What does a financial incentive signal? A lottery experiment in Uganda*

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Abstract

This experiment measures the impact of financial incentives aside from their direct price effects. The widely-used policy of incentive lotteries are the ideal setting to examine such effects, since by design, most people exposed to incentive lotteries do not receive the incentive even as they become aware of it. We examine a lottery incentive for micro-nutrient powder, an essential health good in rural Uganda, where childhood malnutrition is high. We find that randomly assigned participants who are made aware of the incentive, but do not receive it, have lower demand for the incentivized product. Their willingness to pay, based on the incentive-compatible Becker-DeGroot-Marchak elicitation mechanism, for the micro-nutrient powder is lower. Despite the reduced demand for the product, we can rule out a change in elicited beliefs about its effectiveness. Thus our results are consistent with a reference dependence mechanism, in which financial incentives change individuals' reference point for the price of an incentivized product, rather than one in which awareness of the incentive provides information about the incentivized product.

Keywords: reference dependence, incentives, lotteries, signaling, development, health, behavioral
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1 Introduction

Lotteries, a common approach to implementing financial incentives, have been widely used to induce a range of socially optimal activities, from avoiding HIV to increasing savings.[1] Perhaps the most well-known example of such incentives were the lotteries designed to increase the take-up of COVID-19 vaccines across 20 U.S. states in 2021 (Fuller et al., 2022). The commonly stated appeal of this approach is that it optimizes scarce resources if, as cumulative prospect theory predicts, participants are risk seeking over low probability gains (Tversky and Kahneman, 1992).[2] This application of behavioral economics theory does not fully take into account key aspects of incentive design as a policy tool, however. In particular, it is essential to consider how such incentives affect behavior after the lottery is realized, since most incentivized behaviors are expected to continue over the long term, especially in contexts such as savings and health. In addition, once the lottery is realized, it becomes highly salient that only a few participants actually receive the incentive. Instead, most participants lose the lottery and thus become aware of incentive but do not receive it.

This naturalistic randomized experiment examines these potential impacts of incentives aside from their direct price effects. To do so, we study the behavior of the participants in incentive lotteries, especially those who do not receive the incentive after the lottery outcome is realized. This experiment considers two possible mechanisms by which simply learning about an incentive may change behavior. First, there is an information channel, in which learning about the incentive signals the importance of the incentivized behavior. This could in turn inform beliefs and change the demand for that behavior. Although such effects have been widely hypothesized, there is little definitive evidence that identifies them (Kamenica, 2012). Second, there is a reference dependence channel, in which receiving a signal about the existence of an incentive changes a person's reference point. In that case, demand for the incentivized behavior or product could change based on expected price, or in the case of a lottery, a distribution of prices (Kőszegi and Rabin, 2006). In contrast,

[1] Lottery incentives are used in various policy domains, ranging from increasing voter registration (John, MacDonald and Sanders, 2015) to rider behavior on public transportation (Fabbri, Nicola Barbieri and Bigoni, 2019). They have been particularly prevalent in attempts to increase healthy behavior, savings, and survey participation. For example, Bosman et al. (2024) reviews 10 lottery incentive studies focused on HIV-prevention alone, over just a 5-year period. They have also be used to study weight loss (Patel et al., 2018), induce participation in preventative health (Haisley et al., 2012) and increase medication adherence (Kimmel et al., 2012, 2016). In addition, prize-linked savings accounts are a long established policy tool that have been frequently studied in recent years. See, for example, Atalay et al. (2014), Bauer, Eberhardt and Smeets (2022), Filiz-Ozbay et al. (2015), and Cole, Iverson and Tufano (2022). Finally, lottery incentives has been used for decades to increase survey participation. For a relatively recent review, see Singer and Ye (2013).

[2] If participants are risk-neutral, then they would be indifferent between a smaller, certain incentive and a larger, uncertain incentive. Prospect theory initially proposed that loss aversion can induce risk-loving behavior over losses (Kahneman and Tversky, 1979). Later, it was refined to note that effects are likely to be reversed for low probability events.

the traditional neoclassical model, which assumes perfect information and complete preferences, would only allow incentives to affect behavior through their direct price effects. That is, the neoclassical model implies no effect on individuals who are made aware of an incentive but do not receive it.[3]

In the experiment, we examine the indirect signaling effect of an incentive lottery on two main outcomes: demand for the incentivized product, as measured by willingness-to-pay (WTP), as well as beliefs about the effectiveness of the product. The experiment relied on randomizing over 2000 Ugandan households in two stages, resulting in four treatment groups as well as a control. In the first stage, households are randomly assigned to either a control group or into one of two lotteries, offering either a *high* or *low* incentive intended to increase the take up of micronutrient powder (MNP). In the second stage, those selected to participate in the lottery are further randomized to either win the incentive (i.e., *payout* treatment) or lose the lottery (i.e., *signaling* treatment). The low incentive is a free box of MNP (valued at 12,000 Ugandan shillings or UGX), a common type of incentive in developing countries, and the high incentive adds an additional 60,000 UGX framed as payment to encourage the use of MNP.[4] The focus of the study is on the two *signaling* treatments, in which the participants are made aware of the incentive but do not receive it. This allows us to isolate the indirect signaling effects of the incentives without the confounding influence of its direct price effect.

Our two outcome measures work together to help disentangle the relative plausibility of the two potential mechanisms for a signaling effect. Our primary outcome is WTP as measured by a Becker-DeGroot-Marshak (BDM) approach. BDM is an incentive-compatible elicitation process: the dominant strategy is for the person to reveal their true valuation for a product. This allows us to precisly determine each participant's WTP.[5] The secondary outcome is participants' beliefs about the effectiveness of MNP. The approach we use to elicit beliefs has been widely validated, and has yielded meaningful findings in a variety of context (Delavande, 2014). If the information channel leads participants to update their beliefs about the value of MNP, we would expect to see changes in both beliefs and WTP. A change only in WTP, however, is more consistent with the reference dependence channel.

Our first main finding is that learning about the lottery incentive, without receiving the incentive

[3] Any effect of incentives that change demand indirectly (i.e., not through a change in price) is a contradiction of the predictions from the standard neoclassical model. The information channel stems from imperfect information, while the reference dependence is a deviation from rational choice axioms.

[4] Such labeled cash transfers have been shown to be effective in other settings (Benhassine et al., 2015).

[5] This is in contrast to a take-it-or-leave-it approach in which people are offered a product at a given price and determine whether or not to purchase the product. A limitation of this design is that it is only designed to determine how many people are willing to purchase at a given price. The BDM is also in contrast to simply asking people their valuation, since they may have incentives to understate or overstate their true valuation.

itself, decreases WTP for the incentivized product. On average, the two signaling treatments reduced WTP by 315.5 Ugandan shillings (UGX), or 7%, relative to the control mean of $4,457.66$ UGX, an effect which is statistically significant at the 5% level. The effect is larger for the high incentive (-346.9 UGX) than for the low incentive (-272.3 UGX), though the difference between the two coefficients is not statistically significant.

Next, we find that the signaling treatments have no impact on beliefs about the effectiveness of the incentivized product. This null result is precisely estimated. Specifically, the average effect of the two signaling treatments was -0.03 on a 20-point scale, and we can rule out effects larger than 1 point with 95% confidence. This suggests that any information conveyed by the incentive did not alter beliefs. Thus, the information channel is unlikely to explain the negative impact on WTP for the product we observe. Taken together, the findings on WTP and beliefs are consistent with the signaling treatments changing a participant's WTP through a reference dependence channel.

When we examine the effect of the incentive on the *payout* treatment, those that actually received the incentive, the results are consistent with the predictions of the neoclassical model. Participants who received the low incentive reduced their WTP by 23%, which is consistent with decreasing marginal demand for a second box of MNP after having just received one for free. In contrast, participants who received the high incentive increased their WTP by 12% relative to the control, consistent with the income effect from the large cash payment dominating the diminishing marginal demand from having just received a free box.

Finally, we consider the average impact of participating in a financial incentive lottery. Even in our high lottery condition in which receiving the financial incentive significantly increased demand, the average effect remained small and statistically insignificant. This is because the impact of receiving the incentive is positive while the impact of losing the lottery is negative and significant. These findings highlight the importance of separately analyzing the impacts on winners and losers in lottery-based incentives.

