

Social Signaling and Childhood Immunization: A Field Experiment in Sierra Leone

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Abstract

This paper investigates social signaling in the context of childhood immunization in Sierra Leone. Despite attending initial visits, many parents do not complete their children's vaccination timely. I introduce color-coded bracelets for children's vaccination, enabling parents to durably signal their actions. Consistent with theory, parents use the bracelets to learn about others' actions, and bracelets' impact varies with the social desirability of the action. A signal linked to a highly valued vaccine increases complete vaccinations by 14 percentage points at \$1 per child. I estimate that parents' value of signaling completion is equivalent to the cost of walking 5-8 miles.

JEL Classifications: D01, D62, D81, D82, D83, D91, I12, O10

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1 Introduction

Childhood immunization is one of the most cost-effective ways of reducing child mortality (UNICEF 2018).¹ Over the past decade, remarkable progress has been made in increasing the availability and reliability of immunization services (UNICEF and WHO 2016). In 2008, almost 20 percent of children in Sierra Leone had not received their first vaccine by the age of one (Sierra Leone DHS 2009). This number had dropped to five percent by 2013 (Sierra Leone DHS 2014). Despite this improvement in initial vaccination rates, only 56 percent of children complete the first-year series of vaccinations (Sierra Leone DHS 2020), a pattern that is common across many low-income countries.² In this paper, I ask two questions: Can we increase timely and complete vaccination, by allowing parents to signal to others that they vaccinated their child? Beyond visibility, what are the mechanisms through which social signals affect decision-making in a dynamic, real-life setting?

To answer these questions, I design a field experiment based on Bénabou and Tirole's (2006; 2011) theory of social signaling, which states that individuals' utility depends on the expectations that others form about their type, based on the actions they take. In the context of my study, there are strong social norms surrounding the importance of vaccination – 79 percent of communities in my sample believe that parents who fail to vaccinate their children are negligent. As vaccines are currently imperfectly observable, I create an opportunity for parents to publicly show that they correctly vaccinated their child by introducing a durable signal - in the form of differently colored bracelets - that children receive upon vaccination. I experimentally vary the information that the bracelets provide about the take-up of different vaccines, by randomizing 120 clinics into three treatment arms and one Control Group.³ For each clinic, I randomly select two adjacent communities (0 to 2 miles away) and three far communities (2 to 5 miles away), to create a final sample of 582 communities. I exploit two important features of childhood immunization in my experimental design: (1) individuals have to take multiple actions, as children require five vaccinations before the age of one; (2) individuals make decisions over a long time horizon, from the first vaccination at birth to the last vaccination at 9 months of age (WHO 2018).

Using (1), I randomly vary access to three different bracelets with varying signaling

¹The benefits of vaccines go beyond the direct health impacts: vaccines contribute to higher educational outcomes, reduced poverty, and lower household spending (Verguet et al. 2013; van der Putten et al. 2015). It is estimated that every 1 USD invested in immunization programs, results in at least 16 USD in net health and economic benefits (Ozawa et al. 2016).

²Global immunization coverage continues to stagnate. For example, in India (India DHS 2020), Peru (Peru DHS 2015), and Indonesia (Indonesia DHS 2017), while 98 percent, 91 percent, and 91 percent of children, respectively, begin vaccinations, only 78 percent, 62 percent, and 65 percent complete the full first-year series. Demand-side factors play an increasingly important role in accelerating progress (Strategic Advisory Group of Experts on Immunization 2017).

³There is a total of 1,221 public clinics in Sierra Leone. The experiment was implemented at a large scale, covering ten percent of clinics.

content. In each of the first two treatment groups (hereafter Signal at 4 treatment and Signal at 5 treatment), children receive a yellow bracelet upon their first vaccine. In the Signal at 4 treatment, the yellow bracelet is exchanged for a green bracelet once a child completes the fourth vaccine on time. In the Signal at 5 treatment, the yellow bracelet is exchanged for a green bracelet once a child completes the fifth vaccine on time. The last treatment, the Uninformative Bracelet, conveys no information about a child’s later vaccinations. Parents choose a yellow or green bracelet at the first vaccine and the child keeps the same color bracelet for all subsequent vaccinations. This design allows me to both test the extent to which signaling preferences vary with the perceived benefits of vaccines, and isolate the effect of these preferences from alternative mechanisms such as increased salience, consumption utility, or social learning about vaccines. Finally, the time variation between the various vaccinations allows me to examine the extent to which future signaling payoffs affect parents’ decisions to vaccinate their child today.

I combine survey and administrative data for over 7,000 children to estimate the partial effect of social signaling preferences on vaccination decisions. In addition, I collected detailed survey data on individuals’ preferences and first- and second-order beliefs about children’s vaccine status to test the underlying mechanisms of the theory for a random subsample of 1,314 parents. The beliefs data reveal large information asymmetries: parents in the Control Group have accurate information about other children’s vaccinations for only 49 percent of children in their community. Similarly, parents believe that only 48 percent of other parents in their community have knowledge about their own child’s vaccinations. Parents use signals to learn about the number of vaccines that other children received, consistent with Bayesian learning, updating their beliefs conditional on the bracelet color observed: for a child with a green (compared to a yellow) bracelet, parents are 34 and 28 percentage points more likely to believe that a child completed vaccine four, and 28 and 40 percentage points more likely to believe that a child completed vaccine five in the Signal at 4 and Signal at 5 treatments, respectively. I find no evidence of such learning effects for the Uninformative Bracelet treatment, in spite of similar rates of bracelet retention and visibility. This indicates that parents were able to correctly understand the colors in the different bracelet treatments. Both the Signal at 4 and Signal at 5 treatments led to a decrease in actual (13 and 17 percent, respectively) and perceived (29 and 23 percent, respectively) information asymmetries compared to the Control Group. Notably, the Uninformative Bracelet also improved perceived information asymmetries: mothers were 18 percent more likely to believe that other mothers in their community knew the number of vaccines their child has received. This suggests that bracelets, independent of their color, had a positive impact on the perceived visibility of vaccine decisions across all bracelet treatments. Only the Signal at 4 and 5 treatments, through their colors, led to vaccine specific learning, as parents made inferences about others completion of vaccines 4 and 5.

The signaling treatments led to a significant increase in the share of children that timely received the fourth and fifth vaccine, increasing shares from 71 to 79 percent, and from 55 to 64 percent, respectively, compared to the Control Group. The effect is masked by substantial heterogeneity: Signal at 4 led to small and insignificant increases of 3.2 percentage points for vaccine four, and 3 percentage points for vaccine five, in the share of children vaccinated. Signal at 5 led to significant and large increases of 12.2 percentage points for vaccine four, and 14.4 percentage points for vaccine five. Effects remain large and significant (8.9 and 9.8 percentage points) when comparing Signal at 5 to the Uninformative Bracelet, providing further evidence for social signaling preferences. Moreover, treatment effects persist for children born 10 to 12 months after the launch of the experiment. This finding raises the question of why Signal at 5 worked, while Signal at 4 did not, if both signals were equally potent in terms of increasing the visibility of vaccinations. Survey data shows that individuals assigned a higher importance to vaccine five than vaccine four, considering the fourth vaccine as the least important among the five. This result suggests that for signals to be effective, they need to be both informative about others' actions and linked to actions that are sufficiently valued. Reassuringly, I find no significant differences in individuals' preferences for different vaccines across treatment and Control Groups, ruling out that the observed treatment effects are purely due to normative influence of signals or social learning.

In addition to the treatment effects at vaccines five and four, Signal at 5 also led to significant increases in the share of children that were timely vaccinated for vaccines three (8.2 percentage points) and two (4.6 percentage points). Combining the reduced-form estimates for all five vaccinations, Signal at 5 significantly increased the average total number of vaccines completed on time from 4.0 to 4.4 compared to the pure Control Group. Importantly, parents were more likely to vaccinate their children for earlier vaccines, responding to a signaling benefit half a year in advance, without necessarily making it all the way to vaccine five. This pattern of treatment effects is consistent with theoretical predictions from a signaling model where individuals make decisions dynamically under uncertainty. More generally, these findings imply that individuals aim to complete later vaccines, but may drop out early due to unforeseen cost or preference shocks.

I estimate a dynamic discrete-choice model that takes into account these features and uses distance to the clinic as a numeraire to quantify the value of social signaling. On average, parents' valuation of signaling timely and complete vaccination is equivalent to 5 to 8 miles walking distance. Benchmarking this to the average walking distance of 2 miles to a clinic, a parent will take their child for 2 to 4 additional vaccinations in order to receive a green bracelet that signals completion of vaccine five.

Beyond its impacts on timely completion, the Signal at 5 treatment significantly increases the share of children that received a given vaccine by the age of one year: from 89 to 95 percent for vaccine four and from 67 to 81 percent for vaccine five, compared to

the Control Group. Treatment effects for vaccines four and five are of similar magnitude and significant for Signal at 4 (5.9 and 9.9 percentage points) and the Uninformative Bracelet (6.3 and 7.5 percentage points, insignificant for the latter). These effects on immunizations are consistent with the impacts of all bracelets on parents' beliefs about the visibility of their vaccine decisions for older children (9 months to one year age).

Taken together, these findings are of substantive policy importance: a signal that allows parents to broadcast an action they value for their child's health increased timely and complete vaccination to levels necessary for herd immunity, at a cost of less than 1 USD per child, far less than estimates from existing interventions.⁴

This study makes four contributions. First, to my knowledge, this is the first field experiment designed to test for social signaling in a dynamic setting. Existing studies have shown that individuals are willing to incur considerable costs when faced with a decision to take an immediate action that allows them to signal their type to others (Bursztyn et al. 2017). My findings show that signals can motivate individuals to take an action more than six months in advance, even when there is substantial uncertainty about whether signaling benefits can be realized. Importantly, observed behavior changes are very likely due to social signaling preferences, since I experimentally only vary the margin at which individuals can signal, which allows me to control for leading alternative mechanisms. This is also one of the first experimental studies to examine the effect of a durable signal that allows individuals to continuously signal their type to others (with the exception of Bursztyn et al. (2018)).

Second, this study contributes to a nascent literature of field experiments examining the mechanisms underlying social image concerns (Bursztyn et al. 2018, 2017; Bursztyn and Jensen 2017; Chandrasekhar et al. 2018). In contrast to many existing studies (Ashraf et al. 2014; DellaVigna et al. 2016; Perez-Truglia and Cruces 2017), my experimental design moves beyond manipulating the visibility of actions, by introducing multiple signals that are linked to different actions. By drawing an important distinction between the role of signals in providing information about others' actions and the opportunity they provide to signal one's type, this paper shows that the impact of signals varies significantly with the social desirability of actions. This result illustrates, on the one hand, the limitations of social signaling as a mechanism to increase public goods, when individuals assign a low private valuation to an action that has large externality benefits. On the

⁴Vaccine four includes, among other diseases, diphtheria, for which reaching herd immunity requires 83-85 percent of children to be vaccinated, and pertussis, for which reaching herd immunity requires 92-94 percent of children to be vaccinated (Anderson and May 2013). Signal at 5 reaches the former when assessing the share of children vaccinated timely at six months for vaccine four (84.6 percent), and the latter when assessing the share of children having completed vaccine four by one year of age (95.2 percent). Gibson et al. (2017) increase full immunization by 12 months age from 82 percent to 90 percent by sending SMS reminders for vaccine 2, 3, 4 and 5 and providing a USD 2 incentive for each timely vaccination (total incentive cost of 8 USD). Banerjee et al. (2010) find that offering 1 kg of raw lentils for each vaccine and a metal plate upon completion of the full series increases vaccination rates in India from 18 to 39 percent (total incentive cost of 6.64 USD).

other hand, it illustrates the scope of social signaling to incentivize individuals to take an action that they undervalue by strategically placing signals on actions with high social image concerns.

Third, this paper provides the first evidence on social signaling in health, and therefore contributes to a large literature on incentives to increase the use of health services and public goods in low-income settings (Thornton 2008; Banerjee et al. 2010; Ashraf et al. 2014; Sato and Takasaki 2017; Karing and Naguib 2021). Recent studies have found large effects of cash and consumption incentives. For example, Banerjee et. al (2010) find that offering 1 kg of raw lentils for each vaccination visit and a metal plate upon completion of the full series increases vaccination rates in India from 18 to 39 percent. In contrast, my paper looks at immunization in a context where initial take-up is close to universal and completion rates are much higher than in India, identifying social signals as a potential low-cost way to address the “last-mile problem” of reaching immunization thresholds.

Fourth, the results of this paper have the potential to inform policy strategies for increasing the demand for complete and timely vaccination. Current immunization programs rely heavily on health campaigns and outreach activities to achieve target immunization levels. These activities consume a large share of total health expenditures, are often donor financed and hence not sustainable, and crowd out other investments needed to advance primary healthcare in low-income countries⁵. This paper shows that social signals can increase parents’ willingness to travel further to receive vaccinations. This provides relevant information to governments who face trade-offs between keeping health workers at central clinics to serve patients and mobilizing them to more remote areas. Further, timely clinic attendance is vital for infants’ health : (1) delayed vaccination puts children at a risk when they are most vulnerable to diseases as they cannot be vaccinated yet but lack immunity, (2) child immunizations are the main access point to formal healthcare, as next to immunizations, trained health workers monitor children’s growth and detect diseases.

Lastly, this paper provides one of the first estimates of the value of social signaling in a low-income country. While most social signaling studies have been implemented in high-income countries, this study demonstrates the feasibility of implementing a more subtle behavioral intervention through government institutions in a low-resource setting.

The remainder of this paper is organized as follows. Section 2 provides an overview of the empirical setting, including the application of social signaling to childhood immunization in general and the context of Sierra Leone in particular. Section 3 discusses the theoretical framework and predictions for the main outcome and mechanisms. Section 4 describes the experimental design, discusses the implementation and randomization checks. Section 5 presents the experimental results, providing a separate discussing of

⁵In 2019, GAVI disbursed over 4 million USD to support Measles catch-up campaigns. <https://www.gavi.org/programmes-impact/country-hub/africa/sierra-leone>

mechanisms and main outcomes. In Section 6, I provide a structural estimate of the value of social signaling. Section 7 concludes.

2 Childhood Immunization and Sierra Leone

This section provides a brief description of the routine immunization schedule, the health benefits of immunization, and the setting of childhood immunization in Sierra Leone. The information is important for the experimental design and an understanding of individuals' binding constraints to timely and complete vaccination.

2.1 Childhood Immunization

A child under the age of one needs to receive five routine vaccinations: the first vaccine, BCG, at birth or shortly thereafter, the second, third, and fourth vaccines, diphtheria, tetanus, and pertussis (DTP) 1, DTP 2, and DTP 3, at 1.5, 2.5, and 3.5 months of age, respectively, and the fifth vaccine, Measles, at 9 months of age (WHO 2018).⁶ At the same time that DTP 1, 2, and 3 are administered, a child also receives one dose of the Polio, Rotavirus, and PCV vaccine.⁷ While the first and last vaccine can be administered together with other vaccines, DTP 1, 2, and 3 need to be given one month apart.⁸ According to WHO guidelines, the DTP series should be completed by six months of age (WHO 2018). Complete and timely vaccination provides private benefits by protecting infants from potentially life-threatening diseases, as the immunity from their mother wanes off, and social benefits by increasing overall immunization rates to herd immunity levels.⁹ Private and social benefits may not perfectly align: DTP doses 1 and 2 are, for most children, sufficient to obtain protection against the disease; the third dose is necessary in order for 94 to 100 percent of children to have protective antibody levels and hence to reach herd immunity.¹⁰ The latter is particularly important as pertussis predominantly affects children younger than six months, who therefore may be too young to be protected by immunizations.

⁶BCG protects against tuberculosis. DTP is a 3-dose series offering protection against diphtheria, tetanus and whooping cough.

⁷Pneumococcal conjugate vaccine protects against diseases caused by the bacterium *Streptococcus pneumoniae*.

⁸For example, a child can receive BCG and DTP 1, or Measles and DPT 3 together in one visit.

⁹Infants and young children are at the highest risk to fall ill and die from these diseases: one out of five children who get diphtheria at age younger than 5 years old dies (WHO 2017).

¹⁰The antibody level increases after the second dose of diphtheria toxoid and it is much higher after the third dose; while most children have a base level of protection from the first two doses of DTP, the third dose is necessary for 94-100 percent of children to have protective antibody levels > 0.01 IU/mL and reach herd immunity thresholds (WHO 2017).

2.2 Low-Income Country Context of Sierra Leone

Sierra Leone has one of the highest infant and under-five mortality rates, with 92 and 156 deaths per 1,000 live births, respectively. One in every 11 Sierra Leonean child dies before reaching age one and one in every 7 does not survive to her fifth birthday (DHS 2013). Rotavirus is the most common cause of severe and fatal diarrhea in young children worldwide; in Sierra Leone, it is estimated that one third of all under-five diarrheal disease hospitalizations are caused by rotavirus (PATH 2017).

The country is one of the poorest in the world, ranking 181 out of 188 in the Human Development Index (UNDP 2016). Women are the primary caregivers of children, taking them for vaccinations over 99.99 percent of the time. 47 percent of mothers in my endline sample have no education, 30 percent have any primary education, and only 23 percent have any secondary education. 73 percent of mothers are engaged in farm work, and fewer than 12 percent possess a mobile phone. Birth rates are high, with mothers having, on average, three children by the age of 26 years (see Table 2).

In Sierra Leone, vaccines are free of charge and readily available.¹¹ A possible concern is that, even if vaccines are free of charge, clinics may run out of them. Table 1 provides relevant information: at baseline, fewer than 14 percent of clinics in my study sample reported having a stock-out of one or more vaccines, and during the study period, only 7 percent of clinics experienced any stock-outs on immunization days. Immunization services are offered on a fixed schedule, either on a weekly (66 percent of sample) or monthly (34 percent of sample) basis, and clinics have, on average, three staff that implement those.¹² At the same time that vaccinations are given, children’s weight and height are recorded, and their overall health checked. Vaccinations, both in Sierra Leone and many other low-income countries, are therefore the main point of contact for monitoring newborns’ health and detecting problems such as malnutrition. The functionality of the supply side is reflected in communities’ perceptions, see Table 1: 79 percent of communities name, as the most common reason, negligence of parents, for delayed or missed vaccination. Lack of knowledge of the benefits of vaccination and distance to clinics are ranked as secondary factors, mentioned by 65 percent and 42 percent of communities respectively. Importantly, child vaccination is a well-known technology: 94 percent of communities at baseline know that children need five vaccinations, and are aware of the health benefits of vaccinations.¹³

¹¹Healthcare for children under the age of five, pregnant women, and lactating mothers is free in Sierra Leone since the introduction of the Free Healthcare Initiative in 2010.

¹²Staff includes formally trained health workers (e.g. State Enrolled Community Health Nurses), informally trained workers (e.g. vaccinators) and volunteers who assist with the filling of clinic records and give out health information.

¹³Individual surveys corroborate this finding: 96 percent of mothers attending vaccinations, who were randomly sampled for short surveys during their clinic visit, were aware that children under the age of one require five vaccinations.

3 Theoretical Framework

The experimental design is grounded in Bénabou and Tirole’s (2006; 2011) theory of social signaling. In this section, I map their framework into the specific empirical decision problem of child vaccination, and discuss the main predictions of the model and augment it to include uncertainty about future cost shocks.

3.1 Social Signaling without Uncertainty

Preferences are described by:¹⁴

$$U(a_i; v_i, x, r, \lambda, \omega_r) = B(a_i; v_i) - C(a_i) + x\lambda\omega_r \begin{cases} E_{-i}(v|a_i \geq r) & \text{if } a_i \geq r \\ E_{-i}(v|a_i < r) & \text{if } a_i < r \end{cases} \quad (1)$$

Individuals, indexed by i , make a decision to take their child for zero, one, two, three, four or five vaccinations $a_i \in \{0, 1, 2, 3, 4, 5\}$. Individuals differ in their intrinsic motivation v_i to look after their child’s health. v_i is drawn from the continuous distribution of type v , with c.d.f. $F(v)$, where $F(v)$ is common knowledge. Intrinsic motivation v_i is known to individual i but is not observed by other individuals, i.e., it is private information of individual i . $B(a_i; v_i)$ denotes the private benefit of vaccination, which is a function of i ’s choice a_i and i ’s type.¹⁵ $C(a_i)$ denotes the cost of vaccination, defined in terms of travel distance to the clinic. I assume that $B(a_i; v_i)$ is increasing and concave, $\frac{\partial B(a_i; v_i)}{\partial v_i} > 0$ and $C(a_i)$ is weakly convex.

Ignoring the third term of equation 1, we have a simple maximization problem where individual i chooses the number of vaccines $a_i = a_i^*$ to maximize $U(a_i; v_i) = B(a_i; v_i) - C(a_i)$. With the above assumptions, there is a unique function that maps for each individual i her type v_i to her optimal action: $a_i^* = a(v_i)$. Without loss of generality, I assume that $\frac{\partial B(a_i; v_i)}{\partial v_i} > 0$, higher types receive greater utility from vaccinating and therefore will choose to vaccinate more.¹⁶

The key part of the model is the third term, the reputational benefits and costs associated with the expectations that others, indexed by $-i$, will form about i ’s type as actions become visible. Let $r \in \{1, 2, 3, 4, 5\}$ denote the threshold number of vaccines, that partition, for each r , the six possible actions a_i into two groups of observable vaccine decisions: others can either observe that i chose to vaccinate her child for at least r vaccines, that is $a_i \geq r$, or that i chose to vaccinate her child for fewer than r vaccines, that is $a_i < r$. Let $x \in [0, 1]$ denote the probability that others observe i ’s choice. I henceforth refer to $x > 0$ as “visibility”. The parameter λ measures how much individual i cares about the

¹⁴I follow Bénabou and Tirole (2006), Bénabou and Tirole (2011) and Bursztyn and Jensen (2017).

¹⁵I abstract from the externality benefits of vaccines since individuals in the context of my study predominantly think of vaccination as a private good and lack an understanding of externalities.

¹⁶That is, $a \geq a' \forall v, v'$ such that $v > v'$.

expectations that others form about her, and ω_r corresponds to the social desirability of being seen as a type who chooses $a_i \geq r$. Following the literature, I assume that $\lambda \geq 0$ and $\omega_r \geq 0$ given that the action $a_i \geq r$ is desirable. In equilibrium, different types choose different actions, leading others to form expectations about i 's type conditional on the action observed, that is, $E_{-i}(v|a_i \geq r)$ or $E_{-i}(v|a_i < r)$. Importantly, the expectations of others enter directly and additively into i 's utility as expressed in equation 1. Following the logic of Bénabou and Tirole (2006; 2011) there exists a unique set of actions under visibility such that each individual chooses an action a_i^{s*} , given the equilibrium actions of all other individuals. This equilibrium is characterized by the cut-off type \hat{v}_r (who is indifferent between choosing the optimal a_i^* without visibility and deviating to $a_i^{s*} = r$) and the reputational returns which solve the fixed-point equation:

$$U(a_i^{s*}) - U(a_i^*) = \underbrace{B(a_i^{s*}; \hat{v}_r) - C(a_i^{s*}) - B(a_i^*; \hat{v}_r) + C(a_i^*)}_{\text{Difference in direct benefits}} + \underbrace{\lambda \omega_r \Delta(\hat{v}_r)}_{\text{Reputational returns}} = 0 \quad (2)$$

where $\Delta(\hat{v}_r) = \underbrace{E(v|a_i^{s*} \geq r) - E(v|a_i^* < r)}_{\text{Difference in the average type based on **observed** actions}}$

Given the assumption that $\frac{\partial B(a_i; v_i)}{\partial v_i} > 0$, in equilibrium, individuals with higher types will choose to vaccinate more than those with lower types.^{17,18}

An empirical object of consistent interest in this paper will be the discrete probability density function $g(a) = Pr(a_i(v) = a)$, with the associated discrete cumulative distribution function $G(a) = Pr(a_i(v) \leq a)$.¹⁹ I will use the cumulative distribution function to specify the share of children that completed at least a vaccines, that is, $Pr(a_i(v) \geq a)$.

3.1.1 Equilibrium Simulations with Signaling

Figure 1 presents results from two calibrated simulations, first assuming $x=0$ (no visibility of actions) and second $x=1$ (full visibility of actions), to illustrate the equilibrium effects of visibility on the cut-off type, \hat{v}_r , and type expectations. Using the empirical rates of vaccination for vaccine one, two, three, four and five from the Control Group data, I calibrate the moments of a normal type distribution $v \sim N(\mu_v, \sigma_v)$ and the parameters

¹⁷To make the link between types and actions more transparent, note that $E(v|a_i^{s*} \geq r) - E(v|a_i^* < r) = E(v|v \geq \hat{v}_r) - E(v|v < \hat{v}_r)$.

¹⁸It is relatively straight-forward: Suppose, for the sake of contradiction, that there exists an equilibrium in which the action taken by v, v' with $v > v'$ is $a < a'$. By definition the third term concerning other people's inferences, given actions, is the same for all types v . Consequently, if a lower type v' prefers to take the action a' instead of a , then it must be that a higher type must also prefer the action. This contradicts the initial supposition that the higher type prefers a to a' .

¹⁹I am dropping excess parameters here, since in the empirical part of the analysis these are unobservable.

of the utility function:

$$U(a_i; v_i) = (v_i - \kappa D)a_i - \sum_{a=1}^{a_i} \alpha(a-1) + x\lambda\omega_r \mathbf{1}(a_i = r)[E(v|a_i \geq r) - E(v|a_i < r)] \quad (3)$$

where I assume that the marginal cost of vaccination κ is constant, and the marginal benefit is declining. $D = 2$ is set to the mean walking distance. The calibrated parameters are $\mu_v = 1.51$, $\sigma_v = 0.69$, $\kappa = -0.1$, $\alpha = -0.3$. I assume that individuals can signal that they took their child for five vaccinations, with $r = 5$ and that $\lambda\omega_5 = 0.2$. I solve for the cut-off type \hat{v}_5 and $\Delta(\hat{v}_5)$ using the fixed-point equation 2. Visibility, as indicated by “Signal at 5” in Figure A1, leads to a shift in the cut-off, v_5 , to the left, meaning that individuals with lower types are now choosing $a_i^{s*} = 5$. However, given the magnitude of reputational returns $\lambda\omega_r\Delta(\hat{v}_5)$, only some individuals who previously chose $a_i^* = 4$ now vaccinate further, while everyone who chose $a_i^* < 4$ in the absence of visibility, will continue to choose the same number of vaccines. As v_5 shifts to the left, and lower types start to vaccinate further, $E(v|a_i^{s*} = 5) < E(v|a_i^* = 5)$ and $E(v|a_i^{s*} < 5) < E(v|a_i^* < 5)$, meaning that visibility lowers the average type expectations for those who vaccinate at 5 (since some low type individuals moved in) and for those who vaccinate at less than 5 (since some high type individuals moved out).

3.1.2 Theoretical Predictions

In Section 4, I experimentally manipulate the visibility of vaccines x and threshold number r to test their effects on the share of children vaccinated. I here lay out the theoretical predictions of the effect of x on the distribution $G(a)$ and the empirical predictions that follow from the underlying mechanisms and assumptions of the model.

Main outcome

1. $\frac{\partial Pr(a_i(v) \geq r)}{\partial x} > 0$, i.e. the probability of individuals choosing to vaccinate at at least r increases with visibility, if the action is perceived as socially desirable ($\omega_r > 0$) and individuals value others’ perceptions of their type ($\lambda > 0$).
2. $\frac{\partial Pr(a_i(v) \geq r - \tau)}{\partial x} \geq 0$, i.e. the probability of individuals vaccinating at at least $r - \tau$ remains constant, unless all individuals who previously vaccinated at $r - \tau$ moved to r , such that $Pr(a_i(v) \geq r) = Pr(a_i(v) \geq r - \tau) \forall \tau \in \{1, 2 \dots r - 1\}$.
3. $\frac{\partial Pr(a_i(v) \geq r + \tau)}{\partial x} \geq 0$, i.e. the probability of individuals choosing to vaccinate at at least $r + \tau$ depends on the cost-benefit structure of vaccination. The probability remains constant if the marginal net benefits are constant or declining ($\frac{B(a_i; v_i) - C(a_i)}{a_i} \leq 0$), and it increases if marginal net benefits are increasing $\frac{B(a_i; v_i) - C(a_i)}{a_i} > 0 \forall \tau \in \{1, 2 \dots S - 1\}$.

4. $\frac{\partial^2 \Pr(a_i(v) \geq r)}{\partial x \partial \lambda} > 0$, i.e. the effect of an increase in x is increasing in the value individuals assign to their social image.
5. $\frac{\partial^2 \Pr(a_i(v) \geq r)}{\partial x \partial \omega_r} > 0$, i.e. the effect of an increase in x is increasing in the social desirability of being seen as type who chooses $a_i \geq r$. If there are no concerns of social approval or disapproval ($\omega_r = 0$), changing x should have no effect on vaccine outcomes.

Mechanisms

- i. Individuals observe others' actions more often than not: $\Pr_{-i}(a_i \geq r | a_i \geq r) - \Pr_{-i}(a_i \geq r | a_i < r) > 0$.
- ii. Individuals form expectations about others' types conditional on the actions observed: $\Delta(\hat{v}_r) = E_{-i}(v | a_i \geq r) - E_{-i}(v | a_i < r) > 0$.

Assumption

Individuals have imperfect information about others' actions, so that visibility in actions provides new information about others' actions (and subsequently types).

