Changing Behavior through Experimental Games: Evidence from Sanitation and Hygiene in Tamil Nadu

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Abstract

Much policy interest in sanitation and hygiene promotion focuses on changing behavior and increasing demand for these goods. This study tests whether an experiential learning exercise structured around an experimental game can be used to shift preferences and behavior around sanitation and hygiene. A minimum effort coordination game is adapted to the setting by linking game choices to real-world investment decisions and payoffs in terms of health and status. Individuals from 20 villages in rural Tamil Nadu were randomly assigned to one of three groups: one that played a game in which communication between rounds was allowed, another that played a game in which communication was prohibited, and a control group that only completed a survey. Based on a comparison of survey responses across treatment arms,

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the game improved stated preferences in relation to sanitation and hygiene both immediately aas well as ten months after the exercise. This effect was larger when communication was allowed, and men responded on average more strongly than women across both versions of the game. In a follow-up survey ten months later, individuals who had played the game were more likely to have bought toilets, increased the frequency of soap purchases and soap expenditures as compared to those who did not play the game. These results demonstrate that experimental games can be a valuable tool not only for the study of decision-making but for changing preferences and fostering pro-social behavior change.

Keywords: hygiene, sanitation, health promotion, behavior change, experimental games, India.

JEL Codes: Q56, I12, I15, O13.

1 Introduction

Community-led total sanitation (CLTS) is an approach to improving sanitation based on social mobilization to end open defecation in the community. In contrast to earlier sanitation programs that emphasized the construction of physical latrines, that is, the hardware of sanitation, community-led total sanitation (CLTS) focuses on sustained behavior change and the attainment of "open defecation free" (ODF) status, i.e. the software of sanitation. Program facilitators guide communities in a self-analysis of their sanitation situation health promotion, practices, and toward discovery of contextually appropriate solutions. CLTS stresses subjective drivers of behavior change, including cultivating feelings of disgust and dissatisfaction with the status quo, shame at unhygienic conditions, pride when improved sanitation is attained, and so on. (Ahmed (2008)).

CLTS project activities typically consist of a set of "triggering activities", a variety of tools such as community meetings, information and education campaigns, and demonstrations/workshops. For example, a common exercise as part of CLTS projects is a village mapping activity where facilitators abd villagers draw a map of the community and identify where people defecate. This exercise provides a powerful visual representation of fecal contamination, which often surprises villagers with new knowledge about how exposed they are to other people's fecal matter and serves as a contrast to their personal knowledge of private sanitation behaviors. Another example of CLTS project activities is the involvement of children in seeking out people who defecate in the open; the children then mark the area with a small, brightly colored flag with the open defecator's name. The range of activities can vary substantially, but they are united by a common theme of encouraging community involvement and sparking subjective feelings of disgust and shame, which motivate behavior change among those who fail to use a latrine and continue to defecate in the open. By so doing CLTS projects aim to change social norms in relation to sanitation and thereby stimulate demand for sanitation (Chambers and Myers (2016)).

In practice, the implementation of these triggering activities varies dramatically by facilitator, by activity, and across space. Differential program intensity, as reflected in delayed, weak, or insufficient triggering days, has been identified as a serious barrier to the effectiveness of CLTS programs, such as the Total Sanitation Campaign in India (Patil et al. (2014)). Due to such limitations, the Government of India, the World Health Organization, the Water and Sanitation Program of the World Bank, and others have taken a substantial policy interest in identifying improved triggering activities that change behavior in desirable ways. More generally, the lack of understanding about how to change behavior remains an issue of critical policy concern to governments and aid organizations (for example, UK Department for International Development (2013)).

Against this policy backdrop, this study examines a novel approach to behavior change that is easy to implement, cost-effective, and highly scalable. An experimental game on sanitation and hygiene is implemented as part of a framed field experiment. This game is designed carefully to reflect interdependencies in decision-making around sanitation and hygiene by highlighting for participants how individual decisions aggregate into social consequences. This key feature of the game is similar to features of recent behavior change initiatives in related contexts of social coordination. For example, in an ongoing study, Onyango, Reimer and Stopnitzky (2014) use a repeated common-pool resource game with opportunities for deviating from and enforcing social norms in an attempt to affect behavior of fishers in Tanzania. Carter et al. (2008) used financial education games to explain index insurance to populations that had no prior experience with such products. Meinzen-Dick et al. (2016) used experimental games to raise awareness among Indian villagers on how crop choice affects groundwater depletion. Turiansky (2015) found evidence that playing public goods games with Haitian rice farmers caused them to increase their private contributions to the public irrigation system. Another early examples of this idea include a study of how experience playing the prisoner's dilemma affects environmental donations (Rommel et al. (2015)). These studies represent the earliest efforts

at crafting experimental games to affect real-world behavior. This study, which attempts to change preferences and behavior regarding sanitary practices, provides new evidence on this potentially valuable approach and applies it to a novel context.

Using randomly assigned treatment and control groups, the study estimates the impact of playing a sanitation/hygiene-focused coordination game on a broad measure of sanitary preferences, determinants of hygienic behavior, and behavior change outcomes. The experimental estimates of the sanitation games treatment effects are large and economically meaningful. The games were successful in fostering pro-sanitation and pro-hygiene attitudes and preferences, and an endline survey provides evidence that key sanitation and hygiene outcomes were shifted by the prior experience with the game. These effects are stronger in the version of the game that allowed communication and, further, the effect of the game was stronger among males than among females. These findings suggest important design features for any possible scaling up or further implementation of this game-based approach to behavior change, in particular in rural Tamil Nadu or in similar social settings. These policy implications are an additional contribution of this paper.

The paper begins with important background information on sanitation and hygiene in rural India in general and Tamil Nadu in particular. Section 3 explains the study's experimental design, including details of the game (and relevant variants) in Section 3.2 as well as how the game applies to the coordination and social norms that structure individual behavior around sanitation and hygiene. Section 4 presents sample characteristics, balance tests across randomly assigned treatment groups, estimates of average treatment effects, and an exploration of heterogeneous treatment effects. Finally, Section 6 interprets these results and discusses their importance in relation to current sanitation policy in India.

2 Sanitation and Hygiene in Tamil Nadu

The setting for this project is Tamil Nadu, India, which has a low rate of sanitation coverage compared with other Indian states, including other states in southern India. According to of India (2011), Tamil Nadu is ranked 20th out of 28 states in terms of rural latrine coverage. Only 23.2 percent of the rural population had access to latrines in that year. By way of comparison, the state with the highest rate of coverage was Kerala, also a southern Indian state that shares a large border with Tamil Nadu, had 93.2 percent coverage. Karnataka and Andhra Pradesh, Tamil Nadu's neighbors to the northwest and north, respectively, had rural sanitation coverage rates of 28.2 percent and 32.2 percent. While both are substantially lower than Kerala, which is an outlier, Tamil Nadu is clearly the large southern state with the worst sanitation coverage.[1]

This study's survey data provide additional evidence of inadequate sanitation and poor hygiene, in terms of both self-reported behaviors and determinants of sanitation and hygiene. For example, only 38 percent of respondents agreed with the statement "most people they know defecate in toilets" and approximately 80 percent of respondents agreed or strongly agreed that it is acceptable to defecate in the open if there are no toilets nearby.

A similar pattern of attitudes and behaviors emerges with respect to hygiene. More than half of respondents (56 percent) disagreed or strongly disagreed that most people they know know to wash their hands after going to the bathroom. Roughly 27 percent of respondents believed that needs to needs to wash hands only if they "look dirty or smell bad" and 39 percent reported that washing hands used up water better used for other purposes. There was additional lack of knowledge regarding the appropriate means of washing hands. For example, only about three-quarters of sample respondents (78 per-

[1]Interestingly, these census figures differ from official administrative data from the Total Sanitation Program for most states. But the largest discrepancy among this group occurs for Tamil Nadu, which appears to show 83.6 percent coverage according to program administrative data but only 23.2 percent for census data. This difference in individual coverage generated by this administrative data over-reporting amounts to an estimated seven million people (Kapur and Ibrahim (2013)).

cent) identified washing hands with soap and water as the "best way to clean hands" (other categories were: not washing, washing with water alone, using ash or mud, and "does not matter") and 41 percent thought that washing well with just water was sufficient.