This study is the first to isolate and experimentally measure the impact of incentives on those who learn about an incentive, but do not receive the incentive itself. In doing so, it contributes to multiple literatures. First, it contributes to the rich literature on reference dependence generally, and particularly to a recent thread in that literature that focuses on the impact of disappointing outcomes from uncertain events.[6] One thread in this literature examines how perceived losses affect participation in future risky decisions (Post et al., 2008; Gill and Prowse, 2012; Backus et al., 2022). There are also a few studies that rely on naturalistic empirical work to examine

[6]See O'Donoghue and Sprenger (2018) for a review of the theoretical work on reference dependence as well as on empirical work of two of its most studied applications: the endowment effect and labor supply.

disappointment effects in a range of unique domains, from domestic violence to moving residences (Adhvaryu, Nyshadham and Xu, 2023; Card and Dahl, 2011; Mas, 2006). This study, however, is the first field experiment to test a key prediction of Kőszegi and Rabin (2006), the seminal model of expectations-based reference dependence, with regards to the impact of distributions of uncertain prices on demand.[7] Studying demand as an outcome has the advantage of broad relevance in the field of economics. In addition, the experiment directly measures both WTP and beliefs, and thus allows us to shed light on potential mechanisms.

The experiment presented here also contributes to a growing literature in economics that recognizes that, beyond their direct price effects, incentives may be a signal or a source of information about the inherent value of the incentivized behavior or product. A number of empirical studies have found that the response to incentives is not especially sensitive to their size, with small incentives inducing relatively large changes in behavior and large marginal increases in incentive size having only a modestly increased impact on response (Baird, McIntosh and Özler, 2011; Thornton, 2008; Karlan and List, 2007). A commonly proposed explanation for these findings is that incentives provide information about the value of a behavior. One thread in the literature has considered the learning that can arise from trying a product as the result of receiving an incentive (Dupas, 2014; Tarozzi et al., 2014). In contrast, in this experiment, we isolate the signal from a lottery incentive by focusing on participants who learn about but do not receive the incentive. In this setting, our results are consistent with a reference dependence rather than an information channel.

Finally, the paper has key implications for the use of lotteries to incentivize behavior. As noted above, incentive lotteries are commonly used in public policy.[8] The evidence of the impacts of such incentives is highly mixed, and many studies do not compare their results relative to receiving a certainty-equivalent incentive, but only to a control that received no incentive.[9] Furthermore, even if they have positive impacts before the outcome of the lottery is realized, the implications for behavior after the outcome is realized are not always fully considered.[10] We also note that even studies on incentive lotteries that report outcomes after the lottery is realized often only report the

[7]There is some work on reference dependence and consumer pricing although it is either observational (Caputo, Lusk and Nayga, 2020) or informed by lab experiments (Wenner, 2015).

[8]See footnote 1 for a review of lottery incentives.

[9]Singer and Ye (2013) and Bosman et al. (2024) each review eight studies with lottery incentives in the context of survey response and HIV prevention respectively, and find that in the most cases, the lottery incentives do not out perform the fixed or even no incentive controls. Björkman Nyqvist et al. (2018) finds positive impacts of a lottery incentive, but does not include a certainty equivalent. Meiselman et al. (2022) finds large negative impacts of the lottery incentive relative to a fixed incentive. Haisley et al. (2012) finds positive impacts of a lottery incentive relative to a fixed incentive.

[10]For example, after the COVID-19 vaccination lotteries were realized, public health experts have recommended at least three additional rounds of booster vaccines thus far, and there was little, if any, provision of incentive lotteries for those boosters.

average effects of the incentive. This study uniquely highlights that lotteries can generate substantial heterogeneity of outcomes across winners and losers, and in particular, can have significant negative impacts on those who do not win lotteries. These effects are concealed by only measuring outcomes before the outcome of the lottery is realized or by only reporting average effects across winners and losers even after the outcome of the lottery is realized.

2 Framework

In this experiment, we consider two mechanisms through which receiving a signal about an incentive can indirectly affect the study participants behavior: the information channel and the reference dependence channel. The two outcomes we consider, willingness to pay and beliefs about the effectiveness of the incentivized product, help inform which mechanism is more likely. Both of these mechanisms relax assumptions of the traditional neoclassical model. Under perfect information and complete preferences, learning about the existence of an incentive, but not receiving it, would have no impact on WTP or beliefs.

The information channel can positively or negative affect beliefs about the incentivized product and demand for it. It may have a positive effect, for example, if a trusted organization provides an incentive to use a health product, and beneficiaries perceive that as a signal of the importance and value of using that health product. This is a commonly hypothesized explanation for the findings from several studies where incentives have price effects that cannot easily be explained by neoclassical demand curves.[11] If this positive information channel was the dominant mechanism in our setting, we would expect that both WTP and the belief about the effectiveness of the product would increase for those assigned to the *signaling* treatments. The intervention in this experiment had the potential to capture a positive information effect, since it was associated with a trusted organization.

Conversely, an incentive could convey negative information about the incentivized product or behavior. A lower-priced health product could potentially signal lower quality, since it may indicate that a producer needed to reduce prices to clear low-demand inventory, for example. There is an extensive literature on the signaling effects on prices that considers such mechanisms (See e.g., Overgaard (1993), Judd and Riordan (1994), Ellingsen (1997), Adriani and Deidda (2011). In addition, the possibility that discounted or free health products in developing countries may reduce demand through such a mechanism has been an important concern in the aid community (Kremer

[11] Several studies find that larger incentives are not meaningfully more effective than smaller ones (Thornton, 2008; Karlan and List, 2007; Baird, McIntosh and Özler, 2011). Relatedly, other work has found that labeled cash transfers can be highly effective (Benhassine et al., 2015). The potential role of incentives as signals is also discussed in Kamenica (2012).

and Miguel, 2007). If such a negative information channel dominated in this context, then we would expect that the *signaling* treatments would reduce WTP and beliefs in the effectiveness of the product would decrease.

The information that incentives signal may also have non-monotonic effects. Non-monotonicity can arise if incentives undermine intrinsic motivation to undertake a desired behavior and thus unintentionally reduce the behavior, a phenomenon described as "crowding out" (Frey and Oberholzer-Gee, 1997). Bénabou and Tirole (2003) propose a model in which larger incentives are a stronger signal relative to small incentives. In contrast, Gneezy and Rustichini (2000) find evidence that small incentives reduce the incentivized behavior, but larger incentives increase it, suggesting that as the incentive size grows, the effect of the direct payment begins to dominate the signaling effect.[12] Thus, we test two incentive sizes in this experiment.

Alternatively, receiving a signal about the existence of the incentive may lead to participants to set a reference point with regards to how much they should pay for the product. In one of the extensions of their model of reference dependence, Kőszegi and Rabin (2006) demonstrate how loss aversion will affect consumers' WTP. Specifically, the extension has a clear prediction when consumers are faced with a distribution of prices, as in the case of an incentive lottery: WTP is an increasing function of the *lowest* price in the distribution. Furthermore, for some levels of loss aversion, a consumer's WTP may be less than their intrinsic value. Thus, the high signal treatment, which exposes participants to an incentive that has a negative price, would induce a lower WTP than participants in the low signal treatment who are exposed to the low incentive price of zero. Similarly, the low signal treatment would induce a lower WTP than the control, since control participants are only exposed to the at-cost price, which is the high price in the distribution of prices in the two lotteries.[13]

Finally, we consider the impact of the incentives for the participants who receive the payouts. Those participants may also be subject to the indirect signaling effects of incentives, as has been widely considered in previous literature. Their demand for the incentivized product, however, will also be influenced by the payout that they have received. In particular, anyone who receives the product due to the incentive may have a diminished marginal value for an additional product. Conversely, any incentive could increase demand due to an income effect.

[12] See Frey and Oberholzer-Gee (1997) for another model of crowd out and incentives. Another recent paper studies the selection effects of different incentive sizes for participation (Ambuehl, Ockenfels and Stewart, 2022).