3.2 Social Signaling with Uncertainty

The above model assumes that individuals have perfect information about the future. However, uncertainty is a common feature in the real world. In reality, individuals are exposed to cost or preference shocks, in the form of sickness of household members or unforeseen work obligations, that make it difficult to travel to the clinic. Instead of assuming that individual i has perfect information and can choose the preferred number of vaccinations at the outset, I now consider the case where she decides, in each period t , whether to take her child for the next vaccine, or instead to stop vaccinating. Not vaccinating is an absorbing state, that is, once a parent is late for or missed a vaccine, she cannot be complete the vaccinations series on time. The flow utility of vaccinating at time $t \in \{1, 2, 3, 4, 5\}$ is given by:²⁰

$$u_{it} = b(t; v_i) - c(t) + x\lambda\omega_r\Delta(\hat{v}_r)\mathbb{1}\{t = r\} + \epsilon_{it}$$

and the utility of stopping vaccination is $u_{it} = \epsilon_{it}$, which is normalized to zero in the following. This gives the value function for a parent who has not yet stopped vaccinating:

$$V_{it} = \max\{0, u_{it} + \underbrace{E[V_{it+1} | v_i]}_{\text{Continuation value}}\} \quad \text{for } t < 5$$

$$V_{i5} = \max\{0, u_{i5}\} \quad \text{for } t = 5$$

²⁰For simplicity I am dropping parameters here and denoting $u(t; v_i, x, r, \lambda, \omega_r)$ as u_{it} .

whereas the value function for choosing not to vaccinate is zero.²¹ $b(t; v_i)$ and $c(t)$ denote the marginal benefit and cost of vaccine $t \in \{1, 2, 3, 4, 5\}$, $\lambda\omega_r\Delta(\hat{v}_r)$ the reputational return from vaccinating up to $t = r$, and ϵ_{it} a new, second source of unobserved individual heterogeneity in the form of iid logistically distributed shocks.²² Individuals are assumed to know the distribution of shocks, but only learn in period t about the realization of their shock. Individuals therefore maximize the *expected* future value of vaccines. This decision-problem is solved by backward recursion, with individuals optimizing according to the decision-rule: vaccinate if $V_{it} > 0$, stop otherwise.

Comparing individual decision-making under uncertainty to that without, theoretical predictions 2 and 3 change. As individuals plan dynamically, individuals' decision to deviate from the optimal action chosen in the absence of visibility, is now partly decoupled from their decision to vaccinate up to r . Individuals choose to vaccinate further if the option value of signaling is sufficiently large for them to expect to vaccinate up to r , and will stop vaccinating before reaching r if they receive a too negative cost draw. As a result, individuals are more likely to complete earlier vaccines ($r - \tau \forall \tau \in \{1, 2 \dots r - 1\}$), even if not making it to r , where the signaling benefit occurs (formally $\frac{\partial \Pr(a_i(v) \geq r - \tau)}{\partial x} \geq 0$, without the condition $\Pr(a_i(v) \geq r) = \Pr(a_i(v) \geq r - \tau)$). Further, individuals are more likely to vaccinate for $r + \tau$ vaccines even if the marginal net benefit of vaccination is declining. Some of the individuals who vaccinate up to r , receive a positive cost shock in $t = r + \tau$ making it optimal for them to vaccinate further.

Figure 1 shows how augmenting the social signaling model to include uncertainty changes the qualitative predictions of the model, by comparing the simulated effects of visibility at vaccines four and five, for the cases with and without uncertainty. Extending the signaling model to include uncertainty produces less stark bunching predictions at thresholds $r \in \{4, 5\}$ and more continuous shifts in the distribution $G(a)$.

4 Experimental Design

The first part of this section introduces the signaling mechanism used in this study and the different experimental treatments used to test the theoretical predictions. Next, I describe the selection and randomization of clinics and communities, followed by a discussion of the identification of signaling preferences. I then provide information about the timeline and the data sources collected at different points of the experiment. Finally, I discuss

²¹For this reason, I omit the number of vaccines when writing the value function: V_{it} implicitly refers only to the value function at any history such that a parent has not yet stopped vaccinating.

²²Relating back to the static model without uncertainty in Equation 1, the action a in the dynamic model is denoted by t since the decision to take a certain number of vaccines (e.g. $a_i = 2$, two vaccines) coincides with the time period (e.g. $t = 2$). The marginal benefit and cost in the dynamic model are therefore equivalent to $b(t; v_i) = B(t; v_i) - B(t - 1; v_i)$ and $c(t; v_i) = C(t; v_i) - C(t - 1; v_i)$. In the dynamic model, I am assuming we are in equilibrium, with individuals taking reputational returns as given.

balance checks and compliance with the implementation.

4.1 Experimental Treatments: Bracelets as Signals

To create visibility in actions, I experimentally introduce a signal - in the form of colored bracelets that children receive upon vaccination at public clinics. The bracelets create an opportunity for parents to publicly signal that they correctly vaccinated their child. Specifically, I introduce experimental variation in two ways to test the theoretical predictions of the model: (1) I increase the visibility of vaccination decisions; (2) I exploit the fact that children need to receive multiple vaccinations and place signals at different vaccination. Figure 2 displays the four experimental groups and the specific bracelet treatments that health workers implement at each of the five vaccinations:

Control Group: No bracelets are given to children at vaccinations.

Signal at 4: Children receive a yellow “1st visit” bracelet when coming for the first vaccine. Children keep the same bracelet for vaccines two and three. When a child comes in a timely way (before reaching six months age) for vaccine four, health workers exchange the yellow bracelet for a green “4th visit” bracelet. If a child comes late for vaccine four, the bracelet is exchanged for an identical yellow “1st visit” bracelet. At vaccine five, the bracelet is exchanged for a new but identical green “4th visit” bracelet (or yellow “1st visit” bracelet if the child was late for vaccine four).

Signal at 5: Children receive a yellow “1st visit” bracelet when coming for the first vaccine. Children keep the same bracelet for vaccines two and three, and the bracelet is exchanged for an identical yellow “1st visit” at vaccine four. If a child comes in a timely way (by 11 months age) for vaccines five, health workers exchange the yellow bracelet for a green “5th visit” bracelet. If a child comes late for vaccine five, the bracelet is exchanged for an identical yellow “1st visit” bracelet.

Uninformative Bracelet: Parents can choose a green or yellow “1st visit” bracelet at vaccine one. Children keep the same bracelet for vaccines two and three. At vaccines four and five the bracelet is exchanged for a new identical “1st visit” bracelet of the originally chosen color.

In all three signaling treatments actions are grouped into two signals. In Signal at 4, others can only tell whether a child was vaccinated for four or more vaccines, or whether a child received fewer than four vaccines. In Signal at 5, the yellow and green bracelets allow others to observe if a child received five vaccines, or fewer. The Uninformative Bracelet allows parents to signal that their child started vaccination but provides no

information about the completion of later vaccinations.

Figure 2b shows the actual bracelets that were given out at clinics. All bracelets were made out of silicone and were size-adjustable so that they could comfortably fit the wrist of a child between the ages of zero and twelve months. The latter was key for the experimental design i) as it made the bracelet a *durable* signal that could be observed by others and allow for comparisons beyond the time of the vaccination, and ii) so that the size of the bracelet would not be informative about the number of vaccinations a child has completed.²³ Over the course of the experiment, a total of 36,000 bracelets were handed out by health workers. Appendix C Figures C1, C2, C3 and C4 display the messages that clinic staff were trained in to give to mothers when handing out or exchanging the bracelets.²⁴

4.2 Identifying Effects

The combined effect of increased salience (e.g. reminder effects), consumption utility, and social signaling preferences is captured by the comparison of the share of children vaccinated at vaccines four and five in the Control Group to Signals at 4 and 5.²⁵

The comparison of Signal at 4 and Signal at 5 to the Uninformative Bracelet at vaccines four and five allows me to isolate the effect of social signaling preferences on vaccination decisions. I implement bracelet hand outs and exchanges in all three signaling treatments at the same vaccines in order to hold constant any additional consumption utility of bracelets. By distributing bracelets and using the colors green and yellow in all three signaling treatments, I further hold constant salience and reminder effects that are due to (1) the general visibility of vaccinations through bracelets, and (2) the introduction of new colors over time. In other words, the only difference remaining is what actions can be signaled, that is, the completion of a specific vaccine. If the green bracelets in Signal at 4 and Signal at 5 treatments acted as vaccine-specific reminders for vaccines four and five, we would expect to see a significant increase in the share of children taking these vaccines. However, we would not expect increases in earlier vaccinations. Observing a child with a yellow bracelet makes salient that she received either one, two or three vaccines, but provides no direct reminder for vaccines four and five.²⁶

²³As a child's wrist grows, even in the absence of a change in bracelet color, a too small bracelet that no longer fits, could be informative about whether a child is up-to-date with its vaccinations.

²⁴Each clinic was given a laminated hard copy of the messaging card to be used at immunization days.

²⁵I omit the comparison to the Uninformative Bracelet and the Control Group at vaccine one, since take-up is almost universal for the first vaccine.

²⁶This is a fundamental challenge when introducing visibility. Information is exchanged both ways: individuals can observe i 's actions, while i can observe other individuals' actions. An additional treatment in the form of a private reminder e.g. text messages, would be needed to separately capture the effect. This was logistically not possible in this setting (see low phone ownership, Table 2). Karing and Karim (2021) find that even in the presence of SMS reminders, treatment effects from social signals, in the form of bracelets, persist. Further, there are existing reminders. Every child in Sierra Leone receives a vaccine card that indicates which vaccines a child has taken, as well as due dates for future vaccines.

A larger increase in the share of children who are timely vaccinated for vaccine four in Signal at 5 compared to Signal at 4 implies a higher social signaling value in treatment Signal at 5 compared to treatment Signal at 4: $\lambda\omega_4\Delta(\hat{v}_4) < \lambda\omega_5\Delta(\hat{v}_5)$. This could be due to two reasons: (i) differences in the social desirability parameter of how much society values the timely completion of vaccines four and five, that is, $\omega_4 < \omega_5$, or (ii) differences in the type expectations that others form upon observing the timely completion of vaccine four versus vaccine five, such that Signal at 4 is less informative about different types, that is, $E_{-i}(v|a_i \geq 4) - E_{-i}(v|a_i < 4) < E_{-i}(v|a_i = 5) - E_{-i}(v|a_i < 5)$. An increase in the share of children who complete earlier vaccines (vaccines one, two, or three for Signal at 4; vaccines one, two, three, or four for Signal at 5), without transition probabilities from vaccines three to four and four to five respectively equaling one, demonstrates that individuals make decisions dynamically and under uncertainty. Parents who vaccinate their children for earlier vaccines due to an increase in the future value of vaccination but do not make it to vaccine four (for Signal at 4) or vaccine five (for Signal at 5), must have *targeted* to complete four or five vaccines but stopped earlier due to unforeseen cost or preference shocks.

Finally, a comparison of the share of children vaccinated at vaccine five in Signal at 4 to the Uninformative Bracelet quantifies the extent to which observed treatment effects are due to some form of social learning or normative influence. If individuals have incorrect priors over the share of parents that vaccinate their children, and are uncertain about the benefits of vaccination, observing signals about timely take-up of vaccine four or five, could lead them to update their beliefs about take-up levels and the usefulness of vaccinations. Similarly, health workers giving a “reward” to parents for vaccination, could act as a signal about the importance of vaccinations for children’s health. By design, parents in the Signal at 4 treatment have no signaling incentive to complete vaccine five, as green bracelets do not allow for a distinction between parents who took their children for four vaccines, versus those who went for five. An increase in the share of children vaccinated at vaccine five could therefore be due to two reasons: (i) if uncertainty plays an important role, some parents who now complete vaccine four in Signal at 4 treatment receive a positive cost or preference shock and also take vaccine five; (ii) parents learn from signals about the benefits of vaccinations, leading them to also increase their valuation of vaccine five. To distinguish (i), which still falls within the predictions of the signaling model, from (ii) which is an alternative behavioral mechanism, I can compute the transition probability between vaccines four and five. If I observe an increase in the transition probability in Signal at 4 treatment relative to the Uninformative Bracelet, it strongly suggests that learning is a relevant alternative mechanism.

Lastly, to address concerns regarding learning about the importance of vaccine five in Signal at 5 compared to the Uninformative Bracelet or Control Group, I elicit individuals’ preferences for the different vaccinations and test for differences across arms.

4.3 Clinic Randomization and Community Selection

Treatment was randomized at the clinic level so that every child living in the catchment area of a clinic was eligible for the same bracelet treatment.^{27,28} In total, I selected 120 clinics across four of Sierra Leone’s 14 districts to be part of the study. To randomly draw 120 clinics from the pool of 243 public clinics across the four districts, I used an acceptance-rejection method whereby I randomly picked clinics, checked their acceptability based on their overlap with already selected clinics, and if accepted, added them to the selected sample. This process was repeated until it had selected the requisite number of clinics. If no acceptable clinic remained before completion, the whole process was restarted. Each clinic had a 5 mile radius as catchment circle. A clinic was considered acceptable if its catchment circle did not leave any of the already selected clinics’ non-overlapping catchment circle smaller than 35 percent of its area. Clinics were then randomly assigned, stratified over the four districts and two implementation waves, to the three different bracelet treatments and the Control Group.²⁹ Figure 3 shows the geographic span of the experiment across the four districts in Sierra Leone and the final selection of clinics. During the launch of the study in each clinic, surveyors selected - using in-field randomization - two communities at close distance (0 to 2 miles) and three communities at far distance (2 to 5 miles) from the clinic, from the pre-specified non-overlapping catchment area of each clinic. Figure A3, the upper map, shows the non-overlapping catchment areas and the lower map provides an example map for one of these clinic areas, that surveyors were given for the in-field community selection. In total, the experiment included 582 communities. Table A23 provides a break down of the number of communities by district, as well as the mean travel distances between clinics and communities. On average individuals walk 2 miles to clinics.³⁰

4.4 Information Treatment

While such a high level of randomization significantly increased the logistical demands of the experiment, it was key to reducing the risk of incorrect implementation by health workers, and to creating a common understanding of the bracelets among individuals.

At the launch of the experiment, surveyors visited each of the selected 582 communities

²⁷A catchment area of a clinic is defined by the communities surrounding it that the clinic serves. For detailed information on the community selection see Appendix B.

²⁸Children that were born before the launch of the experiment and had already started vaccinations, would receive their first bracelet when coming for their next vaccination (e.g. “5th visit” green if came for vaccine five timely in Signal at 5 treatment).

²⁹The experiment was phased in in two waves: wave one from mid-June to mid-July 2016 where 44 clinics were launched, and wave two from end of September to end of November 2016 where the remaining 76 clinics were launched.

³⁰86 percent of parents surveyed during clinic visits report to travel to clinics by foot. 12 percent travel by motorbike and 1 percent by car. The average one-way travel time to a clinic is 47 minutes, the median time 30 minutes.

to hold an information meeting with the community. The objective was to highlight the health and economic benefits of timely and complete vaccinations, to discuss existing barriers, and in signaling treatments, to inform a wide range of community members about the bracelets and create common knowledge about their meaning (see Appendix C Figures C5 and C6 for the scripts used by surveyors for the information meetings). The average meeting attendance was 43 people, with almost all meetings attended by a health representative (94 percent of meetings e.g. a community health worker) and a community leader (98 percent of meetings, e.g. chief). A second information meeting was held in each community two to four months later, to again discuss the importance of vaccinations and the meaning of the bracelets, now that clinics were handing them out.

4.5 Experiment Timeline and Data

Below, I detail the timeline of the experiment implementation and the main data collection activities.

Jun '16 - Nov '16	• Experiment launch: baseline clinic and community survey; training of 348 government health workers across 120 clinics in messaging to parents and implementation of bracelets; information meetings about the benefits of vaccination and meaning of bracelets in 582 communities including close to 25,000 adults.
Jul '16 - Apr '18	• Monitoring of implementation: health workers hand out bracelets as part of regular monthly or weekly routine vaccination services at clinics; surveyors regularly visit clinics (every 1-2 months) to verify the correct hand out and exchanges of bracelets, messages given to parents, and recording of vaccine visits; training of new clinic staff in implementation; digitization of administrative records for ~ 37,892 children; follow-up information visits in communities.
Sep '17 - Jan '18	• Listing survey: comprehensive listing of 14,048 children in selected communities.
Feb '18 - Apr '18	• Endline data collection: survey of 1,314 parents and 120 nurses in charge of vaccination services.

I will use several data sources that I collected at different points of the experiment for the analysis:³¹

(1) *Baseline data:*

- i) Clinic survey: survey with nurses in charge of clinics, recording of staff numbers, regularity of vaccination services (monthly versus weekly), supply side conditions (vaccine stock outs), and a list of catchment communities and their characteristics

³¹The analysis includes 119 clinics, excluding one clinic in the urban part of Western Area Rural where the implementation and data collection were seriously impeded by turn-over of clinic staff, relocation of selected communities and deficiencies in monitoring and data collection by a surveyor.

(distance to clinic, size, proximity to other clinics) to determine the eligibility of communities for selection.

- ii) Community survey: survey conducted with participants of information meetings, knowledge about vaccinations, and perceived barriers to complete and timely vaccination; further captured data on attendance and the implementation of meetings.

(2) *Administrative data*: Throughout the experiment, surveyors digitized vaccination records of children that visited the study clinics including names of children and parents, date of birth, vaccine received, date of vaccination and whether the child received a bracelet, the color of the bracelet, and whether the child had lost the bracelet.

(3) *Listing survey data*: surveyors conducted a census of all children (age 0 to 18 months age) residing in the 582 selected communities, recording the status of children (residing in the community, traveling, permanently moved, deceased), names of children and parents, date of birth, list of vaccines received (from the vaccine card and parents' memory), date of vaccination, bracelet ownership and visibility.

(4) *Endline data*: survey of 1,314 mothers across 381 communities, eliciting first- and second-order beliefs about other children's vaccinations, their bracelets and color, and preferences and knowledge about vaccinations. Appendix B details how endline respondents were sampled.³²

4.6 Balance Checks and Compliance with Implementation Protocol

Tables 1, 2 and 3 report the experimental balance checks. I report results separately for clinic, community and individual level characteristics, as well as for the implementation of the experiment launch and the main listing survey. 21 of 288 coefficients are statistically significant at the 10 percent level across all comparisons. The F-tests for joint significance always yield p-values greater than 0.10. Attrition is low and not affected by treatment: 11.5 percent of children had moved or were permanently traveling, and 2.7 percent of children were deceased at the time of the listing survey. There are no statistically significant differences in the timing of the clinic launches or the survey implementation across treatments. I further find no statistically significant differences in pre-trends for vaccines one, two and three.³³ I also report normalized differences as proposed by Imbens and Wooldridge (2009) and Imbens and Rubin (2015) to remove the dependency on the sample size for the balance tests. Tables A1, A2 and A3 show that

³²Not included in this analysis is the choice experiment that I conducted in a random sample of 12 control clinics, 42 communities. I elicited mothers' preferences for bracelet color and love of variety through a two-stage choice experiment where they were first given a bracelet of a random color as a gift for their participation in the endline survey and two weeks later the opportunity to exchange the bracelet for a new bracelet of the same or a different color at a small cost.

³³Due to budget constraints, I could only collect vaccine information for children born as early as January 2016. This allows me to access pre-trends for vaccines 1, 2 and 3 but not for vaccines 4 and 5.

there are no meaningful imbalances.

To verify if health workers correctly handed out and exchanged bracelets, surveyors asked each parent to report the bracelet color that was given to the child during vaccination, and the number of vaccines the child had received by that time. Figure 4 shows the fraction of children in each group that received a yellow, green, or no bracelet, conditional on the number of vaccines received. Almost every child had a bracelet (94%), with no significant differences across arms. In the Uninformative Bracelet treatment, there is no overall significant relationship between the number of vaccines a child has received and the reported bracelet color.³⁴ We can see that the majority of individuals prefer the color yellow (62%) over the color green (38%).

For Signal at 4 and Signal at 5, there is a clear relationship between child’s bracelet color and the number of vaccination received: there is a large increase (up to 61% for Signal at 4 and 70% for Signal at 5) in the share of children with a green bracelet at vaccines four and five, respectively. Children who received vaccine four and/or five but had a yellow bracelet either came late for the vaccine or received an incorrect bracelet from a health workers (see Figure A4 in Appendix). Therefore, a yellow bracelet on an older child³⁵ provides a noisy signal about the number of vaccines received. Conversely, almost no child (1.8%) is reported to have received a green bracelet before the signaling threshold. A green bracelet is therefore a highly informative signal about a child having received vaccine four or five in the Signal at 4 and Signal at 5 treatments.

5 Do Signals Affect Vaccination Decisions?

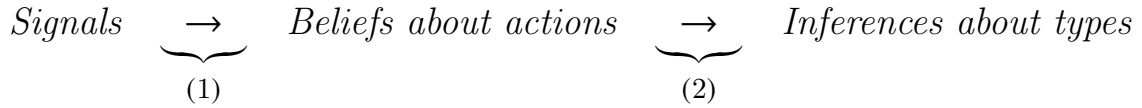
I now present the main results of this paper, separately discussing the mechanisms underlying the theory. I will first test the extent to which individuals use signals to learn about others’ actions and make subsequent type inferences, and second test the extent to which individuals value the opportunity to signal that they correctly vaccinated their child for vaccines four and five.

5.1 Informativeness of Signals

In this experiment, the bracelet signals are aimed to create an opportunity for parents to show that they correctly vaccinated their child. For this to work, individuals must (1) learn about others’ actions from signals, and (2) form expectations about others’ types conditional on the signals observed. In this subsection, I will empirically verify these mechanisms and the assumptions associated with them.

³⁴There is only a small significant increase in the share of children with a green bracelet at vaccine 5.

³⁵A child that is 6 plus months in the Signal at 4 treatment or 11 plus months in the Signal at 5 treatment.



5.1.1 Method

I first elicit individuals’ first- and second-order beliefs about vaccine decisions and the perceptions of others.³⁶ To measure **beliefs**, I gave each mother at endline a random sample of five other children in her community and asked separately for each child the following questions:³⁷

1. “What is your relation to the child’s mother?”

First-order beliefs

2. “How many vaccinations do you think this child has received?”
3. “Does the child have a bracelet?; If so, what color bracelet does the child have?”

Second-order beliefs

4. “Do you think the mother knows that you have taken your child for [x] vaccines?”
5. “Do you think that the woman knows you have a [color] bracelet?”

First-order beliefs about other mothers’ vaccine decisions were incentivized: respondents received a small reward in the form of a maggi seasoning cube (value of 3 US Cents) for each child they correctly guessed the number of vaccines for.

To measure **perceptions**, each mother was asked about her perceptions of others’ concerns about her own child’s vaccinations:

1. “Is there anyone in your community or your house who is concerned about your child’s vaccination?; If so, who?”
2. “How would community members view you?” and “What actions would they take if you?”
 - a. “...took your child for all vaccinations?”
 - b. “...missed taking your child for vaccinations?”

The sample used for the beliefs analysis is mothers of all children who were eligible to have received a specific vaccine. The sample size therefore differs across different outcomes.³⁸ For the analysis of perceptions, the answers of all mothers are included, as

³⁶These questions were extensively piloted to be easily understandable for respondents - irrespective of their level of education - and to mitigate social desirability biases.

³⁷If a mother did not recognize the name of another child/mother, she was given the name of a different child/mother until she identified a total of 5 children. On average, respondents were asked about 6.5 other children in their community and recognized 4.3 children. 63 percent of respondents were able to recognize 5 children. Only 12 percent of respondents recognized fewer than 3 other children. For those who recognized fewer, there were either fewer than 5 children in the community, or respondents were unable to recognize 5 other children. There are no significant differences in the average number of children recognized or number of children asked about across intervention arms.

³⁸For example, the sample of children used in the analysis of beliefs about completion of vaccine four is larger than that used for beliefs about the completion of vaccine five, since a greater number of children had reached 3.5 months age (the time when vaccine four can be administered) by the time the endline survey was conducted, and fewer children that were born since the start of the experiment had reached

these questions are not specific to a particular vaccine, and therefore age category. All regressions include strata fixed effects, and standard errors are cluster bootstrapped at the clinic level. Beliefs regressions include controls for own or other child age and the relationship between endline respondents and other mothers, as well as distance to the clinic, and clinic and community population size.

To assess the accuracy of first-order beliefs about other children’s vaccinations, I linked respondents’ answers with administrative clinic records of children.^{39,40}

5.1.2 Do Individuals Learn from Signals about Actions?

Assumptions

For individuals to draw new information from signals, two assumptions have to be met: (i) individuals have imperfect information about other parents’ vaccination decisions, (ii) signals are publicly visible. Table 5 quantifies the information asymmetries, revealing they are large. Columns 1 and 2 indicate that mothers in the Control Group have accurate knowledge about the number of vaccinations a child received for only 47.2 to 49.3 percent of children in their community age 3.5 months and older. Similarly, Columns 3 and 4 show that mothers believe that only 48 to 49.2 percent of other mothers in their community have knowledge about their own child’s vaccination, if their own child is 3.5 months and older. There is no statistically significant difference in these information asymmetries across mother-pairs with distant and close relationships.⁴¹ These findings suggest there is scope for signals to provide information about others’ vaccination decisions. Second, Table 4 shows that bracelets were highly visible in all three signaling treatments. Column 1 presents respondents’ knowledge about whether other children in their community have a bracelet, while Column 3 presents respondents’ beliefs about other mothers’ knowledge of their own child’s bracelet color. For 92 percent of children, mothers report knowing whether they have a bracelet.⁴² For 95 percent of these children, respondents also report knowing the child’s bracelet color.⁴³ Importantly, for the major-

9 months age (the time when vaccine five is due) at endline.

³⁹The challenge with vaccinations is: as children are all of different ages, they all have different due dates for the specific vaccines. In order to accurately measure the correctness of beliefs, vaccination data has to be collected at the (almost) same time as beliefs are elicited. Using earlier collected vaccine data, such as the listing data, would mismeasure information asymmetries. Digitizing administrative clinic records, allowed me to verify beliefs for a larger sample of other children - instead of only for respondent-other mother pairs who were surveyed at endline.

⁴⁰Fewer than 10 percent of respondent-other mother belief answers could not be verified, as surveyors were unable to find administrative records for 270 children out of the total 2,833 other children. There is no significant difference in the share of children not found across intervention arms.

⁴¹39 percent of other mothers were identified as regular community members, while 35 percent as relatives (see Table A20).

⁴²Only four percent of children are believed to have no bracelet, with equal probability across arms.

⁴³There is a significant difference in respondents’ reported knowledge about other children’s bracelet color between treatment groups. 98 percent of Signal at 4 and Signal at 5 treatment groups report knowing other children’s colors. This number drops to 90 percent in the Uninformative Bracelet group - a significant difference of eight percentage points. This is likely due to individuals paying greater

ity of children (87 percent), respondents state that they know the baby has a particular color of bracelet because they saw the child with that bracelet color. Only for 10 percent of children do respondents state that they know from the number of vaccines the child has or because every child receives a bracelet (reverse inference, see Table A6).

Similarly, respondent mothers believe that 75.9 percent of other mothers know about their own child’s bracelet color, with no significant differences across signaling treatments. The perceived knowledge of others about the color is key for any potential differential impact of Signal at 4 and 5, compared to the Uninformative Bracelet. The visibility of bracelets for all signaling treatments is further verified by the fact that retention of bracelets was similar across groups (see Appendix, Table A17).

Beliefs Updating

Figure 5 shows mothers’ beliefs about the number of vaccinations other children in their community received, conditional on bracelet color, testing the underlying mechanism that signals convey information about others’ actions:⁴⁴

$$Pr_{-i}(a_i \geq r | \text{Green}_i) - Pr_{-i}(a_i \geq r | \text{Yellow}_i) > 0.$$

Using respondents’ joint beliefs about the color of bracelet a child has and the number of vaccines the child has completed, I compute the conditional probabilities of a child having completed at least three, four, or five vaccines, conditional on having a yellow or green bracelet. The almost perfectly overlapping green and yellow bars for the Uninformative Treatment group in Figure 5 demonstrate that there is no significant difference in the probabilities that mothers assign to children having completed vaccines three, four, and five when comparing children with yellow bracelets to those with green bracelets.⁴⁵ In contrast, for Signal at 4 and Signal at 5, I observe large and significant differences in the probabilities assigned: mothers in both treatments believe that 56 and 69 percent of children (respectively) with a yellow bracelet completed vaccine four, compared to 91 and 97 percent of children with a green bracelet - an increase by 34 and 28 percentage points respectively. The same applies to vaccine five: mothers in both treatments believe that 35 and 37 percent of children (respectively) with a yellow bracelet completed vaccine five, compared to 63 and 77 percent of children with a green bracelet - an increase by 28 and 40 percentage points respectively. While different in magnitude, there is no statistically significant difference between individuals’ inferences in the Signal at 4 and Signal at 5 treatments. Both signals were equally potent in providing information about other

attention to a bracelet’s color in the signaling treatments, as the color carries information.

⁴⁴The probability that others assign to a mother’s own child having completed vaccine a conditional on her child’s bracelet color, is equivalent to the probability that the mother assigns to other children having completed vaccine a conditional on their bracelet color.

⁴⁵The difference between the conditional probabilities for vaccine five for children with green versus yellow bracelets, in the Uninformative Bracelet treatment, is not statistically significant.

parents' vaccinations decisions.

Figure A5 reveals that individuals' beliefs are consistent with Bayesian learning. Mothers in Signal at 4 and Signal at 5 correctly recognize that some children with a yellow bracelet came for vaccines four and five (either because of untimeliness or implementation errors). The comparison further reveals that mothers do not fully update their beliefs in response to bracelet signals: the probabilities assigned to a child having attended vaccine four in Signal at 4, and vaccines four and five in Signal at 5 should have been one.

To what extent did signals reduce information asymmetries about actions? Columns 3 and 4 in Table 5 show that mothers in Signal at 4 and 5 treatments are significantly more likely to believe that other mothers have greater knowledge about their own child's vaccinations, with significant increases between 11 to 17 percentage points over the control means of 48 and 49.2 percent, for children eligible for vaccines four and five respectively. Columns 1 and 2 show that mothers in Signals at 4 and 5 have only weakly more accurate knowledge (with p-values between 0.028 and 0.211) about other parents' vaccination decisions in their community: mothers are between 13 and 17 percent more likely to correctly infer the number of vaccines that children have received in Signal at 4 and 5 treatments compared to the Control Group. Treatment responses are larger, up to twice in magnitude, for Signals at 4 and 5 compared to the Uninformative Bracelet but the Uninformative Bracelet also improved perceived information asymmetries: mothers were 18 percent more likely to believe that other mothers in their community knew the number of vaccines their child has received. This suggests that bracelets, independent of their color, had a positive impact on the perceived visibility of vaccine decisions across all bracelet treatments.

I find no significant differences in changes in information asymmetries across mothers with both distant and close social connections. As to be expected, mothers are more likely (by 21 to 24 percentage points, see Columns 3 and 4 Table A5) to believe that other mothers in their community have knowledge about their child's vaccinations if that mother is a friend or a relative (close relationship). Yet, the bracelets are equally potent in changing perception about the knowledge of others for close and far relationships. In other words, bracelets led mothers to believe that even mothers who are regular community members have greater information about their actions.

