

# Changing Preferences Through Experimental Games: Evidence from Sanitation and Hygiene in Tamil Nadu

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## Abstract

Much policy interest on sanitation and hygiene promotion focuses on changing behavior and increasing demand for these goods. Yet the effectiveness of large-scale interventions has been mixed, in large part because of the difficulty of changing attitudes on deeply held behaviors. I test whether an experiential learning exercise, which is structured around an experimental game, can be used to shift preferences around sanitation and hygiene. I design and adapt a minimum coordination game to the sanitation and hygiene setting by linking game choices to real-world investment decisions and payoffs in terms of health and status. Within 20 villages in rural Tamil Nadu, I randomly assign individuals to three groups: a game where communication between rounds is allowed, another where communication is prohibited, and a control group that only completes a survey. Comparing survey responses across treatment arms, I find that the game improved stated preferences toward sanitation and hygiene. This effect was larger when communication was allowed and men responded on average stronger than women across both versions of the game. These results suggest that experimental games can be a valuable tool not only for the study of decision-making but for improving knowledge and pro-sanitation preferences.

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

**JEL Codes:** Q56, I12, I15, O13.

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Community-led total sanitation is an approach to improving sanitation based on social mobilization around ending open defecation in the community. In contrast to earlier sanitation programs that emphasized the construction of physical latrines, i.e. 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. Communities are guided by program facilitators toward a self-analysis of their sanitation situation, health promotion, and the discovery of contextually appropriate solutions. It is further characterized by the stressing of subjective drivers of behavior change, including the cultivation of feelings of disgust and dissatisfaction with the status quo, shame at unhygienic conditions, pride when improved sanitation is attained, etc (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, at the beginning of a CLTS project, a community meeting is typically held in which a village map is generated on the ground and each person is asked to mark with brightly colored spice or dye powder where they openly 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 adopt a latrine and/or continue to defecate in the open. By so doing they aim to change social norms around 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 serious barrier to the effectiveness of CLTS programs, such as the Total Sanitation Campaign in India (Patil et al. (2014)). Due to such limitations in the triggering activities, there exists substantial policy interest—among the Government of India, the World Health Organization, the Water and Sanitation Program of the World Bank, etc—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 (e.g. UK Department for International Development (2013)).

Against this policy backdrop, this study examines a novel approach to behavior change, which is easy to implement, cost-effective, and highly scalable. I implement an experimental game on sanitation and

hygiene as part of a framed field experiment. This game is designed carefully to reflect interdependencies in decision-making around sanitation and hygiene, and so highlights for participants how individual decisions aggregate into social consequences. This key feature of the game is similar to recent behavior change initiatives in related contexts of social coordination. For example, in an ongoing study Onyango, Reimer and Stopnitzky (2016) use a repeated common-pool resource game with opportunities for deviating from and enforcing social norms in an attempt to affect fishermen behavior in Tanzania. Carter et al. (2008) used financial education games to try and explain index insurance to populations that have no prior experience with such products. Meinzen-Dick et al. (Forthcoming) used experimental games to raise awareness among Indian villagers on how crop choice affects groundwater depletion. And Turiansky (2015) found evidence that playing public goods games with Haitian rice farmers causes them to increase their private contributions to the public irrigation system. These studies represent early efforts in 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 to motivating households to change behavior.

After randomly assigning individuals to treatment, I estimate the impact of playing a sanitation/hygiene-focused coordination game on a broad measure of preferences and determinants of hygienic behavior. These experimental estimates are large and economically meaningful. The games were successful in fostering “better”, i.e. pro-sanitation and pro-hygiene, attitudes and preferences. This effect appears to be stronger in the version of the game that allowed communication. 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 2 explains this study’s experimental design, including details of the game (and relevant variants) in Section 2.2 as well as how the game is relevant to the coordination and social norms that structure individual behavior around sanitation and hygiene. Section 3 describes the sample characteristics, balance tests across randomly assigned treatment groups, estimates of average treatment effects, and an exploration of heterogeneous treatment effects. Finally, Section 4 interprets these results and discusses their importance in relation to current sanitation policy in India.

# 1 Sanitation and Hygiene in Tamil Nadu

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

Our survey data provides additional evidence of inadequate sanitation and poor hygiene, both in terms of self-reported behaviors and determinants of sanitation and hygiene. For example, only 38% of respondents reported that “most people they know defecate in toilets” and approximately 80% of respondents (strongly) agree 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. 56% of respondents (strongly) disagreed that most people know to wash their hands after going to the bathroom. Roughly 27% of respondents believed one only needs to wash hands if they “look dirty or smell bad” and 39% 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%) 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/mud, or “does not matter”) and 41% 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 are attitudinal and behavioral rather than supply-based. For example, over 90% of respondents say they know where to buy soap, 87% say there is “always enough water to wash hands” and the same number agree they can “always buy soap if they need it”. In addition, two-thirds of households (67%) report they know someone who has the skills to build a good toilet and roughly half of respondents say 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 our experimental intervention, which attempts

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<sup>1</sup> 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% coverage according to program administrative data but only 23.2% 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)).

to affect precisely these preferences and norms.