[13] It should be noted that lotteries, which aim to incentivize a behavior (rather than a product) *may* require people to engage in that behavior in order to be eligible for the incentive. So, there is the potential for habit formation or learning beyond what is expected here. This learning can be positive or negative, however. In particular, if the costs of participation are easy to observe and the benefits are more difficult to observe, this learning may be negative. In addition, whether these effects exist would vary depending on the design of the incentive, the specifics of the incentivized activity and the number of times it was incentivized.

3 Study Design

3.1 Background on micronutrient deficiency

Micronutrient deficiency is a widespread global health issue, with significant prevalence across many regions. In Sub-Saharan Africa alone, an estimated 98 million preschool-aged children are affected (Stevens et al., 2022). This issue is often termed "hidden hunger" because it can occur even when caloric intake is sufficient, particularly in low- and middle-income countries where diets predominantly consist of staple foods lacking essential vitamins and minerals (Burchi, Fanzo and Frison, 2011). These deficiencies significantly undermine educational and economic productivity, thereby hindering broader development goals. Thus, micronutrient deficiencies are a critical public health issue, impacting health, cognitive development, and economic productivity.

In Uganda, micronutrient deficiencies are widespread due to a combination of factors including limited dietary diversity, high rates of infectious diseases, and inadequate health infrastructure. Among these, iron, vitamin A, iodine, and zinc deficiencies are particularly prevalent. The Uganda Demographic and Health Survey highlights significant rates of anemia, primarily caused by iron deficiency, affecting a large number of children under five and women of reproductive age (Uganda Bureau of Statistics, 2016).

Micronutrient powders contain a blend of essential vitamins and minerals, and are a proven intervention to address childhood malnourishment (Dewey and Vosti, 2017). Such nutrition-related interventions are commonly identified as having significant returns, but demand remains low (Zlotkin and Tondeur, 2007). Ensuring MNP use is a policy priority of Uganda Ministry of Health as evidenced by its SPRING Initiative, an initiative focused on delivering nutrition interventions to children under the age of two (SPRING Project, Uganda, 2020).

In the study we used MixMe, a brand of MNP for which BRAC had previously obtained approval to sell in Uganda from the Ministry of Health.[14] MixMe contains 15 essential vitamins and minerals and is primarily targeted to children aged 6 to 24 months. The recommended dosage is 120 sachets per child annually.

3.2 Experimental Design

3.2.1 Overview

The study reached 2062 households, in 102 villages in rural Luwero, a district in central Uganda. The main fieldwork for the study was conducted from August 27, 2022 to October 28, 2022. Once

[14] BRAC initially distributed MixMe in some villages in the region in a pilot. We excluded those villages from the study. MNP is not made locally and thus we imported MixMe from South Africa.

fieldwork began, in the first step of the study, we identified eligible households for the experiment through a listing exercise. As soon as the listing exercise in a given village was complete, we began the main experimental activities in that village, which involved two visits. First, a health worker visited each household to implement the interventions, which included information about MNP and, for treatment households, the incentive lotteries. Then an enumerator visited each household to collect the outcome data.

The health worker began each visit by reconfirming the household's eligibility (described in Section 3.2.2 below) and identifying the appropriate caregiver, to whom they administered the interventions.[15] The health worker was guided through their activities at each household by an application on a tablet. Before beginning the interventions, the health worker collected data on a few basic characteristics about the household. Next, the health worker provided information about the MNP product to all households. After that phase was completed, the application revealed to the health worker the random assignment for the first stage of the randomization, in which households were assigned to one of three main conditions: the control, a low incentive lottery condition or a high incentive lottery condition. If the caregiver was assigned to the control, the health worker left without mentioning any incentives. If the caregiver was assigned to one of the lotteries, then the health worker read a script specific to that lottery to the caregiver. Finally, the caregiver was invited to push a button to reveal the outcome of the lottery, and the health worker and caregiver learned the outcome of the lottery together.

The experiment activities concluded with an enumerator visit to the same caregiver to collect outcome data. The enumerator visit generally took place on the same day or the day after the health worker visit. The time between these two visits was minimized in order to reduce the opportunity for spillovers from the treatments to the control. The enumerator collected the main outcomes, WTP and beliefs, as well as other supporting data.

3.2.2 Sampling

Our sampling approach began with the selection of villages. We randomly selected 102 villages from a list of all eligible villages in the Luwero district.[16] Then, enumerators conducted a listing survey in the selected villages to identify households that were eligible for the study.

The study targeted caregivers of young children in rural Uganda who would benefit from MNP.

[15] The study was designed to be administered to one eligible caregiver per household. We will use the terms caregiver and participant interchangeably throughout.

[16] We excluded 86 villages where BRAC had previously sold MixMe. Villages could be replaced using a randomized list if the villages were adjacent to each other so the news of the study would not spread before the arrival of the health workers, or if after the listing, the village had fewer than 10 households with eligible children.

To participate in the study, households needed to have a child between 6 and 24 months, the recommended age range for using the MNP product. In addition, the study required the primary caregiver to be 18 years or older. Finally, we required that the primary caregiver had not used MixMe before, so that she would be receptive to any information conveyed by the incentive. We then returned to these 2062 households for the main experiment with the caregiver.

On average, these caregivers were 29 years of age, had 8 years of education, lived in a household with 1 eligible child, and reported that overall child health was 7.6 on a scale of 1 to 10 (increasing in health) (Table 2). Similarly, the mean response of whether they believed their child was anemic was 2, sick more often than normal was 2.6, and too small was 3.3, (on a scale of 1 to 10, increasing in the belief that they exhibited poor health). Despite the high self-reported health of the child, when asked about their children in the past two weeks, 42% reported that they had diarrhea, 62% reported that they had a cough, 43% reported weakness and low appetite, and 25% reported they had malaria. We report these numbers for the total sample, though the latter questions were asked after the lottery was implemented. We observe no statistically significant differences across treatment status.

3.2.3 MNP intervention

All caregivers in this study received information about the importance of MNP from a trained health worker and the opportunity to buy a box at of MixMe the at-cost price. This aspect of the study was the continuation of a program that was previously piloted by BRAC Uganda, and it was explained as such to participants.[17]

BRAC Uganda is a branch of one of the world's largest NGOs, BRAC International. BRAC Uganda runs diverse poverty alleviation programs spanning health, microfinance, education, and agriculture. BRAC's health program has trained local community health providers (CHPs) who operate by procuring over-the-counter (OTC) medicines at wholesale prices from BRAC and then selling these products to their communities at a slight markup, facilitating access to essential products. Thus, BRAC is a trusted organization in this setting, as we confirm in Section 3.4.

For the purposes of this study, we hired health workers with a high level of education who could credibly inform caregivers about the importance of MNP and could focus on implementing the study protocols accurately. All of the health workers in the study had at least a tertiary degree in health or nutrition.[18] We trained them to provide information and answer questions about MNP.

[17] BRAC did not continue the previous pilot, since few households were interested in paying the at-cost price of 12,000 UGX for a box of MNP.

[18] This is contrast to BRAC CHPs, where the focus is on hiring people who are local, and thus they do not in general have teritiary degrees.

See SA1 for the script and brochure which provided them with a starting point to discuss MNP with caregivers.

3.2.4 Randomization Design

Our study design relied on a two-stage randomization. First, we randomized caregivers into the control or into one of the two incentive lotteries for MNP.[19] Those randomly assigned to the *high incentive lottery condition* participated in a lottery where the prize was a free box of MNP and 60,000 shillings, and those randomly assigned to the *low incentive lottery condition* participated in a lottery where the prize was only a free box of MNP. The caregivers in the *control condition* were neither informed nor participated in any such lottery. Caregivers assigned to one of the lottery conditions were subject to the second stage of the randomization, where they could win the lottery and receive the incentive with 20% probability. Caregivers who did not win the lottery were assigned to either the *low* or *high signal treatment*, depending on the lottery condition to which they were assigned to in the first stage. Similarly, caregivers who were assigned to receive the incentive, by winning the lottery, were assigned to either *low* or *high payout treatment*. See Table 1 for an overview of the randomization design.