5.1.3 Do Individuals Learn from Signals about Types?

Figure A7 shows that mothers believe that community members form different opinions about them - in terms of their intrinsic motivation - depending on the vaccinations that their child completed.⁴⁶ 92 percent of mothers state that others would view them as

⁴⁶Community members are one of four main reference groups mothers believe are concerned about their child's vaccinations. 62 and 61 percent of mothers respectively named their husband/father of the child and family members as individuals who are concerned, and named second, with 30 and 36 percent

“caring” if they took their child for all vaccinations, and “careless” if they missed any, verifying the underlying mechanism that higher actions are linked to higher types, that is:

$$E_{-i}(v|a_i \geq r) - E_{-i}(v|a_i < r) > 0.$$

On the contrary, few believed that others link their vaccine decision to their knowledge about benefits $B(a_i)$ (e.g. “know of importance”, or “are ignorant”) or cost-factors $C(a_i)$ (e.g. “are too busy with work”, or “too poor to travel to the clinic”). These answers also shed light on the question of what individuals are trying to signal to others when making actions visible (Bursztyn and Jensen 2017). There are two immediate explanations in my context: (i) mothers want to signal that their child is healthy and does not pose a threat to other children in terms of spreading diseases (\sim inference about child’s health status); (ii) mothers want to show that they look after their child’s health (\sim inference about responsible parent). The first explanation does not seem to be a motive for signaling: the majority of mothers view vaccines as beneficial only to their own child’s health and lack an understanding of the externalities of vaccination. Specifically, fewer than 20 percent believe that other, unvaccinated children can be harmful to their own child’s health, or that their child could be harmful to others if not vaccinated (see Table A11).⁴⁷

Taken together, the mechanism results show that mothers in the Signal at 4 and 5 treatments, as intended, used the color of bracelets to learn about other children’s vaccinations, and make different inferences about parents’ motivation to look after their child’s health conditional on their vaccine decisions.⁴⁸

5.2 Effect of Signals on Vaccine Decisions

The main outcome of the experiment is the share of children vaccinated in a timely manner for a given vaccine. The experimental design allows for a direct test of the effect of social signaling preferences on the outcome. Having established that bracelets as signals were informative about parents’ actions and their types, this part of the paper investigates to

respectively, regular community members and community health workers/nurses.

⁴⁷At endline 91 percent of mothers believe that vaccinations are helpful for their own child’s health, stating that “[they] help my child to grow well and healthy” and “prevent my baby from paralysis [and] blindness”. Only 15 and 19.5 percent of mothers respectively agree that other children can pose a risk to their child when not being vaccinated, or that their child could be harmful to others if she is not vaccinated, stating reasons such as: “Because if she is not immunized, she can transfer diseases like measles if she happens to contact it”. When mothers are asked why they think their vaccination decisions cannot help others, common answers were: “Because they do not have the same body, or same blood” or “Because the vaccines in my child won’t jump and help other children”. See Tables A10 and A11 for details.

⁴⁸Beyond the *opinions* that mothers believe others will form about them as parent, they also name specific *actions* that they believe others will take. 74 percent of mothers (see Figure A8 in the Appendix) believe that others would scold them if they missed vaccinations, while 22 percent said they would be praised in the community and people would speak well about them.

what extent parents value signaling that they look after their child’s health. Specifically, the reduced form tests if the parameters λ and ω_r jointly are greater than zero.

5.2.1 Empirical Strategy

My preferred specification for the main outcome is:

$$Vaccine_i = \alpha + \beta T_{j(i)} + \delta X_i + \rho_{s(i)} + \varepsilon_i \quad (4)$$

in which $Vaccine_i$ denotes the binary outcome variable for a child i being vaccinated for a given vaccine $a \in \{1, 2, 3, 4, 5\}$ by the age of 3 months for vaccine one, 4 months for vaccine two, 5 months for vaccine three, 6 months for vaccine four, and 11.5 months for vaccine five; $T_{j(i)}$ are treatment indicators for Signal at 4, Signal at 5, and the Uninformative Bracelet assigned at the clinic level (j); X_i denotes the control variables of child age, distance to the clinic, clinic and community population size; and $\rho_{s(i)}$ denotes the strata fixed effects. Standard errors are cluster bootstrapped at the clinic level.

The timeliness cut-offs were determined following WHO guidelines that state that the DTP series should be completed by six months of age (WHO 2018). I allow for an equal 2.5 months buffer window for each vaccine such that for vaccine one, which is due at birth or shortly thereafter, the timeliness cut-off is set at 3 months, for vaccine two which is due at 1.5 months, the timeliness cut-off is set at 4 months, etc. In the main specification, I code children that received a given vaccine before the timeliness cut-off as one and zero otherwise. In the later part of the analysis, I will consider the effect of signals on complete vaccination by the age of one year, independent of the time a child received the vaccine.

I combine data collected during the listing survey with data from administrative clinic records to measure outcomes. The listing survey data provides the sample of all children that reside in the selected communities and were born since the launch of the experiment. I use the administrative data to extend the vaccine history for children that had not yet reached one year of age at the time of the listing survey.⁴⁹ Given the sequential timing of vaccines and the corresponding timeliness cut-offs of 3, 4, 5, 6 and 11.5 months, I observe more children for vaccine one and two than for vaccines three, four or five. I include all available data and the sample size therefore differs across the five different vaccine outcomes. In total, I observe 7,246 children for vaccine one, 6,869 for vaccine two, 6,352 for vaccine three, 5,794 for vaccine four and 2,281 children for vaccine five across 119 clinics and 582 communities.⁵⁰ For children age one year and above, I observe a total of 1,914.

⁴⁹As indicated in the timeline in subsection 4.5, the listing survey was implemented between September 2017 and January 2018, while the administrative data was collected between February and April 2018 and therefore provides further information about children’s vaccinations.

⁵⁰One clinic of the 120 selected, located in Western Area Rural district is excluded from the analysis due to serious complications in the implementation and data collection.

5.2.2 Effect of Signals on Timely Completion of Vaccines 4 and 5

The discussion of the empirical results follows the theoretical predictions outlined in Section 3.1.2 and the experimental identification outlined in Section 4.2.

I first examine the effect of signals on timely completion of vaccines:

$$\frac{\partial \Pr(a_i(v) \geq r)}{\partial x} > 0$$

Figure 6 shows the combined effect of Signals at 4 and 5 on the share of children timely vaccinated for all five vaccines over the Control Group. Vaccination levels in the Control Group reveal a sharp drop-off between vaccines three and four (12.6 percentage points), and vaccines four and five (16 percentage points), illustrating the scope for parents to signal the timely completion of these vaccines. The signaling treatments led to a significant increase in the share of children that received vaccines four and five, increasing timely shares from 71 to 79 percent and from 55 to 64 percent, respectively. The effects indicate that the signaling treatment reduced drop-off by 60 and 53 percent, respectively.⁵¹

The effect is masked by substantial heterogeneity.⁵² Figures 7 and 7b show treatment responses for each signal separately: Signal at 4 led to a small and insignificant increase of 3.3 percentage points for vaccine four, and 3 percentage points for vaccine five. Signal at 5, on the other hand, led to a significant and large increase of 12.2 percentage points for vaccine four, and 14.4 percentage points for vaccine five. A comparison between the Uninformative Bracelet and the Control Group, in Figure 8, reveals that the effect of bracelets as a consumption incentive and reminder was limited: I find small to moderate treatment effects of the Uninformative Bracelet of 3.4 and 4.6 percentage points for vaccines four and five respectively.⁵³ As a result, the effects of Signal at 5 for vaccines four and five remain large and significant (8.9 and 9.8 percentage points) when compared to the Uninformative Bracelet, providing compelling evidence for social signaling preferences. Bracelets as signals for completion of vaccine five increased timely completion of the DTP series to levels necessary to reach herd immunity for diphtheria.⁵⁴

⁵¹Regression results for all comparisons can be found in Table 6. Table A12 displays results for the same estimation without control variables or strata-fixed effects.

⁵²Regression results for all comparisons can be found in Table 7. Table A13 displays results for the same estimations without control variables or strata-fixed effects.

⁵³The effects on vaccine five are mainly driven by a large positive effect early in the experiment. See treatment effects for first two birth cohorts after the launch in Figures 10 and 10b.

⁵⁴Herd immunity for diphtheria requires 83-85 percent (Anderson and May 2013) of the population to be vaccinated with all three doses.

5.2.3 Social Desirability of Different Signals

I now examine the social desirability of different signals:

$$\frac{\partial^2 Pr(a_i(v) \geq r)}{\partial x \partial \omega_r} > 0$$

Health workers in both Signal at 4 and Signal at 5 implemented the same bracelet hand outs and exchanges, with the only difference being the vaccine at which children receive a green bracelet.^{55,56} Moreover, as shown in the previous subsection, bracelets were equally visible and informative about actions across both signaling treatments. Observed differences in treatment responses therefore must be linked to differences in the signaling value of each bracelet, either caused by (i) differences in the social desirability of actions, that is, ω_r or (ii) differences in type expectations, that is, $\Delta(\hat{v}_r)$. The similarly large drop-off between vaccines three and four and vaccines four and five, and mothers' awareness of both (see Figure 5), suggests that there should be a similar wedge in type expectations for Signal at 4 and Signal at 5, rendering (ii) an unlikely reason to explain such a large difference in treatment effects.

To capture differences in social desirability, mothers were asked at endline what they considered to be the most and the second most important vaccine.⁵⁷ Figure 9 shows that mothers assign a higher importance to vaccine five than vaccine four, considering the fourth vaccine overall to be the least important among the five and ranking vaccine five as the second most important vaccine after vaccine one. These preferences, taken at face value, imply a low valuation of a signal at vaccine four, and a higher valuation of a signal at vaccine five.

This raises the question: how informative is Signal at 4 about a child having received vaccine five? Put differently, if Signal at 4 is as informative about the completion of vaccine five, as is Signal at 5 then we would expect to see similar treatment effects for both, despite the differences in preferences. Figure 5 for Vaccine 5 shows that both Signal at 4 and 5 were significantly more informative about the completion of vaccine five than was the Uninformative Bracelet. In terms of magnitude, Signal at 4 was approximately two-thirds as informative about the completion of vaccine five as Signal at 5.⁵⁸ Scaling the observed treatment effect on vaccine four for Signal at 5 accordingly, we would expect

⁵⁵Table A17 Column 3 shows that there are no significant differences in bracelet exchanges at vaccines four and five across Signal at 4, Signal at 5, and the Uninformative Bracelet.

⁵⁶While there are fewer children that have a green bracelet in Signal at 5 compared to Signal at 4 treatment, I find no evidence for that scarcity or abundance of green (compared to yellow) bracelets could drive the observed differences in treatment effects.

⁵⁷Ideally, I would also have elicited second-order beliefs about preferences, asking mothers what they thought others thought were the most important vaccines. Piloting showed that these question are difficult to implement.

⁵⁸Simple calculation: $\frac{Pr_{-i}^{S5}(a_i \geq 4|Green) - Pr_{-i}^{S5}(a_i \geq 4|Yellow)}{Pr_{-i}^{S4}(a_i \geq 4|Green) - Pr_{-i}^{S4}(a_i \geq 4|Yellow)} = \frac{0.28}{0.40} = 70$.

to see a treatment effect of around 8.5 percentage points on vaccine four for Signal at 4. The actual point estimate is 3.3 and therefore 2.6 times smaller. Given the noisiness of the coefficient one should consider the confidence interval of the estimate $[-5.1, 11.59]$, which does include the value. I interpret these results as evidence for the importance of linking signals to actions that are commonly perceived as valuable, and that the information they provide about other closely-related actions might be down-weighted by individuals.

Reassuringly, Table 9, shows that there are no significant differences in individuals' preferences for different vaccines across treatment and Control Groups, ruling out that the observed treatment effects for Signal at 5 are due to normative influence of signals or social learning.

5.2.4 Effect of Signal at 5 on Timely Completion of Earlier Vaccines

I next examine the effect of Signal at 5 on vaccinations before the signaling threshold at vaccine five:

$$\frac{\partial \Pr(a_i(v) \geq r - \tau)}{\partial x} \geq 0$$

Figures 7b and 8b depict that in addition the treatment effects at vaccines five and four, Signal at 5 also led to significant increases in the share of children that were vaccinated for vaccines three (8.2 and 4.9 percentage points) and two (4.6 and 2 percentage points) compared to the Control Group and Uninformative Bracelet. The pattern of treatment responses reveals that parents were more likely to vaccinate their children for earlier vaccines, without necessarily making it to vaccine five. That is, parents responded to a signaling benefit at vaccine five (\sim option value of signaling) six to nine months in advance, without being able to necessarily realize the benefit. These effects are consistent with the theoretical predictions from the signaling model discussed in Section 3.2 where individuals make decisions dynamically under uncertainty. More generally, this responses to treatment imply that individuals aim to complete later vaccines, but drop out early due to unforeseen preference or cost shocks.

Table 7 Column 6 combines the reduced form treatment estimates for all five vaccinations. Signal at 5 significantly increased the average total number of vaccines completed from 4 to 4.4, over the Control Group and from 4.2 to 4.4 over the Uninformative Bracelet. I find no significant difference between the Uninformative Bracelet and Signal at 4.

5.2.5 Treatment Effects over Time

Figures 10 and 10b plot the time trends of average treatment effects of Signal at 4, Signal at 5, and the Uninformative Bracelet, compared to the Control Group for vaccines four and five, by birth cohorts. Children are binned into birth cohorts of two months.

The vertical grey line represents the time of the launch of the experiment. Looking at effects over time for Signal at 4, there is some indication of a positive trend in treatment effects for children born six to 12 months after the roll out. Such patterns are consistent with a signal with an initially low value, due to it being linked to an action that is not considered relevant for social image concerns, but that becomes more valuable as the visibility and salience of the action increases the relevance that people assign to it. For the Uninformative Bracelet, I observe the opposite trend: the bracelet led to large and significant increases in timely take-up of vaccine four for children born zero to two months after the roll out, but had no detectable effect for cohorts born four to 12 months after the launch. Importantly, for Signal at 5, the patterns across time show consistently high treatment effects between 8 and 15 percentage points for vaccine four, which persist for children born 10 to 12 months after the launch of the experiment (see Figure 10). For vaccine five, where I observe fewer cohorts (see Figure 10b), treatment effects seem to increase over time, from 13 percentage points for children born immediately after the roll out to 15 percentage points for children born six months into the implementation.

5.2.6 Intensive versus Extensive Margin Effect of Bracelets

Signals were tied to the timely completion of vaccinations. An alternative measure used in public health is the share of children that received a given vaccination by the age of one year. Table 8 Columns 1 to 3 show that almost all children had received vaccine one, two and three by twelve months age, with levels of completion at 99, 97.9 and 94.6 percent.⁵⁹ However, there is still a substantial drop off for vaccines four and five, with 89 and 66.9 percent of children completing those. Columns 4 and 5 shows the effects of all three bracelet treatments on the share of children vaccinated for vaccines four and five, compared to the Control Group.⁶⁰ Signal at 5 treatment not only led to intertemporal shifts, encouraging parents to vaccinate their children more timely (see Table 8b for constant sample comparison), but also led to shifts on the extensive margin, with more children getting vaccinated by the age of one: shares increased by 6.2 and 13.7 percentage points for vaccines four and five respectively compared to the Control Group. Treatment effects are similarly large for Signal at 4 and the Uninformative Bracelets for vaccines four (5.9 and 6.3 percentage points) and five (9.9 and 7.5 percentage points respectively, the latter not being significant). The impacts on immunizations are consistent with the effects of bracelets on parents' beliefs about the knowledge that others' have about their own child's vaccinations. Column 4, Table 5) shows that perceived information increased by 35

⁵⁹Table A14 displays results for the same estimation without control variables or strata-fixed effects.

⁶⁰Note: by changing the definition to children vaccinated by the age of one, I restrict the sample to children who were at least one year old by the end of the experiment, which results in a sample that is composed of birth cohorts who were early on exposed to the intervention. Given the dynamics observed in Figures 10 and 10b for the Uninformative Bracelet, it is plausible that extensive margin effects would look different for this treatment for children that were born later.

percent for Signal at 5, 29 percent for Signal at 4 and 18 percent for the Uninformative Bracelet, compared to the Control Group, while immunization rates increased by 20 percent, 15 percent and 11 percent for Signals at 5 and 4 and the Uninformative Bracelet respectively compared to the Control Group (see Column 5, Table 8b).

Bracelets, as social signals that increase the perceived visibility of vaccinations, had a significant and large effect on the completion of routine vaccinations by the age of one year. Particularly relevant for protection levels against these diseases, bracelets raised completion rates for the DTP series to over 95 percent, reaching immunization rates necessary for herd immunity against whooping cough, and increasing Measles vaccination rates up to 81 percent.

5.3 Discussion

The preceding analysis yields three main takeaways. First, the results provide the first field experimental evidence of the impact of social signaling in a low-income setting, showing that individuals are willing to take meaningful actions to signal their type as good parents. Parents vaccinated their children more timely, and completed on average an additional 0.5 vaccinations at a cost of less than 1 USD per child. This finding provides compelling evidence for the potential of social signaling, as an informal enforcement mechanism, to increase public goods.⁶¹ Second, the findings show that for signals to be effective, they need to both be informative about individuals' actions and to be *clearly* linked to actions that are sufficiently valued and therefore considered as socially desirable. By placing a signal on an action that is commonly valued, individuals can be motivated to take actions they value less, such as taking their child more timely for vaccine four. Alternatively, signals may need to be combined with a normative messaging intervention, that highlights the externality effects of an action and increases social image concerns through that. Third, these results show that parents make dynamic decisions when deciding about the optimal number of vaccinations. Parents respond to the option value of signaling, by taking their children timely for earlier vaccines, without necessarily making it to vaccine five and realizing the benefit. This is relevant information when considering the optimal structure of signaling or other types of incentives. For example, there is a multitude of (preventative or curative) health behaviors where individuals are required to follow through with multiple visits but after initial take-up of treatment people drop out (Bai et al. 2017). My results highlight that a non-linear incentive scheme, with a social signaling benefit in the far future, can be effective at mitigating drop out. However, given the continued “gap” between individuals' target number of vaccinations and the actual number of vaccinations they complete, a linear incentive scheme, with a benefit at each

⁶¹Compared to formal laws that require parents to vaccinate their child for them to be allowed to attend daycare, like in the U.S..

vaccine could potentially lead to further increases in completion rates.

6 The Value of Social Signaling under Dynamic Decision-Making

In order to quantify the value of social signaling taking into account i) the dynamic nature of decision-making, where parents respond to the option value of social signaling and uncertainty over future cost or preference shocks, and ii) type selection effects at later vaccines, I estimate a dynamic discrete-choice model. I use distance to the clinic as a numeraire to price out the signaling value. To do so, in this section, I first demonstrate the reduced form relationship between distance and its impact as a cost on vaccination outcomes. Secondly, I set up the dynamic model estimating the relevant parameters.

6.1 Distance as Cost in Reduced Form

Figure A9 plots a bin scatter of the average number of timely vaccines completed against the travel distance from communities to clinics, separately for the Control Group and Signal at 5. Distance has a linear effect on the number of vaccinations completed: in the Control Group, the total number of vaccines completed declines from 4.3 at zero miles to 3.2 vaccines at five miles. Figure 11 shows the effect of distance on the share of timely vaccinated children by vaccine. Each vaccine graph plots a bin scatter of the share of children vaccinated (for vaccine 2, 3, 4 and 5) against the distance from communities to clinics, separately for the Control Group and Signal at 5. It is evident again that distance has a linear effect on the share of children vaccinated for each vaccine. Importantly, both figures make clear that Signal at 5 mitigated the negative effect of distance, increasing the share of children vaccinated at four miles to that of children vaccinated at zero miles. Differently put, the reduced form results show that Signal at 5 increased parents' willingness to walk for a given vaccine by four miles distance to the clinics.

It is important to note that distance was not exogenously varied in this experiment. We should therefore be worried about the effect of distance on vaccination behavior being confounded by other observable or unobservable characteristics. While I cannot account for the latter, Tables A15 and A16 show that the inclusion of relevant observable characteristics, such as mothers' education, economic status, or the birth order of children, has no significant effect on the impact of distance on vaccinations in the endline sample.

6.2 Quantifying Social Signaling Utility

Following the discussion of the model of signaling under uncertainty in Section 3.2, I empirically specify the flow utility of a vaccine at time $t \in \{1, 2, 3, 4, 5\}$ as follows:

$$u_{it} = v_i - \kappa D_i - \eta_t + S_4 T_{4i} \mathbb{1}\{t = 4\} + S_5 T_{5i} \mathbb{1}\{t = 5\} + \epsilon_{it}. \quad (5)$$

The model includes two dimensions of unobservable heterogeneity: (i) ϵ_{it} cost or taste shocks which are independent and identically distributed following the logistic distribution, and (ii) individuals differ in their type v , which is assumed to be randomly drawn from a normal distribution in period zero and is persistent across time t . The mean μ_v and variance σ_v of the type distribution will be identified in the structural estimation as I observe individuals making decisions across multiple periods. Further, the model includes two dimensions of observable heterogeneity: (i) individuals' travel distance D_i which discretely varies from zero to five miles and (ii) the signaling treatments T_{4i} and T_{5i} which are exogenously assigned. The parameter κ captures the marginal disutility of one additional mile distance to the clinic. The parameters S_4 and S_5 capture the social signaling utility $\lambda \omega_r \Delta(\hat{v}_r)$ and η_t denotes the disutility of a vaccine in period t .⁶²

The reduced form effects of the Signal at 5 treatment at earlier vaccines operate solely through option value. The implied valuation must be filtered through individuals' expectations about the probability that they make it to the end and receive the signaling payoff. At $t = 5$ there is no option value component left and the problem becomes a static one, but the valuation is that of a non-random subset of individuals that differ from the rest in their type v , and not the type population as a whole. Computing the valuation from the reduced form requires linking of all the choice probabilities and treatment effects at each t together. The structural model allows me to do that. I estimate the model using maximum likelihood.

Table 10 presents the results from the structural estimation, with Column 1 showing the parameters from an estimation where I compare the shares of children vaccinated timely in Signal at 5 and Signal at 4 to those in the Control Group, and Column 2 showing the parameter estimates comparing both signaling treatments to the Uninformative Bracelet. Taking the ratio of the parameters S_5 and κ gives an estimate of the social signaling utility in miles. On average, parents' valuation of social signaling is equivalent to 5 to 8 miles walking distance to the clinic. In other words, at the mean walking distance of 2 miles to a clinic, the opportunity to signal the completion of vaccine five increases parents' willingness to take their child for 2 to 4 additional vaccinations. Figure 12 compares the reduced form predictions for the choice probabilities of the structural model with

⁶²I set η_t such that the relative size of η_t and $\eta_{t'}$, $t' \neq t$, is proportional to the relative self-reported importance that individuals assign to different vaccines t and t' , shown in Figure 9. That is, $\eta_t = \alpha \mathbb{1}(t = 2) - 3\alpha \mathbb{1}(t = 3) - 4\alpha \mathbb{1}(t = 4) - \alpha \mathbb{1}(t = 5)$.

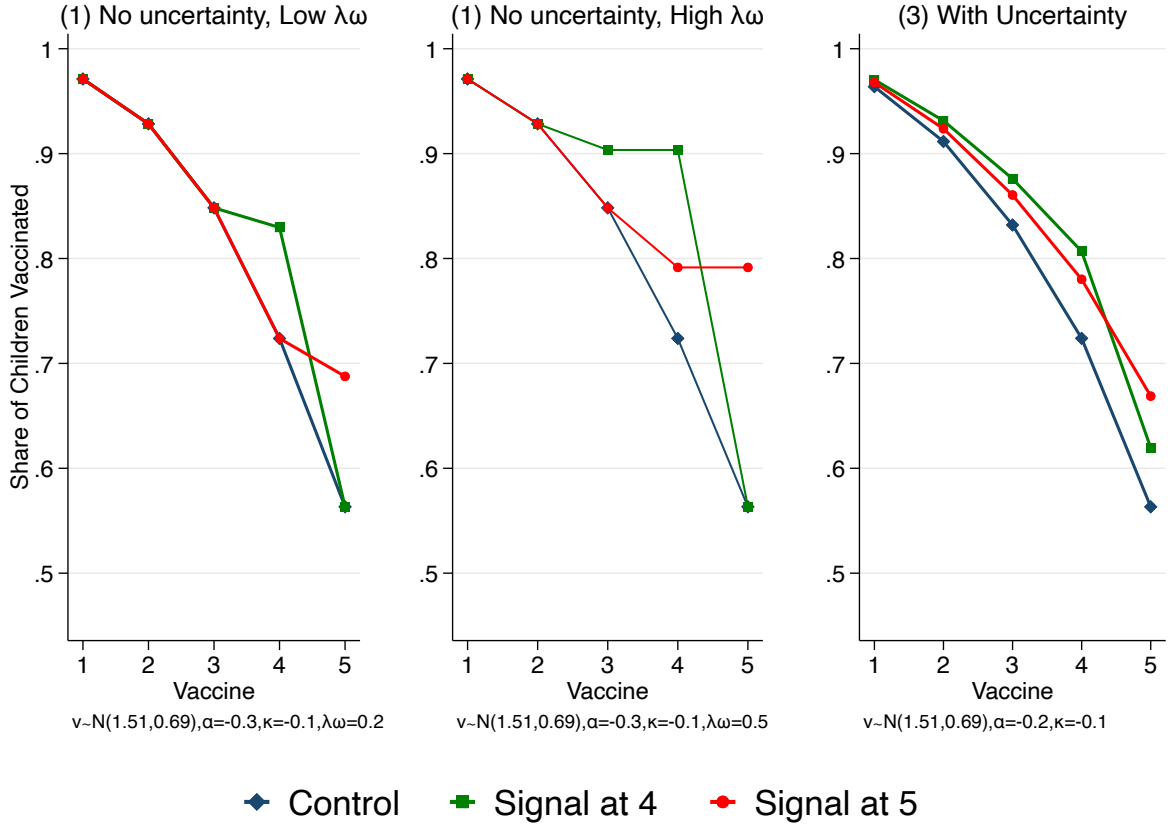
their empirical analogues. The model predicts the empirical reduced form probabilities reasonably well.

7 Conclusion

This paper analyzes the effect of social signaling in the dynamic setting of childhood immunization, examining how individuals respond to the opportunity of signaling to others that they are responsible parents. Different to most studies, the experiment implements a durable signal that allows parents to continuously signal their type over the first year of a child's life. My results suggest that the effects of social signals are large, when the action signaled is sufficiently valued. This provides impetus for future research on how the effects of social signals could be enhanced if they are combined with normative messages that emphasize the otherwise undervalued social benefits of actions (like the completion of vaccination series). Moreover, this study shows that individuals' response to signals is consistent with decision-making under uncertainty, shedding light on the constraints that parents face to timely vaccinating their children in contexts like Sierra Leone. It is a question for further research whether a non-linear incentive scheme, where a signaling benefit is only provided at completion of all vaccines is optimal, or if a more linear scheme with signals at multiple points could lead to further reductions in drop-off. On the one hand, signaling benefits might be smaller if there is less scope for parents to separate themselves from others in their intrinsic motivation; on the other hand, if the variance of cost shocks is large, even a smaller signaling benefit at each vaccine could compensate parents for unanticipated cost shocks.









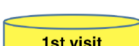
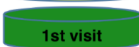
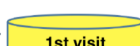
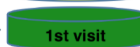
Overall, the findings of this study are of substantive policy importance: signals increased immunization rates to levels necessary for herd immunity at a cost of less than 1 USD per child. Moreover, they address a problem pertinent to many low-income countries: scarcity of trained health workers and relatively low rural population density. As social signals increase parents' willingness to travel further to receive vaccinations, health workers can remain at clinics and make themselves available to as many patients as possible. Importantly the effects of this intervention persist for children 12 months after the launch of the experiment, demonstrating that a subtle behavioral intervention like this can feasibly be implemented at a large scale through existing government institutions.

Figure 1: Simulation of the Effect of Signaling at Vaccine 4 and 5 on the Cumulative Distribution of Vaccinations, With and Without Uncertainty



Notes: This figure shows the simulated cumulative distributions of vaccine take-up for the case without signaling ($x=0$) - calibrated based of the observed levels of vaccine take-up from the Control Group - and with signaling at Vaccines 4 and 5, with and without uncertainty over future cost or preference shocks. Individual i 's utility is given by: $U(a_i; v_i) = (v_i - \kappa D)a_i - \sum_{a=1}^{a_i} \alpha(a-1) + x\lambda\omega_r \mathbb{1}(a_i = r)[E(v|a_i \geq r) - E(v|a_i < r)]$ with two signaling thresholds $r \in \{4, 5\}$ and $D = 2$ set to the mean walking distance. The parameter values used are indicated below each graph, with $\lambda\omega_r$ being set to 0.2 in graph (1) and to 0.5 in (2). For the no uncertainty cases, displayed in graphs (1) and (2), I solve the fixed-point equation 2, to obtain \hat{v}_r and the corresponding equilibrium type expectations $\Delta(\hat{v}_r) = E(v|a_i \geq r) - E(v|a_i < r)$. For the case of uncertainty, I assume that signaling utilities are the same as under certainty with $S_4 = \lambda\omega_4 \Delta(\hat{v}_4) = 0.68$ and $S_5 = \lambda\omega_5 \Delta(\hat{v}_5) = 0.6$. I assume that the flow utility of a vaccine at time $t \in \{1, 2, 3, 4, 5\}$ is given by: $u_{it} = v_i - \kappa D - \alpha \mathbb{1}(t=2) - 3\alpha E \mathbb{1}(t=3) - 4\alpha \mathbb{1}(t=4) - \alpha \mathbb{1}(t=5) + xS_r \mathbb{1}(t=r) + \epsilon_{it}$, with ϵ_{it} being iid logistically distributed and α being scaled by the relative importance that individuals assign to different vaccines (see Figure 9). The utility of stopping vaccination is normalized to zero. The value function for individual i who has not yet stopped vaccinating is: $V_{it} = \max\{0, u_{it} + E[V_{it+1}|v_i]\}$ for $t < 5$ and $V_{i5} = \max\{0, u_{i5}\}$ for $t = 5$, and is zero in all future periods once chosen not to vaccinate.