In addition to helping characterize the current sanitation and hygiene situation, the survey data moreover suggest that the primary constraints on sanitation and hygiene are based on attitudes and behaviors, not supply. For example, more than 90 percent of respondents said they knew where to buy soap, 87 percent said there is "always enough water to wash hands" and the same number agreed they can "always buy soap if they need it". In addition, two-thirds of households (67 percent) reported they know someone who has the skills to build a good toilet and roughly half of respondents said it is "easy" to find good financial support to build a toilet if you want one.

This particular combination of factors—low rates of latrine ownership and handwashing combined with adequate potential supply and levels of knowledge—suggests that preferences and norms are key drivers of observed outcomes. This setting therefore is well-suited to this study's experimental intervention, which attempts to affect precisely these preferences and norms.

3 Experimental Design

The study design is based on an artefactual field experiment nested in a framed field experiment (in the typology of Harrison and List (2004)). This description captures the experimental design in the sense that subjects knew they were participating in a study and experienced a treatment in the form of an experimental game. Whereas many experimental games are designed to elicit preferences or behavior *within* the game, a design that commonly raises issues of internal and external validity (see, for example, Levitt and List (2007)), this study focuses instead on how the experience of playing a game, working

through strategies, and observing various outcomes influences stated preferences regarding sanitation and hygiene. This shift in focus from the game as a tool to study behavior and preferences to one that might alter behavior/preferences is one of the primary contributions of this paper.

Villages and individuals were randomly selected, and treatment assignment was block randomized within villages using a lottery, with 10 individuals being assigned to control and 20 to the game treatment groups (10 each to two variants of the game), for a total of three experimental arms. This blocking design was intended to reduce sampling variability by ensuring equal numbers of participants in each arm within a village, where individuals face similar idiosyncratic and covariate life characteristics, including public infrastructure, features of the environment, governance, disease burden, and so on. The study design is internally valid if assignment to experimental arms is random and thus potential outcomes are on average balanced across arms.

This block randomized design does create, however, the possibility of treatment spillovers should community members discuss the game with each other following the treatment. Given the way the game and survey were administered, such spillovers are not a concern for the analysis of the immediate impact of the game on stated preferences. But for the analysis of the endline survey data, it is possible that within-village spillovers across treatment arms or from treatment to control groups could bias my estimates of treatment effects. If individuals in the control group learn anything positive about the game from treated individuals and adjust their stated attitudes or behaviors accordingly, this would cause treatment effect estimates based on differences-in-means or linear regression to be downward biased. Due to this design feature, then, the estimates presented later should be interpreted as lower bounds on the true average treatment effect.

The three arms of the experiment are the following. The first treatment arm was assigned a sanitation-focused minimum–effort game (described in Section 3.2 on Game Details) with explicit instructions not to communicate or share choices openly with others in

the same group. After playing this game, individuals in this arm participated in a short, approximately 20-minute debriefing exercise in which facilitators from the implementation partner (described more fully in the section on sampling and implementation (3.1)) answered questions about the game and explained that the interdependent decision-making in the game mirrored the real-life consequences of sanitation and hygiene behavior. Then individuals were given a survey that gathered information on household demographics and basic socioeconomic variables, including numerous questions designed to identify behavioral determinants of sanitation and hygiene, including knowledge, assets, abilities, attitudes, and preferences known to predict sanitation and hygiene behavior, as identified by the Water and Sanitation Program of the World Bank (Hernandez et al. (2012)).

Individuals in the second treatment arm were given the same game with similiar instructions but were encouraged to communicate with each other about their strategies and choices if they so desired; this group also completed the survey after completing the game and postgame discussion. The third arm served as a pure control. Individuals assigned to this group participated in a facilitated discussion about sanitation and hygiene but were not given the chance to play the game. They then completed the same survey as the other groups. In this framework, causal effects of exposure to the game are identified by comparing outcomes across different arms of the experiment. The analysis presented below shows results for the two game-playing arms together as well as for each version of the game separately.

In each village, an average of 10 people were randomized to each arm, for a total of 30 per village in 20 villages. Thus, there were 200 people in each arm and 600 participants total.

3.1 Sampling and Implementation

The implementation partner for this project was the LEAF Society (Leadership through Education and Action Foundation), a registered NGO based in Tamil Nadu. The LEAF Society has extensive experience in the water and sanitation sector, including the use of games to encourage sanitary behavior among children, as well as with large-scale household surveys. It is also active in promoting local legal advocacy, promoting lifeskills among children, and creating livelihood opportunities for women and children. The LEAF Society's previous work in this geographic area, however, raised the issue of contamination of the present study through its prior, related project activities.

To avoid this concern, researchers identified 40 rural villages in two blocks of Namakkal district, Erumapatty and Mohanur, with which the LEAF Society had no previous contact as an organization. From this list of 40 candidate villages, 20 villages were randomly selected for participation in the study. Within each village, households were invited to participate in the experiment based on a selection rule of every fifth house, with one person allowed per household, until 30 people were selected. Households were informed that an activity related to sanitation and hygiene was being organized that day. Women were the primary target group but men were allowed to participate if no adult woman from their household was available. As stated above, this selection rule resulted in a sample comprising 87 percent women and 13 percent men. Men and women played the game in separate groups–that is there were no mixed-sex groups. Although the sample of men selected in this manner cannot be considered truly random, balance tests provide evidence that the selection rule did not lead to any systematic differences in household characteristics or behaviors that would threaten identification when comparing groups of men or women across treatment arms within a village.

3.2 Game Details

3.2.1 Concept

This study uses repeated play of a carefully designed sanitation game based on a modified minimum-effort game as a pedagogical, capacity-building tool for training individuals on the direct and indirect effects of open defecation on their communities.

Minimum-effort games are motivated by the observation that in many situations individual outcomes for people in a group depend on the behavior of the group member who contributes least. Examples include many team settings, such as sports, production and assembly lines, and so on. This strategic structure maps, in my view, nicely to the problem of sanitation/hygiene in rural India, where exposure to disease-causing pathogens will be dictated not by whether one or more households purchase latrines, but rather whether (some number of) individuals most likely to practice open defecation actually exert sufficient effort to prevent everyone else in the community from possible exposure to their fecal matter. Similarly, one can imagine a minimum-effort game in a household setting with regard to handwashing: the level of child exposure to potentially disease-causing pathogens will depend on the minimal effort exerted by one of the multiple household members responsible for feeding the child.

This section explains the structure of the basic game and outlines modifications that ground game play in real-world decisions about sanitation and hygiene.

3.2.2 Minimum Effort Coordination Games

The minimum-effort game is a variant of the coordination game in which members of a group comprising n individuals simultaneously choose an action or level of effort, which will be denoted e_i. The payoff structure of the game is such that individual i's payoff is a function of his or her own effort, e_i, as well as the minimum of all others' levels of effort,

denoted by $\underline{e}_{-i}$. In particular, payoffs are given by:

$$\pi(e_i, \underline{e}_{-i}) = a\left[\min(e_i, \underline{e}_{-i})\right] - be_i + c \tag{1}$$

, where a and b are scaling parameters assumed to satisfy $a > b > 0$, and c is a constant selected to ensure positive payoffs irrespective of the choice of a and b. All players know the payoff function and strategy space are common knowledge.

This structure implies weak complementarity in effort and multiple (Nash) equilibria, which have a clear Pareto ranking, whereby higher levels of effort strictly dominate lower levels of effort. If players explicitly coordinate their actions, then the fact that $a > b$ means that every player should choose the maximum effort allowed in the strategy space; this agreement would be self-enforcing. However, without the ability to negotiate a plan ex-ante, each potential level of $\underline{e}_{-i}$ implies a best response of $e_i = \underline{e}_{-i}$, so every possible n-tuple of $(e, ..., e)$ is a Nash equilibrium.

Each player must evaluate two components to arrive at a decision. First, the player must correctly forecast $\underline{e}_{-i}$, the expected minimum effort level that prevails as each player of the group moves simultaneously but individually. If a player's forecast is incorrect, their individual strategy is suboptimal. Second, even if all players give a best response, it is possible that the group will coordinate on a suboptimal, Pareto-dominated equilibrium. For example, consider the case in which player i forecasts a low minimum effort level, while each of the players $-i$ also forecast correctly. Then player i's optimal response is the same low level. In this case, even with perfect forecasts, the group coordinates on a Pareto-dominated equilibrium.