## 2 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, which raises common issues of internal and external validity (see, e.g. 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 tool to study behavior/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 subjects being assigned to control and 20 to the game treatment (10 each to two variants of the game), for a total of three experimental arms. This blocking design reduces 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, etc. The study design is internally valid if assignment to experimental arms is random and thus potential outcomes are on average balanced across arms; Table 4 below presents statistical evidence on covariate balance across treatment arms in support of successful randomization.

The three arms of the experiment are the following. The first treatment arm was assigned a sanitation-focused minimum effort game (described in Section 2.2 below) with explicit instructions to not communicate or share your choices openly with others in your group. After playing this game, individuals in this arm participated in a short, approximately 20-minute debriefing exercise in which facilitators from my implementation partner (about which more below in section 2.1) answered questions about the game and explained how interdependent decision-making in the game mirrored real life consequences of sanitation and hygiene behavior. Then individuals were given a household survey that gathered information on household demographics, basic socio-economic variables, and numerous questions designed to identify behavioral determinants of sanitation and hygiene, as developed by the Water and Sanitation Program of the World Bank (Hernandez et al. (2012)). These determinants are measures of knowledge, assets, abilities, attitudes, and preferences known to predict sanitation and hygiene behavior.

Individuals in the second treatment arm were given the same game, with the same instructions, but were encouraged to communicate about their strategies and choices if they so desired; this group also completed the survey after completing the game and post-game 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. In the analysis presented later, I show results both for the two game-playing arms together as well as for each version of the game separately individually.

In each village, 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.

## **2.1 Sampling and Implementation**

The implementation partner for this project was the LEAF Society, a registered NGO based in Tamil Nadu. The LEAF Society has extensive experience working in the water and sanitation sector, including in the use of children's games to encourage sanitary behavior among children, as well as with large-scale household surveys. They are also active in the areas of promoting local legal advocacy, promotion of life-skills among children, and creating livelihood opportunities for women and children. The LEAF Society's previous work in this geographical area, however, raised the issue of contamination by prior, related project activities.

To avoid this concern, the LEAF Society and I identified 40 rural villages in two blocks of Namakkal district, Erumapatty and Mohanur, in which they had no previous contact as an organization. From this list of 40 candidate villages, I randomly selected 20 villages 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 they were the only household member home and no adult woman was available. As stated above, this selection rule resulted in a sample comprised of 87% women and 13% men. Men and women played the game in separate groups, i.e. 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 cause any systematic bias that would threaten identification when comparing groups of men or women *across* treatment arms within a village.

## 2.2 Game Details

### 2.2.1 Concept

This study uses repeated game play of a carefully designed sanitation game, which is 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 in sports, various production/assembly lines, etc. 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 when (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 regards 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/hygiene.

### 2.2.2 Minimum Effort Games of Tacit Coordination

The minimum effort game is a variant of coordination game in which a group comprised of  $n$  individuals simultaneously choose an action/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 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:

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

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 where higher levels of effort strictly dominate lower levels of effort. If players explicitly coordinate their actions, then the fact  $a > b$  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  $(e, \dots, e)$  is a Nash equilibrium.

Each player must evaluate two components to arrive at their 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 their forecast is incorrect, their individual strategy is suboptimal. At the same time, the second issue arises that even if all players give a best response, it is possible that the group coordinates on a suboptimal, Pareto-dominated equilibrium. For example, consider the case in which player  $i$  forecasts that 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 the 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", i.e. on low-effort, Pareto-dominated effort levels that secure a relatively high individual payoff when others also choose low levels of effort or where there is uncertainty about others' behavior. Numerous subsequent efforts studied 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 subjects with different subject pools used in prior studies. These authors provide evidence of Pareto-efficient coordination in various group sizes (up to six) in contrast to the previous literature. As distinct from comparing different subject pools, other studies have manipulated parameters of the game and/or experimental instructions. For example, Chaudhuri, Schotter and Sopher (2009) run experiments using version of the game with non-overlapping generations, in which generations can pass on "advice" to their successors, but they find 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 of perfect versus imperfect monitoring plays in fostering coordination (Deck and Nikiforakis (2012)).