Figure 2: Experimental Treatment Groups

	Vaccine 1 Hand Out	... 2	... 3	Vaccine 4 Exchange	Vaccine 5 Exchange
Control					
Signal at 4	Yellow 	Green 	
Signal at 5			
Uninformative Bracelet	 	 	 

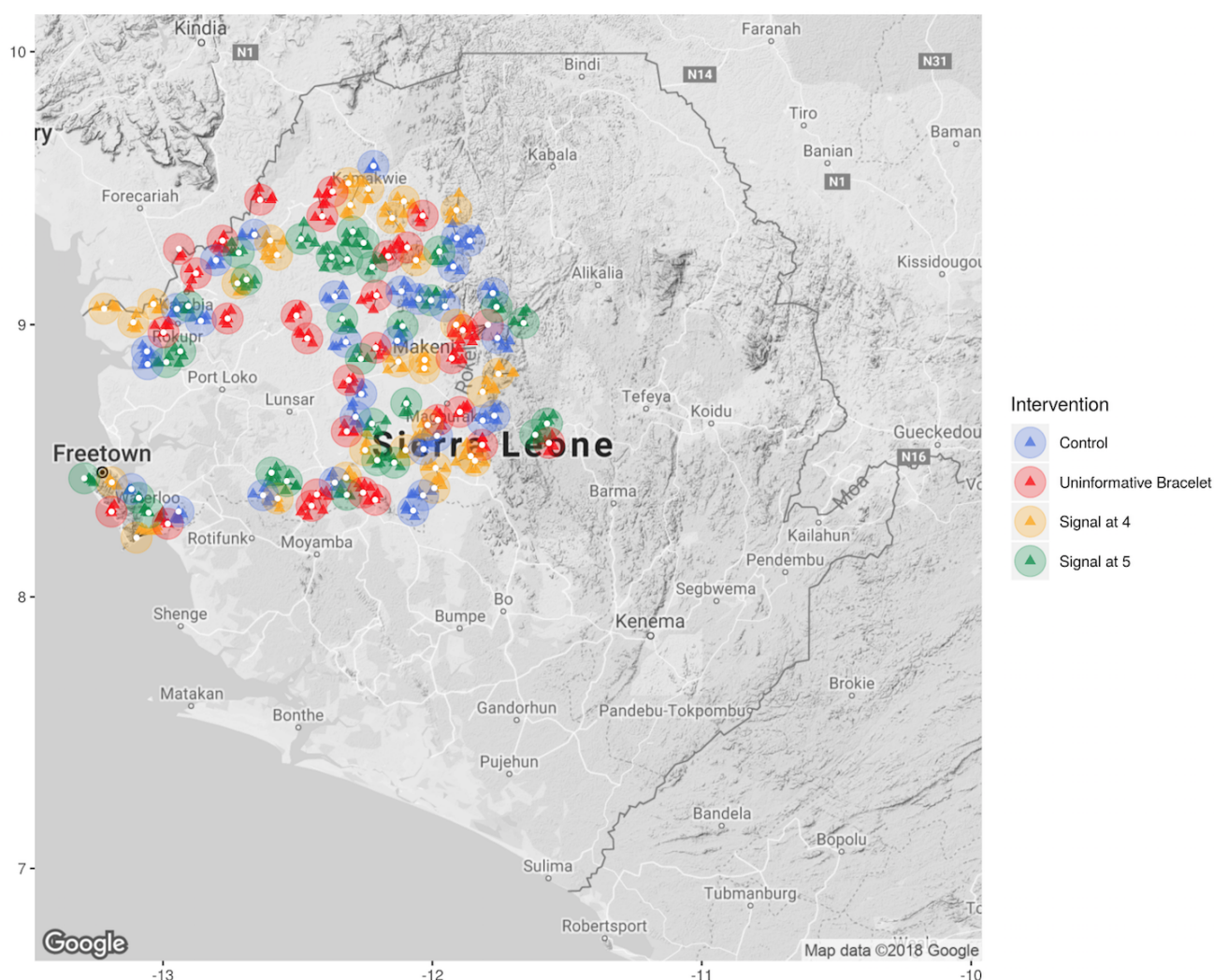
Notes: This figure displays the four different intervention arms and the bracelet hand out and exchanges that take place at each of the five vaccinations. At vaccine one children receive a bracelet that has written on it “1st visit” and has the color yellow in Signal at 4 and Signal at 5 treatments. In the Uninformative Bracelet, parents can choose for their child a yellow or green bracelet. A child keeps the same bracelet for vaccines two and three. At vaccine four, in the Signal at 4 treatment, the yellow bracelet is exchanged for a green bracelet that says “4th visit” if the child comes timely (i.e. before 6 months age), otherwise the bracelet is exchanged for an identical yellow bracelet. In the Signal at 5 the bracelet is exchanged for an identical yellow bracelet. In the Uninformative treatment, the bracelet is exchanged for an identical bracelet, of the same color as the parent chose at the first visit. At vaccine five, in the Signal at 4 treatment, the green (or yellow, depending on whether the child was timely at vaccine four) is exchanged for an identical bracelet. In the Signal at 5 treatment, the bracelet is exchanged for green bracelet that says “5th visit” if the child comes timely (i.e. by 11 months age). In the Uninformative Bracelet, the bracelet is again exchanged for an identical “1st visit” bracelet of the color originally chosen.

Figure 2b: Different Bracelets handed out across Three Signaling Treatments



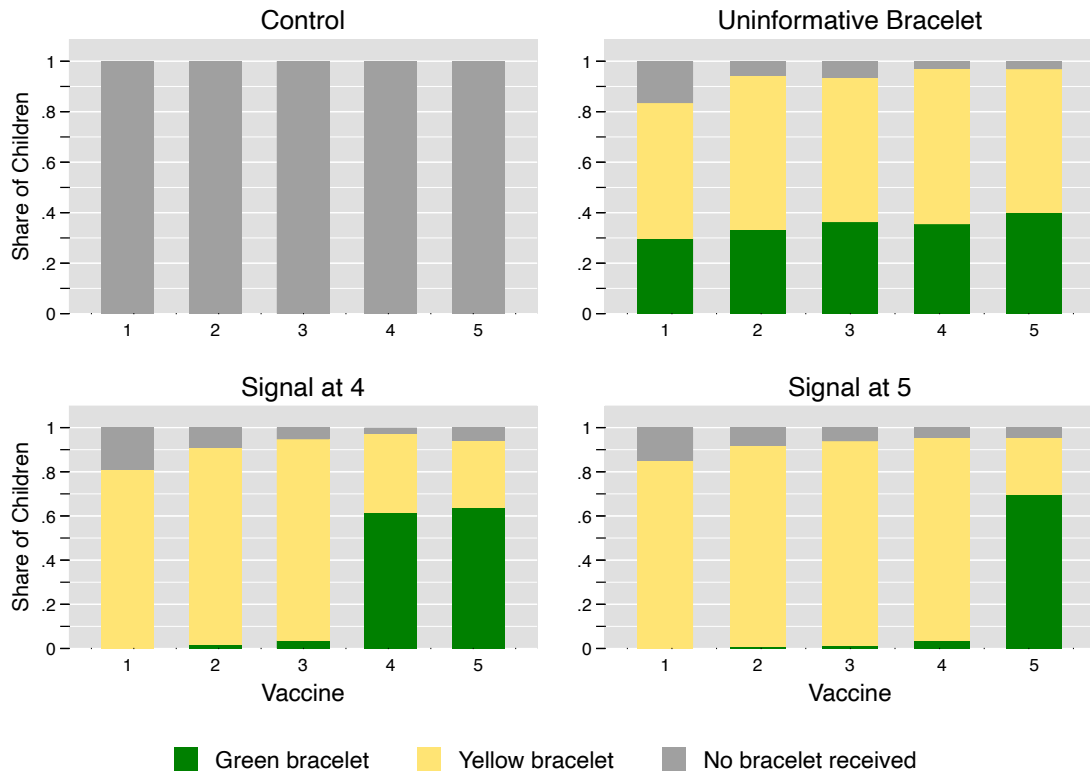
Notes: The image displays the bracelets that health workers give out at clinics: the yellow “1st visit” bracelet is used in Signal at 4, Signal at 5 and the Uninformative Bracelet treatment; the green “1st visit” bracelet is given to children in the Uninformative treatment; the green “4th visit” bracelet is given to children in the Signal at 4 and the green “5th visit” bracelet to children in the Signal at 5 treatment.

Figure 3: Clinic Randomization



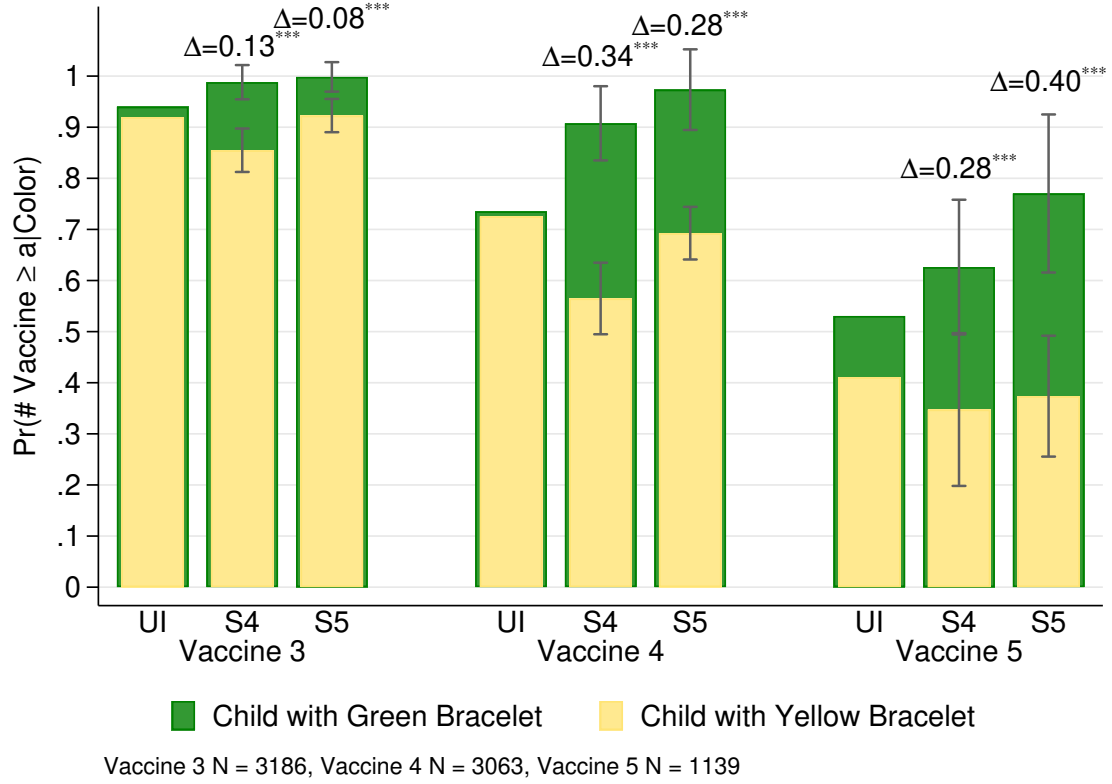
Notes: Map of Sierra Leone that shows the geographic span of the experiment, with 120 clinics, that is ten percent of Sierra Leone's public clinics, being randomized into the four different intervention arms. The clinic randomization was stratified by district. Four out of Sierra Leone's 14 districts were selected for the experiment in collaboration with the Government of Sierra Leone and its partners, based on the criteria: i) baseline vaccination rates, ii) Ebola affectedness, iii) reliability of the supply side of immunization, and iv) other ongoing interventions. To avoid spillovers, the set of 120 clinics was chosen from a sample of 243 clinics, using an algorithm that ensured that each selected clinic had a catchment radius of 5 miles, of which at least 35 percent of the area was non-overlapping with any adjacent clinic's catchment area.

Figure 4: Correct Hand Out of Bracelets by Treatment Groups



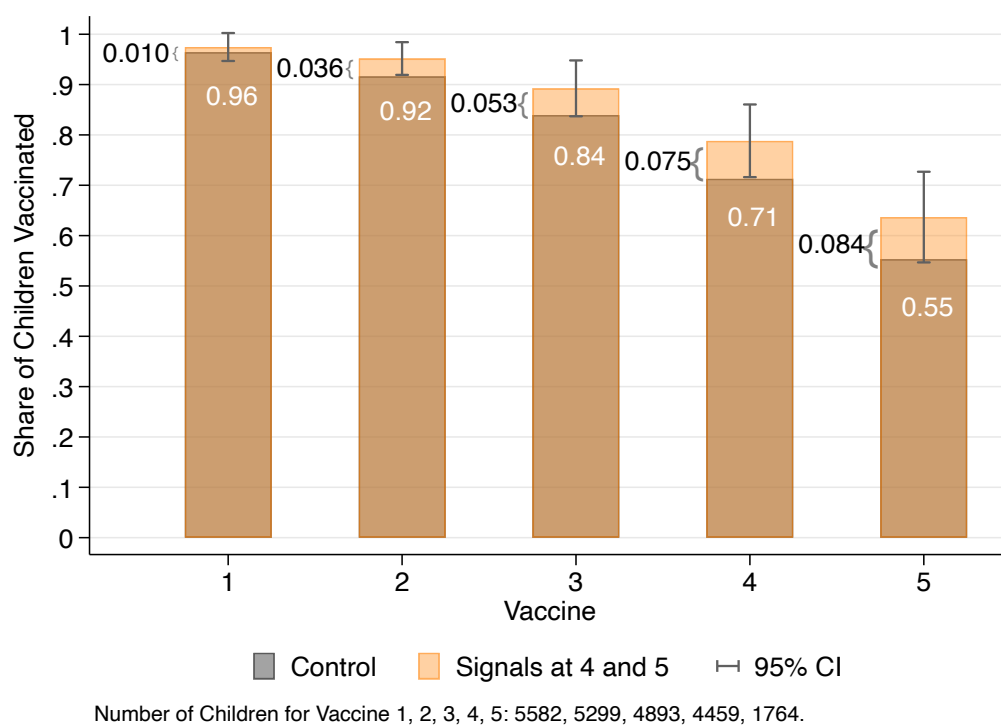
Notes: This figure displays the share of children with a green, yellow, or no bracelet conditional on the number of vaccines a child has received, separately for each treatment arm. The sample includes 7,055 children that were born after the experiment was launched and that were surveyed during the listing survey, which took place 12 - 15 months after the intervention was launched in a particular clinic. Surveyors asked each parent “What color bracelet was your child given when you went for vaccination?” and recorded all vaccines the child had received up to that point. The share of children with “No bracelet received” shows that almost every child received a bracelet (94%) across all three bracelet treatments. In the Uninformative Bracelet treatment, there is overall no significant relationship between the number of vaccines a child received and the color of bracelet. For Signal at 4 and Signal at 5, there is a clear relationship between color of bracelet and the number of vaccines a child received: there is a large spike - from close to zero to 61 percent for Signal at 4 and 70 percent for Signal at 5 - in the share of children with a green bracelet at vaccines four and five respectively. Children who had taken vaccine four and/or five but had a yellow bracelet had either come late for the vaccine (~ one-third) or health workers had missed to give the correct bracelet (~ two-thirds).

Figure 5: The Effect of Signals on Beliefs about Other Children's Vaccinations



Notes: This figure shows endline respondents' beliefs about the number of vaccinations a child received conditional on the color of bracelet. Beliefs are shown by vaccine, and by treatment, where UI = Uninformative Bracelet, S4 = Signal at 4, S5 = Signal at 5. The yellow and green bars show the conditional probability $\Pr(\# \text{ Vaccine} \geq a \mid \text{Color})$ of a child having received (at least) vaccine 3, 4, or 5 (i.e. $a = \{3, 4, 5\}$) conditional on the respondent observing the child having a yellow or green bracelet. Vaccines one and two are excluded from the figure since individuals believe that (close to) 100 percent of children complete these vaccines. The confidence intervals (at 95 percent) for Signal at 4 and Signal at 5, on the green and yellow bars respectively, compare the beliefs in the signaling treatments to those in the Uninformative Bracelet. Δ denotes the difference between the two conditional probabilities: $\Pr(\# \text{ Vaccine} \geq a \mid \text{Green}) - \Pr(\# \text{ Vaccine} \geq a \mid \text{Yellow})$. The samples used for each vaccine include all children below the age of one who were eligible for the specific vaccine: age 2.5, 3.5 and 9 months and older for vaccines three, four and five respectively. Using the estimated joint probabilities from regressions of a binary variable for a child having a green (yellow) bracelet and at least a vaccines (fewer than a vaccines), on treatment indicators for Signal at 4 and Signal at 5, with the Uninformative Bracelet as excluded category (e.g. $\Pr(\text{Green and Vaccine} \# \geq 4)$ and $\Pr(\text{Green and Vaccine} \# < 4)$) I compute the marginal probabilities for bracelet color (e.g. $\Pr(\text{Child has Green Bracelet})$) and finally the conditional probabilities e.g. $\Pr(\# \text{ Vaccine} \geq 4 \mid \text{Green}) = \frac{\Pr(\text{Green and Vaccine} \# \geq 4)}{\Pr(\text{Child has Green Bracelet})}$. Estimating the probabilities in a regression framework, I control for the mean take-up level of vaccine a at the clinic and child age. Both controls are demeaned. All regressions include strata fixed effects. Standard errors are clustered at the clinic level.

Figure 6: The Combined Effect of Signals at 4 and 5 on Timely Vaccinations



Notes: This figure shows the results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months, respectively, on a treatment indicator for Signal at 4 and 5, with the omitted category being the Control Group. The sample includes all children born since the launch of the experiment. All regressions include strata-fixed effects, demeaned controls for child age, distance to the clinic, clinic and community population size. The 95 percent confidence intervals were computed using standard errors that are cluster bootstrapped (1000 repetitions) at the clinic level.

Figure 7: The Effect of Signal at 4 on Timely Vaccinations

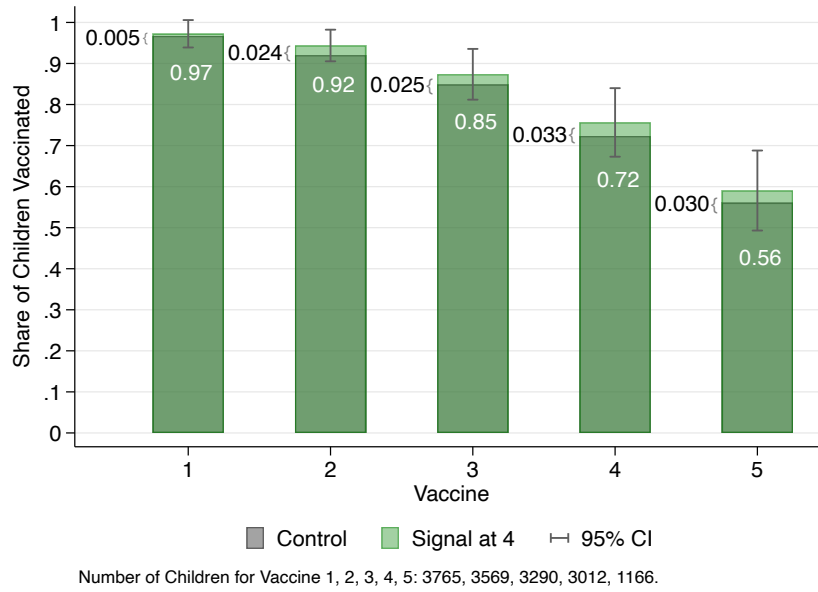
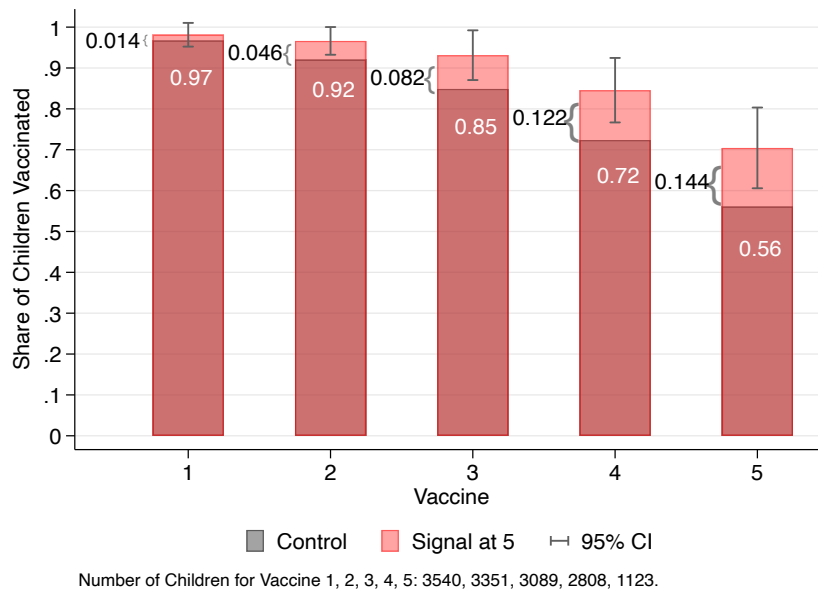


Figure 7b: The Effect of Signal at 5 on Timely Vaccinations



Notes: These figures show the results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months, respectively, on treatment indicators for Signal at 4 and Signal at 5, with the omitted category being the Control Group. The sample includes all children born since the launch of the experiment. All regressions include strata-fixed effects, demeaned controls for child age, distance to the clinic, clinic and community population size. The 95 percent confidence intervals were computed using standard errors that are cluster bootstrapped (1000 repetitions) at the clinic level.

Figure 8: The Effect of the Uninformative Bracelet on Timely Vaccinations

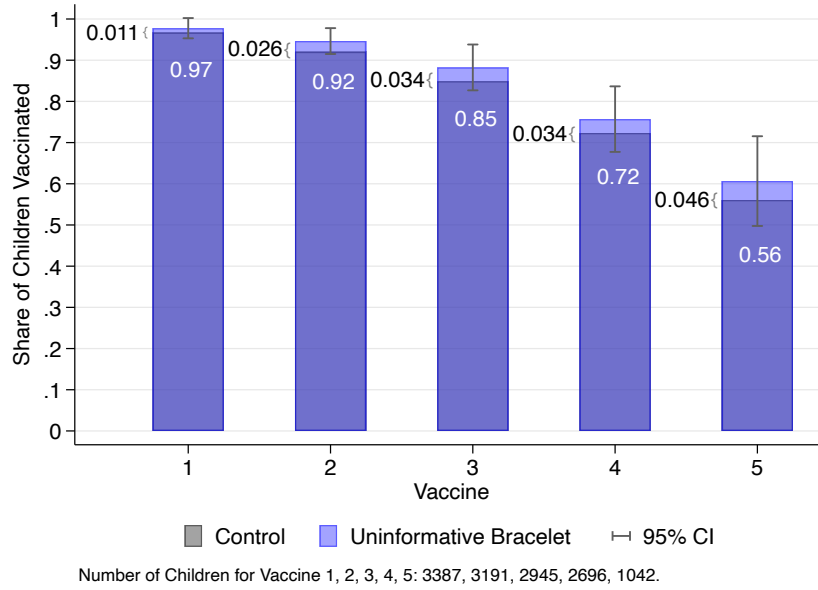
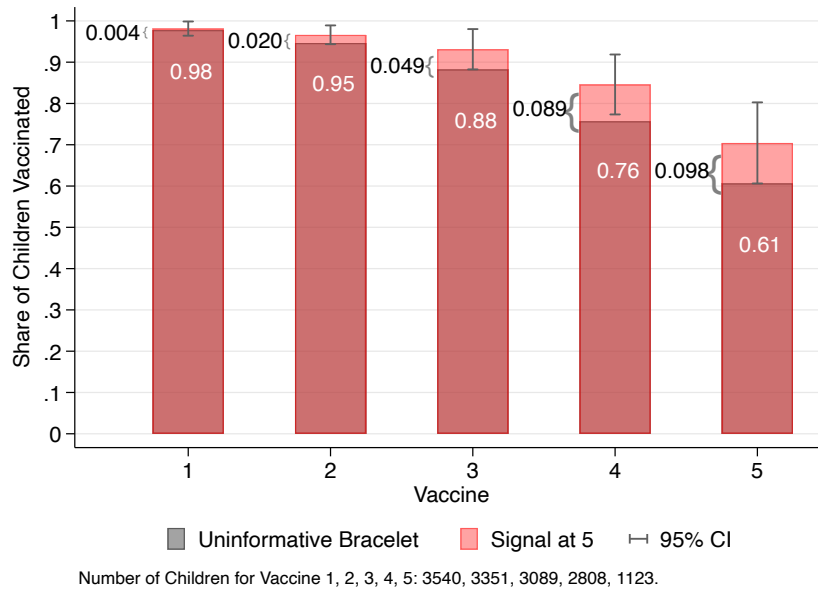
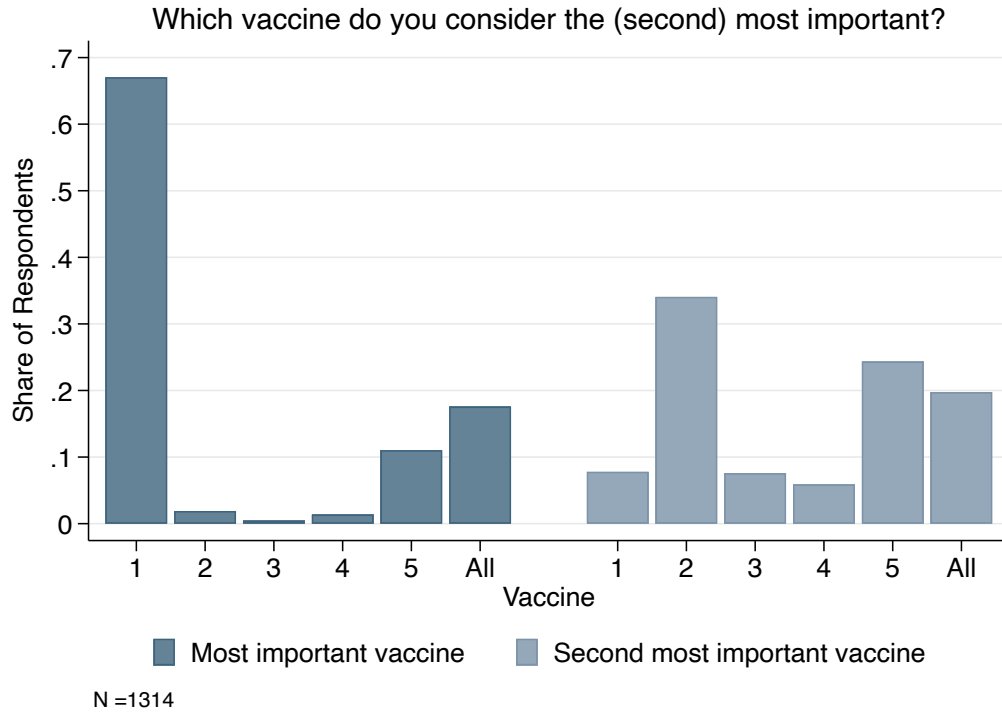


Figure 8b: The Effect of Signal at 5 versus the Uninformative Bracelet on Timely Vaccinations



Notes: This figure shows the results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months, respectively, on a treatment indicator for Signal at 5 and Signal at 4, respectively, with the omitted category being the Control Group and Uninformative Bracelet, respectively. The first comparison captures the effect of bracelets through increases in consumption utility and salience (e.g. reminder effects). The second comparison holds constant the effect of bracelets through increased consumption utility and salience (e.g. reminder effects). The sample includes all children born since the launch of the experiment. All regressions include strata-fixed effects, demeaned controls for child age, distance to the clinic, clinic and community population size. The 95 percent confidence intervals were computed using standard errors that are cluster bootstrapped (1000 repetitions) at the clinic level.

Figure 9: Preferences for Different Vaccinations



Notes: This figure shows mothers' perceptions about the relative importance of the five vaccinations. Mothers were first asked about which vaccination they thought was the most important, and then which one they thought was the second most important (conditional on not having answered "All" to the first question). The figure plots the share of respondents that answered vaccine one, two, three, four, five or all vaccines are the most important (on the left), and the second most important (on the right). The sample includes all mothers that were surveyed at endline. Answers are pooled across treatments. Table 9 shows there are no significant differences in preferences across intervention arms.