The previous experimental literature, including the foundational paper that established this game (Van Huyck, Battalio and Beil (1990)), finds that players often coordinate on what the original authors described as a strategy of "security"–that low, Pareto-dominated effort levels that secure a relatively high individual payoff when others also

choose low levels of effort or when there is uncertainty about others' behavior. Numerous subsequent papers have studied the conditions under which these low levels of effort could be overcome to attain higher-(Pareto)-ranked equilibria. Engelmann and Normann (2010) compare coordination among Danish game participants with that previously found in different participant pools used in prior studies. The authors found evidence of Pareto-efficient coordination in various group sizes (up to six), in contrast to the previous literature. As distinct from comparing different participant pools, other studies have manipulated parameters of the game, experimental instructions, or both. For example, Chaudhuri, Schotter and Sopher (2009) ran experiments using a version of the game with non-overlapping generations, in which generations could pass on "advice" to their successors, but they found little improvement; these results are consistent with theoretical predictions on the importance of "almost" common knowledge in shaping incentives to contribute more than minimal amounts (Rubinstein (1989)). Other researchers have studied interactions of observability and timing of choices in coordination games (Weber, Camerer and Knez (2004)) as well as the role perfect versus imperfect monitoring plays in fostering coordination (Deck and Nikiforakis (2012)).

Whereas previous literature attempted to study cooperative behavior *within the game setting*, this study instead aims to affect preferences and behavior *outside the game*. The focus of this paper differs, therefore, from the literature related to minimum-effort (or other coordination) games in that it focuses on the treatment effects generated by exposure to the game rather than the decisions adopted in the course of playing the game.

3.2.3 Sequence of Play

The sequence of game play was as follows:

1. Groups were formed randomly from individuals selected in each village.

2. Instructions were read aloud to the entire group at once.

3. Groups played three practice rounds without money and then began playing five rounds for real money.

4. Following each round, the minimum effort level within the group was announced.

5. Payoffs were calculated from each round, and the enumerator verified and recorded each payoff.

6. The game was repeated five times to provide an opportunity for learning and for evolution of cooperative norms.

7. Payoffs were disseminated in Indian rupees.

8. Once the game concluded, the experimenter facilitated a group discussion on the game, emphasizing strategic interdependencies between sanitation/hygiene investments.

3.2.4 Adaptation to Sanitation and Hygiene Setting

The purpose of this game was to highlight to participants important aspects of the interdependencies that affect their sanitation and hygiene behavior. The instructions given to the players provided an ordered list of sanitary effort based on the following choices: (1) doing nothing, (2) washing one's hands after using the bathroom three times per week, (3) ending open defecation by one's family three days per week, (4) washing one's hands *always* after using the bathroom, and (5) building a latrine for one's household and making sure everyone in the household stops openly defecating. Costs increase as one opts for increasing levels of effort, which highlights to participants the real costs associated with being more sanitary, even if the amounts are merely proportional to the actual direct costs that might be incurred with higher sanitation/hygiene investment.

The experimental protocol, which includes a detailed description of the game and explanations of how the set of game choices maps to real-life decisions, can be found in

the appendix. The instructions to participants emphasized that the higher costs associated with more handwashing each week can be understood in terms of the need to purchase or obtain more soap and water, and the cost associated with reducing open defecation can be viewed as time costs to travel to a toilet or the cost of constructing a latrine.

3.2.5 Payoff Structure

Figure 3.1 depicts a representative payoff structure associated with this game, with parameters $a = 2, b = 1, c = 6$ over a strategy space $e_i \in \{0, 1, 2, 3, 4, 5, 6\}$. As shown in the figure, there is weak complementarity in strategies; payoffs increase with individual effort but have higher rewards when others also contribute. For example, consider the case in which individual i chooses a midrange value of 3. Her payout will be determined by the minimum effort level in the group, for instance, 2, which yields a payoff of 7. Had the minimum level of effort in the group been at least 3, the player could have earned a maximum of 9 points given her choice. But had she forecast correctly that the minimum effort level in the group would be 2, she could have herself improved her payout by matching that minimum effort level (in this case, earning a payoff of 8). The example highlights two key features of the game: the importance of accurate forecasts of the minimum effort level and the hierarchy of Pareto-dominated outcomes that improve as the minimum effort level in the group increases.

Figure 3.1–Generic Payoff Matrix in a Minimum Effort Game

Minimal Effort Level in Group

Individual Effort	0	1	2	3	4	5	6
0	0	6	6	6	6	6	6
1	5	7	7	7	7	7	7
2	4	6	8	8	8	8	8
3	3	5	7	9	9	9	9
4	2	4	6	8	10	10	10
5	1	3	5	7	9	11	11
6	0	2	4	6	8	10	12

Assumption: a = 2, b = 1, c = 6

Figure 3.2 details the game parameters that were used to operationalize the payoff structure for the setting in rural Tamil Nadu. Parameters were chosen so that minimum payoffs, which were estimated following pilot testing of the game and survey instruments, were approximately equal to the local daily wage for unskilled labor. This structure ensured that even very poor outcomes in the game setting would not cause the participant to leave the experiment with monetary losses. Possible individual payoffs per game ranged from 20 to 60 rupees. Because each player was allocated a–40 rupee budget at the beginning of each game, no player risked losing during the experiment any real money that he or she possessed prior to consenting to participate. Given the five rounds that participants played, total payouts ranged from a minimum of 100 rupees (about US$1.50) to a maximum possible of 300 rupees (about US$4.50), with average payouts across all participants amounting to 200 rupees (about US$3.00).

Figure 3.2–Payoff Matrix in the Sanitation/Hygiene Minimum Effort Game

Payoff Table for Sanitation/Hygiene Choices

		Minimum Effort Observed Within Group				
		Do nothing	Wash hands sometimes	Reduce open defecation sometimes	Wash hands always	End open defecation completely/buy toilet
Individual Effort		Cost = 0	Cost = 10	Cost = 20	Cost = 30	Cost = 40
Do nothing	Cost = 0	20	20	20	20	20
Wash hands sometimes	Cost = 10	10	30	30	30	30
Reduce open defecation sometimes	Cost = 20	0	20	40	40	40
Wash hands always	Cost = 30	-10	10	30	50	50
End open defecation completely/buy toilet	Cost = 40	-20	0	20	50	60
	payoff function	payoff = a*min{e, ei) - b*e + c				
	parameters	a (benefit)	2			
		b (cost)	1			
		c (constant)	20			
	notes	1. Costs/payoffs in rupees.				
		2. Explain that increasing costs for different choices analogous to buying more soap/devoting more time/investing more in sanitation/hygiene.				

4 Empirics

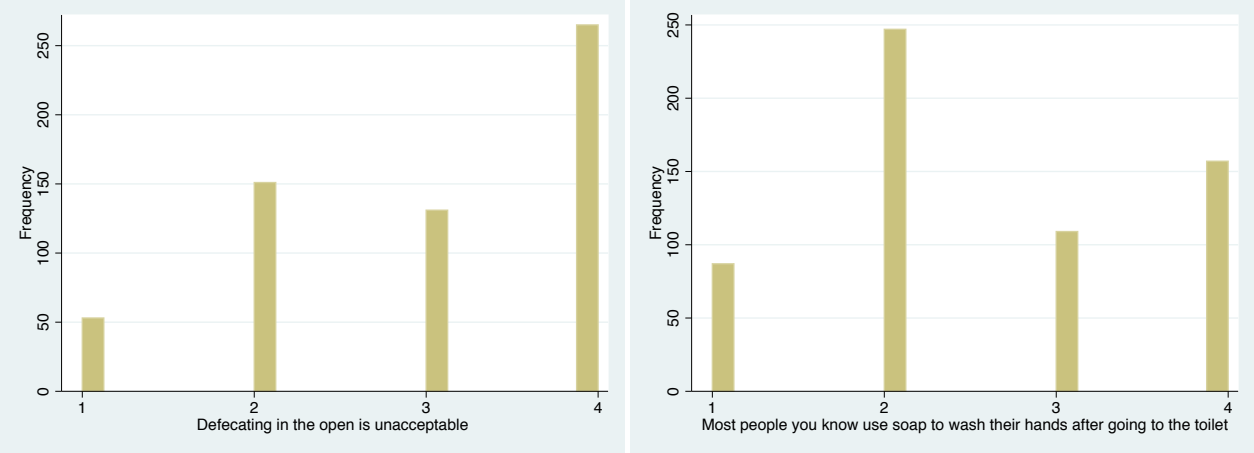
4.1 Sample Characteristics

This section describes key characteristics of the sample of 600 respondents. The sample was 87 percent female and 65 percent literate, with the largest share of respondents having completed primary school only. Individuals reported daily earnings of approximately 100 Indian rupees per day (and total household earnings of about 260 rupees per day, or about US$ 3.88 per day), with the vast majority of workers (83 percent) engaged in

unskilled manual labor. Average household size was 4 people.