The focus of our study is how demand for and beliefs about MNP change among caregivers assigned to the two signaling treatments and the control. Since the caregivers assigned to the signaling treatments learn about the existence of the incentive, but do not receive the incentive, the comparison isolates the effect of receiving a signal about the incentive from its direct price effect. By varying the size of the incentive, the study is also designed to test whether the signaling effects exhibit non-monotonicity. The design also allows us to measure the overall effect of the incentive by comparing *payout treatments* with the *control*, and the average effect of being assigned to the lottery condition by comparing *lottery conditions* with *control*.

3.2.5 The incentive lottery conditions

The incentive lottery conditions were designed to achieve two main goals. The first was to ensure that recipients understood that they had the possibility of receiving an incentive and the nature of that incentive. Second, we designed the treatments to facilitate identifying a positive information channel. We present evidence confirming participants' understanding of the conditions in Section 3.4.

Both lotteries can be seen as price distributions. The low incentive condition enters participants

[19] The random assignment was done in real time using a random number generator in the surveyCTO platform on the health worker's tablet.

Table 1: Randomization Design

First stage	Second stage
High incentive lottery condition: Is entered into lottery for financial incentive (free box of MNP and 60,000 UGX to encourage usage)	*High payout treatment*: Receives incentive through lottery (140 households) ***High signal treatment***: Learns about incentive through lottery, but doesn't receive it (619 households)
Low incentive lottery condition: Is entered into lottery for financial incentive (free box MNP only)	*Low payout treatment*: Receives incentive through lottery (136 households) ***Low signal treatment***: Learns about incentive through lottery, but doesn't receive it (585 households)
Control condition: Does not receive any information about any financial incentive	***Control*** (582 households)

into a lottery with a price distribution such that the low price for the MNP is zero and the high price is the at-cost price of 12,000 UGX. The high incentive condition also received a 60,000 UGX payment, which served as a labeled cash transfer for MNP use.[20] This can also be viewed as a price distribution, in which the low price is negative 60,000 UGX and the high price is 12,000 UGX.

The health workers followed a script in explaining the lottery conditions to caregivers assigned to them. This script was revealed to the health worker in real time on the tablet, and they did not know the random assignment ahead of time:

> *We are offering an incentive to encourage households to use micronutrient powders. The incentive is funded by BRAC International and is being offered as a lottery. We will conduct a lottery in a few moments to see whether you will get the offer. One in five households will get the offer.*
>
> *If you are selected, you will be given a free box of MixMe today, which is a 30-day supply for you to use for your child aged 6-23 months. The cost to purchase the full regimen of MixMe is 12,000 shillings; BRAC International will pay this cost to allow you to have it for free.*

[20] Such labeled cash transfers have been effective in other settings (Benhassine et al., 2015).

> *[High incentive lottery condition only: In addition, BRAC International will give you an additional 60,000 shillings as a reward for using the MNP in feeding your children.] A health worker will check in to see if you are using it, such as calling or visiting you at mealtime to observe you using it.*

The health worker took additional steps after reading this to ensure comprehension and frame the incentive as positive information about MNP. First, the health worker invited questions about the lottery and how it worked. Next, the health worker restated the exact incentive based on the participants' condition assignment, *Your incentive is an entry into a lottery for a free box of MixMe [+ 60,000 UGX].* Then, the health worker made an additional statement to ensure that households understood that the purpose of the promotion, from BRAC's perspective, is to signal the importance of MNP:

> *BRAC International is funding this incentive because micronutrient powder is very important for your child's health. That is why they are providing this lottery incentive to eligible households.*

We also, however, aimed to isolate any additional information conveyed by the incentive. Thus, instead of the entire above script, the health worker shared the following message with participants in the control condition at the end of the information session about MNP:

> *BRAC International is funding this project because MNP is very important for your child's health. That is why they are providing information about MNP to eligible households. A 30-day supply of MixMe costs 12,000 shillings.*

Finally, we designed the study with the aim of ensuring that the lottery was transparent to participants, and that participants believed that it was real even if they did not receive it. Thus, immediately before the drawing, health workers physically placed the relevant incentive in front of the participants. Next, the health worker invited the caregiver to push the button themselves on the tablet that randomly assigned whether they would receive the incentive or not. Furthermore, as indicated in the script above, the health worker informed participants of their odds of winning the lottery, which were one in five.

3.3 Data collection

Before the health workers implemented the interventions, they collected four key pieces of information on each household: caregiver age and educational attainment, the number of eligible children in the household, and overall child health (on a scale from 1 to 10). This parsimonious set of variables allows us to establish a baseline without overburdening health workers, who need to focus on correctly implementing the intervention and treatments.

After the health worker's visit, an enumerator visited the caregiver to conduct the main survey, which focuses on our outcomes of interest: WTP and beliefs about about the effectiveness of MNP. A key component of the data collection activities involved ensuring that respondents understood what was being asked of them. As outlined below, both the WTP and beliefs elicitation relied on detailed explanations and the opportunity to answer practice questions.

After collecting data on our main outcomes, the enumerators collected additional data to help us understand the validity of our study. This included questions on: the likelihood of following health advice from different sources, comprehension of the initial intervention, and the potential existence of spillovers.[21]

3.3.1 Willingness-to-pay elicitation

Our main outcome measure captures the caregiver's demand for MNP. We measure the respondent's WTP for MNP using the incentive-compatible BDM method. Using a BDM elicitation as a measure of demand has two main advantages. First, relative to offering participants a product at a take-it-or-leave-it price, BDM reveals the full range of our sample's value for the health investment. In particular, it allows us to observe subjects' demand for MNP even when they do not value it enough to purchase it at the standard price. This is especially important when demand is low, as is commonly the case for health investments such as MNP. Second, compared to simply asking participants the price that they are willing to pay, this elicitation process is incentive compatible: the dominant strategy is for the participant to reveal their true valuation. This approach has been previously used successfully to elicit demand in developing countries, including for health products (Berry, Fischer and Guiteras, 2020).

Conducting the BDM elicitation was a multi-step process. Initially, the enumerator took several steps to ensure the participants understood the elicitation, including: providing detailed instructions, conducting a practice round with a bar of soap, and conducting comprehension checks. Then, the enumerator implemented the BDM for MNP itself, which is a three step process. First, the enumerator asked the participant to place the maximum amount in cash that they were willing to pay for a box of the MixMe MNP in front of the enumerator (i.e., their WTP for MNP). Second, the caregiver drew a random price between zero to 12,000 UGX by pushing a button on the survey tablet.[22] In the third step, the participants either purchased MNP at the *randomly drawn*

[21] We also collected data on preferences (risk and negative reciprocity), beliefs about their own child's health, who makes decisions about food and health for the children in the household, and food insecurity in the last three months.

[22] As discussed above, 12,000 UGX is the at-cost price of a box of MixMe. The price was drawn from a uniform

price if that price was below the participant's stated WTP, or they did not purchase the MNP if the randomly drawn price was above their stated WTP. Thus, the enumerator either refunded the difference between the stated WTP and the drawn price if the participant was able to purchase the MNP or the enumerator refunded the entire amount if the participant was not able to purchase the MNP.[23]

The comprehension checks confirm that subjects understood the demand elicitation. In order to explain the BDM elicitation, the enumerator first explained the general idea of the elicitation, and then walked through how it would work in the context of a hypothetical example using soap. Next, the participants answer three comprehension questions about the example.[24] The participants answered those with a high level of accuracy: above 98% (Table SA4). Then, the participants began a practice round based on the example by stating their WTP for the soap. After they named their WTP, but before conducting the draw, we asked participants two questions to confirm they understood the implications of their bid.[25] We also asked the equivalent comprehension questions after the stated their bid in the actual BDM for the MNP. Participants could change their bids if the comprehension checks indicated they did not understand the implications of their bid. This was almost never necessary, however, since the comprehension checks indicate that fewer than 1% of initial bids were higher or lower than their final bid.