Figure 10: Treatment Effects over Time for Vaccine 4

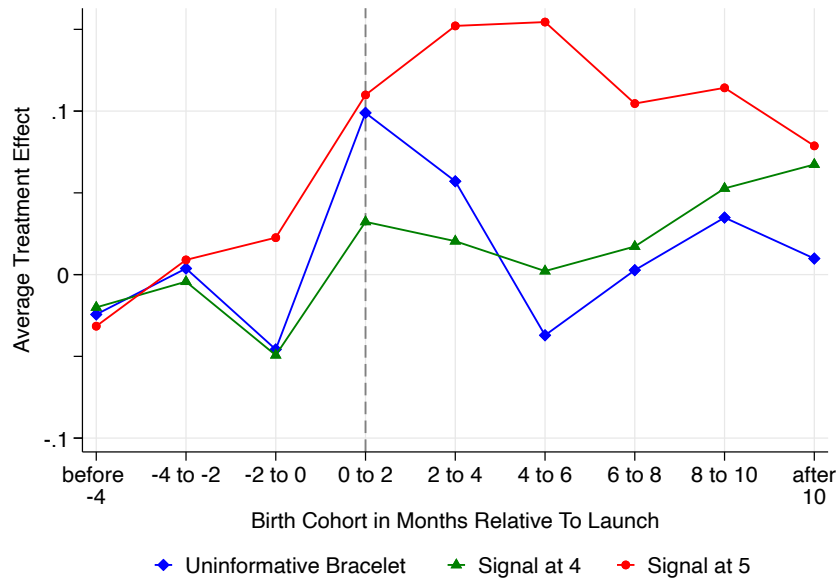
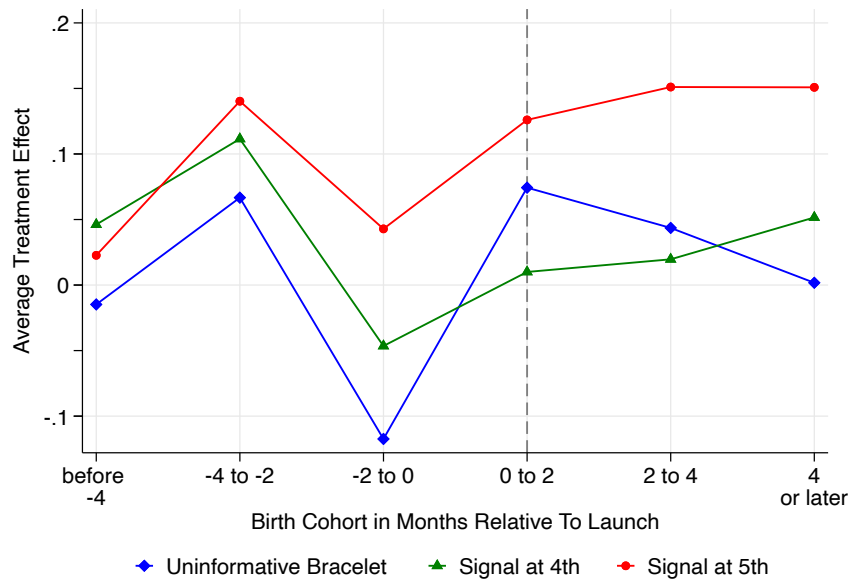
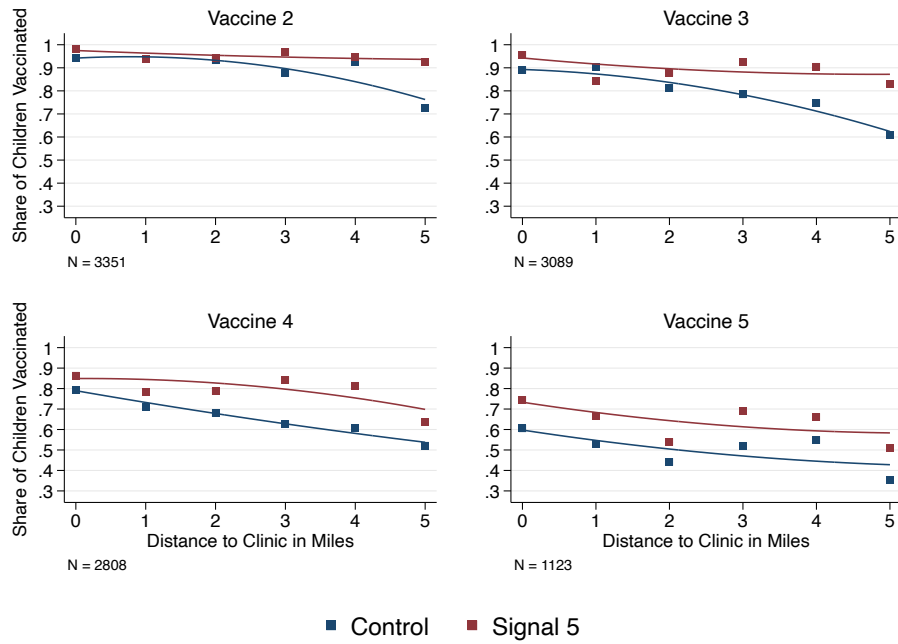


Figure 10b: Treatment Effects over Time for Vaccine 5



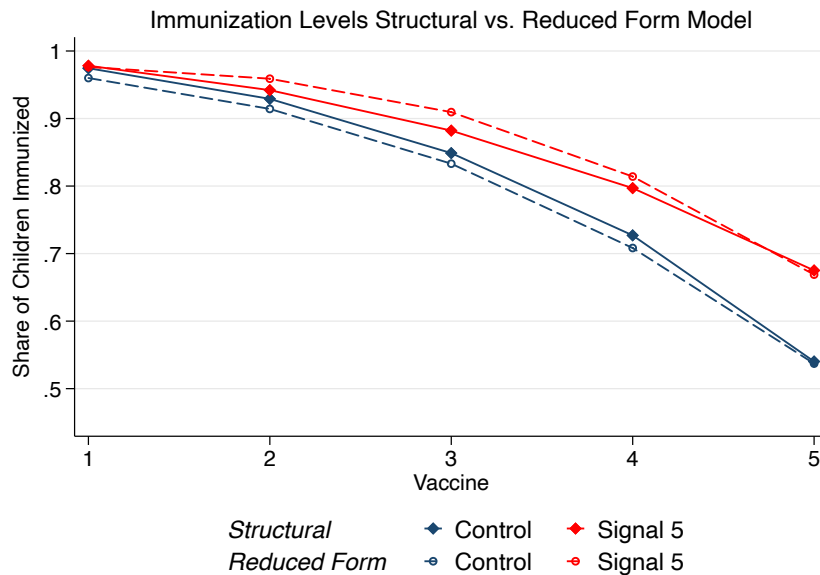
Notes: These figures plot the average treatment effects of Signal at 4, Signal at 5 and the Uninformative Bracelet treatment compared to the Control Group for vaccines four and five, respectively, by birth cohorts. Children are grouped into birth cohorts of two months. The dotted line indicates the launch of the experiment. The sample size (number of children) in each bin, starting from the left, is 1455, 501, 899, 918, 939, 948, 1126, 967 and 1024, and 1447, 685, 921, 912, 702 and 689, respectively.

Figure 11: The Effect of Distance on Take-up in the Control and Signal at 5 Group



Notes: The graph shows the effect of distance on the share of timely vaccinated children by vaccine. Each vaccine graph plots a bin scatter of the share of children vaccinated against the distance from communities to clinics, separately for the Control Group and Signal at 5. The sample includes all children born since the launch that were at least 4, 5, 6 and 11.5 months old by the end of the experiment, to be considered for vaccine 2, 3, 4 or 5 respectively.

Figure 12: Social Signaling under Uncertainty: Model Fit



Notes: The figure shows the simulated cumulative distribution of vaccine take-up for the Control Group and Signal at 5 using the parameter estimates from the dynamic discrete-choice model in Table 10. The reduced form estimates are from simple regressions without strata-fixed effects or controls.

Table 1: Description of Clinic and Baseline Community Characteristics

Variable	(1) Control Mean/SE	(2) Signal Mean/SE	(3) Signal at 5 Mean/SE	(4) Uninformative Mean/SE	(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(2)-(4)	(3)-(4)	F-test for joint orthogonality
Panel A: Clinic characteristics											
Baseline characteristics											
# of staff involved in immunization	2.900 (0.435)	2.667 (0.340)	3.034 (0.459)	2.733 (0.437)	0.607	0.526	0.654	0.596	0.989	0.856	0.884
Frequency of immunization services (1=weekly, 0=monthly)	0.700 (0.085)	0.633 (0.089)	0.600 (0.087)	0.600 (0.091)	0.553	0.900	0.432	0.651	0.736	0.447	0.792
Stockout of vaccines in the past 2 months (1=Yes, 0=No)	0.200 (0.074)	0.133 (0.063)	0.100 (0.065)	0.100 (0.056)	0.387	0.813	0.187	0.963	0.802	0.733	0.683
Part of ANC study (1=Yes, 0=No)	0.267 (0.082)	0.267 (0.084)	0.276 (0.084)	0.267 (0.082)	1.000	0.617	0.968	0.624	0.908	0.594	0.942
Experiment implementation											
Timing of intervention roll-out (# of days relative to first clinic)	83.867 (10.949)	91.267 (11.321)	94.966 (10.810)	84.800 (11.775)	0.136	0.094	0.832	0.797	0.208	0.278	0.229
Time spent in communities for information meetings (in days)	1.867 (0.298)	2.200 (0.388)	2.034 (0.278)	1.967 (0.247)	0.485	0.914	0.950	0.240	0.417	0.838	0.765
Time spent to list all babies in communities (in days)	3.300 (0.254)	3.133 (0.178)	3.345 (0.188)	3.300 (0.215)	0.558	0.950	1.000	0.474	0.628	0.907	0.888
# of clinic monitoring visits during immunization services	7.300 (0.494)	8.800 (0.560)	8.069 (0.457)	8.200 (0.468)	0.020	0.205	0.235	0.237	0.296	0.979	0.118
Service indicators collected throughout implementation											
Received a food supplement for child at last immunization visit (1=Yes, 0=No)	0.023 (0.009)	0.054 (0.016)	0.017 (0.008)	0.027 (0.012)	0.057	0.742	0.771	0.037	0.092	0.473	0.165
Received a bednet at last immunization visit (1=Yes, 0=No)	0.062 (0.011)	0.041 (0.013)	0.049 (0.011)	0.039 (0.010)	0.281	0.496	0.180	0.691	0.847	0.619	0.475
Gave money to the nurse at last immunization visit (1=Yes, 0=No)	0.146 (0.031)	0.177 (0.036)	0.161 (0.031)	0.141 (0.031)	0.531	0.793	0.815	0.768	0.486	0.758	0.895
Amount given to the nurse at last immunization visit (in Leones)	1603.556 (384.588)	1873.968 (420.939)	1966.667 (532.409)	1363.492 (397.664)	0.620	0.590	0.688	0.917	0.503	0.529	0.828
Immunization service was shifted in the last 2 months (1=Yes, 0=No)	0.083 (0.021)	0.128 (0.030)	0.094 (0.025)	0.100 (0.021)	0.225	0.721	0.446	0.402	0.472	0.913	0.668
Stockout of vaccines in the past 2 months (1=Yes, 0=No)	0.089 (0.021)	0.057 (0.016)	0.067 (0.019)	0.101 (0.024)	0.129	0.300	0.526	0.738	0.105	0.306	0.267
Clinics	30	30	29	30							
Panel B: Community characteristics											
Community knowledge											
Know # of vaccines required (1=Yes, 0=No)	0.951 (0.022)	0.945 (0.024)	0.906 (0.026)	0.953 (0.019)	0.838	0.098	0.973	0.172	0.754	0.127	0.380
Observations	143	146	138	148							
Clinics	30	30	29	30							
Perceptions of reasons for parents to miss vaccines											
Negligence from parents	0.817 (0.050)	0.746 (0.061)	0.754 (0.065)	0.835 (0.059)	0.225	0.397	0.916	0.731	0.213	0.768	0.642
Lack of knowledge of benefits	0.642 (0.074)	0.627 (0.072)	0.669 (0.065)	0.642 (0.072)	0.778	0.998	0.602	0.616	0.892	0.577	0.867
Distance to clinic	0.400 (0.058)	0.449 (0.050)	0.364 (0.055)	0.450 (0.057)	0.299	0.936	0.380	0.143	0.984	0.173	0.417
User fees	0.225 (0.061)	0.153 (0.051)	0.169 (0.057)	0.193 (0.059)	0.688	0.564	0.897	0.929	0.617	0.542	0.794
Staff attitude	0.117 (0.046)	0.212 (0.053)	0.119 (0.044)	0.119 (0.040)	0.102	0.514	0.839	0.722	0.130	0.529	0.550
Observations	120	118	118	109							
Clinics	25	24	25	23							

Notes: This table summarizes relevant clinic and community characteristics collected at the start of and throughout the experiment. The table reports mean values of each variable for every treatment group. The final column reports the joint significance level of treatment indicators in a regression with strata-level fixed effects. The values displayed for t-tests and F-tests are p-values. Standard errors are clustered at the clinic level.

Table 2: Description of Study Sample from Endline Survey

Variable	(1) Control Mean/SE	(2) Signal Mean/SE	(3) Signal at 4 Mean/SE	(4) Uninformative Mean/SE	T-test P-value			F-test for joint orthogonality	
					(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(3)-(4)
Interviewed the mother of the child	0.988 (0.006)	0.997 (0.003)	0.997 (0.003)	1.000 (0.000)	0.165	0.065	0.031	0.737	0.308
Mother age (in years)	26.225 (0.436)	26.345 (0.292)	26.169 (0.365)	26.500 (0.358)	0.861	0.834	0.578	0.698	0.753
Is married	0.607 (0.042)	0.487 (0.053)	0.545 (0.049)	0.528 (0.052)	0.056	0.350	0.095	0.184	0.580
Most common ethnicity (1=Temne)	0.515 (0.081)	0.558 (0.079)	0.646 (0.077)	0.597 (0.079)	0.733	0.197	0.415	0.312	0.524
Second most common ethnicity (1=Limba)	0.269 (0.074)	0.201 (0.066)	0.179 (0.064)	0.195 (0.068)	0.548	0.330	0.478	0.735	0.940
Lived in community for over 1 year	0.967 (0.009)	0.976 (0.007)	0.969 (0.010)	0.959 (0.012)	0.446	0.665	0.524	0.581	0.172
Education									
Has no education	0.432 (0.030)	0.478 (0.034)	0.467 (0.033)	0.494 (0.038)	0.246	0.205	0.101	0.844	0.805
Has some primary education	0.325 (0.027)	0.327 (0.028)	0.307 (0.029)	0.261 (0.029)	0.871	0.555	0.025	0.589	0.058
Has some secondary education	0.243 (0.029)	0.195 (0.033)	0.226 (0.026)	0.245 (0.032)	0.286	0.396	0.888	0.454	0.144
Occupation & Assets									
Works on farm	0.754 (0.032)	0.732 (0.045)	0.693 (0.038)	0.745 (0.041)	0.671	0.317	0.921	0.678	0.571
Has a mobile phone	0.112 (0.022)	0.112 (0.020)	0.154 (0.028)	0.107 (0.022)	0.961	0.444	0.734	0.150	0.618
Floor (1=Cement/Tile, 0=Mud)	0.331 (0.032)	0.381 (0.037)	0.376 (0.044)	0.346 (0.043)	0.252	0.510	0.742	0.897	0.434
Roof (1=Corrugated iron, 0=Thatch)	0.896 (0.024)	0.906 (0.021)	0.912 (0.018)	0.855 (0.021)	0.548	0.829	0.133	0.946	0.062
Child characteristics									
Birth order of child	3.308 (0.100)	3.422 (0.077)	3.376 (0.087)	3.494 (0.090)	0.366	0.412	0.143	0.835	0.608
Age of child (in months)	8.539 (0.191)	8.514 (0.223)	8.207 (0.134)	8.349 (0.193)	0.987	0.073	0.552	0.289	0.549
Observations	338	339	319	318					
Clinics	30	30	29	30					

Notes: This table summarizes socio-economic characteristics for a random sample of 1,314 endline survey respondents. All respondents were mothers, who had a child that was born since the start of the experiment, and who resided in one of the selected clinic catchment communities. The table reports mean values of each variable for every treatment group. The final column reports the joint significance level of treatment indicators in a regression with strata-level fixed effects. The values displayed for t-tests and F-tests are p-values. Standard errors are clustered at the clinic level.

Table 3: Listing sample characteristics and Vaccine 3 Sample Table 7

Variable	(1)		(2)		(3)		(4)		T-test			F-test			
	N/[Clinics]	Control Mean/SE	N/[Clinics]	Signal at 4 Mean/SE	N/[Clinics]	Signal at 5 Mean/SE	N/[Clinics]	Uninformative Mean/SE	(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(2)-(4)	(3)-(4)	for joint orthogonality
Panel A: Characteristics Listing Sample															
Regular listed baby (1=Yes, 0=No)	3126 [30]	0.860 (0.015)	3976 [30]	0.876 (0.011)	3554 [29]	0.849 (0.015)	3095 [30]	0.843 (0.015)	0.403	0.878	0.376	0.248	0.024	0.521	0.225
Moved or travelled baby (1=Yes, 0=No)	3126 [30]	0.112 (0.012)	3976 [30]	0.098 (0.011)	3554 [29]	0.124 (0.014)	3095 [30]	0.127 (0.013)	0.389	0.713	0.301	0.215	0.033	0.643	0.200
Deceased baby (1=Yes, 0=No)	3126 [30]	0.028 (0.005)	3976 [30]	0.026 (0.004)	3554 [29]	0.027 (0.004)	3095 [30]	0.030 (0.005)	0.775	0.487	0.920	0.918	0.297	0.486	0.903
Child has a vaccine card (1=Yes, 0=No)	2689 [30]	0.901 (0.014)	3483 [30]	0.896 (0.011)	3016 [29]	0.900 (0.011)	2609 [30]	0.895 (0.008)	0.508	0.598	0.234	0.687	0.970	0.502	0.723
Vaccine card is of good quality (1=Yes, 0=No)	1370 [20]	0.904 (0.020)	1818 [18]	0.905 (0.018)	1561 [19]	0.910 (0.015)	939 [14]	0.918 (0.026)	0.885	0.891	0.640	0.906	0.375	0.471	0.906
Respondent could easily recall the last vaccine (1=Yes, 0=No)	2116 [30]	0.689 (0.048)	2906 [30]	0.740 (0.030)	2323 [29]	0.728 (0.042)	1882 [30]	0.705 (0.036)	0.323	0.532	0.782	0.599	0.222	0.438	0.695
Panel B: Covariates used in main specification															
Age of child (in days)	1390 [30]	307.647 (3.474)	1726 [30]	309.064 (2.633)	1537 [29]	308.717 (2.549)	1390 [30]	308.118 (2.849)	0.390	0.881	0.721	0.964	0.533	0.687	0.935
Community distance to clinic (in miles)	144 [30]	2.181 (0.093)	145 [30]	2.317 (0.114)	142 [29]	2.155 (0.130)	145 [30]	2.359 (0.096)	0.264	0.910	0.194	0.730	0.694	0.176	0.498
Community population	144 [30]	15.340 (1.235)	145 [30]	18.131 (1.851)	142 [29]	17.000 (1.280)	145 [30]	14.910 (1.018)	0.155	0.513	0.986	0.536	0.131	0.078	0.299
Clinic population	30 [30]	66.967 (5.501)	30 [30]	79.600 (7.893)	29 [29]	73.724 (5.360)	30 [30]	63.233 (4.755)	0.201	0.482	0.648	0.659	0.097	0.060	0.191
Panel C: Pre-trends in vaccination outcomes															
Vaccine 1	302 [19]	0.970 (0.011)	411 [19]	0.956 (0.015)	331 [19]	0.970 (0.011)	352 [19]	0.952 (0.014)	0.384	0.796	0.263	0.306	0.932	0.301	0.590
Vaccine 2	237 [19]	0.911 (0.019)	302 [19]	0.907 (0.030)	254 [19]	0.921 (0.018)	273 [19]	0.886 (0.021)	0.611	0.832	0.336	0.372	0.797	0.175	0.604
Vaccine 3	171 [19]	0.778 (0.046)	223 [19]	0.821 (0.032)	191 [19]	0.806 (0.034)	206 [19]	0.816 (0.033)	0.743	0.932	0.571	0.874	0.960	0.797	0.952

Notes: This table summarizes relevant characteristics of the listing sample under Panel A, the covariates that were included in the main specification of Table 7 under Panel B, and in Panel C immunization rates of children born before the launch of the experiment that resided in the 76 wave 2 clinics. The table reports mean values of each variable for every treatment group. The final column reports the joint significance level of treatment indicators in a regression with strata-level fixed effects. The values displayed for t-tests and F-tests are p-values. Standard errors are clustered at the clinic level.

Table 4: The Visibility of Bracelets by Treatment Group

Dependent variable:	Know if other child has a bracelet (1)	Know other child's bracelet color (2)	Others know if own child has yellow or green bracelet (3)
Signal at 4	0.038 (0.020)	0.108 (0.022)	0.047 (0.041)
Signal at 5	0.010 (0.020)	0.081 (0.024)	0.050 (0.041)
Uninformative Bracelet mean	0.908	0.816	0.759
Observations	3068	3068	2920
Age of child	Yes	Yes	Yes
Relationship to mother	Yes	Yes	Yes

Notes: This table shows endline respondents' first- and second-order beliefs about the visibility of bracelets. The unit of observation is a respondent-other mother pair. Columns (1) and (2) report first-order beliefs, asking respondents if another (randomly selected, but to the respondent known) child in their community has a bracelet and what color the bracelet is. Know if other child has bracelet is a dummy variable that equals one if the respondent answered "Yes" or "No" and zero if she answered "Don't know". Know other child's bracelet color equals one if the respondent answered "Yellow" or "Green" and zero if she answered "Don't know". Column (3) reports second-order beliefs, asking respondents if they thought that another (randomly selected, but to the respondent known) mother in their community knew what color bracelet their own child has. Others know if own child has a green or yellow bracelet is a dummy variable that equals one if the respondent answered "Yes" and zero if she answered "No" or "Don't know". The sample includes answers from all endline respondents across the three bracelet treatments. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size and relationship to other mother. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 5: The Effect of Signals on First- and Second-Order Beliefs about Vaccine Decisions

Dependent variable:	Know # of vaccines other children		Others know # of vaccines own child	
	(1)	(2)	(3)	(4)
	> 3.5 months age	> 9 months age	> 3.5 months age	> 9 months age
Signal at 4	0.066 (0.038)	0.078 (0.056)	0.139 (0.043)	0.145 (0.068)
Signal at 5	0.083 (0.038)	0.069 (0.055)	0.108 (0.047)	0.172 (0.075)
Uninformative Bracelet	0.050 (0.038)	0.051 (0.055)	0.088 (0.046)	0.087 (0.078)
Control Group mean	0.493	0.472	0.480	0.492
Observations	4005	1458	4310	1558
Age of child	Yes	Yes	Yes	Yes
Relationship to mother	Yes	Yes	Yes	Yes
$S_4 > 0$: $p(\text{UI} = S_4)$	0.710	0.609	0.190	0.380
$S_5 > 0$: $p(\text{UI} = S_5)$	0.422	0.723	0.634	0.254
$p(S_4 = S_5)$	0.662	0.852	0.439	0.687
Joint F-Test	0.135	0.522	0.013	0.093

Notes: This table shows results from endline respondents' first- and second-order beliefs about other children's and own child's vaccinations. I linked respondents' answers with administrative records to assess the correctness of first-order beliefs; that is, if respondents had more accurate beliefs about other parents' vaccine decisions. The unit of observation is a respondent-other mother pair. Columns (1)-(2) show regression results of a binary variable for correct knowledge of the number of vaccinations another child has received (\sim first-order beliefs) on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as excluded category. The outcome variable is coded one if respondents correctly guessed the number, and zero if the answer was incorrect or the respondent answered "Don't know". Column (1) displays the result for the sample of other children ages 3.5 months and above (i.e. who are eligible for Vaccine 4 and therefore receive a green bracelet in Signal at 4); Column (2) the results for other children ages 9 months and above (i.e. who are eligible for Vaccine 5 and therefore receive a green bracelet in Signal at 5). Columns (3)-(4) show regression results of a binary variable for respondent's belief about another mother's knowledge of her own child's number of vaccinations (\sim second-order beliefs). The outcome variable is coded one if a respondent answered "Yes", i.e. the other mother knows, and zero if a respondent answered "Don't know" or "No", i.e. the other mother does not know. Column (3) displays the result for the sample of own children age 3.5 months and above (i.e. who are eligible for Vaccine 4 and a green bracelet in Signal at 4 therefore); Column (4) displays the results for own children age 9 months and above (i.e. who are eligible for Vaccine 5 and a green bracelet in Signal at 5 therefore). The bottom rows give the p-values from a test that the effect of the Uninformative Bracelet (UI) is equivalent to the effect of Signal at 4 (S_4) or to Signal at 5 (S_5), and that the effect of Signal at 4 is equivalent to that of the Signal at 5. Last is a joint hypothesis test of all three bracelet treatments. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size and relationship to other mother. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 6: The Combined Effect of Signals at 4 and 5 on Timely and Complete Vaccination

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5
	(1)	(2)	(3)	(4)	(5)
Panel A: Compared to Control Group					
Signal at 4 and 5	0.010 (0.014)	0.036 (0.017)	0.053 (0.028)	0.075 (0.037)	0.084 (0.046)
Control Group mean	0.964	0.916	0.839	0.713	0.553
Observations	5582	5299	4893	4459	1764
Panel B: Compared to Uninformative Bracelet					
Signal at 4 and 5	-0.004 (0.006)	0.003 (0.009)	0.010 (0.021)	0.030 (0.034)	0.026 (0.046)
Uninformative Bracelet mean	0.976	0.943	0.879	0.750	0.594
Observations	5523	5248	4866	4433	1756

Notes: This table shows results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months, respectively, on a treatment indicator for Signal at 4 and 5, with the omitted category being the Control Group in Panel A and the Uninformative Bracelet in Panel B. The sample includes all children born since the launch of the experiment. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 7: The Effect of Signals on Timely and Complete Vaccination, Separate by Treatment

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5	Total # of vaccines timely
	(1)	(2)	(3)	(4)	(5)	(6)
Signal at 4	0.005 (0.017)	0.024 (0.020)	0.025 (0.032)	0.032 (0.043)	0.030 (0.050)	0.081 (0.134)
Signal at 5	0.014 (0.015)	0.046 (0.017)	0.082 (0.031)	0.122 (0.040)	0.144 (0.050)	0.419 (0.133)
Uninformative Bracelet	0.011 (0.013)	0.026 (0.016)	0.034 (0.028)	0.033 (0.041)	0.046 (0.056)	0.194 (0.134)
Control Group mean	0.967	0.920	0.849	0.724	0.561	4.023
Observations	7246	6869	6352	5794	2281	2281
$S_4 > 0$: $p(\text{UI} = S_4)$	0.621	0.848	0.725	0.986	0.740	0.357
$S_5 > 0$: $p(\text{UI} = S_5)$	0.683	0.087	0.050	0.016	0.051	0.066
$p(S_4 = S_5)$	0.421	0.086	0.023	0.011	0.007	0.003
Joint F-Test	0.669	0.034	0.031	0.008	0.012	0.004

Notes: Columns (1) through (5) of this table show results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months respectively on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the excluded category. The sample includes all children born since the launch of the experiment. Columns (6) and (7) show results from a regression of the discrete variable “total number of vaccines”, coded 1, 2, 3, 4 or 5, on the treatment indicators Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the omitted category. The sample includes all children born since the launch that were at least 11.5 months old (Column (6)) and 12 months old (Column (7)) by the end of the experiment. Column (6) shows treatment effects on the total number of timely vaccines received, that is by age 3, 4, 5, 6 and 11.5 months for vaccines 1, 2, 3, 4 and 5; Column (7) shows treatment effects on the total number of vaccines received by the age of 12 months, irrespective of the time of vaccination. For all columns, the bottom row gives the p-values from a test that the effect of the Uninformative Bracelet (UI) is equivalent to the effect of Signal at 4 (S_4) or to Signal at 5 (S_5), identifying social signaling preferences ($S_4 > 0$, $S_5 > 0$), and that the effect of Signal at 4 is equivalent to the Signal at 5. Last is a joint hypothesis test of all three bracelet treatments. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 8: The Extensive Margin Effect of Bracelets: Complete Vaccination by Age One

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5	Total # of vaccines by one year age
	(1)	(2)	(3)	(4)	(5)	(6)
Signal at 4	0.010 (0.006)	0.016 (0.008)	0.033 (0.017)	0.059 (0.032)	0.099 (0.049)	0.217 (0.091)
Signal at 5	0.001 (0.007)	0.006 (0.009)	0.028 (0.016)	0.062 (0.031)	0.137 (0.047)	0.235 (0.090)
Uninformative	0.005 (0.006)	0.011 (0.009)	0.031 (0.016)	0.063 (0.029)	0.075 (0.049)	0.188 (0.087)
Control Group mean	0.990	0.979	0.946	0.890	0.669	4.473
Observations	1914	1914	1914	1914	1914	1914
$S_4 > 0$: $p(\text{UI} = S_4)$	0.297	0.370	0.877	0.858	0.579	0.677
$S_5 > 0$: $p(\text{UI} = S_5)$	0.486	0.559	0.771	0.988	0.104	0.488
$p(S_4 = S_5)$	0.153	0.129	0.658	0.858	0.311	0.788
Joint F-Test	0.280	0.142	0.201	0.159	0.028	0.061

Notes: This table shows results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 12 months - ignoring whether a child received a given vaccine on time - on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the excluded category. The sample includes all children born since the launch of the experiment that were 12 months or older when last observed. The bottom rows give the p-values from a test that the effect of the Uninformative Bracelet (UI) is equivalent to the effect of Signal at 4 (S_4) or to Signal at 5 (S_5), and that the effect of Signal at 4 is equivalent to the Signal at 5. Last is a joint hypothesis test of all three bracelet treatments. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 8b: The Intensive Margin Effect of Bracelets, Constant Sample

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5
	(1)	(2)	(3)	(4)	(5)
Signal at 4	-0.003 (0.013)	0.003 (0.022)	0.024 (0.035)	0.026 (0.041)	0.029 (0.051)
Signal at 5	0.004 (0.013)	0.033 (0.020)	0.097 (0.035)	0.129 (0.045)	0.155 (0.052)
Uninformative	0.007 (0.012)	0.018 (0.020)	0.047 (0.035)	0.041 (0.046)	0.048 (0.055)
Control Group mean	0.978	0.937	0.843	0.722	0.565
Observations	1914	1914	1914	1914	1914
$S_4 > 0$: $p(\text{UI} = S_4)$	0.404	0.383	0.436	0.709	0.691
$S_5 > 0$: $p(\text{UI} = S_5)$	0.768	0.301	0.071	0.051	0.033
$p(S_4 = S_5)$	0.570	0.039	0.004	0.007	0.005
Joint F-Test	0.846	0.123	0.008	0.016	0.009

Notes: This table shows for same sample as in Table 8 the effect of signals on timely and complete vaccination, separate by treatment. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 9: The Effect of Signals on Preferences for Different Vaccinations

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5	All vaccines
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:	Most Important Vaccine					
Signal at 4	-0.024 (0.050)	-0.013 (0.010)	0.006 (0.004)	-0.015 (0.011)	0.012 (0.026)	0.042 (0.050)
Signal at 5	-0.022 (0.055)	-0.007 (0.013)	0.003 (0.004)	-0.019 (0.011)	0.011 (0.031)	0.039 (0.045)
Uninformative Bracelet	-0.019 (0.048)	0.001 (0.012)	0.010 (0.006)	-0.008 (0.013)	-0.013 (0.024)	0.038 (0.044)
Control Group mean	0.663	0.040	-0.000	0.022	0.139	0.125
Observations	1314	1314	1314	1314	1314	1314
$S_4 > 0$: $p(\text{UI} = S_4)$	0.907	0.170	0.596	0.521	0.259	0.921
$S_5 > 0$: $p(\text{UI} = S_5)$	0.956	0.525	0.328	0.264	0.370	0.977
$p(S_4 = S_5)$	0.965	0.642	0.604	0.596	0.957	0.947
Joint F-Test	0.964	0.441	0.160	0.313	0.658	0.760
Panel B:	Second Most Important Vaccine					
Signal at 4	-0.025 (0.026)	0.032 (0.060)	-0.003 (0.032)	0.032 (0.029)	-0.024 (0.051)	-0.006 (0.019)
Signal at 5	0.024 (0.036)	0.091 (0.057)	-0.031 (0.028)	0.003 (0.026)	-0.066 (0.048)	-0.007 (0.019)
Uninformative Bracelet	-0.010 (0.024)	0.025 (0.056)	-0.027 (0.027)	0.025 (0.029)	0.013 (0.047)	-0.016 (0.017)
Control Group mean	0.122	0.351	0.089	0.052	0.343	0.029
Observations	1075	1075	1075	1075	1075	1075
$S_4 > 0$: $p(\text{UI} = S_4)$	0.480	0.898	0.402	0.796	0.439	0.495
$S_5 > 0$: $p(\text{UI} = S_5)$	0.296	0.202	0.891	0.360	0.086	0.511
$p(S_4 = S_5)$	0.140	0.274	0.342	0.232	0.358	0.944
Joint F-Test	0.471	0.383	0.576	0.536	0.345	0.776

Notes: This table shows results from a linear probability model of the binary outcome variables for vaccine 1, 2, 3, 4 or 5, or all vaccines being considered as most (second most) important vaccine on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as excluded category. The bottom rows give the p-values from binary comparisons between the Uninformative Bracelet, Signal at 4 and Signal at 5, testing for any significant differences in preferences between bracelet treatments. Regressions include strata-fixed effects. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table 10: Structural Estimation Results Dynamic Discrete-Choice Model

Parameter	Compared to Control Group		Compared to Uninformative Bracelet	
	Estimate (1)	SE (2)	Estimate (3)	SE (4)
S_5	0.712	0.102	0.384	0.106
S_4	0.054	0.092	-0.257	0.097
κ	-0.092	0.009	-0.081	0.009
μ_v	1.284	0.092	1.446	0.096
σ_v	0.471	0.096	0.531	0.085
α	-0.155	0.028	-0.164	0.029
Signaling utility $\frac{S_5}{\kappa}$	7.74 miles		4.74 miles	

Notes: This table shows the parameters estimated from the dynamic-discrete choice model. S_5 and S_4 denote the parameters capturing the signaling utility of treatments Signal at 5 and Signal at 4, κ denotes the parameter measuring the marginal disutility of walking one mile, μ_v and σ_v capture the mean and standard deviation of the normal type distribution. The sample used for the estimation is the same as used in the reduced form estimations, that is, all children that were born since the start of the experiment. Regular standard errors are reported (not clustered). Columns (1) and (2) report parameter estimates, with the effect of Signals at 4 and 5 being compared to the Control Group and Columns (3) and (4) from the comparison to the Uninformative Bracelet.