Modal responses on questions related to determinants of hygiene and sanitation were often "correct" in the sense that many respondents expressed favorable attitudes toward hygiene. Nevertheless, the variance of responses was high, with many people reporting preferences that attribute little importance to sanitation and hygiene. Figure 4.1 displays frequency distributions for two key questions, on open defecation and handwashing, that serve to illustrate this point.

Figure 4.1–Frequency Distributions on Two Key Outcome Variables



The scale is: 1 strongly disagree, 2 disagree, 3 agree, 4 strongly agree.

Table 4.1 presents evidence on the statistical balance of important observables, pointing to successful randomization. Columns (5)–(7) present p-values on t-tests of the variable mean for each arm of the study. As can be readily seen, there is no imbalance along any key characteristics or outcomes, apart from marital status between the control arm and the treatment arm that allowed between-round communication, number of children between control and the two treatment arms, and household size across the two treatments. Given these differences, I control for marital status, household size, and number of children.

4.2 Summary Indices

The survey instrument on determinants of handwashing contains a large number of potential outcome variables, some that the treatment could hypothetically affect and others that it could not possibly affect. For example, many of these variables are on expenditures or assets, which will not be affected by participants' experience at playing the sanitation game (at least not during the same day, although perhaps subsequently).[2] Some determinants focus more on knowledge (such as how to use soap) or beliefs about others (for instance, other people defecate in the same place you do), while other variables are more attitudinal and preference-oriented. Studying treatment effects on such an assortment of possible outcomes of interest poses a problem of multiple inference and the possibility of ad hoc data mining.

To overcome these concerns, the analysis uses two intuitive measures of preferences based on summary indices, which combine multiple outcome measures into a single test that maximizes the amount of information provided by the constituent variables via inverse covariance weighting. Such summary indexes have three main attributes as compared with an analysis of individual outcomes: (1) they are robust to overtesting, (2) they provide a statistical test of a general program effect, and (3) they can be more powerful than individual tests (Anderson (2008)). In the present study, each of these issues provides an important reason to use a summary index. In particular, we have a large number of important outcomes, none of which is singularly important, and all of these outcome variables have a high variance, which undermines the power of any one of them.

To create a summary index, each variable is first transformed so that scores move monotonically–that is, the agree-disagree scale is converted to align with positive or negative statement in prompt so that higher numbers always reflect "better" answers. Second, each response is demeaned and divided by the standard deviation to convert values

[2]Follow-up research with these respondents will look precisely at these variables, and changes thereof, over time.

into standardized effect sizes (z-scores). Third, a new variable is created that is a weighted average of the transformed outcomes from the preceding step, whereby the weights use the inverse covariance matrix of the transformed variables. Thus, variables that are highly correlated are weighted less in the final index value than variables that are less correlated, which maximizes the information content of the index.

The two summary indexes constructed for this study use either (1) all 48 determinants of sanitation and handwashing behavior in the survey or (2) a list of 7 target determinants hypothesized to be most affected by treatment. For the latter index, the seven variables were selected based on the following criteria: First, any determinants that could not possibly be affected by the game were removed from consideration; examples include questions such as "you know of a place where you can buy soap" and "septic tanks are easily emptied in this area." Second, any determinants that focused on technical knowledge about handwashing or sanitation (such as when soap should be used) were excluded on the grounds that they reflected knowledge more than preferences or attitudes. Third, variables were excluded if they did not highlight in some way the interdependencies or norms of sanitation and hygiene behavior, which is precisely the predicted value of playing a coordination game that mirrors real life. Finally, in addition to these criteria of exclusion, one variable, whether information about the importance of handwashing has ever been provided to the participant, was included because it should clearly be affected by the game.

The variables that remained were the following seven statements, with which participants were able to agree or disagree:

1. People who don't wash their hands with soap deserve to be criticized.

2. It is acceptable for young children to defecate in the open.

3. Defecating in the open is unacceptable.

4. Information on the importance of handwashing with soap has never been given to

you.

5. Although your ancestors defecated in the open, it's not all right for you to do it.

6. Defecating in the open is a proper thing to do because everybody does it.

7. It's unacceptable to defecate in the open if you can't make it to a toilet.

The analysis that follows presents results for both the summary index of all determinants and the summary index of these target determinants.

4.3 Immediate Effect of Game Play on Stated Preferences

We estimate average treatment effects of the game experience on preferences by regressing the summary index outcomes on a dummy variable for treatment and on a set of individual and village controls. The outcome variables are two versions of a summary index of determinants of sanitation and handwashing behavior. The basic empirical specification is as follows:

$$\text{Preference Index}_{iv} = \alpha + \beta D_{iv} + \mathbf{X}_i'\gamma + \delta_v + \epsilon_{iv}, \tag{2}$$

where $D_i \in \{0, 1\}$ is a dummy variable indicating assignment to either of two treatments (a later section explores differential effects across treatment arms); $\mathbf{X}_{iv}$ is a vector of characteristics of individual i in village v; δ_v is a set of village fixed effects; and ϵ_{iv} is an individual-level idiosyncratic shock allowed to be arbitrarily correlate across individuals in a village-round; this term is assumed to be orthogonal to treatment due to random assignment. The preferences summary index is a standardized outcome interpreted like a z-score; the coefficient β identifies the causal effect of playing the sanitation game on this index in terms of standard deviations. Table 2 presents results from these regressions.

All regressions include a set of individual-level controls, $\mathbf{X}_{iv}$, to improve precision. These are household income, household size, number of children, highest year of edu-

cation of the respondent, type of roof, whether the house has electricity, type of water source, marital status of the respondent, and how many meals the respondent typically eats per day. Income, roof type, electricity, water source, and number of meals adjust for the income and wealth status of the household. Marital status, household size, and number of children reflect important demographic considerations that might influence sanitation investments, attitudes, or both; for example, having more people in a household could affect demand if people have heterogeneous preferences for sanitation (Stopnitzky (2017)). Three of these variables (household size, number of children, and marital status) are also the only ones found to be imbalanced across any of the treatment arms, which is an additional reason to include them as controls. Finally, education is included because those with higher education might have systematically different preferences for sanitation/hygiene; they might also respond differently to the game than those with less education. Nearly all of these controls, however, are statistically indistinguishable from zero in all specifications.

The game treatment (including both variants of the game) had an average effect of increasing the preference index of all determinants by 0.049 standard deviations; this effect is statistically significant at the 5 percent level. This is a notable and economically significant effect given the relatively "light" intervention: a game that lasted no more than 30 minutes in both instruction and play. But this summary index includes certain variables that are unlikely to be directly influenced by playing this coordination game, such as variables on technical knowledge about proper handwashing. Columns (4) through (6) of Table 2 therefore reports causal effects of game exposure on a summary index of seven variables most directly related to attitudes toward handwashing and sanitation behavior, such as acceptability of open defecation by adults, children, or both. Point estimates of treatment effects now are nearly twice the magnitude of the broader, less focused summary index measure. The causal effect of exposure to either game is estimated to be 0.091 standard deviations, increasing to 0.130 in the version of the game that allowed com-

munication between players as they made their choices. These estimates are statistically significant at the 5 percent and 1 percent levels, respectively.

4.4 Heterogeneous Treatment Effects on Stated Preferences

4.4.1 Across Game Versions

An important source of heterogeneity in treatment responses is differential impacts across versions of the game (with and without communication); these heterogenous effects can be seen in columns (5) and (6) in Table 2. The participants who played the game that allowed communication appear to have a higher treatment effect than those who played the version without communication. A formal test of equality of these coefficients fails to reject the null hypothesis, however, for the summary index of all determinants. In contrast, there is a statistically significant difference at the 10 percent level (prob $> \chi^2 = 0.097$) between the treatment effects estimates of the communication and non-communication versions of the game when only the target determinants are considered. This difference suggests that the communication version of the game was more effective in altering preferences.