3.3.2 Belief in MNP effectiveness

After eliciting WTP, the enumerators elicited the caregivers' beliefs in the effectiveness of MNP. Specifically, we elicited their beliefs about MNP's ability to improve the health of a child of twelve months age in their village along three metrics: the child is too small, they are anemic or micronutrient deficient, and they are sick more than normal. The enumerators separately asked caregivers how likely it would be for each health concern to be resolved in one year under each of the following scenarios: the child was not given any MixMe over the year, and alternatively, the child had been given MixMe as directed over the year. We elicited beliefs using an approach that has been widely validated in developing countries (Delavande, 2014). We asked the likelihood of each event on a scale of 0 to 10, where participants were given 10 beans and asked to add the beans to a plate based on how likely they thought the outcome would be. We then calculate difference in the

distribution in increments of 100 shillings.

[23] Respondents were always able to buy a box or an extra box of MixMe at the price of 12,000 UGX at the end of experiment, after all data collection was complete. In practice, this occurred 62 times (3 percent of the sample.

[24] The three questions are based on a hypothetical example in which a person bids a WTP of 2,500 UGX: 1) If they draw 2,600 UGX would they purchase the soap? 2) If they draw 2,400 would they purchase the soap? 3) How much would they purchase it for?

[25] The questions ask if the participant would: 1) be willing to purchase the item for 100 UGX more than their initial bid, and 2) if they would be willing to purchase the item for less than their initial bid.

reported likelihoods of the two scenarios to estimate beliefs in the effectiveness of MNP.[26]

We provided a detailed explanation of the belief elicitation and confirmed comprehension before proceeding to the main questions. Specifically, after the explanation of the elicitation, the enumerator asked participants how likely it was that they would go to the market in the next two days, and then how likely it was that they would go in the next two weeks. The vast majority indicated that a probability of going to the market in the next two weeks that was weakly greater than the likelihood of going to the market in the next two days (99.8%) (Table SA4). We also note that 98% of participants indicated that the likelihood of the child's health issues resolving was weakly greater with MixMe than without (Table SA4). It is possible that even if the participants understood the elicitation, a meaningful percentage might be believed that MNP had a negative effect. That said, consistency of direction on this question further indicates comprehension. This last comprehension check also suggests that respondents likely understood and trusted the health workers' information that MixMe was an effective method for improving child health.

3.4 Validity of the study

We consider several factors in confirming the validity of study, including: correct implementation of protocols, salience of the intervention, and spillovers. To assess these factors, we rely on data that the enumerators collected at the end of the survey. In particular, the enumerators asked caregivers about what, if any, incentives they had been offered, the extent to which they trusted various sources of health information, and whether they had heard of the intervention previously. The steps taken to confirm comprehension of the primary outcome variables are discussed throughout Section 3.3 above.

3.4.1 Confirming study protocols

The first step we take in considering the validity of the study design is assessing the randomization by confirming balance. Table 2a finds no significant differences across treatment and control for characteristics asked prior to any revelation of treatment status: age, number of eligible children in the household, and self-perception of child health. We also confirm balance on characteristics that would not expect to be affected by treatment that were collected after theintervention: educational attainment, food security, and negative reciprocity preferences (Table 2b. Reported symptoms of poor health among children are also balanced.

Next, we simultaneously confirm that the health workers followed the random assignments and that caregivers understood the incentive interventions. Over 98% of caregivers in the two signaling

[26] Thus, the difference in beliefs ranges from -10 to 10, increasing in the effectiveness of MNP.

treatments correctly answered whether or not they participated in an incentive lottery (Table SA1). Furthermore, in the low signal treatment, 98% of caregivers correctly stated the type of incentive they were offered in the lottery, and in the high signal treatment, 84% of caregivers answered correctly.

3.4.2 Salience of the intervention

One of the objectives of the study design was to create a setting that was conducive to the incentive sending a positive information signal. In particular, we aimed to link both the MNP intervention and the incentive to an organization that was known in the community. Thus, we assess trust levels across organizations in the survey. The findings from this data is reassuring. Participants in the study rated their likelihood of following advice from BRAC at an average of 4.3 on a 5-point scale, with the median response of 5 being "extremely likely" (Table SA2). While the average response for BRAC is slightly lower than the Ugandan Ministry of Health and its associated Village Health Teams (VHTs), it surpasses other notable sources like Makerere University and UNICEF. This demonstrates that BRAC is widely seen as credible and trustworthy intermediary for delivering health interventions.[27]

Thus, we confirm that the incentive was understood by the caregivers, was offered by a trusted source for health advice, and that respondents believed that MNP was a product that would improve child health. This highlights that our intervention was successful in creating a scenario where a positive information signal from the financial incentive was likely: caregivers were aware of the incentive being offered to them and had trust in BRAC.

3.4.3 Spillovers

A major consideration in designing this intervention, likely many information interventions, was spillovers. In particular, if control households previously learned about the incentives from participants who had been entered into a lottery, then that could attenuate our results. We accounted for this in two ways. First, even though the intervention was at the household-level, we excluded buffer villages close to study villages if there would have been a delay between when the research team reached the included village and the buffer village. Second, we limited the time frame between the health worker visit and the enumerator visit. Thus, control households in the same village would not have had time to speak with nearby treated households in the interim. This limited our ability to measure outcomes over the longer term, but we believed it would be essential to limit spillovers. These efforts were successful in minimizing spillovers. We observe very little information spread

[27]This response pattern is the same across all treatment groups.

across households prior to our intervention: less than 3% of the sample had heard of MNP prior to the visit, and less than 1% had heard of any of the promotions (Table SA1).

3.4.4 Social desirability bias

We considered the potential role of social desirability bias in designing the data collection. Any social desirability bias is likely to be constant across treatments and control, given that all households are visited by a health worker and informed about the importance of MNP. Still, in order to minimize any potential concerns about such bias, efforts were made to distance the lottery interventions from the data collection. First, the outcome data were collected by enumerators, rather than health workers. Furthermore, the enumerators made a series of efforts throughout the survey to convey that they were not with a health promotion organization and there was no right way to respond to questions.[28] The confidentiality of their answers, including from the health worker, was also emphasized. These efforts were designed to ensure that respondents were unlikely to tailor their answers to please the enumerator or give responses they believe were correct in the context of health promotion.

3.5 Estimation

To estimate the signaling and direct price effects of the incentives on the demand for and beliefs about MNP, we estimate the following:

$$Y_{ij} = \alpha + \delta_1\ LowSignal_i + \delta_2\ HighSignal_i + \delta_3\ LowPayout_i + \delta_4\ HighPayout_i + \lambda_j + \epsilon_{ij}, \quad (1)$$

where Y_{ij} is an outcome of interest for caregiver i who interacted with health worker j. The two coefficients, δ_1 and δ_2, estimate the signaling effects of learning about the low and high incentive lottery condition, respectively, relative to not being informed of any financial incentive. The coefficients δ_3 and δ_4 estimate the overall effect of the incentive, by comparing those who won the lottery and received the incentive with the control households that were not informed about the incentive lottery. This study relies on household-level randomization, and the random assignment is generated automatically from software on each tablet. Since each tablet is linked to a specific

[28] At the beginning of the survey, they introduced themselves as conducting a research study for the survey firm, IGREC, and informed the caregiver that they were "not affiliated with BRAC or any other health promotion organization." In introducing the WTP elicitation, caregivers were told that there is not "a right or wrong way for a household to behave." In addition, before their bid was elicited, the enumerator told them that their stated price would not influence MNP prices in the future.

health worker throughout the study, the randomization is stratified by health worker. Thus, we include a health worker fixed effect, λ_j, in all specifications.

4 Results

Our results focus on two main, pre-specified outcomes: demand as measured by WTP for MNP and beliefs about the effectiveness of MNP.[29]

4.1 Signaling effects of incentives

First, we examine the signaling effects of the incentives on participants who learn about the existence of the incentive, but do not receive it, by losing the lottery. We find that the signaling treatments reduce caretakers' demand for MNP (Table 3, Panel A). On average, the two signaling treatments decrease WTP by 315.5 UGX, a finding that is significant at the 5% level. Examining the two incentives separately, the high signal treatment reduces WTP by a larger amount, 346.9 UGX (significant at the 5% level), than the low signal treatment, which reduces WTP by 272.3 UGX (significant at the 10% level) (Table 3, Panel B). We cannot reject that these two coefficients are equal to each other, however (p-value = 0.594). The estimated treatment effects are relative to a mean WTP in the control group of $4,457.66$ UGX; thus, the average effect of learning about the incentive reduces WTP by 7 percent. Taken together, our findings indicate that receiving a signal about an incentive for a product through a lottery decreases one's WTP for that product.