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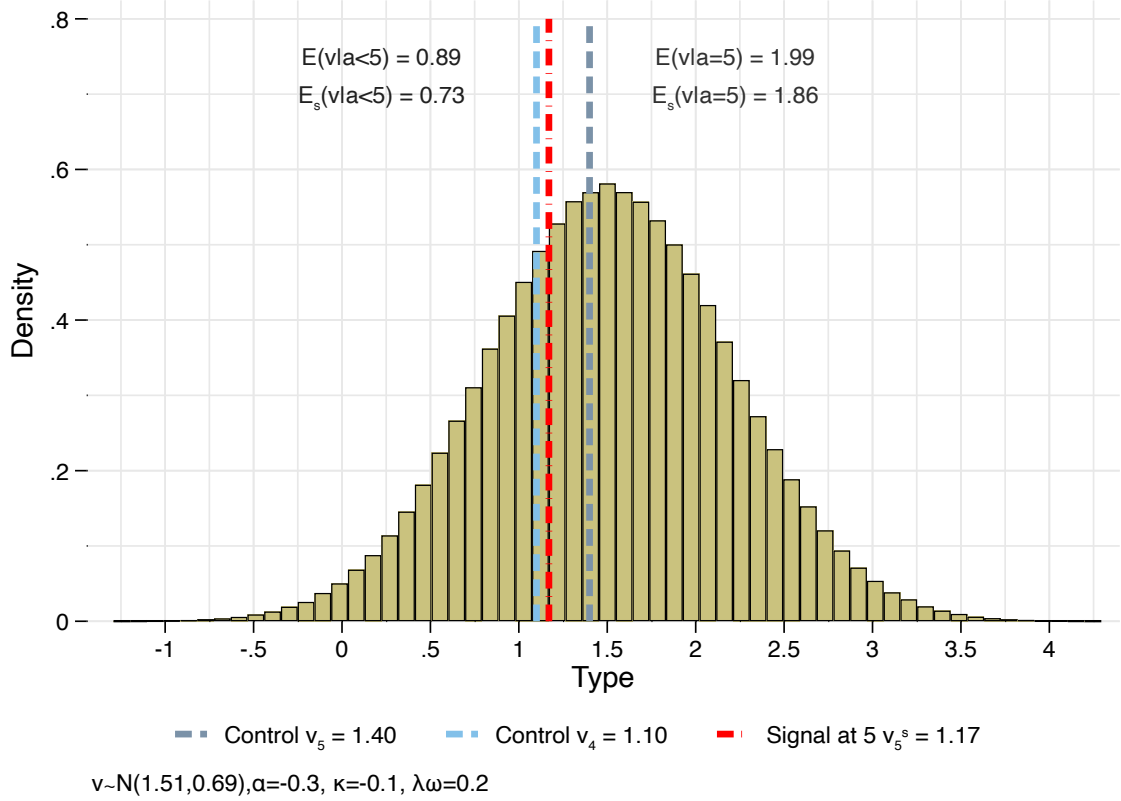
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A Supplementary Appendix

Figure A1: Simulation of the Effect of Signaling at Vaccine 5 on Cut-off Type and Expectations



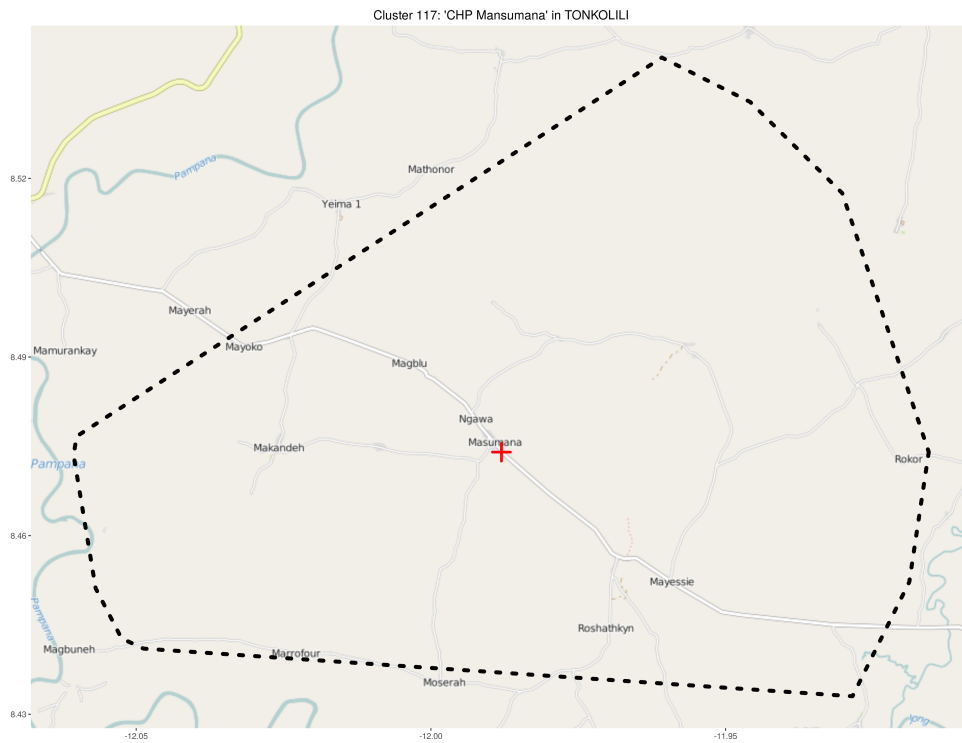
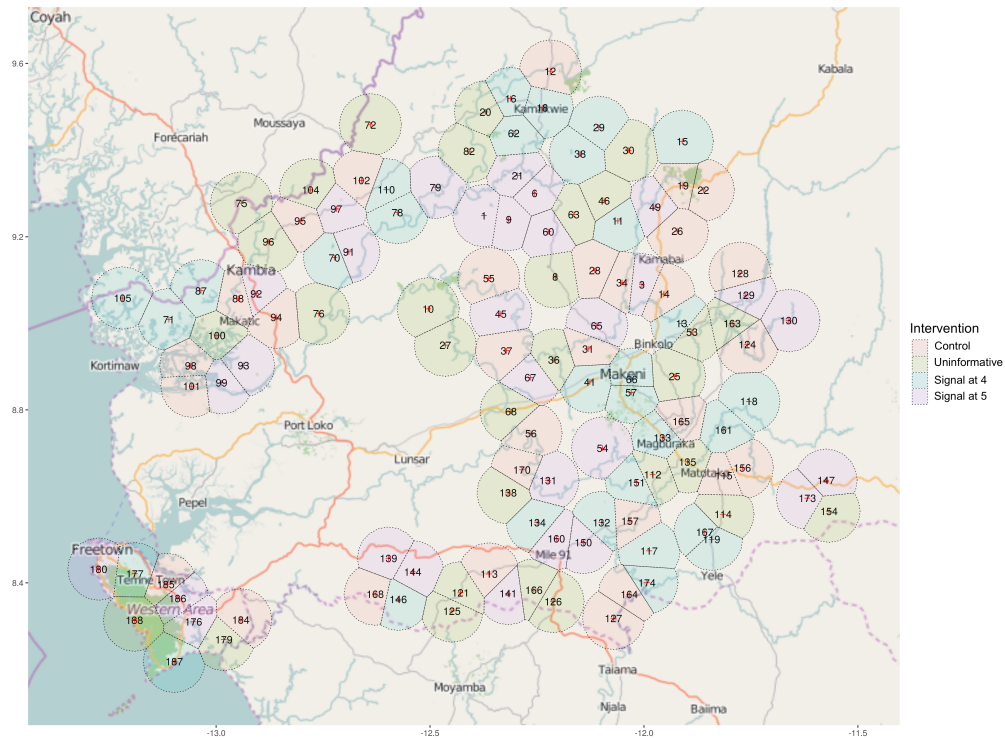
Notes: This figure shows a simulated type distribution, calibrated based on the observed levels of vaccine take-up in the Control Group. I assume that the type distribution is normal, the marginal cost of vaccination is constant (captured by the parameter κ interacted with D miles walking distance to the clinic) and the marginal benefit is declining (captured by the parameter α), with individual i 's utility being given by: $U(a_i; v_i) = (v_i - \kappa D)a_i - \sum_{a=1}^{a_i} \alpha(a-1) + x\lambda\omega_r \mathbb{1}(a_i = r)[E(v|a_i \geq r) - E(v|a_i < r)]$ with one signaling threshold $r \in \{5\}$ and $D = 2$ set to the mean walking distance. The calibrated parameters are $\mu_v = 1.51$, $\sigma_v = 0.69$, $\kappa = -0.1$, $\alpha = -0.3$. I assume $\lambda\omega_5 = 0.2$, i.e. the weight assigned to social image is equivalent to 2 miles walking. Control v_5 and v_4 are cut-off types for vaccine 5 and 4, in the absence of signaling ($x=0$). I solve for v_5^s under signaling ($x=1$), solving the fixed-point equation 2. E and E_s define the expectations formed about types conditional on actions. The cut-off type v_5^s pins down the new equilibrium type expectations $E_s(v|a_i < 5) = E_s(v|v < v_5^s)$ and $E_s(v|a_i = 5) = E_s(v|v = v_5^s)$. $v_4 < v_5^s < v_5$ implies that some individuals who previously chose $a_i^* = 4$ now choose $a_i^{s*} = 5$, while anyone who chose $a_i^* = 3$ will still choose $a_i^{s*} = 3$, given parameters.

Figure A2: Babies wearing Bracelets



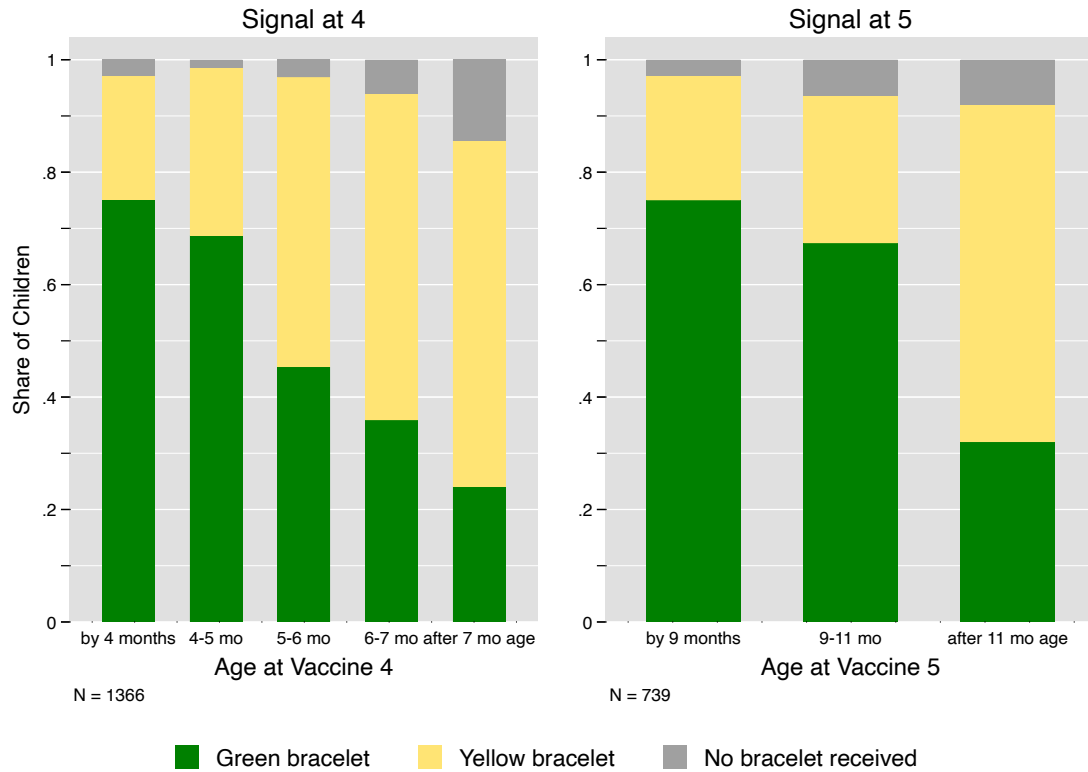
Notes: Mothers are sitting outside a clinic, waiting for their child to be vaccinated. The children in this photo are wearing yellow “1st visit” bracelets on their wrist.

Figure A3: Process of Clinic and Community Selection



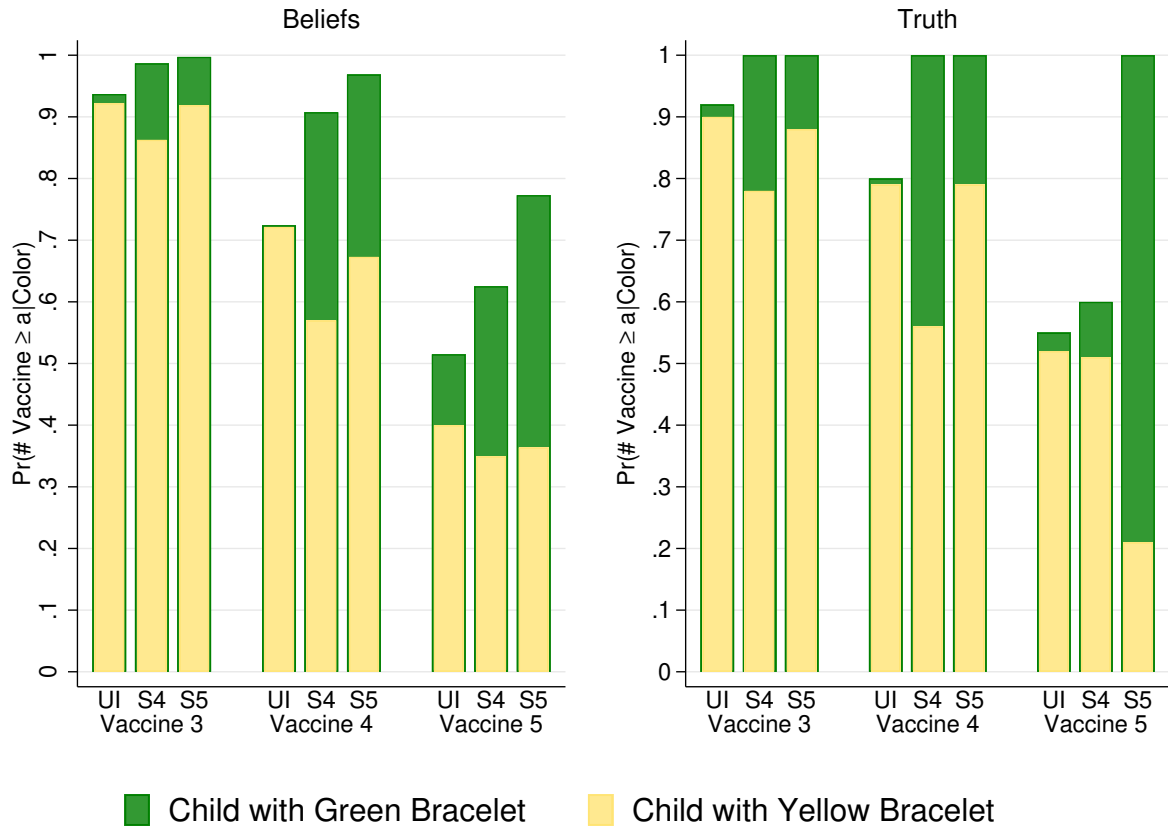
Notes: The upper map displays the 120 selected clinics and their non-overlapping catchment areas, with radius of five miles around each clinic. The bottom map displays one out of the 120 maps that surveyors were subsequently given, that showed the area that is non-overlapping and from which they would select five communities (two at close, 0-2 miles distance from the clinic and three communities at far, 2-5 miles distance).

Figure A4: Hand Out of Green Bracelets in Signals at 4 and 5 according to Timely Vaccination



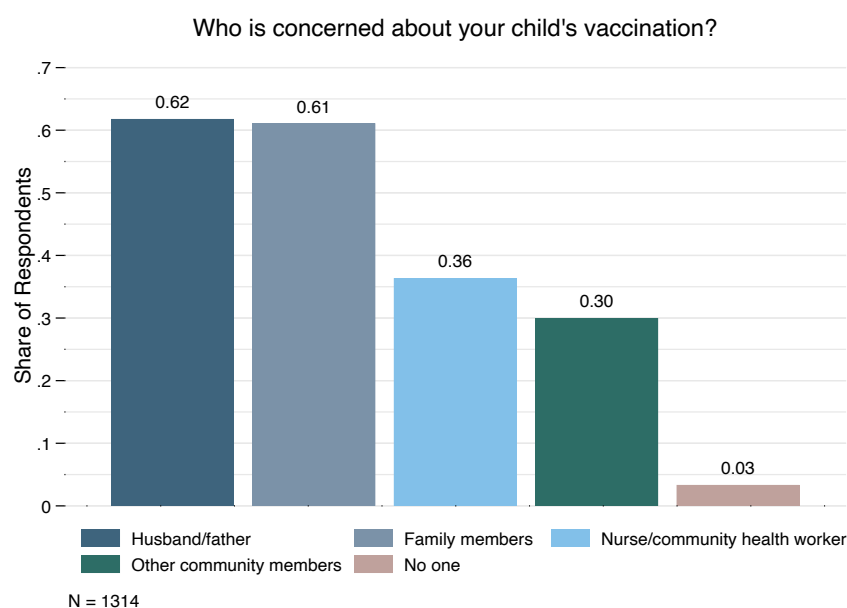
Notes: This figure shows the share of children with a green or yellow bracelet according to the time they took vaccines four and five in Signal at 4 and Signal at 5 treatments. Health workers were instructed to give the child a green bracelet if it came for vaccine four before six months of age (Signal at 4) and vaccine 5 by 11 months of age (Signal at 5). If a child came after this time, health workers were instructed to exchange the green bracelet for a new yellow “1st visit” bracelet instead. The sample includes children that were due for vaccination after the start of the experiment. The panel on the left (Signal at 4) shows that the probability of receiving a green bracelet is monotonically decreasing in the age at which the child took vaccine four, from 75.2 percent if the vaccine was taken by four months age, to 68.8, 45.3, 35.9 and 24 percent if the child received the vaccine by 5, 6 or 7 months, or after 7 months age. The panel on the right (Signal at 5) shows a similar pattern: the probability of receiving a green bracelet is monotonically decreasing in the age at which the child comes for vaccine five, from 75 percent if the vaccine was taken by 9 months age, to 67.4 and 32 percent by 11 months and after 11 months age.

Figure A5: Stated Beliefs Compared to Beliefs under Bayesian Learning



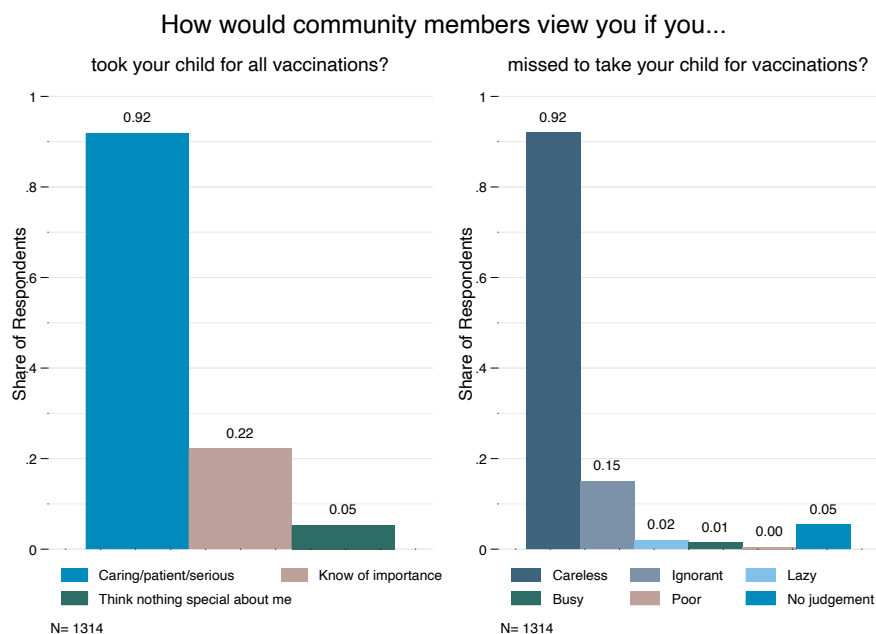
Notes: This figure compares individuals' beliefs about the number of vaccines children received conditional on having a yellow or green bracelet ("Beliefs"), to beliefs under Bayesian learning ("Truth"). The latter are simulated using the observed true vaccination outcomes from the survey and administrative data and the probabilities of a child receiving a green or yellow bracelet for a given vaccination and vaccine age from the observed implementation (see Figure 4). Same as in Figure 5, beliefs are shown by vaccine, and by treatment, where UI = Uninformative Bracelet, S4 = Signal at 4, S5 = Signal at 5.

Figure A6: Reference Groups for Social Signaling



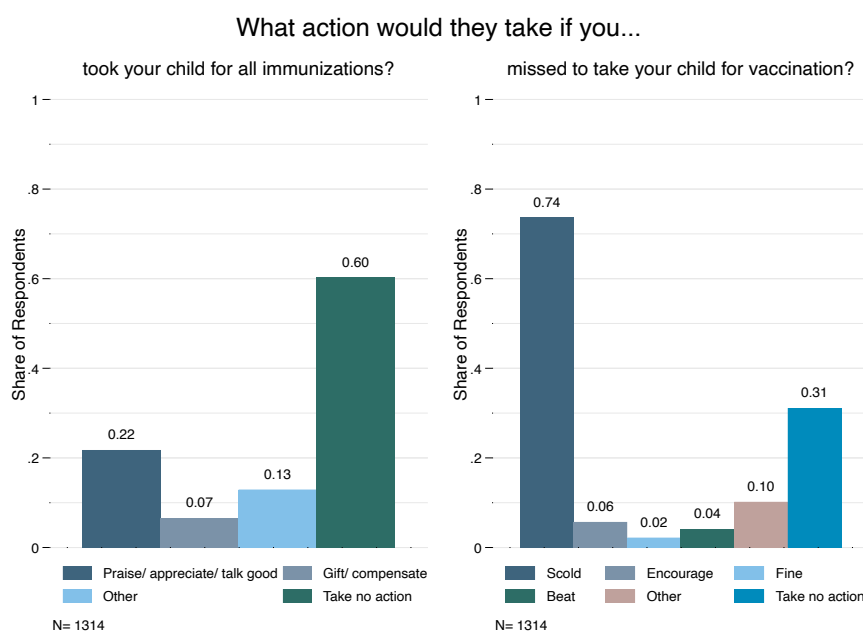
Notes: This figure displays the different reference groups mothers believe are in general concerned about their own child's vaccinations and might form opinions about their actions. The sample includes all endline survey respondents.

Figure A7: Inferences about Types Conditional on Vaccine Decisions



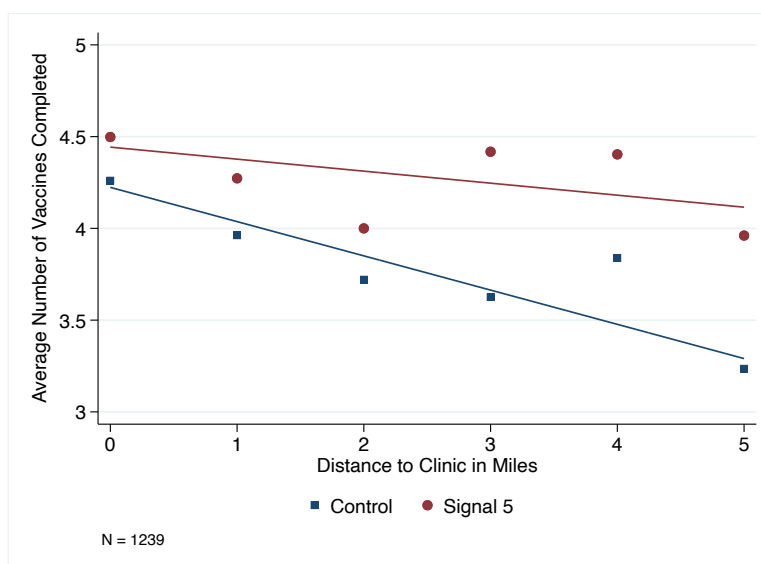
Notes: This figure shows mothers' beliefs about the inferences that community members would make, conditional on observing that they took their child for all vaccinations or missed any. The sample includes all endline survey respondents. There are no significant differences for these responses across treatment arms.

Figure A8: Motives for Social Signaling



Notes: This figure shows mothers' beliefs about the actions that community members would take, conditional on observing that they took their child for all vaccinations or missed any. The sample includes all endline survey respondents.

Figure A9: The Effect of Distance on the Total Number of Vaccines Completed



Notes: The graph plots a bin scatter of the average number of timely vaccines completed against the travel distance from communities to clinics, separately for the Control Group and Signal at 5. The sample includes all children born since the launch that were at least 11.5 months old by the end of the experiment, to be considered for all five vaccinations. The plot shows that distance has a linear effect on the number of vaccinations completed in the Control Group. Signal at 5 mitigated the negative effect of distance: the average total number of vaccines completed at zero miles in the Control Group (4.3) is approximately the same as the average number completed at 4 miles in Signal at 5.