4.4.2 Across Genders

Another important source of differential treatment responses occurs by gender. In every specification—for either of the two summary index outcomes and for the combined treatment or game version–specific regressions—the estimated impact of the game on men's preferences is much larger than for women. These results are presented in Table 3 for the summary index of all determinants and Table 4 for the summary index of target determinants. For example, comparing estimates across genders for the impact of either game on all determinants reveals that the estimated effect of the game on men is more than five times larger than the estimate for women; this difference is significant at the five percent

level (prob $> \chi^2 = 0.022$). This heterogeneity is most clearly seen in columns (3) and (4), the game with communication treatment, of both Tables 3 and 4. This finding contrasts with the much smaller (and statistically insignificant) differences across genders for the treatment arm without communication.

4.5 Causal Effect of Game Play on Stated Preferences at Endline

The immediate effect of exposure to the game on stated preferences regarding sanitation and hygiene, as documented in the preceding section, raises the question of whether game exposure alters attitudes in a lasting way. To explore this question, this study returned to the same villages where the baseline was conducted and re-interviewed participants. Individuals were administered the same survey questionnaire as during baseline, with the addition of three questions designed to understand how information about the game was shared and considered and two questions about whether individuals communicated about the game wit others. They did not play the game again. Attrition was low (8.8%); enumerators were able to find and interview 91.1% of the original participants (547 of 600). I conducted statistical tests to explore whether there were meaningful differences in characteristics or outcomes between attriters and non-attriters; the results of these balance tests are reported in Table 6. There are no statistically significant differences between these two groups other than attriters being less likely to have electricity at home.

This analysis begins by exploring the effect of the game treatment on an individual's opinion of the game's effect. That is, I ask three questions designed to elicit opinions about the effectiveness of the game: (1) did our last visit cause you to think sanitation was more important? (2) did our last visit make you want to increase handwashing? did our last visit make you want to build a toilet? I regress each of these outcomes on the same empirical specification as in Equation (2), i.e. conditional means of these responses in the endline survey are compared across treatment groups. These results are presented in Table 7. For each of the three outcomes and for each game variant, individuals were

17-23 percentage points more likely to report that the research team's prior visit caused them to increase how important they thought sanitation and handwashing are. Some of this could be driven by social desirability bias, of course, because those who played the game had a structured interaction with the enumerator that was framed precisely around the importance of sanitation and hygiene. Later, I conduct placebo tests that help mitigate concerns about bias of this form. For now, I simply note that the game caused a differential response to our prior visit across treatment groups and will next explore additional impacts that are less prone to biased responses.

I next construct the same preference index of seven target determinants described in Section 4.2 above using responses from the endline survey. As before, I estimate linear regressions following Equation (2), with coefficients on treatment effects interpreted in terms of standard deviations. The results from this analysis are reported in Table 8. As was the case when asking respondents immediately following the game, both game versions have positive impacts on target determinants of handwashing and sanitation ten months later. But where previously there was a differential impact across the two game versions, this difference appears to have vanished after 10 months, perhaps due to subsequent communication after the game providing the opportunity to process and learn the lessons the communication group achieved during the game itself. Most interestingly, the effects of the game on stated preferences appear to have *intensified* over time, as compared to the initial, immediate game effect on preferences. While these changes are only statistically significant at the 10% level, they do provide some evidence of attitudes and knowledge generated by the game settling in and being reinforced through further reflection and/or communication with others.

4.6 Causal Effect of Game Play on Behavior at Endline

I have documented that this structured game experience altered stated preferences immediately after playing and that this effect persists, indeed appears to intensify somewhat,

ten months after first exposure. I now turn to an analysis of behavioral outcomes. I focus on the three variables that are most closely related to those the game attempted to change: handwashing (soap purchasing and expenditure) and toilet usage (rather than openly defecating). Treatment effects of each game on these outcomes are presented in Table 9. Game exposure causes individuals to report purchasing soap .85 times more per month as compared to those who did not play the game. This increase is associated with additional monthly soap expenditures of 27.5 rupees. As before, there is some evidence that the communication game was more effective than the non-communication game, but the consistently larger estimated treatment effects are not statistically significantly different from each other at conventional levels.

The use of a toilet at home appears to have increased as well when considering the effect of playing either game, although the effect in the game without communication is statistically indistinguishable from zero. By contrast, individuals in the communication treatment group increase their reported defecation at home (rather than "in the open") by 10 percentage points over the control mean of 35%; this effect is significant at the five percent level. This is a substantial impact from the structured treatment exercise, which is within the range of estimates, although somewhat lower, than estimates from other studies of demand-focused triggering activities (e.g. Patil et al. (2014); Pattanayak et al. (2009)).

5 Social Desirability Bias and Robustness

One possible concern about these estimates is that the game, the facilitated discussion, or both primed participants to answer the various determinant questions in a manner consistent with a social desirability bias. To test for this possibility, the analysis uses a summary index composed exclusively of determinants that cannot possibly be affected by the game, such as whether most homes in the community have water and soap for

washing after using the bathroom.[3] Given the context of the game and study, these outcomes should exhibit any social desirability that might affect the other outcomes that are of principal interest. Yet, this placebo summary index should not be affected by exposure to the game or, more precisely, it should not systematically differ from the impact of the game on target determinants. The results from regressing this placebo outcome against the various treatment variables supports these arguments (results reported in Table 5). There are no statistically significant effects of game exposure on the outcomes that cannot reasonably be affected (immediately at least) by such game exposure. This evidence that social desirability bias is not systematically affecting individuals' responses to the survey questions.

Note, however, the one variable that appears as statistically significant in the placebo regression results in Table 5: water source. This variable should not be affected by treatment but appears to be correlated with the placebo index measure precisely because of the important role that water sources play among the set of placebo determinants.

6 Discussion

This study explores whether the experience of playing a short experimental game, which was deliberately designed to mimic strategic interdependencies in sanitation and hygiene behavior, can alter preferences and behavior related to sanitation and hygiene. The evidence gathered on a large set of preferences around sanitation and hygiene provides strong evidence that even a short structured game can significantly alter these important

[3]The full list of 14 variables are: whether one knows of a place to buy soap, whether one always has enough water to wash hands, whether one needs permission to buy soap, whether one can always find soap to buy if they want, whether most people one knows wash their hands only with water, whether most people one knows wash their hands with soap after using the toilet, whether most homes in the community have water and soap for washing after the bathroom, whether the local school promotes handwashing among children, whether local septic tanks are easily emptied, whether most people you know defecate in the toilet, whether there are any local masons who know how to build good toilets, whether financing is available for toilets, whether it's easy to get information about toilets in one's community, and whether you know someone who has the skills to build a good toilet.

determinants of behavior both in the short-run and over the medium term.

The magnitude of these effects is economically meaningful: the beneficial impacts of this novel method compare favorably with other efforts to promote health. For example, a randomized controlled trial of cutting-edge, large-scale handwashing promotion was recently conducted in Peru by the Water and Sanitation Program of the World Bank with funding from the Bill and Melinda Gates Foundation (Galiani et al. (2015)). This intervention had two components: (1) a mass media campaign coupled with a direct consumer communication campaign at the province level (delivered via radio advertisements, print materials, street parades, and local theater performances in public places); and (2) a community intervention that combined the previous treatment with training of trainers of "community change agents," capacity building, provision of handwashing training to mothers, and new handwashing curricula in primary schools. This intervention was focused primarily on how to promote health cost-effectively and at scale. Experimental estimates of the impact of these two components on handwashing determinants was 0.110 standard deviations for the community intervention and 0.089 for the school component. The magnitude of the Peru program's effect is therefore comparable to the overall effect found in the Tamil Nadu study when the overall effect of exposure to either game is estimated, but substantially less than the impact of only the game with communication. The relative success of the game-based learning exercises on knowledge and attitudes grew still further over time, and these improvements were matched by improvements in actual behavior. These impacts from a simple yet powerful learning activity suggest that carefully designed, experiential games can be a useful tool in the package of "triggering activities" among CLTS programs and health promotion programs. More generally, when viewed in combination with the very small but growing literature on usefulness of this approach, these results suggest that structured strategic games can be a highly cost-effective way of mitigating coordination failures in a wide variety of social dilemmas.