Next, we consider the signaling effects of the incentives on participants' beliefs about the effectiveness of MNP. We find that signaling treatments have no impact on an index of beliefs, a result that is precisely estimated (Table 3). Specifically, the average effect of the two signaling treatments on the belief index is -0.016σ and statistically insignificant. Furthermore, we can even rule out modest effects below $-.11\sigma$ with 95% confidence. We find similar results when we examine the two signaling treatments separately, and the same general pattern for each underlying health concern: a child that is too small, anemic/micronutrient deficient, or sick more than normal.

Turning to the implications of these results, the signaling effects of the incentives reduce caregivers' WTP, but do not influence their beliefs about the effectiveness of MNP in addressing health concerns. This pattern is consistent with the signal from the incentives influencing a caregiver's reference point for the price of MNP, rather than conveying negative information about the quality of the product. The negative information channel is unlikely since we can rule out small effects on beliefs about MNP's effectiveness. In addition, there is a relatively high level of trust in BRAC

[29] These are the two primary outcomes that we pre-registered according to AEARCTR-0008685. We report additional pre-specified analysis in Section SA3.

(Section 3.4 and Table SA2). To further understand whether this a likely mechanism, we included questions in the survey about control group caregivers' beliefs about the intention of the incentives that had been offered to those in the lottery conditions. A large majority indicated that the incentives would not negatively affect their perceptions of MNP. For example, 90% stated that offering health products for free or at a lower price is rarely or never due to low quality (Table SA2). Instead, 74% believed such actions are often or always motivated by the importance of the products for health.

We also consider the implications of the results for the two signaling treatments, separately. Although the estimated effects from these coefficients are not statistically significantly different from each other, they are monotonic. Thus, we do not find any evidence for the theory that smaller incentives send a larger negative signal than larger incentives, although we cannot definitively rule it out.

4.2 Overall effects of incentives

We also examine the behavior of participants assigned to the payout treatments, that is, the participants who received the lottery payouts (Table 3).[30] In contrast to the behavior of participants assigned to the signaling treatments, their behavior is broadly consistent with the neoclassical model. The participants in the low payout treatment, have a much lower WTP than the control (-1,010.9 UGX), a result which is significant at the 1% level. This is consistent with a decreasing marginal utility from having just received a free box. In contrast, we find that participants who are assigned to the high payout treatment have a substantively higher positive WTP (556.4 UGX) relative to the control, a result that is significant at the 5% level. This is consistent with an income effect from the incentive outweighing the decreasing marginal utility of purchasing an additional box after having just received one. Thus, it appears that the direct payout effects of the incentives dominate the indirect signaling effects.

To conclude our analysis of the impact of the treatments on demand for MNP, we consider the average impact of being entered into a given lottery condition on WTP (Table SA3). This effect is relevant since it is typically the object of interest in most studies that measure of the impact of lottery incentives. In our setting, we find that the average effect of being entered into the high lottery on WTP is −179.6 UGX, which is not statistically different from zero . This is an average effect, which conceals that the effect on lottery winners is positive and significant, while the effect

[30]Note the analysis focusing on the caregivers assigned to the payout treatments (as opposed to the signaling treatments) is exploratory. This was not pre-specified since the focus of the study was on the signaling treatments. It was always our hope to examine these groups, but it was unclear if it would be possible to do so due to logistical constraints of the study.

on lottery losers is negative and significant. This highlights the importance of separately examining the results of an incentive lottery on winners and losers, since if they have substantially different outcomes, as in the case of this study, it could have implications for policy.

Our results also highlight that without incentives, adoption of MNP would be very low. Among the control, the average WTP is $4,457.66$ UGX. Notably, this is much lower than the break-even cost 12,000 UGX for a box of MNP. Given participants receive a 12,000 UGX participation payment at the beginning of the study, we would expect that this is an upper bound of the WTP in the absence of such a transfer. These results may not be surprising given that 12,000 UGX is likely a significant sum for participants, but regardless, these results further indicate the need to substantially subsidize essential health products in developing countries.

5 Conclusion

This study is the first to isolate the indirect signaling effects of financial incentives on people who learn about incentives, but do not receive them. We study this question in the context of lottery incentives for MNP. Lottery incentives have become popular policy tools in a variety of contexts, especially in the context of health behavior. With these incentives, by design, many people become aware of the incentive as they are entered into the lottery, but they do not ultimately receive the payout. In this study, we measure the impact of the lottery after its outcome is realized. Understanding the implications of lottery incentives after the lottery is realized is highly relevant to this literature, since many incentivized behaviors, especially in the health context, are expected to continue after the incentives cease.

In this experiment, we consider two potential mechanisms for the indirect signaling effects of the incentive, the information channel and the reference dependence channel. We find that the signaling treatments, which isolate this effect, significantly reduce demand as measured by an incentive-compatible WTP elicitation. The signaling treatments do not, however, have an impact on participants' beliefs about the effectiveness of MNP. These findings are consistent with the reference dependence, rather than information, channel. Thus, this study is the first to find evidence for expectation-based reference dependence using demand as an outcome.

This study has potentially important policy implication beyond (lottery) incentives. In particular, we note that a range of social programs are allocated via lotteries, including in the context of randomized controlled trials. In some cases, similar to this study, participants are explicitly informed of and entered into those lotteries. While this approach can have advantages for transparency, this study is the first to document moderate but meaningful changes in the behavior of lottery losers, at least in the short term. It thus highlights the need for greater study of this question over the long term. Still, our findings suggests that researchers should weigh whether the benefits in their setting from transparency outweigh the advantages of a research design in which the control group is unaware of the randomization.

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Table 2: Randomization Balance

(a) Pre-treatment data

Variable	(1) Total Mean/(SE)	(2) Control Mean/(SE)	(3) High Signal Mean/(SE)	(4) Low Signal Mean/(SE)	(5) High Payout Mean/(SE)	(6) Low Payout Mean/(SE)	F-test for balance across all groups F-stat/P-value
Age	28.689	28.286	28.708	28.924	28.771	29.221	0.510
	(0.198)	(0.365)	(0.362)	(0.378)	(0.727)	(0.813)	0.728
N. eligible children in household	1.057	1.047	1.066	1.060	1.050	1.061	0.508
	(0.006)	(0.009)	(0.011)	(0.011)	(0.018)	(0.026)	0.730
Overall child health (10 = best health)	7.572	7.484	7.582	7.543	7.704	7.891	1.236
	(0.046)	(0.088)	(0.082)	(0.087)	(0.164)	(0.172)	0.293
Number of observations	2003	559	606	567	140	131	2003

Note: Sample is restricted to observations with non-missing values for all variables. Results are similar without this restriction.

(b) Post-treatment data

Variable	(1) Total Mean/(SE)	(2) Control Mean/(SE)	(3) High Signal Mean/(SE)	(4) Low Signal Mean/(SE)	(5) High Payout Mean/(SE)	(6) Low Payout Mean/(SE)	F-test for balance across all groups F-stat/P-value
Educational attainment	8.313	8.373	8.388	8.355	7.921	7.948	1.080
	(0.072)	(0.134)	(0.132)	(0.138)	(0.269)	(0.286)	0.365
Food security index	1.969	1.981	1.946	1.944	2.093	2.000	0.672
	(0.024)	(0.044)	(0.043)	(0.045)	(0.089)	(0.095)	0.611
Willingness to take risks (1-10)	4.158	4.316	4.258	3.976	3.836	4.142	0.983
	(0.082)	(0.156)	(0.150)	(0.156)	(0.309)	(0.311)	0.415
Negative reciprocity: others	2.718	2.742	2.776	2.673	2.879	2.373	0.516
	(0.074)	(0.139)	(0.140)	(0.137)	(0.284)	(0.281)	0.724
Negative reciprocity: self	2.474	2.389	2.553	2.609	2.550	1.821	1.811
	(0.072)	(0.134)	(0.133)	(0.137)	(0.278)	(0.260)	0.124
Negative reciprocity: take revenge	2.241	2.312	2.207	2.233	2.450	1.910	0.571
	(0.073)	(0.139)	(0.131)	(0.137)	(0.278)	(0.273)	0.684
Child had diarrhea (past 2 wks)	0.424	0.450	0.428	0.390	0.446	0.419	1.172
	(0.011)	(0.021)	(0.020)	(0.020)	(0.042)	(0.042)	0.321
Child had cough (past 2 wks)	0.621	0.587	0.644	0.642	0.611	0.576	1.634
	(0.011)	(0.021)	(0.019)	(0.020)	(0.041)	(0.043)	0.163
Child had weakness (past 2 wks)	0.435	0.410	0.425	0.450	0.507	0.449	1.340
	(0.011)	(0.020)	(0.020)	(0.021)	(0.042)	(0.042)	0.253
Child had malaria (past 2 wks)	0.253	0.241	0.258	0.279	0.200	0.229	1.292
	(0.010)	(0.018)	(0.018)	(0.019)	(0.033)	(0.036)	0.271
Number of observations	2030	573	608	575	140	134	2030