Table A1: Description of Clinic and Baseline Community Characteristics (Normalized differences)

Variable	(1) Control Mean/SE	(2) Signal Mean/SE	(3) Signal at 4 Mean/SE	(4) Uninformative Mean/SE	(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(2)-(4)	(3)-(4)	F-test for joint orthogonality
Panel A: Clinic characteristics											
Baseline characteristics											
# of staff involved in immunization	2.900 (0.435)	2.667 (0.340)	3.034 (0.459)	2.733 (0.437)	0.110	-0.056	0.070	-0.169	-0.031	0.125	0.884
Frequency of immunization services (1=weekly, 0=monthly)	0.700 (0.085)	0.633 (0.089)	0.600 (0.087)	0.600 (0.091)	0.140	0.022	0.208	-0.118	0.068	0.186	0.792
Stockout of vaccines in the past 2 months (1=Yes, 0=No)	0.200 (0.074)	0.133 (0.063)	0.138 (0.065)	0.100 (0.056)	0.177	0.164	0.278	-0.013	0.103	0.116	0.683
Part of ANC study (1=Yes, 0=No)	0.267 (0.082)	0.267 (0.082)	0.276 (0.084)	0.267 (0.082)	0.000	-0.021	0.000	-0.021	0.000	0.021	0.942
Experiment implementation											
Timing of intervention roll-out (# of days relative to first clinic)	83.867 (10.949)	91.267 (11.321)	94.966 (10.810)	84.800 (11.775)	-0.122	-0.189	-0.015	-0.062	0.103	0.166	0.229
Time spent in communities for information meetings (in days)	1.867 (0.298)	2.200 (0.388)	2.034 (0.278)	1.967 (0.247)	-0.177	-0.108	-0.067	0.090	0.132	0.048	0.765
Time spent to list all babies in communities (in days)	3.300 (0.254)	3.133 (0.178)	3.345 (0.188)	3.300 (0.215)	0.140	-0.037	0.000	-0.214	-0.155	0.041	0.888
# of clinic monitoring visits during immunization services	7.300 (0.494)	8.800 (0.560)	8.069 (0.457)	8.200 (0.468)	-0.506	-0.296	-0.339	0.262	0.213	-0.053	0.118
Service indicators collected throughout implementation											
Received a food supplement for child at last immunization visit (1=Yes, 0=No)	0.023 (0.009)	0.054 (0.016)	0.017 (0.008)	0.027 (0.012)	-0.437	0.112	-0.072	0.525	0.354	-0.172	0.165
Received a bednet at last immunization visit (1=Yes, 0=No)	0.062 (0.011)	0.041 (0.013)	0.049 (0.011)	0.039 (0.010)	0.312	0.214	0.392	-0.124	0.035	0.181	0.475
Gave money to the nurse at last immunization visit (1=Yes, 0=No)	0.146 (0.031)	0.177 (0.036)	0.161 (0.031)	0.141 (0.031)	-0.166	-0.085	0.034	0.089	0.197	0.120	0.895
Amount given to the nurse at last immunization visit (in Leones)	1603.556 (384.588)	1873.968 (420.939)	1966.667 (532.409)	1363.492 (397.664)	-0.122	-0.145	0.114	-0.036	0.228	0.238	0.828
Immunization service was shifted in the last 2 months (1=Yes, 0=No)	0.083 (0.021)	0.128 (0.030)	0.094 (0.025)	0.100 (0.021)	-0.314	-0.089	-0.144	0.226	0.201	-0.044	0.668
Stockout of vaccines in the past 2 months (1=Yes, 0=No)	0.089 (0.021)	0.057 (0.016)	0.067 (0.019)	0.101 (0.024)	0.306	0.202	-0.096	-0.099	-0.385	-0.286	0.267
Clinics	30	30	29	30							
Panel B: Community characteristics											
Community knowledge											
Know # of vaccines required (1=Yes, 0=No)	0.951 (0.022)	0.945 (0.024)	0.906 (0.026)	0.953 (0.019)	0.026	0.176	-0.008	0.150	-0.034	-0.184	0.380
Observations	143	146	138	148							
Clinics	30	30	29	30							
Perceptions of reasons for parents to miss vaccines											
Negligence from parents	0.817 (0.050)	0.746 (0.061)	0.754 (0.065)	0.835 (0.059)	0.171	0.152	-0.048	-0.020	-0.218	-0.199	0.642
Lack of knowledge of benefits	0.642 (0.074)	0.627 (0.072)	0.669 (0.065)	0.642 (0.072)	0.030	-0.058	-0.001	-0.089	-0.031	0.057	0.867
Distance to clinic	0.400 (0.058)	0.449 (0.050)	0.364 (0.055)	0.450 (0.057)	-0.099	0.073	-0.100	0.172	-0.001	-0.173	0.417
User fees	0.225 (0.061)	0.153 (0.051)	0.169 (0.057)	0.193 (0.059)	0.185	0.139	0.079	-0.046	-0.106	-0.060	0.794
Staff attitude	0.117 (0.046)	0.212 (0.053)	0.119 (0.044)	0.119 (0.040)	-0.257	-0.006	-0.008	0.250	0.247	-0.002	0.550
Observations	120	118	118	109							
Clinics	25	24	25	23							

Notes: This table summarizes relevant clinic and community characteristics collected at the start of and throughout the experiment. The table reports mean values of each variable for every treatment group. Instead of t-test p-values as in Table 1, I report here normalized differences as suggested by [Imbens and Wooldridge \(2009\)](#). The point estimates used to compute the normalized differences and the p-values of the F-tests come from regressions with strata-level fixed effects. Standard errors are clustered at the clinic level for regressions assessing community characteristics.

Table A2: Description of Study Sample from Endline Survey (Normalized differences)

Variable	(1) Control Mean/SE	(2) Signal at 4 Mean/SE	(3) Signal at 5 Mean/SE	(4) Uninformative Mean/SE	(1)-(2)	(1)-(3)	Normalized differences (1)-(4)	(2)-(3)	(2)-(4)	(3)-(4)	F-test for joint orthogonality
Interviewed the mother of the child	0.988 (0.006)	0.997 (0.003)	0.997 (0.003)	1.000 (0.000)	-0.104	-0.100	-0.152	0.003	-0.076	-0.079	2.042
Mother age (in years)	26.225 (0.436)	26.345 (0.292)	26.169 (0.365)	26.500 (0.358)	-0.019	0.009	-0.043	0.028	-0.024	-0.053	0.143
Is married	0.607 (0.042)	0.487 (0.053)	0.545 (0.049)	0.528 (0.052)	0.240	0.123	0.158	-0.117	-0.083	0.034	1.499
Most common ethnicity (1=Tenne)	0.515 (0.081)	0.558 (0.079)	0.646 (0.077)	0.597 (0.079)	-0.086	-0.265	-0.166	-0.180	-0.081	0.099	0.650
Second most common ethnicity (1=Limba)	0.269 (0.074)	0.201 (0.066)	0.179 (0.064)	0.195 (0.068)	0.162	0.217	0.175	0.056	0.014	-0.042	0.350
Lived in community for over 1 year	0.967 (0.009)	0.976 (0.007)	0.969 (0.010)	0.959 (0.012)	-0.054	-0.007	0.044	0.047	0.098	0.051	0.560
Education											
Has no education	0.432 (0.030)	0.478 (0.034)	0.467 (0.033)	0.494 (0.038)	-0.092	-0.071	-0.124	0.022	-0.032	-0.053	0.880
Has some primary education	0.325 (0.027)	0.327 (0.028)	0.307 (0.029)	0.261 (0.029)	-0.004	0.039	0.141	0.043	0.146	0.102	1.953
Has some secondary education	0.243 (0.029)	0.195 (0.033)	0.226 (0.026)	0.245 (0.032)	0.116	0.040	-0.006	-0.076	-0.122	-0.046	0.629
Occupation & Assets											
Works on farm	0.754 (0.032)	0.732 (0.045)	0.693 (0.038)	0.745 (0.041)	0.052	0.138	0.021	0.086	-0.031	-0.117	0.729
Has a mobile phone	0.112 (0.022)	0.112 (0.020)	0.154 (0.028)	0.107 (0.022)	0.001	-0.121	0.018	-0.122	0.017	0.139	1.287
Floor (1=Cement/Tile, 0=Mud)	0.331 (0.032)	0.381 (0.037)	0.376 (0.044)	0.346 (0.043)	-0.103	-0.094	-0.031	0.009	0.072	0.063	0.465
Roof (1=Corrugated iron, 0=Thatch)	0.896 (0.024)	0.906 (0.021)	0.912 (0.018)	0.855 (0.021)	-0.031	-0.054	0.125	-0.023	0.155	0.177	1.521
Child characteristics											
Birth order of child	3.308 (0.100)	3.422 (0.077)	3.376 (0.087)	3.494 (0.090)	-0.076	-0.045	-0.123	0.030	-0.048	-0.077	0.712
Age of child (in months)	8.539 (0.191)	8.514 (0.223)	8.207 (0.134)	8.349 (0.193)	0.008	0.107	0.061	0.098	0.053	-0.047	0.788
Observations	338	339	319	318							
Clinics	30	30	29	30							

Notes: This table summarizes socio-economic characteristics for a random sample of 1,314 endline survey respondents. All respondents were mothers, who had a child that was born since the start of the experiment, and who resided in one of the selected clinic catchment communities. The table reports mean values of each variable for every treatment group. Instead of t-test p-values as in Table 2, I report here normalized differences as suggested by [Imbens and Wooldridge \(2009\)](#). The point estimates used to compute the normalized differences and the p-values of the F-tests come from regressions with strata-level fixed effects. Standard errors are clustered at the clinic level.

Table A3: Listing sample characteristics and Vaccine 3 Sample (Normalized differences) Table 7

Variable	(1) N/[Clinics]	(1) Control Mean/SE	(2) Signal at 4 Mean/SE	(2) N/[Clinics]	(3) Signal at 5 Mean/SE	(3) N/[Clinics]	(4) Uninformative Mean/SE	(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(2)-(4)	(3)-(4)	F-test for joint orthogonality
Panel A: Characteristics Listing Sample														
Regular listed baby (1=Yes, 0=No)	3126 [30]	0.860 (0.015)	3976 [30]	3554 [29]	0.849 (0.015)	3095 [30]	0.843 (0.015)	-0.047	0.033	0.048	0.080	0.096	0.016	0.225
Moved or travelled baby (1=Yes, 0=No)	3126 [30]	0.112 (0.012)	3976 [30]	3554 [29]	0.124 (0.014)	3095 [30]	0.127 (0.013)	0.047	-0.037	-0.046	-0.085	-0.094	-0.009	0.200
Deceased baby (1=Yes, 0=No)	3126 [30]	0.028 (0.005)	3976 [30]	3554 [29]	0.026 (0.004)	3095 [30]	0.030 (0.005)	0.008	0.003	-0.013	-0.005	-0.022	-0.016	0.903
Child has a vaccine card (1=Yes, 0=No)	2689 [30]	0.901 (0.014)	3483 [30]	3016 [29]	0.900 (0.011)	2609 [30]	0.895 (0.008)	0.019	0.004	0.020	-0.015	0.001	0.016	0.723
Vaccine card is of good quality (1=Yes, 0=No)	1370 [20]	0.904 (0.020)	1818 [18]	1561 [19]	0.910 (0.015)	939 [14]	0.918 (0.026)	-0.006	-0.023	-0.050	-0.017	-0.044	-0.027	0.906
Respondent could easily recall the last vaccine (1=Yes, 0=No)	2116 [30]	0.689 (0.048)	2906 [30]	2323 [29]	0.728 (0.042)	1882 [30]	0.705 (0.036)	-0.114	-0.086	-0.035	0.028	0.079	0.051	0.695
Panel B: Covariates used in main specification														
Age of child (in days)	1390 [30]	307.647 (3.474)	1726 [30]	1537 [29]	308.717 (2.549)	1390 [30]	308.118 (2.849)	-0.017	-0.013	-0.006	0.004	0.012	0.007	0.935
Community distance to clinic (in miles)	144 [30]	2.181 (0.063)	145 [30]	142 [29]	2.155 (0.130)	145 [30]	2.359 (0.096)	-0.084	0.016	-0.110	0.097	-0.025	-0.123	0.498
Community population	144 [30]	15.340 (1.235)	145 [30]	142 [29]	17.000 (1.851)	145 [30]	14.910 (1.018)	-0.145	-0.116	0.030	0.059	0.168	0.145	0.299
Clinic population	30 [30]	66.967 (5.501)	30 [30]	29 [29]	73.724 (5.360)	30 [30]	63.233 (4.755)	-0.337	-0.229	0.133	0.160	0.450	0.378	0.191
Panel C: Pre-trends in vaccination outcomes														
Vaccine 1	302 [19]	0.970 (0.011)	411 [19]	331 [19]	0.970 (0.011)	352 [19]	0.952 (0.014)	0.073	0.002	0.095	-0.071	0.021	0.093	0.590
Vaccine 2	237 [19]	0.911 (0.019)	302 [19]	254 [19]	0.921 (0.018)	273 [19]	0.886 (0.021)	0.014	-0.036	0.082	-0.050	0.069	0.118	0.604
Vaccine 3	171 [19]	0.778 (0.046)	223 [19]	191 [19]	0.806 (0.034)	206 [19]	0.816 (0.033)	-0.107	-0.070	-0.094	0.037	0.013	-0.024	0.952

Notes: This table summarizes relevant of the listing sample under Panel A, the covariates that were included in the main specification of Table 7 under Panel B, and in Panel C immunization rates of children born before the launch of the experiment that resided in the 76 wave 2 clinics. The table reports mean values of each variable for every treatment group. Instead of t-test p-values as in table 3, I report here normalized differences as suggested by Imbens and Wooldridge (2009). The point estimates used to compute the normalized differences and the p-values of the F-tests come from regressions with strata-level fixed effects. Standard errors are clustered at the clinic level.

Table A4: Description of Sample Characteristics for First- and Second-Order Beliefs, Table 5

Variable	(1) Control Mean/SE		(2) Signal at 4 Mean/SE		(3) Signal at 5 Mean/SE		(4) Uninformative Mean/SE		T-test P-value			F-test for joint orthogonality	
	N / [Clinics]	N / [Clinics]	N / [Clinics]	N / [Clinics]	N / [Clinics]	N / [Clinics]	N / [Clinics]	(1)-(2)	(1)-(3)	(1)-(4)	(2)-(3)	(3)-(4)	(2)-(4)
Number of mothers we asked about	338	6074 (0.385)	339	6.779 (0.302)	319	6.627 (0.297)	318	6.544 (0.324)	0.129	0.285	0.347	0.558	0.654
Number of mothers that were unknown	338	1311 (0.359)	339	2.392 (0.353)	319	2.235 (0.307)	318	2.443 (0.376)	0.318	0.702	0.332	0.968	0.821
Child was found in clinic administrative record (1=Yes, 0=No)	691	0.886 (0.031)	733	0.914 (0.016)	735	0.899 (0.024)	674	0.920 (0.013)	0.350	0.606	0.236	0.562	0.394
Panel A: Children > 3.5 months													
Age of own child (in days)	636	193.612 (4.825)	697	192.628 (4.107)	619	187.989 (3.912)	631	194.461 (4.864)	0.841	0.459	0.693	0.417	0.845
Age of other child (in days)	653	252.351 (5.324)	673	254.073 (7.757)	623	250.790 (5.684)	600	246.337 (7.310)	0.808	0.793	0.678	0.762	0.371
Friend (1=Yes, 0=No)	636	0.057 (0.009)	697	0.075 (0.012)	619	0.050 (0.013)	631	0.060 (0.012)	0.167	0.732	0.749	0.199	0.408
Regular community member (1=Yes, 0=No)	636	0.390 (0.041)	697	0.372 (0.045)	619	0.360 (0.036)	631	0.385 (0.061)	0.401	0.638	0.893	0.962	0.540
Guardian (1=Yes, 0=No)	636	0.000 (0.000)	697	0.003 (0.002)	619	0.000 (0.000)	631	0.000 (0.000)	0.133	N/A	N/A	0.133	N/A
Neighbour (1=Yes, 0=No)	636	0.135 (0.023)	697	0.139 (0.034)	619	0.138 (0.034)	631	0.136 (0.034)	0.202	0.320	0.590	0.658	0.504
Relative (1=Yes, 0=No)	636	0.392 (0.034)	697	0.439 (0.028)	619	0.331 (0.032)	631	0.387 (0.039)	0.245	0.188	0.716	0.990	0.321
Panel B: Children > 9 months													
Age of own child (in days)	357	319.501 (2.240)	382	316.270 (3.636)	380	317.095 (2.427)	345	322.043 (4.112)	0.435	0.323	0.644	0.936	0.162
Age of other child (in days)	340	318.326 (2.540)	416	313.969 (2.928)	292	317.031 (2.791)	382	319.814 (2.558)	0.157	0.790	0.674	0.469	0.093
Friend (1=Yes, 0=No)	340	0.053 (0.014)	416	0.060 (0.015)	292	0.051 (0.016)	382	0.089 (0.018)	0.676	0.973	0.162	0.713	0.256
Regular community member (1=Yes, 0=No)	340	0.015 (0.044)	416	0.389 (0.042)	292	0.411 (0.050)	382	0.395 (0.062)	0.507	0.807	0.991	0.573	0.540
Guardian (1=Yes, 0=No)	340	0.000 (0.000)	416	0.002 (0.002)	292	0.000 (0.000)	382	0.000 (0.000)	0.320	N/A	N/A	0.322	0.321
Neighbour (1=Yes, 0=No)	340	0.112 (0.024)	416	0.118 (0.029)	292	0.147 (0.040)	382	0.131 (0.040)	0.797	0.819	0.753	0.820	0.959
Relative (1=Yes, 0=No)	340	0.371 (0.031)	416	0.377 (0.028)	292	0.312 (0.028)	382	0.335 (0.039)	0.837	0.166	0.442	0.070	0.346

Notes: This table summarizes relevant child- and parent information of the sample in table 5. The table reports mean values of each variable for every treatment group. The unit of observation is a respondent. The final column reports the joint significance level of treatment indicators in a regression with strata-level fixed effects. The values displayed for t-tests and F-tests are p-values. Standard errors are clustered at the clinic level for regressions assessing community characteristics. ***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table A5: The Effect of Signals on First- and Second-Order Beliefs: Heterogeneity by Social Proximity

Dependent variable:	Know # of vaccines other children		Others know # of vaccines own child	
	(1)	(2)	(3)	(4)
	> 3.5 months age	> 9 months age	> 3.5 months age	> 9 months age
Signal at 4	0.052 (0.040)	0.055 (0.070)	0.147 (0.051)	0.116 (0.087)
Signal at 5	0.071 (0.038)	0.014 (0.072)	0.118 (0.057)	0.189 (0.093)
Uninformative Bracelet	0.064 (0.044)	0.024 (0.070)	0.091 (0.058)	0.085 (0.094)
Close	0.026 (0.052)	-0.084 (0.088)	0.205 (0.058)	0.239 (0.107)
Signal at 4 \times Close	0.030 (0.042)	0.057 (0.087)	-0.019 (0.059)	0.066 (0.097)
Signal at 5 \times Close	0.030 (0.044)	0.141 (0.093)	-0.026 (0.053)	-0.046 (0.096)
Uninformative Bracelet \times Close	-0.032 (0.043)	0.067 (0.079)	-0.008 (0.057)	0.007 (0.090)
Control Group mean	0.495	0.559	0.397	0.435
Observations	4005	1458	4310	1558
Age of child	Yes	Yes	Yes	Yes
Relationship to mother	Yes	Yes	Yes	Yes

Notes: This table shows results from endline respondents' first- and second-order beliefs about other children's and own child's vaccinations, same as in Table 5 but testing for heterogeneous effects by social proximity. Social proximity is defined by the relationship between the respondent mother and the mother of the other child. I create a binary indicator, coded as one and defined as a "close" if the respondent reported the mother to be a friend or relative, and zero and defined as "far" if she said that she is a regular community member or neighbor. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size and relationship to other mother. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A6: Knowledge about the Color of the Bracelet

How do you know that this baby has a green/yellow bracelet?					
Dependent Variable:	Saw bracelet on child (1)	Saw nurse give bracelet (2)	Went to clinic together (3)	Everyone gets one (4)	Right # of vaccines (5)
Signal at 4	0.048 (0.042)	0.056 (0.040)	0.061 (0.035)	-0.006 (0.016)	0.063 (0.018)
Signal at 5	0.036 (0.037)	0.052 (0.041)	0.060 (0.040)	0.034 (0.020)	0.063 (0.015)
UI Group Mean	0.644	0.228	0.085	0.031	0.003
Observations	4192	4192	4192	4192	4192
p(S4 = S5)	0.772	0.939	0.984	0.064	0.985

Notes: This table summarizes bracelet knowledge elicited at endline. The unit of observation is as in table 5, a respondent-other mother pair. Next to first- and second-order beliefs about immunization about their own and the other mother's child, I asked respondent under UI, Signal at 4, and Signal at 5 clinics, whether they know that the other mother's baby has a bracelet, and if so, how they know about whether the baby has a green or yellow bracelet. The responses of the respondent are summarized in this table, where each outcome variable is binary and one if the respondent mentioned the respective choice, and zero otherwise. Each respondent was able to provide multiple reasons. In this table, we focus on the top 5 responses given by respondents, exclude those with very low frequencies. The excluded ones are "The mother showed me the bracelet" named by 1.5%, "Other" by 1.8%, and "We gave birth at the same time" by 0.38%. In all regressions, I include strata-fixed effects, demeaned controls for distance to the clinic, community and clinic population. Standard errors are cluster bootstrap at the clinic level.

Table A7: Reference Groups for Social Signaling

Dependent Variable:	Who is concerned about your child's vaccinations?				
	Anyone concerned (1)	Father of child (2)	Family member (3)	Nurse/CHW (4)	Community member (5)
Signal at 4	0.002 (0.014)	0.028 (0.042)	-0.017 (0.051)	-0.041 (0.056)	-0.004 (0.015)
Signal at 5	-0.034 (0.019)	0.073 (0.040)	0.008 (0.052)	-0.019 (0.055)	0.004 (0.013)
Uninformative Bracelet	-0.004 (0.015)	0.061 (0.043)	-0.048 (0.051)	-0.005 (0.059)	-0.015 (0.014)
Control Group mean	0.971	0.626	0.672	0.364	0.023
Observations	1314	1270	1270	1270	1270
$S_4 > 0$: $p(\text{UI} = S_4)$	0.691	0.435	0.562	0.551	0.446
$S_5 > 0$: $p(\text{UI} = S_5)$	0.147	0.758	0.285	0.814	0.133
$p(S_4 = S_5)$	0.063	0.230	0.621	0.722	0.572
Joint F-Test	0.283	0.259	0.709	0.888	0.493

Notes: At endline we asked respondents “Is there anyone in your community or your house who is concerned about your child’s immunization?”. If the respondent answered “Yes”, we asked “Who will be concerned?”. Column (1) is a binary indicator which is equal to one if a respondent confirmed that someone in her community is concerned about her child’s immunizations, and zero otherwise. Columns (2)-(5) displays regression results for the different groups a respondent could subsequently mention. For each indicator, I regress the binary outcome variable on the treatment indicators for Signal at 5, Signal at 4 and the Uninformative Bracelet, with the Control Group as excluded category. All regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A8: Inferences about Types Conditional on Vaccine Decisions

Dependent Variable:	How would community members view you if you... missed to take your child for vaccinations?					
	Careless (1)	Ignorant (2)	Lazy (3)	Busy (4)	Poor (5)	No judgement (6)
Signal at 4	-0.003 (0.019)	-0.047 (0.034)	-0.012 (0.010)	-0.016 (0.013)	0.006 (0.005)	-0.002 (0.012)
Signal at 5	-0.009 (0.020)	-0.043 (0.036)	0.000 (0.012)	-0.020 (0.012)	0.010 (0.006)	0.003 (0.013)
Uninformative Bracelet	-0.012 (0.023)	-0.015 (0.038)	-0.008 (0.013)	0.004 (0.019)	0.003 (0.004)	0.003 (0.014)
Control Group mean	0.959	0.194	0.025	0.020	0.000	0.021
Observations	1270	1270	1270	1270	1270	1270
$S_4 > 0$: $p(\text{UI} = S_4)$	0.707	0.367	0.748	0.293	0.643	0.743
$S_5 > 0$: $p(\text{UI} = S_5)$	0.908	0.444	0.562	0.181	0.314	1.000
$p(S_4 = S_5)$	0.759	0.914	0.304	0.618	0.581	0.718
Joint F-Test	0.937	0.479	0.637	0.296	0.192	0.979

Table A9: Inferences about Types Conditional on Vaccine Decisions

Dependent Variable:	How would community members view you if you... took your child for all vaccinations?		
	Caring/patient/serious (1)	Know of importance (2)	Think nothing special about me (3)
Signal at 4	-0.009 (0.020)	-0.035 (0.062)	-0.005 (0.013)
Signal at 5	0.000 (0.022)	-0.042 (0.065)	-0.004 (0.014)
Uninformative Bracelet	0.010 (0.020)	-0.023 (0.065)	-0.003 (0.015)
Control Group mean	0.953	0.247	0.025
Observations	1270	1270	1270
$S_4 > 0$: $p(\text{UI} = S_4)$	0.346	0.836	0.887
$S_5 > 0$: $p(\text{UI} = S_5)$	0.637	0.750	0.920
$p(S_4 = S_5)$	0.663	0.901	0.969
Joint F-Test	0.827	0.921	0.983

Notes: At endline we asked respondents “Is there anyone in your community or your house who is concerned about your child’s immunization?”. If the respondent answered “Yes”, we continued to ask “Who will be concerned?” and “How would these community members view you if you missed to take your child for vaccinations? or ... took your child for all vaccinations?”. I generate binary outcome variables, equal to one if the respondent named the respective answer, and zero otherwise. Regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, clinic and community population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A10: Private and Social Benefits of Vaccination

Dependent Variable:	Vaccinations are helpful for my own child's health		My child's vaccination can be helpful for other children in the community
	(1)	(2)	(3)
Signal at 4	0.001 (0.031)	0.001 (0.004)	-0.019 (0.088)
Signal at 5	0.061 (0.028)	0.003 (0.004)	-0.015 (0.081)
Uninformative Bracelet	-0.008 (0.029)	-0.007 (0.006)	0.006 (0.083)
Control Group mean	0.879	0.994	0.262
Observations	1314	1314	1314
$S_4 > 0$: $p(\text{UI} = S_4)$	0.753	0.174	0.758
$S_5 > 0$: $p(\text{UI} = S_5)$	0.007	0.052	0.790
$p(S_4 = S_5)$	0.038	0.579	0.959
Joint F-Test	0.026	0.232	0.988

Notes: At endline we asked respondents, “Do you think that vaccination is helpful, harmful or both for your child?”. Column (1) displays regression results where the outcome variable is binary and equal to one if the respondent said “Helpful” and zero otherwise. Column (2) displays results where the outcome variable is one if the respondent said “Helpful” or “Both, helpful and harmful”. In the whole sample, 90.2 percent of respondents say “Yes” to “Vaccinations are helpful for my own child’s health”, while 24.5 percent belief that “[their] child’s vaccination can be helpful for other children in the community.”

Table A11: Knowledge of Externalities

Dependent Variable:	My child can be harmful to others if she/he is not immunized	Other children can be harmful to my child if not immunized	Understanding of externalities	
	(1)	(2)	Partial (3)	Full (4)
Signal at 4	-0.004 (0.041)	0.004 (0.050)	-0.003 (0.053)	0.003 (0.037)
Signal at 5	-0.073 (0.039)	-0.058 (0.044)	-0.074 (0.047)	-0.058 (0.034)
Uninformative Bracelet	-0.033 (0.038)	-0.066 (0.042)	-0.076 (0.045)	-0.023 (0.035)
Control Group mean	0.185	0.232	0.283	0.135
Observations	1314	1314	1314	1314
$S_4 > 0$: $p(\text{UI} = S_4)$	0.404	0.103	0.105	0.435
$S_5 > 0$: $p(\text{UI} = S_5)$	0.210	0.846	0.969	0.229
$p(S_4 = S_5)$	0.049	0.163	0.139	0.050
Joint F-Test	0.151	0.213	0.163	0.172

Notes: Columns (1) and (2) display results for the respective survey question, with outcome variables equal to one if answered “Yes”, and zero otherwise. In the overall sample, 19.5 percent said that “their child can be harmful to others if she/he is not immunized”, while 15 percent said that “other children can be harmful to my child if not immunized”. Columns (3) and (4) display the regression results for a binary indicator, coded one if a respondent has a partial- (i.e. if a respondent answered yes to only one of the questions in Columns (1) and (2) or full understanding (i.e. if the respondent answered yes to both questions in Columns (1) and (2) of externalities. Regressions include strata-fixed effects and demeaned controls for child age, distance to the clinic, community and clinic population size. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A12: The Combined Effect of Signals at 4 and 5 on Timely and Complete Vaccination (as Table 6 without controls)

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5
	(1)	(2)	(3)	(4)	(5)
Panel A: Compared to Control Group					
Signal at 4 and 5	0.012 (0.020)	0.034 (0.022)	0.049 (0.032)	0.066 (0.041)	0.083 (0.051)
Control Group mean	0.960	0.914	0.833	0.708	0.537
Observations	5582	5299	4893	4459	1764
Panel B: Compared to Uninformative Bracelet					
Signal at 4 and 5	-0.007 (0.006)	-0.001 (0.008)	0.006 (0.021)	0.025 (0.037)	0.026 (0.047)
Uninformative Bracelet mean	0.978	0.949	0.877	0.750	0.594
Observations	5523	5248	4866	4433	1756

Notes: This table shows results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months, respectively, on a treatment indicator for Signal at 4 and 5, with the omitted category being the Control Group in Panel A and the Uninformative Bracelet in Panel B. The sample includes all children born since the launch of the experiment. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A13: The Effect of Signals on Timely and Complete Vaccination, Separate by Treatment (as Table 7 without controls)

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5	Total # of vaccines timely
	(1)	(2)	(3)	(4)	(5)	(6)
Signal at 4	0.008 (0.021)	0.024 (0.024)	0.026 (0.036)	0.032 (0.047)	0.037 (0.056)	0.084 (0.152)
Signal at 5	0.016 (0.021)	0.045 (0.023)	0.076 (0.036)	0.106 (0.044)	0.132 (0.053)	0.381 (0.140)
Uninformative Bracelet	0.018 (0.020)	0.035 (0.023)	0.044 (0.036)	0.042 (0.050)	0.057 (0.063)	0.206 (0.158)
Control Group mean	0.960	0.914	0.833	0.708	0.537	3.950
Observations	7246	6869	6352	5794	2281	2281
$S_4 > 0$: $p(\text{UI} = S_4)$	0.175	0.342	0.457	0.815	0.711	0.352
$S_5 > 0$: $p(\text{UI} = S_5)$	0.786	0.339	0.191	0.104	0.138	0.146
$p(S_4 = S_5)$	0.367	0.093	0.039	0.034	0.023	0.009
Joint F-Test	0.459	0.141	0.085	0.045	0.032	0.012

Notes: Columns (1) through (5) of this table show results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 3, 4, 5, 6 and 11.5 months respectively on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the excluded category. The sample includes all children born since the launch of the experiment. Columns (6) and (7) show results from a regression of the discrete variable “total number of vaccines”, coded 1, 2, 3, 4 or 5, on the treatment indicators Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the omitted category. The sample includes all children born since the launch that were at least 11.5 months old (Column (6)) and 12 months old (Column (7)) by the end of the experiment. Column (6) shows treatment effects on the total number of timely vaccines received, that is by age 3, 4, 5, 6 and 11.5 months for vaccines 1, 2, 3, 4 and 5; Column (7) shows treatment effects on the total number of vaccines received by the age of 12 months, irrespective of the time of vaccination. For all columns, the bottom row gives the p-values from a test that the effect of the Uninformative Bracelet (UI) is equivalent to the effect of Signal at 4 (S_4) or to Signal at 5 (S_5), identifying social signaling preferences ($S_4 > 0$, $S_5 > 0$), and that the effect of Signal at 4 is equivalent to the Signal at 5. Last is a joint hypothesis test of all three bracelet treatments. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A14: The Extensive Margin Effect of Bracelets: Complete Vaccination by Age One (as Table 8 without controls)

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5	Total # of vaccines by one year age
	(1)	(2)	(3)	(4)	(5)	(6)
Signal at 4	0.009 (0.006)	0.014 (0.007)	0.034 (0.018)	0.058 (0.033)	0.104 (0.055)	0.220 (0.100)
Signal at 5	0.001 (0.007)	0.006 (0.009)	0.029 (0.017)	0.059 (0.032)	0.130 (0.051)	0.225 (0.098)
Uninformative	0.007 (0.006)	0.011 (0.009)	0.033 (0.018)	0.067 (0.034)	0.085 (0.059)	0.206 (0.105)
Control Group mean	0.989	0.982	0.941	0.876	0.648	4.436
Observations	1914	1914	1914	1914	1914	1914
$S_4 > 0$: $p(\text{UI} = S_4)$	0.459	0.586	0.939	0.683	0.682	0.823
$S_5 > 0$: $p(\text{UI} = S_5)$	0.359	0.488	0.681	0.683	0.240	0.750
$p(S_4 = S_5)$	0.125	0.154	0.606	0.986	0.470	0.934
Joint F-Test	0.192	0.168	0.269	0.251	0.065	0.135

Notes: This table shows results from a linear probability model of the binary outcome variable for a child being vaccinated for 1, 2, 3, 4, or 5 vaccinations by the age of 12 months - ignoring whether a child received a given vaccine on time - on treatment indicators for Signal at 4, Signal at 5 and Uninformative Bracelet, with the Control Group as the excluded category. The sample includes all children born since the launch of the experiment that were 12 months or older when last observed. The bottom rows give the p-values from a test that the effect of the Uninformative Bracelet (UI) is equivalent to the effect of Signal at 4 (S_4) or to Signal at 5 (S_5), and that the effect of Signal at 4 is equivalent to the Signal at 5. Last is a joint hypothesis test of all three bracelet treatments. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A14b: The Intensive Margin Effect of Bracelets, Constant Sample (as Table 8b without controls)

Dependent variable:	Vaccine 1	Vaccine 2	Vaccine 3	Vaccine 4	Vaccine 5
	(1)	(2)	(3)	(4)	(5)
Signal at 4	-0.004 (0.014)	0.000 (0.022)	0.023 (0.040)	0.027 (0.045)	0.039 (0.058)
Signal at 5	0.004 (0.013)	0.030 (0.021)	0.089 (0.037)	0.115 (0.046)	0.144 (0.055)
Uninformative	0.009 (0.013)	0.022 (0.023)	0.050 (0.041)	0.047 (0.052)	0.063 (0.064)
Control Group mean	0.971	0.932	0.819	0.693	0.533
Observations	1914	1914	1914	1914	1914
$S_4 > 0$: $p(\text{UI} = S_4)$	0.241	0.165	0.360	0.632	0.656
$S_5 > 0$: $p(\text{UI} = S_5)$	0.605	0.536	0.125	0.126	0.100
$p(S_4 = S_5)$	0.464	0.019	0.007	0.017	0.018
Joint F-Test	0.692	0.086	0.013	0.038	0.021

Notes: This table shows for same sample as in Table 8 the effect of signals on timely and complete vaccination, separate by treatment. Standard errors are cluster bootstrapped (1000 repetitions) at the clinic level.