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Table 1: SUMMARY STATISTICS AT BASELINE AND BALANCE TESTS

Variable	(1) Control	(2) Game with communication	(3) Game without communication	(4) Overall	(5) (1) vs. (2)	(6) (1) vs. (3)	(7) (2) vs. (3)
Marital status	1.45	1.70	1.88	1.67	0.11	0.01***	0.33
Number of people in HH	3.94	4.08	3.77	3.93	0.36	0.21	0.03**
Number of children	1.68	1.46	1.44	1.52	0.03**	0.02**	0.84
Highest completed education level?	3.60	3.32	3.31	3.41	0.16	0.13	0.98
Wage work last 7 days?	1.33	1.31	1.31	1.32	0.59	0.59	1.00
Individual income last 7 days?	678.85	640.05	748.25	689.05	0.54	0.32	0.11
HH income last 7 days?	1,756.50	1,825.55	1,946.00	1,842.68	0.54	0.16	0.37
Electricity?	1.06	1.05	1.06	1.06	0.67	0.84	0.83
Roof material?	4.09	4.19	4.09	4.12	0.51	1.00	0.49
Floor material?	1.93	1.90	1.96	1.93	0.38	0.21	0.03**
Child diarrhea over last 7 days?	0.00	0.02	0.01	0.01	0.16	0.32	0.56
Soap purchases in last month?	6.50	6.43	6.57	6.50	0.85	0.88	0.72
Where do you usually defecate?	1.46	1.44	1.45	1.45	0.69	0.84	0.84
Where do children usually defecate?	1.55	1.56	1.57	1.56	0.84	0.76	0.92

Notes: Author's estimates from data collected for this study. Means of key variables for control and two treatment arms are presented in columns (1)–(3). Overall sample means are presented in column (4). Columns (5)–(7) present p-values from t-tests of equality of means across pairs. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: CAUSAL EFFECTS OF GAME EXPOSURE ON DETERMINANTS OF SANITATION/HYGIENE

Variable	(1) All	(2) All	(3) All	(4) Targeted	(5) Targeted	(6) Targeted
Any treatment game	0.049**			0.091**		
	(0.024)			(0.040)		
Game w/ communication		0.058**			0.130***	
		(0.029)			(0.047)	
Game w/o communication			0.038			0.053
			(0.028)			(0.047)
Household income (Indian rupees)	–0.000	–0.000	–0.000	–0.000	–0.000	–0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household size	–0.008	–0.005	–0.009	–0.040***	–0.028	–0.052***
	(0.009)	(0.012)	(0.010)	(0.015)	(0.019)	(0.017)
Number of children in household	0.005	0.008	–0.001	0.016	0.017	0.012
	(0.012)	(0.017)	(0.016)	(0.021)	(0.027)	(0.026)
Years of schooling of respondent	0.003	0.005	0.007	0.022**	0.025**	0.026**
	(0.006)	(0.008)	(0.007)	(0.009)	(0.012)	(0.012)
Roof	–0.007	–0.001	–0.010	–0.011	0.002	–0.013
	(0.008)	(0.010)	(0.009)	(0.013)	(0.016)	(0.015)
Electricity	0.030	0.012	0.033	0.122	0.142	0.085
	(0.047)	(0.058)	(0.058)	(0.079)	(0.095)	(0.097)
Water source	0.015	0.010	0.020	–0.007	–0.002	–0.005
	(0.012)	(0.015)	(0.014)	(0.019)	(0.024)	(0.024)
Marital status	–0.002	–0.005	0.002	–0.012	–0.026*	–0.005
	(0.006)	(0.008)	(0.009)	(0.011)	(0.013)	(0.014)
Female	–0.057*	–0.055	–0.019	–0.113**	–0.096	–0.090
	(0.034)	(0.041)	(0.038)	(0.056)	(0.066)	(0.064)
Average number of meals per day	0.038	0.048	0.029	–0.035	–0.012	–0.028
	(0.025)	(0.035)	(0.030)	(0.043)	(0.056)	(0.051)
Village dummy	–0.005**	–0.006**	–0.005*	–0.009**	–0.014***	–0.006
	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.004)
Constant	–0.082	–0.124	–0.090	0.294	0.120	0.290
	(0.128)	(0.173)	(0.152)	(0.216)	(0.280)	(0.257)
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.012	0.006	0.000	0.037	0.051	0.028
N	593	394	395	600	400	400

Notes: Author's estimates from data collected for this study. The dependent variable in the first three columns of results is a summary index of all 48 determinants of sanitation and hygiene in the survey. The dependent variable in columns the last three columns is a summary index of seven attitudinal variables that were targeted by the game design. Columns (1) and (4) report treatment effects across both game types; the primary explanatory variable is a treatment dummy for whether the individual played any version of the game. Columns (2) and (5) report effects from the game with communication and columns (3) and (6) from the game without communication. Coefficients are in standard deviations and standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: EFFECTS OF GAME EXPOSURE ON ALL DETERMINANTS, BY GENDER

	(1) Males	(2) Females	(3) Males	(4) Females	(5) Males	(6) Females
Any treatment game	0.177***	0.032				
	(0.062)	(0.026)				
Game w/ communication			0.251***	0.038		
			(0.089)	(0.031)		
Game w/o communication					0.147*	0.028
					(0.078)	(0.030)
Household income (Indian rupees)	–0.000	–0.000	–0.000	–0.000	–0.000	–0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household size	–0.028	–0.005	–0.016	–0.007	–0.045*	–0.000
	(0.021)	(0.010)	(0.036)	(0.013)	(0.023)	(0.012)
Number of children in household	–0.000	0.003	0.011	0.012	0.010	–0.010
	(0.033)	(0.014)	(0.043)	(0.018)	(0.038)	(0.017)
Years of schooling of respondent	0.012	0.001	0.023	0.000	0.009	0.005
	(0.016)	(0.006)	(0.022)	(0.008)	(0.019)	(0.008)
Roof	–0.000	–0.007	0.003	–0.002	0.009	–0.012
	(0.020)	(0.008)	(0.026)	(0.011)	(0.023)	(0.010)
Electricity	0.095	0.028	0.061	0.002	0.218	0.005
	(0.124)	(0.051)	(0.138)	(0.066)	(0.147)	(0.064)
Water source	0.060*	0.011	0.037	0.006	0.057	0.019
	(0.035)	(0.012)	(0.046)	(0.016)	(0.040)	(0.016)
Marital status	0.014	–0.004	0.019	–0.008	0.021	–0.003
	(0.018)	(0.007)	(0.023)	(0.009)	(0.020)	(0.010)
Female	0.127*	0.014	0.128	0.023	0.110	0.002
	(0.065)	(0.028)	(0.080)	(0.039)	(0.079)	(0.033)
Average number of meals per day	–0.532*	–0.040	–0.569	–0.043	–0.599	0.011
	(0.317)	(0.139)	(0.430)	(0.193)	(0.385)	(0.168)
Village fixed effects	Yes	Yes	Yes			
Adj. R^2	0.167	–0.007	0.115	–0.014	0.124	–0.017
N	76	517	58	336	61	334

Notes: Author's estimates from data collected for this study. Columns (1), (3), and (5) are run for males only. Columns (2), (4), and (6) are run for females only. The dependent variable in all columns is a summary index of seven variables most closely related to the game structure. Columns (1) and (2) report treatment effects across both game types; the primary explanatory variable is a treatment dummy for whether the individual played any version of the game. Columns (3) and (4) report effects from the game with communication and columns (5) and (6) from the game without communication. Coefficients are in standard deviations and standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: EFFECTS OF GAME EXPOSURE ON TARGET DETERMINANTS, BY GENDER