Whereas this literature attempts 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 will focus on treatment effects generated by exposure to the game rather than the decisions adopted in the course of playing the game.



### 2.2.3 Sequence of Play

This section outlines the sequence of game play:

1. Groups formed randomly from individuals selected in each village.
2. Instructions read aloud to the entire group at once.
3. Groups play three practice rounds without money and then begin playing five rounds for real money.
4. Following each round, the minimum effort level within the group will be announced.
5. Payoffs are calculated from that round and the enumerator verifies and records each payoff.
6. The period game is repeated five times to provide an opportunity for learning and the evolution of cooperative norms.
7. Payoffs in rupees are disseminated.
8. Once the game is concluded, the experimenter facilitates a group discussion on the game during which time strategic interdependencies between sanitation/hygiene investments are emphasized.

### 2.2.4 Adaptation to Sanitation and Hygiene Setting

The purpose of this game is to highlight to participants important aspects of the interdependencies that affect their sanitation and hygiene behavior. The instructions given to the players provide an ordered list of sanitary effort based on the following choices: (i) do nothing, (ii) washing your hands after the bathroom three times per week, (iii) ending open defecation by your family three days per week, (iv) washing your hands *always* after using the bathroom, (v) building a latrine for your 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 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. Instructions emphasized that the higher costs associated with more handwashing each week can be understood as the need to purchase or obtain more soap and water, or that reducing open defecation can be time costs to travel to a toilet or the cost of constructing a latrine.

### 2.2.5 Payoff Structure

A representative payoff structure associated with this game, with parameters  $a = 2, b = 1, c = 6$  over a strategy space  $e_i \in \{0, 1, 2, 3, 4, 5, 6\}$  can be found below. As can be seen in Figure 2, there is weak complementarity in strategies; payoffs increase with individual effort but have higher rewards when others also contribute. For example, consider the case where individual  $i$  chooses a mid-range value of three. Her payout will be determined by the minimum effort level in the group, e.g. two, which yields a payoff of seven. Had the minimum level of effort  $e \geq 3$ , the player could have earned a maximum of nine points given her choice. But had she forecasted correctly that the minimum effort level in the group would be two, she could have herself improved her payout by matching that minimum effort level (in this case, earning a payoff of eight). 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 2: Generic Payoff Matrix in a Minimum Effort Game**

		Minimal Effort Level in Group						
		0	1	2	3	4	5	6
Individual Effort	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:  $a = 2, b = 1, c = 6$

To operationalize this payoff structure for our game and setting in rural Tamil Nadu, I parameterized the game as follows (all units are expressed in Indian rupees). 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 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 they had prior to consenting to participate. Given the five games that participants played, total payouts ranged from a minimum of 100 rupees ( $\approx$  \$1.50) to a maximum possible of 300 rupees ( $\approx$  \$4.50) with average payouts across all participants of 200 rupees ( $\approx$  \$3.00).

Figure 2: Payoff Matrix in the Sanitation/Hygiene Minimum Effort Game

Payoff Table for Sanitation/Hygiene Choices

		<i>Minimum Effort Observed Within Group</i>				
		Do nothing	Wash hands sometimes	Reduce open defecation sometimes	Wash hands always	End open defecation completely/by toilet
<i>Individual Effort</i>		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/by toilet	Cost = 40	-20	0	20	50	60
	<b>payoff function</b>	payoff = $a \cdot \min(e, e_i) - b \cdot e + c$				
	<b>parameters</b>	a (benefit)	2			
		b (cost)	1			
		c (constant)	20			
	<b>notes</b>	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.				