Table A15: Correlation of Distance with Socio-Economic Characteristics

Dependent variable:	Vaccine 3	Vaccine 4	Vaccine 5	Vaccine 3	Vaccine 4	Vaccine 5
	(1)	(2)	(3)	(4)	(5)	(6)
Distance 1 mile	-0.026 (0.075)	-0.012 (0.075)	-0.108 (0.118)	-0.020 (0.077)	-0.013 (0.077)	-0.136 (0.122)
Distance 2 miles	-0.090 (0.055)	-0.063 (0.065)	-0.172 (0.098)	-0.091 (0.056)	-0.067 (0.065)	-0.192 (0.103)
Distance 3 miles	-0.085 (0.041)	-0.120 (0.044)	-0.085 (0.096)	-0.079 (0.042)	-0.122 (0.046)	-0.080 (0.100)
Distance 4 miles	-0.050 (0.074)	-0.092 (0.068)	-0.213 (0.114)	-0.040 (0.072)	-0.091 (0.067)	-0.237 (0.117)
Distance 5 miles	-0.108 (0.068)	-0.112 (0.071)	-0.210 (0.103)	-0.102 (0.067)	-0.115 (0.072)	-0.221 (0.110)
Child age				-0.000 (0.000)	-0.001 (0.000)	0.000 (0.001)
Birth order				-0.014 (0.016)	-0.030 (0.019)	-0.022 (0.031)
Mother age				-0.000 (0.004)	0.000 (0.004)	-0.005 (0.007)
Floor cement				0.041 (0.030)	0.031 (0.035)	0.040 (0.065)
Roof corrugated iron				-0.007 (0.043)	0.001 (0.048)	0.061 (0.100)
Has any education				0.015 (0.015)	0.014 (0.016)	-0.005 (0.028)
Works on farm				0.080 (0.055)	0.125 (0.061)	0.184 (0.141)
Trader				0.054 (0.053)	0.054 (0.067)	0.109 (0.148)
Constant	0.799 (0.051)	0.703 (0.049)	0.638 (0.065)	0.884 (0.110)	0.840 (0.134)	0.490 (0.574)
Outcome Mean	0.799	0.703	0.638	0.884	0.840	0.490
Observations	1087	963	255	1087	963	255

Notes: This table shows the effect of distance on timely completion of vaccines 3, 4 and 5, comparing treatment effects from regressions without and with covariates. The sample includes all children (age 4 months and above, to be counted for vaccine 3 etc.) whose parents were surveyed at endline and for whom I therefore observe socio-economic characteristics. Columns (1)-(3) show regression results without covariates, and columns (4)-(6) results with covariates. The covariate child age is coded in days, mother age in years; the variable birth order takes values 1 through 6. The variables Floor cement, Roof corrugated iron, Has any education, Works on farm and Trader are indicator variables that take value one if the respondent's floor is made of cement etc. and zero otherwise. The distance variable takes the values 0 to 5 miles. All regressions include strata-fixed effects. Standard errors are clustered at the clinic level.

Table A16: Test of the Equality of Distance Coefficients from Table [A15](#)

	Distance 1 mile (1)	2 miles (2)	3 miles (3)	4 miles (4)	5 miles (5)
Vaccine 5	0.024 (0.029)	0.022 (0.024)	-0.002 (0.018)	0.034 (0.033)	0.033 (0.030)
Observations	255	255	255	255	255
Vaccine 4	0.007 (0.008)	0.006 (0.009)	-0.000 (0.011)	0.004 (0.014)	0.009 (0.011)
Observations	963	963	963	963	963
Vaccine 3	0.003 (0.007)	0.001 (0.008)	-0.007 (0.009)	-0.006 (0.011)	-0.003 (0.009)
Observations	1087	1087	1087	1087	1087

Notes: This table tests for the equality of the coefficients from the regressions of vaccine 5, 4, and 3 on distance dummy variables with and without covariates (see [A15](#)), using seemingly-unrelated estimation. The table displays the difference in coefficients and associated p-values.

Table A17: Additional Information on Bracelet Retention and Correct Hand Out

Dependent variable:	Child wears bracelet (1)	Child lost bracelet (2)	Bracelet was exchanged (3)
Signal at 4	-0.056 (0.060)	0.028 (0.046)	0.026 (0.075)
Signal at 5	-0.021 (0.059)	-0.070 (0.040)	-0.053 (0.068)
Uninformative Bracelet mean	0.362	0.219	0.652
Observations	3913	941	743
p(S4 = S5)	0.577	0.003	0.305

Notes: This table shows results from a linear probability model of the binary outcome variables (1) for a child wearing a bracelet when observed during the listing survey, (2) whether a child still had or lost her bracelet at endline, and (3) whether a child's bracelet was exchanged when it came for vaccine 4 or 5, on treatment indicators Signal at 4 and Signal at 5, with the Uninformative Bracelet as the omitted category. The sample used for (1) includes all children that were born since the experiment was launched and were physically present during the listing, and surveyors could see the wrist of the child. The sample for (2) includes all children in bracelet treatments that were part of the endline survey; sample (3) does the same but conditions on a child having received vaccines four or five (as otherwise the child would not have been eligible for an exchange of the bracelet). All regressions include strata-fixed effects. Standard errors are clustered at the clinic level.

Table A18: Supplementary to Table A17, Column (1)

Dependent variable:	Child wears bracelet
Child age	-0.001 (0.000)
Outcome Mean	0.505
Observations	3913

Notes: This table shows results from a linear probability model of the binary outcome variable for a child wearing a bracelet when observed during the listing survey on the continuous variable child age, measured in days. Data is pooled across Signal at 4, Signal at 5 and Uninformative Bracelet as no significant differences for "Child wears bracelet" were found in Table A17, Column (1). 50 percent of children age 3 months or below wear the bracelet when visited during the listing survey. The probability declines to 40 and 33 percent for children of age 3 to 6, and 6 to 9 months respectively. Among children that are 12 months or older, 21 percent wear the bracelet. When asking parents during endline, why the child is not wearing the bracelet, the most common answer was that they are afraid of the child losing the bracelet by biting on it or playing with it. Parents further report that the child wears the bracelet when going to the clinic or on special occasions, when visiting relatives or at community events. The regression includes strata-fixed effects. Standard errors are clustered at the clinic level.

Table A19: Verifying the Correct Implementation of Bracelets, Regression Results for Figure 4

Dependent variable:	Signal at 4		Signal at 5		Uninformative Bracelet	
	Green (1)	Yellow (2)	Green (3)	Yellow (4)	Green (5)	Yellow (6)
Vaccine 2	0.016 (0.010)	0.085 (0.054)	0.015 (0.004)	0.053 (0.034)	0.041 (0.053)	0.074 (0.061)
Vaccine 3	0.033 (0.013)	0.102 (0.057)	0.021 (0.006)	0.062 (0.033)	0.064 (0.034)	0.042 (0.055)
Vaccine 4	0.613 (0.043)	-0.443 (0.075)	0.046 (0.006)	0.057 (0.031)	0.056 (0.034)	0.075 (0.052)
Vaccine 5	0.644 (0.033)	-0.509 (0.069)	0.701 (0.040)	-0.595 (0.044)	0.101 (0.036)	0.026 (0.050)
Vaccine 1 mean	0.042	0.773	-0.027	0.869	0.312	0.530
Observations	2022	2022	1813	1813	1624	1624

Notes: This table shows the regression results of a binary variable for green or yellow bracelet on the total number of vaccines a child has received and strata fixed effects, with standard errors cluster bootstrapped (1000 repetitions) at the clinic level.

Table A20: Relationship of Respondent to Other Mother

	Percent
Regular community member	39
Relative	35
Neighbor	14
Friend	7
Other Carer	5
Total	100
Observations	5572

Notes: This table displays the social connection between endline respondents and a sample of randomly selected (other) mothers in their community, conditional on the respondent recognizing the other mother. There are 5,572 respondent-other mother pairs in my endline sample, across all four treatment groups, including 1,304 unique respondents and 2,353 unique other mothers from 119 clinics. Ten endline respondents across all treatments (less than 1% of the sample) did not recognize any of the other mothers.

Table A21: Test for Differential Clinic Attendance

Dependent Variable:	Attend a different clinic (1)
Uninformative Bracelet	0.011 (0.019)
Signal at 4	0.016 (0.018)
Signal at 5	0.008 (0.013)
Post-intervention	0.030 (0.018)
Uninformative Bracelet \times Post-intervention	-0.028 (0.027)
Signal at 4 \times Post-intervention	0.021 (0.035)
Signal at 5 \times Post-intervention	-0.036 (0.029)
Control Group mean	0.075
Observations	152
$S_4 > 0$: $p(\text{UI} = S_4)$	0.183
$S_5 > 0$: $p(\text{UI} = S_5)$	0.794
$p(S_4 = S_5)$	0.137
Joint F-Test	0.347

Notes: In this table, I investigate in how far this project might have shifted clinic attendance differentially across treatment arms. To do that, we code a binary indicator for every alive child that was listed, which is one in case the mother stated she attends a different clinic for immunization and zero otherwise. Then we collapse that data on clinic level though distinguish between pre- and post-intervention period. We define whether a child is included in the pre- or post-intervention sample based on the date of birth. Children born 4 months prior to the launch of a given clinic are considered as pre-intervention and all other babies born 3 months prior to the launch and after as post-intervention ones. I chose a difference-in-difference specification and regress the share of babies that attend a different clinic level on the interaction between the treatment and the time indicator (1= post-intervention, 0 = pre-intervention). I only include for cleanliness the 76 clinics launched in the second wave. The regression includes strata-fixed effects and standard errors are cluster bootstrapped (1000 repetitions) at clinic level.

Table A22: Number of Clinics and Children across Four Districts

District	Clinics					Children				
	Control	Signal 4	Signal 5	Uninform	All	Control	Signal 4	Signal 5	Uninform	All
Bombali	11	11	11	11	44	483	723	594	507	2307
Kambia	6	6	6	7	25	488	407	452	445	1792
Tonkolili	11	11	10	10	42	658	824	698	565	2745
Western Area Rural	2	2	2	2	8	94	88	73	147	402
<i>Total</i>	30	30	29	30	119	1723	2042	1817	1664	7246

Table A23: Number of Communities and Children By Distance to Clinic

Treatment	All Communities			Close (0-2 miles)			Far (2-5 miles)		
	Coms	Distance	Children	Coms	Distance	Children	Coms	Distance	Children
Control	145	2.17 (1.60)	1723	79	0.92 (0.87)	1217	66	3.67 (0.77)	506
Signal 4	146	2.33 (1.67)	2042	73	0.92 (0.92)	1410	73	3.74 (0.83)	632
Signal 5	142	2.15 (1.67)	1817	81	0.90 (0.87)	1192	61	3.82 (0.79)	625
Uninform	149	2.4 (1.63)	1664	74	1.01 (0.91)	1060	75	3.76 (0.84)	604
<i>Total</i>	582	2.26 (1.64)	7246	307	0.94 (0.89)	4879	275	3.75 (0.81)	2367

Notes: The sample includes all children that were born since the start of the experiment, are from one of the selected catchment communities, attend one of the study clinics, and had at least reached the cut-off age for vaccine one. The sample is smaller when excluding children that were too young to have met the timeliness cut-off for vaccines two, three, four and five (which explains the decline in sample size in the estimation of treatment effects across the different vaccines). The clinic randomization was stratified by district. One of the 120 selected clinics, located in Western Area Rural district is excluded from the analysis due to serious complications in the implementation and data collection. For the distance variable, means are reported and standard deviations in parentheses.

B Sampling

Sampling of Communities at Baseline

For each clinic, surveyors selected five communities, using in-field randomization. Surveyors obtained a list of all catchment communities from clinic staff. A community was considered as eligible for selection if the community (i) was primarily served by the clinic, instead of by another close-by clinic, (ii) had at least ten dwelling units. A dwelling unit comprises on average of three to four households and (iii) was not an outreach point, that is, a community where health workers would regularly travel to to vaccinate children. Among the five communities, one was by default the clinic community. In addition, one other close (located 0-2 miles from the clinic) community and three far communities (located 2-5 miles from the clinic) were randomly selected. For clinics that had fewer than three far or two close communities, surveyors were asked to replace the community with another close or far community instead.

Sampling of Respondents at Endline

I used the listing data ($N = 14,048$ children) as sampling frame for endline respondents. Before randomly drawing the mothers to be surveyed, I restricted the sample, excluding:

- Children who had permanently moved or were traveling at the time of the listing exercise and were therefore not present in the community, or had died ($N = 1,971$).
- Children who did not attend any of the study clinics for immunization services. This was the case for communities where multiple clinics were accessible at a similar walking distance. Mothers would normally go for immunization services at the same clinic where they went for prenatal care ($N = 1,242$).
- Children who were born before January 1, 2017, that is, after all 119 clinics had been launched and communities visited for information meetings ($N = 4,858$).
- Communities with fewer than three babies ($N = 126$).

This resulted in a final sample of 5,851 children across 488 communities. I then applied a two-stage randomization: Firstly, I randomly drew four communities for each clinic, stratified by distance, two close and two far communities. Since some clinics had fewer than four communities, this led to a sample of 401 communities, with 205 close and 196 far communities. Secondly, I randomly drew 10 mothers from the set of close communities and 10 mothers from the set of far communities for each clinic (i.e. 20 mothers per clinic). From the set of ten mothers, I randomly selected six mothers to be surveyed and four mothers to serve as replacements in case a mother could not be found, moved or was deceased. In total 1,314 mothers across 381 communities were surveyed at endline, with a mean of 11 respondents, balanced across arms.

C Implementation Materials

Figure C1: Clinic Staff Messaging Cards, Uninformative Bracelet







Social Incentives for Child Immunization



Instruction and messaging card

Give out bracelets to babies that are 15 months or younger and come for immunization.

Schedule	Bracelet type	Comment
Hand out BRACELET at 1 st visit: BCG	 	<p>Give YELLOW OR GREEN BRACELET to EVERY CHILD that comes OR already came for 1st vaccine visit.</p> <p>Allow the caregiver to choose the preferred color.</p>
Exchange BRACELET at: 4 th and 5 th visits: - Penta3 - Measles I	 	<p>EXCHANGE the previous BRACELET for a NEW ONE of the SAME color at EACH of the 4th and 5th vaccine visit.</p>

Please give the following messages to the caregiver.

Show the bracelets to the caregiver and say – we give the YELLOW or GREEN bracelet for the 1st vaccine visit. The bracelets have 1st visit written on them.

YELLOW or GREEN BRACELET – FOR 1st vaccine visit

At BCG	<ul style="list-style-type: none"> I give you the YELLOW / GREEN bracelet because you came for 1st vaccine visit. When you come onto the 4th and 5th vaccine visit I will exchange the bracelet to a NEW one of the same color.
At Penta1, Penta2, Penta3, Measles I or II	<ul style="list-style-type: none"> I give you the YELLOW / GREEN bracelet not because of this visit but because you came for 1st vaccine visit. When you come onto the 4th and 5th vaccine visit I will exchange the bracelet to a NEW one of the same color.

YELLOW or GREEN BRACELET – FOR EXCHANGE at 4th or 5th vaccine visit

At Penta3, Measles I	<ul style="list-style-type: none"> I exchange your bracelet to a new one of the same color because you came for the 4th / 5th vaccine visit.
----------------------	---

Figure C2: Clinic Staff Messaging Cards, Signal at 4



Social Incentives for Child Immunization
Messaging card



Please give the following messages to caregivers.

Show the bracelets to the caregivers and say – we give the YELLOW bracelet for the 1st vaccine visit; we give the GREEN bracelet to a child that comes TIMELY for 4th vaccine visit. The bracelets have 1st and 4th visit written on them.

YELLOW BRACELET – FOR 1st vaccine visit

At BCG	<ul style="list-style-type: none"> I give you the YELLOW bracelet because you came for 1st vaccine visit. When you come TIMELY onto the 4th vaccine visit I will exchange the bracelet to a GREEN bracelet.
At Penta1, Penta2	<ul style="list-style-type: none"> I give you the YELLOW bracelet not because of this visit but because you came for 1st vaccine visit. When you come TIMELY onto the 4th vaccine visit I will exchange the bracelet to a GREEN bracelet.

GREEN BRACELET – For TIMELY 4th vaccine visit, at 14 weeks (~3.5 months)

At Penta3	<ul style="list-style-type: none"> I give you the GREEN because you came ON TIME for the 4th vaccine visit. When you come for the 5th vaccine visit I will exchange the bracelet to a NEW one of the same color.
At Measles I or II	<ul style="list-style-type: none"> I give you the GREEN not because of this visit but because you came ON TIME for the 4th vaccine visit. When you come for the 5th vaccine visit I will exchange the bracelet to a NEW GREEN bracelet.
Defaulter Message	
At Penta3, Measles I or II	<ul style="list-style-type: none"> You don't get GREEN bracelet because you did not come ON TIME for 4th vaccine visit. I give you a NEW YELLOW. When you come for the 5th vaccine visit I will exchange the bracelet to a NEW YELLOW bracelet.

Figure C3: Clinic Staff Messaging Cards, Signal at 5



Social Incentives for Child Immunization
Messaging card



Please give the following messages to caregivers.

Show the bracelets to the caregivers and say – we give the YELLOW bracelet for the 1st vaccine visit; we give the GREEN bracelet to a child that comes TIMELY for 5th vaccine visit. The bracelets have 1st and 5th visit written on them.

YELLOW BRACELET – FOR 1st vaccine visit

At BCG	<ul style="list-style-type: none"> I give you the YELLOW because you came for 1st vaccine visit. When you come TIMELY onto the 5th vaccine visit I will exchange the bracelet to a GREEN bracelet.
At Penta1, Penta2, Penta3	<ul style="list-style-type: none"> I give you the YELLOW bracelet not because of this visit but because you came for 1st vaccine visit. When you come TIMELY onto the 5th vaccine visit I will exchange the bracelet to a GREEN bracelet.

GREEN BRACELET – For TIMELY 5th vaccine visit, at 9 months

At Measles I	<ul style="list-style-type: none"> I give you the GREEN because you came ON TIME for the 5th vaccine visit.
At Measles II	<ul style="list-style-type: none"> I give you the GREEN not because of this visit but because you came ON TIME for the 5th vaccine visit.
Defaulter Message	
At Measles I or II	<ul style="list-style-type: none"> You don't get GREEN bracelet because you did not come ON TIME for 5th vaccine visit. I give you a NEW YELLOW bracelet.

Figure C4: General Rules for Handout of Uninformative, Signal at 4 and Signal at 5 Bracelets



Social Incentives for Child Immunization
General rules for bracelet distribution



Actions to be taken by the clinic staff, please.

If the baby loses the bracelet:

- Register the baby in the Pikin Register, as you would normally do. And indicate bracelet loss with “L” in column of bracelet color.
- Do NOT replace the bracelet!
- Tell mother to bring the lost bracelet to the clinic if she finds it and say that you will exchange it for new one then.

If the baby left the bracelet at home:

- Do NOT give the baby a new bracelet!
- If the baby is due for a bracelet exchange, tell mother that bracelet will be exchanged when she comes back with the old bracelet.

If baby's parent does not want baby to wear the bracelet:

- Register the baby in the Pikin Register, as you would normally do. And indicate bracelet refusal with “R” in column of bracelet color.
- Explain to caregiver that bracelet is meant to help remind her/him to take the child for immunizations.

If baby comes with bracelet from other baby:

- Verify that the bracelet is not the baby's bracelet but belongs to another child.
- Take the bracelet from the child and keep it in the bracelet return back. Give the child its own correct bracelet.

If baby's parent prefers the other color:

- Tell the parent you give out the bracelet according to set RULES. Go to messaging card and read out the message.

Figure C5: Script for Information Meetings in Control Group Communities

<p style="text-align: center;">Sensitization on Child Immunization</p> <p style="text-align: center;">ARM 1</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: right;">1</p>	<p style="text-align: center;">Sensitization on Child Immunization</p> <ul style="list-style-type: none"> • New programme for pikin immunization implemented by the Ministry of Health and Sanitation through the Child Health/EPI Programme and District Health Management Team (DHMT). Innovations for Poverty Action (IPA) supports MoHS and DHMT with the implementation and research on program. • IPA is a research organization based in Freetown. IPA has done extensive work alongside Government Ministries in Health, Agriculture and Education. <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: right;">2</p>
<p>Facilitator Please Note</p> <ul style="list-style-type: none"> • That you must have your sensitization assessment community form open and fill it alongside • Encourage participation by all • Moderate the training very well and focus more on the key areas <p style="text-align: right;">3</p>	<p style="text-align: center;">The Key Idea</p> <ul style="list-style-type: none"> • The MoHS and clinic staff in partnership with IPA, have agreed to engage in community awareness raising and sensitization on immunization as a way to encourage caregivers to take their children for timely and complete immunization. <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: right;">4</p>
<p style="text-align: center;">Importance of Immunization</p> <ul style="list-style-type: none"> • Some people may not exactly know how valuable immunizations are for a child and the community's health and well-being. • Immunizations can prevent your child from diseases. • It will make your child grow healthy. • It reduces household spending on seeking health care services when the child falls ill. • It reduces the spread of diseases among children and other community members. • Every caregiver should take their child for 6 immunization visits between 0 to 15 months old. Plus another 2 visits for Vitamin A and deworming pills. <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: right;">5</p>	<p style="text-align: center;">Immunization Schedule</p> <ul style="list-style-type: none"> • Facilitator: explain the immunization schedule to the participants. Showing the growth card and when immunizations are at the clinic. <p style="text-align: right;">6</p>

What are the barriers to Immunization

Facilitator: Ask them to come up with reasons why people don't bring their children for immunization. You can add the following if not mentioned by a participant:

- 1) Ignorance about the importance of immunization
- 2) Forgetfulness about the dates to come for vaccine
- 3) Little interest in child issues
- 4) Transport cost for long distances



7

What are the barriers to Immunization

- 5) Laziness
- 6) Too busy with other work
- 7) Supply related issues, vaccine not in stock, nurse not around
- 8) Afraid of needles or perceived side effect
- 9) Cultural beliefs about vaccinations



8

Addressing the barriers to immunizations

• **Facilitator** ask: Do caregivers in your communities face some or all of the challenges outlined? Have them discuss these points and state which are relevant in their own communities.

• If yes: How can we address them in a non-punitive way?

• **Facilitator:** Allow them to come up with suggestions.



9

Recap on Presentation

- Now we want to go over what we discussed so far.
- Recap on the importance of immunizations.
- Recap on the challenges on immunizations and its solution.
- Recap on the number of vaccine visits and schedule.



10

Dissemination Strategy

• Now we are about to talk on how to take the awareness raising and sensitization information to other members of our community so everyone will learn and know about the immunizations.

Facilitator: Ask participants on what ways they may want to pass the sensitization message to others?



11

Concluding Statements

- Clinic in-charge or any staff (if Central VDC meeting)
- Rep from community (if Community meeting)
- Village chief
- Facilitator





12

Figure C6: Script for Information Meetings in Bracelet Communities

Social incentives for Child Immunization



ARM 4

1

Social incentives for Child Immunization

- New programme for pikin immunization implemented by the Ministry of Health and Sanitation through the Child Health/EPI Programme and District Health Management Team (DHMT). Innovations for Poverty Action (IPA) supports MoHS with the implementation and research on program.
- IPA is a research organization based in Freetown. IPA has done extensive work alongside Government Ministries in Health, Agriculture and Education.

2

Facilitator Please Note

- That you must have your sensitization assessment community form open and fill it alongside
- Encourage participation by all
- Moderate the training very well and focus more on the key areas

3



Immunization Schedule

- **Facilitator:** explain the immunization schedule to the participants. **Showing the growth card** and when immunizations are at the clinic.

4

Bracelets as Social Incentives

- The MoHS, DHMT and clinic staff in partnership with IPA, have agreed to introduce colorful bracelets as an encouragement for caregivers to take their children for timely and complete immunization.
- Bracelets will be given as token of recognition for certain vaccine visits to show that child has progressed well in the schedule.






5

How are the bracelets given out?

Clinic staff have full instructions on how to give the bracelets to the children.

- A yellow bracelet is given for the 1st immunization visit a child makes. The yellow bracelet shows the child has successfully begun immunizations.
- A yellow bracelet is given for the 1st immunization visit a child has made.
- A green bracelet is given for a TIMELY 5th immunization visit a child makes. The green bracelet shows that the child has progressed well in the schedule.
- A green bracelet is given for a TIMELY 5th immunization visit a child has made.

6

How is the bracelet exchanged?

- The yellow bracelet will be exchanged to a new yellow bracelet, when the child comes for 4th visit.
- The yellow bracelet will be exchanged to a green bracelet when the child comes TIMELY for the 5th visit and brings the yellow bracelet.
- The yellow bracelet will NOT be exchanged for a green bracelet if the child comes late for the 5th visit. Instead, the child will receive a new yellow bracelet.
- Every child who comes for immunization to the clinic will receive a bracelet.



7

What do the bracelets mean?

- When you see a child with yellow bracelet, it means the child has gone for at least 1st visit for immunization. The child has begun immunizations.
- When you see a child with green bracelet, it means the child went on time for timely 5th visit for immunization. You will not be able to tell whether the child has come for 6th immunization visit.
- It is the caregiver's and everyone's responsibility to ensure their children are immunized.
- ANY Questions!



8

The Bracelet Song

- The bracelets come with a song to remind caregivers and everyone on what the bracelets are for and how they are given.



9

Role Play

- Now we are going to have a drama that will further explain what the bracelet stands for and how it should be given.
- Facilitator and Female Member role play.
- Facility and a Male role play.
- Ask participants what they learned from the role play.



10

Dissemination Strategy

- Now we are about to talk on how to take the bracelet information to other members of our community so everyone will learn and know about the bracelet.
- **Facilitator:** Ask participants on what ways they may want to pass the sensitization message to others?



11

Importance of Immunization

- Some people may not exactly know how valuable immunizations are for a child and the community's health and well-being.
- Immunizations can prevent your child from diseases.
- It will make your child grow healthy.
- It reduces household spending on seeking health care services when the child falls ill.
- It reduces the spread of diseases among children and other community members.
- Every caregiver should take their child for 6 immunization visits between 0 to 15 months old. Plus another 2 visits for Vitamin A and deworming pills.



12

What are the barriers to Immunization

Facilitator: Ask them to come up with reasons why people don't bring their children for immunization. You can add the following if not mentioned by a participant:

- 1) Ignorance about the importance of immunization
- 2) Forgetfulness about the dates to come for vaccine
- 3) Little interest in child issues
- 4) Transport cost for long distances



13

What are the barriers to Immunization

- 5) Laziness
- 6) Too busy with other work
- 7) Supply related issues, vaccine not in stock, nurse not around
- 8) Afraid of needles or perceived side effect
- 9) Cultural beliefs about vaccinations



14

Addressing the barriers to immunizations

- Facilitator Ask: Do caregivers in your communities face with some or all of the challenges outlined?
- If yes: How can we address them in a non-punitive way?

- Facilitator: Allow them to come with suggestions.



15

Concluding Statements

- Clinic in-charge or any staff (if Central VDC meeting)
- Rep from community (if Community meeting)
- Village chief
- Facilitator



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