivoire.

In the following table, we report MDEs under different scenarios varying only in the value taken by the R-square derived from the regression of our outcome variables on baseline characteristics (R^2).

Table 5: Minimum detectable effects

Outcome	MDEs (in standard deviations)		
	$R^2=0.1$	$R^2=0.2$	$R^2=0.3$
Parenting knowledge	0.183	0.179	0.175
Parenting practices, - Support for learning index	0.216	0.209	0.200
- Learning materials index	0.166	0.164	0.162
- Inadequate supervision index	0.183	0.179	0.175
Parenting practices, use of violent discipline	0.176	0.173	0.170
Early childhood development	0.166	0.164	0.162

Overall, we believe these to be reasonably small effect sizes. First, videos have proven to be very effective in promoting different types of behaviors, ranging from reducing the acceptability of domestic violence (Banerjee et al., 2019) to improving financial decisions (Berg and Zia, 2017). Second, the latest review on the impact of programs promoting psychosocial stimulation between caregivers and children (J-PAL, 2020) reports considerably larger impacts on parental knowledge, parental practices, and child development: *"all of the 16 studies that measured developmental outcomes found that these programs significantly improved child development in the short-term"* with effect sizes ranging between 0.15 and 1.3 standard deviation.

Research question #2. *To what extent are the messages conveyed by the information campaign using memory cards to disseminate the videos getting through to the targeted populations?*

Our second objective is to measure the extent to which the messages conveyed by the information campaign get through to the target populations (*research question #2*).

a. Theory of change

To estimate the reach of the information campaign, we will ask a series of question investigating if respondents: a) have heard of the videos; b) were handed over a memory card containing the videos; c) have watched at least one of the videos (and, if so, the number of videos watched); d) can provide information on the content of the videos; e) can identify key messages conveyed by the videos.

In order to study dissemination mechanisms, respondents will also be asked how they heard about the memory cards, where they obtained them, and with whom they watched the videos.

b. Minimum detectable effects (MDE)

We compute MDEs under the same assumption as those described just above with the only exception that the sample we will use to answer *research question #2* is smaller with only 5 households per village instead of 10. Under these assumptions, we should be able to detect effect sizes ranging between 0.20 and 0.25 standard deviation.

Again, we believe that this minimum detectable effect is reasonably small. In 2011, DMI tested the effectiveness of the dissemination strategy as part of a non-randomized pilot study carried out in the Gaoua region, Burkina Faso. As part of it, videos dubbed in a local language (Lobiri) were saved on mobile phone memory cards and stocked in local shops for distribution. DMI tested this means of dissemination and found that while only 1% of respondents had watched the videos in the control villages, more than 30% had watched them in the treatment villages (Swigart et al., 2019).[9]

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[9] More information on this pilot study can be found on the following webpage: https://www.developmentmedia.net/burkina-faso-mobile-phone-videos-trial.html

3. Empirical Analysis

To answer our research questions, we will collect follow-up data in April 2021, 3 months after the start of the intervention. This follow up will be carried out by Innovations for Poverty Action which has extensive experience working in the area.

Econometric specification: To measure the impact of the videos and information campaign on an outcome (y_{it}) measured at time *t*, we will estimate the following two equations:

$$y_i = \beta_1 * T_i + \mu + \varepsilon_i \qquad \textbf{(eq. 1)}$$

$$y_i = \beta_1 * T_i + \mu + X_i * \mu + \varepsilon_i \qquad \textbf{(eq. 2)}$$

In these equations, T_i is a dummy variable indicating whether or not respondent *i* belongs to a village which was randomly selected to benefit from the intervention and μ is a vector of region fixed effects. We will investigate whether or not adding a vector of baseline covariates X_i containing respondents' pre-randomization background information change the results. Given the study design and the fact that respondents' characteristics are uncorrelated with their treatment status, we hypothesize that adding X_i to the estimated equation will not have a statistically significant effect on the coefficients.

Standard errors: we cluster standard errors at the village level to account for possible correlation in outcomes within villages.

Multiple hypothesis testing: When carrying out inference, individual outcomes will be aggregated into indexes by families of outcomes to limit the number of statistical tests we will carry out, and, when they will not, p-values will be adjusted using the Romano-Wolf procedure to control the Family Wise Error Rate. This strategy will limit the probability of making one or more false discoveries.

Heterogeneity analysis: We will estimate the impact of the intervention on half of the households with the highest score on the *support for learning* index and the other half of the households with the lowest score. We will do so by estimating the following equation:

$$y_i = a\,(Low_i * T_i) + b\,(High_i * T_i) + \gamma Low_i + X_i\beta + \mu + \varepsilon_i \qquad \textbf{(eq. 3)}$$

In this equation, Low_i and $High_i$ are dummy variables indicating whether respondent *i* belongs to the group with the lowest or the highest score on the *support for learning* index.

Handling of attrition: We will investigate whether or not attrition is balanced across groups by estimating equations (1) and (2). If attrition is found to be related to treatment status, we will use Lee bounds to obtain bounds on the effect of the intervention. We will also report the extent to which attrition correlated with household characteristics at baseline.

Handling of outliers: All continuous variables will be top-coded at the 99 percentile.

Imputation: No imputation for missing data from item non-response will be performed. We will check for each question whether the item specific non-response rate is correlated with respondents' treatment status and, if it is the case, bounds will be constructed to account for the problem.

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