### 3 Empirics

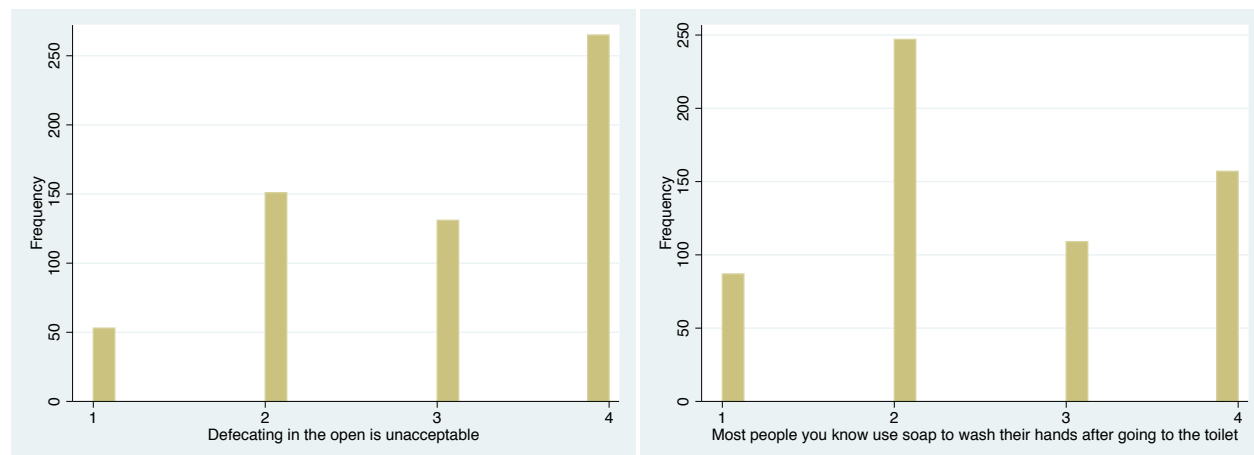
#### 3.1 Sample Characteristics

This section describes key characteristics of the sample of 600 respondents. The sample was 87% female, 65% literate, and the largest share of respondents had completed primary school only. Individuals report daily earnings of approximately 100 Indian rupees per day (and total household earnings of about 260 rupees per day or about \$ 3.88 USD per day), with the vast majority of workers (83%) 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. But despite this, the

variance of responses was high, with many people reporting preferences that attribute little importance to sanitation and hygiene. The following are frequency distributions on two key questions, on open defecation and handwashing, that serve to illustrate this point.

**Figure 3: Frequency Distributions on Two Key Outcome Variables**



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

In Table 4, I present evidence on statistical balance of important observables. These tests thus provide evidence in favor of 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 control and the treatment arm with 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 in all regressions below.

### 3.2 Summary Indices

The survey instrument on determinants of handwashing contains a large number of potential outcome variables, some of which could be hypothesized to be affected by treatment and others impossible to be affected. For example, many of these variables are on expenditures or assets, which will not be affected by experience playing the sanitation game (during the same day, although perhaps subsequently).<sup>2</sup> Some determinants focus more on knowledge (e.g. how to use soap) or beliefs about others (e.g. 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.

<sup>2</sup>Follow-up research with these respondents will look precisely at these variables, and changes thereof, over time.

To overcome these concerns, I construct 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 indices have three main attributes as compared to 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 our 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 power when examining any one of them.

To create a summary index, each variable is first transformed so that scores move monotonically, i.e. the agree-disagree scale is converted to align if the prompt featured a positive or negative statement so that higher numbers always reflect “better” answers. Second, each response is demeaned and divided by the standard deviation to convert values 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, where 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 indices I construct use either (1) all 48 determinants of sanitation and handwashing behavior in my survey or (2) a list of seven 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 (e.g. such as when soap should be used), were excluded on the grounds they reflected knowledge more than preferences/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 those criteria of exclusion, one variable was included based on its direct questioning of whether information about how important handwashing is has ever been provided, something that should clearly be affected by the game.

The variables that remained were the following seven statements on which participants were 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 alright 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.

In the analysis that follows, I present results for both the summary index of all determinants as well as the summary index of these target determinants.

### 3.3 Causal Effect of Game Play on Stated Preferences

I estimate average treatment effects of game experience on preferences by regressing the summary index outcomes on a dummy variable for treatment and 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:

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

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

I include a set of individual-level controls,  $\mathbf{X}_{iv}$ , in all regressions to improve precision. They are: household income, household size, number of children, highest year of education, type of roof, whether the house has electricity, what type of water source the house has, the 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 investment and/or attitudes; for example, having more people in a household could affect demand if people have heterogeneous preferences for sanitation (Stopnitzky (2015)). Two of these variables were 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 from the game than others 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% 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)-(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 and/or children. Point estimates of treatment effects now are nearly twice the magnitude of the broader, less focused summary index measure. I estimate the causal effect of exposure to either game to be 0.091 standard deviations, increasing to 0.130 in the version of the game that allowed communication between players as they made their choices. These estimates are statistically significant at the 5% and 1% levels, respectively.

### 3.3.1 Placebo Test

One possible concern about these estimates could be that the game and/or facilitated discussion primed participants to answer the various determinants questions in a manner consistent with social desirability bias. To test for this possibility, I construct a summary index comprised 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.<sup>3</sup> 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. Indeed, 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.

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<sup>3</sup>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.

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

### **3.4 Heterogeneous Treatment Effects**

#### **3.4.1 Across Game Versions**

An important source of heterogeneity in treatment responses is differential impacts across versions of the game (with and without communication); these heterogeneous 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 without communication. A formal test of equality of these coefficients fails to reject the null, however, for the summary index of all determinants. By contrast, there is a statistically significant difference at the 10% level ( $\text{prob} > \chi^2 = 0.097$ ) between the treatment effects estimates of the communication and non-communication versions of the game when looking specifically at target determinants. This difference suggests that the communication version of the game was more effective in altering preferences.