Note: Sample is restricted to observations with non-missing values for all variables. Results are similar without this restriction. In our pre-analysis plan, we hypothesized that the treatment may change perceptions of child health; this table shows that it did not.

Table 3: Main results on WTP and Beliefs

	WTP for MNP	**Beliefs about the effectiveness of MNP**			
	(1)	(2)	(3)	(4)	(5)
	Final Bid (UGX)	Healthy size	Not anemic	Not sick	Index
Panel A: Average signaling treatments					
Signaling	-313.7**	-0.0495	-0.184	0.0724	-0.0193
	(127.1)	(0.141)	(0.139)	(0.141)	(0.0490)
Observations	1763	1775	1775	1776	1776
Panel B: All treatments					
High signal lottery losers	-341.4**	0.0115	-0.0933	0.205	0.0187
	(145.6)	(0.162)	(0.160)	(0.161)	(0.0562)
Low signal lottery losers	-273.4*	-0.114	-0.278*	-0.0592	-0.0581
	(144.6)	(0.165)	(0.166)	(0.166)	(0.0582)
High payout	562.8**	0.473*	-0.175	0.103	0.0650
	(246.7)	(0.274)	(0.281)	(0.275)	(0.0990)
Low payout	-988.4***	0.0804	-0.406	0.153	-0.0163
	(232.1)	(0.271)	(0.274)	(0.291)	(0.0953)
Observations	2038	2051	2051	2052	2052
Control mean	4457.666	4.762	5.540	5.036	0.009
Control SD	2529.526	2.760	2.684	2.772	0.948
HS = LS signal (p-value)	0.627	0.445	0.275	0.109	0.192
HS = LS payout (p-value)	0.000	0.260	0.520	0.891	0.517

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ Robust standard errors are reported in parentheses. All regressions include health worker fixed effects. Individual beliefs questions are a scale from -10 to 10. The beliefs index is standardized relative to the control mean and standard deviation.

What does an incentive signal? A lottery experiment in Uganda

JohnBosco Asiimwe, Denise Ferris, Sarojini Hirshleifer, Shanthi Manian, Ketki Sheth

Supplemental Appendix for Online Publication
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SA1 Micronutrient powder intervention

All participants in the study, regardless of condition assignment, were informed about the value of micronutrient powder. Health workers read the following script to everyone. They also shared the flyer below, and used it as a starting point for additional discussion.

> *Today I would like to tell you about a new initiative that is inspired by an earlier initiative of BRAC, a non-profit organization that focuses on improving the health of young children. We are reaching out to your household because you have young children and could benefit significantly from this initiative.*
>
> *We are offering a new product in your community. MixMe micronutrient powder is a product for improving child nutrition. The promotion of this product was approved by the Ministry of Health. It is a nutrient supplement with a mix of 15 essential vitamins and minerals that helps your child to grow well and healthy. The powder comes in sachets and it is easily mixed with soft mashed or semi solid food given to young children.*
>
> *During the first six months of life, babies should be exclusively breastfed on breast milk ONLY. After 6 months, breast milk is no longer enough to satisfy a child and hence the need to start feeding the child on soft mashed foods. The foods provided to the child should be diverse and from a variety of food groups. A lack of diet diversity puts children at risk of micronutrient deficiencies, especially during the vulnerable first 1,000 days which is a time period associated with rapid growth and development.*
>
> *Micronutrient powders are vitamins and minerals which are a blend of micronutrients (vitamins and minerals) in powder form, added to foods at the point of use that are for the good health of children aged 6 months to under 5 year.*
>
> *Children aged 6 months to 2 years are targeted for micronutrient powder supplementation because they are the most vulnerable to micronutrient deficiencies especially anaemia. Children aged 6 months to under 5 years are supposed to consume one sachet mixed in solid/semi-solid food every day. A box has 30 sachets. A child needs to use one sachet per day for one month continuously to receive the health benefits. If you have the opportunity to get more MNP in the future, the child would get additional benefit from using two months continuously, then after four months, give more sachets*

for a period of two months. In total, it is most beneficial if a child receives 120 MNP sachets.

Today I would like to tell you about a new initiative that is inspired by an earlier initiative of BRAC, a non-profit organization that focuses on improving the health of young children. We are reaching out to your household because you have young children and could benefit significantly from this initiative.
We are offering a new product in your community. MixMe micronutrient powder is a product for improving child nutrition. The promotion of this product was approved by the Ministry of Health. It is a nutrient supplement with a mix of 15 essential vitamins and minerals that helps your child to grow well and healthy. The powder comes in sachets and it is easily mixed with soft mashed or semi solid food given to young children. During the first six months of life, babies should be exclusively breastfed on breast milk ONLY. After 6 months, breast milk is no longer enough to satisfy a child and hence the need to start feeding the child on soft mashed foods. The foods provided to the child should be diverse and from a variety of food groups. A lack of diet diversity puts children at risk of micronutrient deficiencies, especially during the vulnerable first 1,000 days which is a time period associated with rapid growth and development. Micronutrient powders are vitamins and minerals which are a blend of micronutrients (vitamins and minerals) in powder form, added to foods at the point of use that are for the good health of children aged 6 months to under 5 year.
Children aged 6 months to 2 years are targeted for micronutrient powder supplementation because they are the most vulnerable to micronutrient deficiencies especially anaemia. Children aged 6 months to under 5 years are supposed to consume one sachet mixed in solid/semi-solid food every day. A box has 30 sachets. A child needs to use one sachet per day for one month continuously to receive the health benefits. If you have the opportunity to get more MNP in the future, the child would get additional benefit from using two months continuously, then after four months, give more sachets for a period of two months. In total, it is most beneficial if a child receives 120 MNP sachets.
Mix Me powder:

- Helps your child to grow healthy, strong and active
- Increases a child's appetite
- Improves a child's ability to learn and develop
- Increases the child's blood in the body
- Reduces illnesses

SA2 Appendix Tables and Figures

Table SA1: Treatment Comprehension and Spillovers

	(1) Control Mean/(SD)	(2) High Signal Mean/(SD)	(3) Low Signal Mean/(SD)	(4) High Payout Mean/(SD)	(5) Low Payout Mean/(SD)
Correctly stated whether they were offered an incentive	0.98	1.00	1.00	1.00	1.00
	(0.14)	(0.00)	(0.00)	(0.00)	(0.00)
Correctly stated the type of incentive offered	.	0.81	0.98	0.99	1.00
	(.)	(0.39)	(0.14)	(0.08)	(0.00)
Stated incentive was from BRAC	.	0.71	0.69	0.76	0.74
	(.)	(0.45)	(0.46)	(0.43)	(0.44)
Stated incentive was from another organization	.	0.11	0.13	0.13	0.17
	(.)	(0.32)	(0.34)	(0.34)	(0.38)
Did not know who was offering incentive	.	0.20	0.21	0.14	0.13
	(.)	(0.40)	(0.41)	(0.34)	(0.33)
Heard about MNP project before	0.03	0.01	0.01	0.03	0.03
	(0.16)	(0.11)	(0.12)	(0.17)	(0.17)
Heard about lottery before	0.01	0.00	0.00	0.01	0.01
	(0.07)	(0.07)	(0.00)	(0.12)	(0.09)
Heard about free box before	0.00	0.00	0.00	0.01	0.00
	(0.04)	(0.06)	(0.00)	(0.12)	(0.00)
Heard about paid incentive before	0.00	0.00	0.00	0.02	0.00
	(0.06)	(0.07)	(0.04)	(0.15)	(0.00)
Observations	573	609	570	140	135

Note: In the high signal group, 99 percent correctly stated that they were offered an incentive. 81 percent correctly stated the type of incentive offered, while 18 percent said that they were offered a free box of MNP only.