	(1) Males	(2) Females	(3) Males	(4) Females	(5) Males	(6) Females
Any treatment game	0.211*	0.076*				
	(0.113)	(0.043)				
Game w/ communication			0.317*	0.116**		
			(0.161)	(0.049)		
Game w/o communication					0.188	0.041
					(0.144)	(0.050)
Household income (Indian rupees)	–0.000	–0.000	–0.000	–0.000	–0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Household size	–0.027	–0.044***	–0.009	–0.032	–0.053	–0.051***
	(0.038)	(0.016)	(0.066)	(0.020)	(0.043)	(0.019)
Number of children in household	0.023	0.012	0.079	0.010	0.031	–0.001
	(0.059)	(0.023)	(0.076)	(0.029)	(0.068)	(0.029)
Years of schooling of respondent	0.008	0.024**	0.040	0.024*	0.012	0.028**
	(0.030)	(0.010)	(0.040)	(0.013)	(0.035)	(0.013)
Roof	–0.017	–0.008	–0.026	0.007	–0.001	–0.014
	(0.037)	(0.013)	(0.046)	(0.017)	(0.042)	(0.016)
Electricity	0.141	0.131	0.057	0.158	0.336	0.063
	(0.230)	(0.085)	(0.250)	(0.106)	(0.271)	(0.107)
Water source	0.072	–0.017	0.021	–0.010	0.066	–0.015
	(0.064)	(0.021)	(0.083)	(0.026)	(0.074)	(0.026)
Marital status	0.018	–0.017	0.042	–0.034**	0.019	–0.013
	(0.033)	(0.011)	(0.041)	(0.014)	(0.037)	(0.016)
Female	0.133	–0.070	0.176	–0.063	0.042	–0.051
	(0.119)	(0.047)	(0.145)	(0.063)	(0.146)	(0.056)
Constant	–0.442	0.313	–0.662	0.214	–0.215	0.298
	(0.586)	(0.233)	(0.780)	(0.307)	(0.710)	(0.281)
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.035	0.030	0.036	0.046	0.005	0.019
N	77	523	59	341	62	338

Notes: Author's estimates from data collected for this study. Columns (1), (3), and (5) are run for males only. Columns (2), (4), and (6) are run for females only. Columns (1) and (2) report treatment effects across both game types; the primary explanatory variable is a treatment dummy for whether the individual played any version of the game. Columns (3) and (4) report effects from the game with communication and columns (5) and (6) from the game without communication. The dependent variable in all columns is a summary index of seven variables most closely related to the game structure. Coefficients are in standard deviations and standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: EFFECTS OF GAME EXPOSURE ON PLACEBO DETERMINANTS

	(1)	(2)	(3)
Any treatment game	0.036		
	(0.034)		
Game w/ communication		0.024	
		(0.037)	
Game w/o communication			0.048
			(0.041)
Household income (Indian rupees)	–0.000	–0.000	–0.000
	(0.000)	(0.000)	(0.000)
Household size	–0.007	–0.014	–0.003
	(0.013)	(0.016)	(0.015)
Number of children in household	–0.003	0.000	–0.006
	(0.018)	(0.022)	(0.023)
Years of schooling of respondent	–0.009	–0.010	–0.007
	(0.008)	(0.010)	(0.010)
Roof	–0.003	–0.000	–0.004
	(0.011)	(0.013)	(0.013)
Electricity	0.094	0.116	0.089
	(0.068)	(0.076)	(0.086)
Water source	0.053***	0.045**	0.065***
	(0.017)	(0.020)	(0.021)
Marital status	–0.012	–0.010	–0.012
	(0.009)	(0.011)	(0.013)
Average number of meals per day	0.062*	0.047	0.049
	(0.037)	(0.045)	(0.045)
Constant	–0.243	–0.190	–0.222
	(0.182)	(0.223)	(0.224)
Adj. R^2	0.039	0.032	0.031
N	597	398	398

Notes: Author's estimates from data collected for this study. The dependent variable in each column is a summary index of 14 variables that cannot or should not be affected by exposure to the game. Column (1) provides estimates of program effects based on whether the individual played either version of the game. Columns (2) and (3) report estimates from the version of the game with and without communication, respectively. Coefficients are in standard deviations and standard errors are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: BALANCE TESTS BY ATTRITION STATUS

	(1) Non-attriter	(2) Attriter	(3) Overall	(4) (1) vs. (2), p-value
Marital status	1.77	1.59	1.76	0.49
Number of peoples in household	3.90	4.02	3.90	0.56
Number of children	1.64	1.73	1.65	0.58
Read and write Tamil	1.33	1.35	1.33	0.77
Education level	3.39	3.33	3.39	0.85
wage work in last 7 days	1.33	1.35	1.33	0.69
Your income in last 7 days	663.51	711.96	665.66	0.62
your household income in last 7 days	1800.46	1842.94	1802.34	0.80
Has electricity	1.03	1.12	1.03	0.00
Type of roof	4.16	4.10	4.16	0.75
Type of floor	1.93	1.92	1.93	0.90
Number of days your youngest child had diarrhea in last 7 days	0.01	0.00	0.01	0.60
How many times purchased soap	6.20	6.51	6.21	0.51
Defecating place when at home	1.41	1.47	1.41	0.40
You only need to wash your hands with soap if they look dirty or smell bad	2.47	2.69	2.48	0.15
Most of the people you know defecate in the toilet	2.67	2.55	2.66	0.43
Defecating in the open is unacceptable	3.13	2.98	3.12	0.28

Notes: Author's estimates from data collected during baseline and endline. Means of key variables for attrited and non-attrited individuals are presented in columns (1) and (2). Overall sample means are presented in column (3). Column (4) presents p-values from t-tests of equality of means across pairs. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: PERCEIVED EFFECTIVENESS OF GAMES

	↑ Importance			Buy Toilet			↑ HW		
Treatment dummy	0.216***			0.227***			0.222***		
	(0.034)			(0.043)			(0.040)		
Game w/ communication		0.223***			0.272***			0.244***	
		(0.042)			(0.050)			(0.045)	
Game w/no communication			0.203***			0.178***			0.202***
			(0.043)			(0.051)			(0.045)
Constant	0.392	0.307	0.337	1.373**	1.582***	1.337**	1.115**	0.911*	1.291**
	(0.427)	(0.475)	(0.498)	(0.541)	(0.568)	(0.588)	(0.502)	(0.511)	(0.515)
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.064	0.057	0.045	0.093	0.090	0.079	0.143	0.148	0.139
N	547	371	366	547	371	366	547	371	366

Notes: Dependent variable in Columns (1)-(3) is a binary variable for whether the game made you think sanitation was more important than you thought before. Columns (4)-(6) is whether the game motivated you to wash your hands more. Columns (7)-(9) is whether the game motivated you to buy a toilet. The control variables are household income, household size, number of children, highest education level completed, roof type, electricity, water source, marital status, female, and whether any meals were skipped this week. Standard errors are clustered at the village-round level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: TREATMENT EFFECT OF GAMES ON STATED PREFERENCES AT ENDLINE

	PreferenceIndex	PreferenceIndex	PreferenceIndex
Treatment Dummy	0.133***		
	(0.035)		
Game w/ communication		0.125***	
		(0.041)	
Game w/o communication			0.136***
			(0.039)
Constant	0.237	0.298	0.139
	(0.443)	(0.461)	(0.444)
Village fixed effects	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Adj. R^2	0.057	0.070	0.065
N	546	371	365

Notes: Preference index is comprised of seven variables most likely to be affected by treatment, as described in Section 4.2. The control variables are household income, household size, number of children, highest education level completed, roof type, electricity, water source, marital status, female, and whether any meals were skipped this week. Standard errors are clustered at the village-round level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: TREATMENT EFFECT OF GAMES ON BEHAVIORS AT ENDLINE

	SoapFreq	SoapFreq	SoapFreq	SoapExp	SoapExp	SoapExp	Toilet	Toilet	Toilet
Treatment dummy	0.847***			27.456***			0.084*		
	(0.240)			(7.793)			(0.044)		
Game w/ communication		0.890***			30.132***			0.100**	
		(0.278)			(8.505)			(0.050)	
Game w/o communication			0.756***			24.448***			0.076
			(0.256)			(9.317)			(0.052)
Constant	7.112**	6.679**	6.693**	55.440	35.080	30.309	1.939***	2.020***	2.327***
	(3.035)	(3.151)	(2.951)	(98.742)	(96.551)	(107.277)	(0.557)	(0.571)	(0.593)
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.037	0.052	0.046	0.178	0.190	0.190	0.032	0.055	0.019
N	547	371	366	547	371	366	547	371	366

Notes: The dependent variable *SoapFreq* is the number of times a household has purchased soap in the past month. *SoapExp* is the amount in rupees spent on soap in the past month. *Toilet* is whether you have a toilet at home. The control variables are household income, household size, number of children, highest education level completed, roof type, electricity, water source, marital status, female, and whether any meals were skipped this week. Standard errors are clustered at the village-round level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: TREATMENT EFFECT OF GAMES ON BEHAVIORS AT ENDLINE, BY SELF-REPORTED EXPERIENCE

	Toilet	Toilet	Toilet	Toilet	Toilet	Toilet
Treatment dummy	0.084*			0.149***		
	(0.044)			(0.051)		
Game w/ communication		0.100**			0.172***	
		(0.050)			(0.057)	
Game w/o communication			0.076			0.136**
			(0.052)			(0.058)
Constant	1.939***	2.020***	2.327***	1.727***	1.880***	2.330***
	(0.557)	(0.571)	(0.593)	(0.572)	(0.592)	(0.628)
Village fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.032	0.055	0.019	0.046	0.074	0.038
N	547	371	366	449	293	285

Notes: The dependent variable *Toilet* is whether the individual reports using a toilet at home. Columns (1)-(3) report standard regressions; these are identical to columns (6)-(9) in Table 9. Columns (4)-(6), however, report the results of these regressions conditional on the individual agreeing to the statement "the game made me think that sanitation is important". The control variables are household income, household size, number of children, highest education level completed, roof type, electricity, water source, marital status, female, and whether any meals were skipped this week. Standard errors are clustered at the village-round level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Experimental Instructions

Improving Community-Led Total Sanitation Through Experimental Games

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Welcome and Introduction

1. Thank you all for participating in this exercise. We want to make it clear that your participation in this game and survey is completely voluntary. You are welcome to not play, if you so choose, and you are welcome to withdraw at any point. We will ask that you sign a consent form to confirm that you understood the voluntary nature of this game.