Table SA2: Opinions about Health Promotion and Incentives

(a) Trust in Health Advice

	(1) Control N	Mean/(SD)	(2) High Signal N	Mean/(SD)	(3) Low Signal N	Mean/(SD)	(4) High Payout N	Mean/(SD)	(5) Low Payout N	Mean/(SD)
Likely to follow advice from VHT	573	4.51	612	4.52	575	4.55	140	4.60	135	4.64
		(0.91)		(0.85)		(0.77)		(0.72)		(0.82)
Likely to follow advice from MOH	572	4.67	610	4.74	576	4.65	139	4.74	135	4.73
		(0.76)		(0.63)		(0.68)		(0.63)		(0.60)
Likely to follow advice from Makerere	545	4.06	588	4.08	544	3.94	133	4.08	128	3.87
		(1.22)		(1.21)		(1.23)		(1.17)		(1.40)
Likely to follow advice from BRAC	548	4.23	594	4.28	560	4.24	135	4.44	129	4.29
		(1.09)		(1.03)		(1.03)		(0.90)		(1.05)
Likely to follow advice from UC	440	3.75	472	3.77	429	3.63	112	3.79	104	3.62
		(1.47)		(1.43)		(1.47)		(1.36)		(1.55)
Likely to follow advice from USAID	455	3.96	483	4.03	440	3.89	118	4.03	109	4.02
		(1.30)		(1.22)		(1.25)		(1.22)		(1.26)
Likely to follow advice from US Gov.	472	3.77	524	3.77	469	3.67	118	3.82	105	3.87
		(1.40)		(1.37)		(1.43)		(1.41)		(1.43)
Likely to follow advice from UNICEF	496	4.02	521	4.10	485	4.01	115	4.17	116	4.05
		(1.26)		(1.15)		(1.16)		(1.04)		(1.29)

(b) Opinions: Why are health incentives offered?

	(1) Control N	Mean/(SD)	(2) High Signal N	Mean/(SD)	(3) Low Signal N	Mean/(SD)	(4) High Payout N	Mean/(SD)	(5) Low Payout N	Mean/(SD)
Lower quality or inferior products (Often or Always)	382	0.04	416	0.05	377	0.03	89	0.06	83	0.04
		(0.19)		(0.21)		(0.18)		(0.23)		(0.19)
Most important for health (Often or Always)	382	0.74	416	0.76	377	0.78	89	0.76	83	0.73
		(0.44)		(0.43)		(0.41)		(0.43)		(0.44)

Table SA3: Effect of Incentive lotteries

	(1)
	Final bid for MNP
High Signal	-174.4
	(140.3)
Low Signal	-409.4***
	(138.6)
Observations	2038
Control mean	4457.666
Control SD	2529.526

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table SA4: Willingness to Pay and Belief Elictatation Comprehension

	(1)	
	N	Mean/(SD)
Panel A: BDM Comprehension		
First comprehension check correct	2062	0.983
		(0.129)
Second comprehension check correct	2062	0.995
		(0.073)
Third comprehension check correct	2062	0.998
		(0.049)
Soap bid higher than true WTP	2062	0.001
		(0.031)
Soap bid lower than true WTP	2062	0.005
		(0.069)
MNP bid higher than true WTP	2062	0.002
		(0.049)
MNP bid lower than true WTP	2062	0.001
		(0.031)
Panel B: Belief Comprehension		
Going to market in next 2 wks more likely than 2 days	2062	0.998
		(0.044)
Believes MNP reduces likelihood of anemia	2062	0.988
		(0.107)
Believes MNP reduces likelihood of sickness	2062	0.986
		(0.118)
Believes MNP reduces likelihood of too small	2062	0.983
		(0.129)

SA3 Additional Pre-specified analyses

Table SA5: Beliefs about child's need for MNP

	(1) Belief: Child is too small	(2) Belief: Child is anemic	(3) Belief: Child is too sick
High signal lottery losers	0.0708	0.170	0.161
	(0.143)	(0.150)	(0.153)
Low signal lottery losers	0.115	-0.0512	0.123
	(0.146)	(0.148)	(0.153)
High signal lottery winners	0.0695	-0.0888	-0.0249
	(0.239)	(0.243)	(0.248)
Low signal lottery winners	-0.345	-0.246	-0.176
	(0.232)	(0.229)	(0.243)
Observations	2059	2056	2059
Control mean	3.306	1.989	2.550
Control SD	2.511	2.585	2.617

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table SA6: Heterogeneity: Child Health (Excluding Payout Treatments)

	(1) Final bid for MNP	(2) Final bid for MNP	(3) Final bid for MNP	(4) Final bid for MNP	(5) Final bid for MNP
High Signal	-215.3 (541.6)	-209.2 (198.7)	-115.1 (246.7)	-255.4 (193.9)	-274.4 (172.2)
Overall child health (10 = best health)	6.309 (50.69)				
High Signal × Overall child health (10 = best health)	-21.49 (70.88)				
Low Signal	-360.3 (536.3)	-147.1 (193.5)	-408.5* (227.4)	-242.0 (192.9)	-282.7 (172.2)
Low Signal × Overall child health (10 = best health)	7.530 (70.01)				
Child had diarrhea (past 2 wks)=1		439.5** (210.6)			
High Signal × Child had diarrhea (past 2 wks)=1		-296.8 (290.0)			
Low Signal × Child had diarrhea (past 2 wks)=1		-251.8 (289.9)			
Child had cough (past 2 wks)=1			238.2 (214.9)		
High Signal × Child had cough (past 2 wks)=1			-382.2 (305.4)		
Low Signal × Child had cough (past 2 wks)=1			184.7 (293.3)		
Child had weakness (past 2 wks)=1				246.0 (214.0)	
High Signal × Child had weakness (past 2 wks)=1				-223.0 (292.2)	
Low Signal × Child had weakness (past 2 wks)=1				-91.82 (290.5)	
Child had malaria (past 2 wks)=1					70.35 (230.6)
High Signal × Child had malaria (past 2 wks)=1					-285.1 (316.7)
Low Signal × Child had malaria (past 2 wks)=1					20.71 (312.5)
Observations	1732	1763	1763	1763	1763
Control mean	4457.7				
Control SD	2529.5				

Standard errors in parentheses

Overall Child Health is measured prior to treatment and the remaining variables are measures post-treatment.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table SA7: Heterogeneity: Maternal and Household Characteristics (Excluding Payout Treatments)

	(1) Final bid for MNP	(2) Final bid for MNP	(3) Final bid for MNP
High Signal	-266.6	-419.0	-354.6
	(397.0)	(274.7)	(312.4)
Educational attainment	59.24*		
	(35.19)		
High Signal × Educational attainment	-10.28		
	(44.39)		
Low Signal	-849.6**	79.47	-163.9
	(406.9)	(289.4)	(297.6)
Low Signal × Educational attainment	68.97		
	(45.25)		
Resp. alone makes food decisions=1		236.4	
		(230.1)	
High Signal × Resp. alone makes food decisions=1		88.72	
		(323.4)	
Low Signal × Resp. alone makes food decisions=1		-467.6	
		(334.1)	
Food security index			64.22
			(98.70)
High Signal × Food security index			4.372
			(135.2)
Low Signal × Food security index			-55.61
			(130.6)
Constant	3962.0***	4284.3***	4330.7***
	(314.8)	(192.7)	(227.7)
Observations	1761	1763	1763

Standard errors in parentheses

Note: maternal education, decision-making and food security are measured post-treatment.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$