2. First we will explain the basic structure of the game, and then we will explain the rules in detail. Please wait until the end of the instructions to ask any questions. At that point we will be very happy to explain anything that is not clear.

3. Today you will be participating in a group of five people. The exercise is designed to be similar to the real decisions that you make when deciding about you and your family's sanitation and hygiene. Although you are only playing with four other people, the way that your decisions in this game affect how everybody else in your group does in the game has a direct similarity to how your decisions about sanitation and hygiene affect health in your community.

4. Your decisions in this game, as with real life decisions about hygiene like buying soap or building a toilet, will cost you real money. This is why we will provide a starting budget for you to play the game with. But it's important to realize that you can make this money shrink or grow, depending on the choices you and your group make during the game, just like in real life.

Game Play

1. You will be asked to make a choice over one of five options: (1) do nothing, (2) washing your hands after the bathroom three times per week, (3) ending open defecation by your family three days per week, (4) washing your hands *always* after using the bathroom, (5)

building a latrine for your household and making sure everyone in the household stops openly defecating.

2. On the sheet in front of you is written the costs associated with each of these choices. You can think of the cost to you of handwashing different amounts to be in terms of buying soap for you and your family. You can think of the costs from reducing open defecation in terms of either the time to find a toilet or the cost of constructing a toilet at home. This is a real cost to make that choice, which will be subtracted from the initial budget that we provided you.

3. The payoffs that you receive from your choice will depend on what all of the other members of your group also do.

4. We will begin with three practice rounds to make sure that the sequence of events in the game is clear. This is a great time to ask any questions about aspects of the game that are unclear. These rounds will not affect your budget or payoffs.

5. After the practice rounds, we will play another 5 times. Your decisions in these games will impact on your final payoff.

   (a) Arm 1: you are asked to make your decision privately and not share your decision with others.

   (b) Arm 2: feel free to discuss your decisions with your group members.

6. Once the five rounds are played, we will calculate your total payoff, which depends on the choices you and your group make.

Post-Game Processing

1. Once we are done actually playing the game, we will make the payments to each participants.

2. Then we will have a short discussion with the entire group about how you made decisions in the game, how people see the consequences of their decisions, and what was learned through the experience. Specific questions to be covered are:

   (a) Did you change your decision-making as your experience with the game grew?

   (b) Did you feel like your group *as a group* learned how to make decisions better with experience?

   (c) What was the main lesson that you learned from this game?

- Steer this conversation toward the issue of how decisions about sanitation and hygiene affect not just you but other people around you. (At least) two ways that this happens: (1) contributing to a cleaner environment helps other people in your group/village be healthy and happy, and (2) when more people make the same decisions about what is "good" behavior on sanitation and hygiene, then it can help others do the same thing. Because of this, when you do this "good" behavior, you are helping others make choices that are also "good" for everybody.

3. Allow discussion to continue as needed, using points raised by participants to reinforce the link between the game and actual decisions about sanitation and hygiene in their community.

4. Thank the participants for their time and inform them we will try to follow up with them in the future.

Determinants of Sanitation and Handwashing Behavior

Adapted from O. Hernandez *et al* (2012)

Behavior

1. What is your household's main source of water?
2. When do you think it's necessary to wash your hands?
3. May I look at your hands?
4. What is the best way to clean hands?
5. How much do you usually spend on soap for the HH in a month?
6. How many times in the past month have you purchased soap?
7. Where do you usually urinate when you are at home?
8. Where do you usually defecate when you are at home?
9. Where do the children in the household usually defecate?
10. Where do you usually urinate when you are at work?
11. Where do you usually defecate when you are at work?
12. Do other people in the household urinate/defecate in the same place as you?
13. Do other people in the village urinate/defecate in the same place as you?
14. If not, is there a usual place for people in the village to go?
    - If yes, where is it?

Attitudes and Knowledge

(1 strongly disagree 2 disagree 3 agree 4 strongly agree)

1. You know of a place where you can buy soap.
2. There is always enough water to wash hands when you need it.
3. You can buy soap when you need to without asking for permission.

4. You can always find soap when you need to use it.
5. Most people you know wash their hands with only water.
6. Most people you know use soap to wash their hands after going to the toilet.
7. In most homes in your community, soap and water are available to wash hands after going to the toilet.
8. It is important that all mothers make sure they wash their hands with soap before preparing food.
9. People who don't wash their hands with soap deserve to be criticized.
10. People with good education are more likely to wash their hands with soap.
11. People who have a high social status are more likely to wash their hands with soap.
12. I would criticize a mother who did not wash her hands before feeding her baby.
13. Since handwashing with soap is natural, you don't need to be taught how to do it.
14. Information on the importance of handwashing with soap has never been given to you.
15. It is important to teach children to wash their hands with soap.
16. It's a mother's job to make sure her children wash their hands properly.
17. Someone in your household would criticize you if they saw you wash your hands with soap too often.
18. If a child does not want to wash their hands, there is nothing you can do about it.
19. The school promotes handwashing amongst children.
20. If you wash your hand really well with water you don't need to use soap.
21. You only need to wash your hands with soap if they look dirty or smell bad.
22. Washing your hands with soap before feeding a child is important only if you use your hands to feed them.
23. Washing hands uses up water in a household that could be better used for other purposes.
24. You don't need to wash your hands with soap if you know you have not touched anything dirty.

25. If you wash your hands many times with water you do not need to use soap.
26. It is worth taking a few extra seconds to add soap when washing your hands.
27. Most of the people you know defecate in the toilet.
28. Septic tanks in this area are easily emptied.
29. Having a toilet at home spares your family from being subject of gossip.
30. Having a toilet at home can give comfort to family.
31. There are no masons in this area who know how to build a good toilet.
32. It is acceptable for young children to defecate in the open.
33. Having a toilet will raise your family's pride.
34. People who defecate in the open won't be accepted in your community.
35. Having a toilet allows you to be a better host for guests.
36. Defecating in the open is unacceptable.
37. In this community it is easy to find financial support to build a good toilet.
38. Having a toilet cannot prevent your family from being sick.
39. Although your ancestors defecated in the open, it's not alright for you to do it.
40. Having a toilet can add value to a house.
41. Having a toilet protects your family.
42. In your community it is easy to get good information on how to build a toilet.
43. Having a toilet gives you and your family freedom.
44. You know a person who has skills to build a toilet.
45. Having a toilet makes your house more comfortable.
46. Defecating in the open is a proper thing to do because everybody does it.
47. Having a toilet will not raise your family's status.
48. It's unacceptable to defecate in the open if you can't make it to a toilet.

- Steer this conversation toward the issue of how decisions about sanitation and hygiene affect not just you but other people around you. (At least) two ways that this happens: (1) contributing to a cleaner environment helps other people in your group/village be healthy and happy, and (2) when more people make the same decisions about what is "good" behavior on sanitation and hygiene, then it can help others do the same thing. Because of this, when you do this "good" behavior, you are helping others make choices that are also "good" for everybody.

3. Allow discussion to continue as needed, using points raised by participants to reinforce the link between the game and actual decisions about sanitation and hygiene in their community.

4. Thank the participants for their time and inform them we will try to follow up with them in the future.