#### **3.4.2 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 the either game on all determinants, 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 5% level ( $\text{prob} > \chi^2 = 0.022$ ). This heterogeneity is most clearly seen in columns (3) and (4), the game with communication treatment, of both Table 3 and 4. This finding contrasts with the much smaller (and statistically insignificant) differences across genders for the treatment arm without communication.

## **4 Discussion**

This study explores whether personal experience playing a short experimental game, which was deliberately designed to mimic strategic interdependencies in sanitation and hygiene behavior, might alter pref-



erences and behavior related thereto. Looking at a cross-section of data I am unable to ascertain whether the game treatment alters real-world behavior, although I intend to pursue this question with follow-up surveys in future research. But 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 determinants of behavior.

The magnitude of these effects is economically meaningful. First, the beneficial impacts of this novel method compare favorably to 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 Gates Foundation (Galiani et al. (2015)). Their intervention had two components: (1) a mass media campaign coupled with direct consumer contact communication campaign at the province-level (delivered via radio advertisements, print materials, street parades, and local theatre performances in public places, and (2) a community intervention that combined the previous treatment with training of trainers of “community change agents”, capacity building and 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 0.11 standard deviations for the community intervention and 0.089 for the school component. The magnitude of that program’s effect is therefore comparable to the overall effect I find in this study when estimated the overall effect of exposure to either game but substantially less than the impact of the game with communication.<sup>4</sup>

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<sup>4</sup>Some of this difference might be diminished over time because they conduct surveys months after exposure while I solicit preferences immediately after treatment, but the similar magnitudes highlight the economic significance of the effect sizes generated by this game treatment.

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Table 1: SUMMARY STATISTICS AND BALANCE TESTS

	(1) Control, Only survey	(2) Game with communication	(3) Game without communication	(4) Overall	(5) (1) vs. (2), p-value	(6) (1) vs. (3), p-value	(7) (2) vs. (3), p-value
Marital status	1.45	1.70	1.88	1.67	0.11	0.01***	0.33
Number of peoples in household	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
Can you read and write Tamil?	1.30	1.31	1.34	1.32	0.91	0.39	0.46
What is the highest education level you have completed?	3.60	3.32	3.31	3.41	0.16	0.13	0.98
Did you do any wage work during the last 7 days?	1.33	1.31	1.31	1.32	0.59	0.59	1.00
In the last 7 days, how much income did you (individually) earn?	678.85	640.05	748.25	689.05	0.54	0.32	0.11
In the last 7 days, how much income did your household earn?	1756.50	1825.55	1946.00	1842.68	0.54	0.16	0.37
Do you have electricity in your house?	1.06	1.05	1.06	1.06	0.67	0.84	0.83
What is your roof made out of?	4.09	4.19	4.09	4.12	0.51	1.00	0.49
What is your floor made out of?	1.93	1.90	1.96	1.93	0.38	0.21	0.03**
How many days in the past 7 days did your youngest child have diarrhoea?	0.00	0.02	0.01	0.01	0.16	0.32	0.56
How many times in the past month have you purchased soap?	6.50	6.43	6.57	6.50	0.85	0.88	0.72
Where do you usually defecate when you are at home?	1.46	1.44	1.45	1.45	0.69	0.84	0.84
Where do the children in the household usually defecate?	1.55	1.56	1.57	1.56	0.84	0.76	0.92

Note: 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

	All	All	All	Targeted	Targeted	Targeted
treatment_dummy	0.049** (0.024)			0.091** (0.040)		
treatment_comm		0.058** (0.029)			0.130*** (0.047)	
treatment_nocomm			0.038 (0.028)			0.053 (0.047)
hhincome	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
hhsiz	-0.008 (0.009)	-0.005 (0.012)	-0.009 (0.010)	-0.040*** (0.015)	-0.028 (0.019)	-0.052*** (0.017)
children	0.005 (0.012)	0.008 (0.017)	-0.001 (0.016)	0.016 (0.021)	0.017 (0.027)	0.012 (0.026)
educ	0.003 (0.006)	0.005 (0.008)	0.007 (0.007)	0.022** (0.009)	0.025** (0.012)	0.026** (0.012)
roof	-0.007 (0.008)	-0.001 (0.010)	-0.010 (0.009)	-0.011 (0.013)	0.002 (0.016)	-0.013 (0.015)
electric	0.030 (0.047)	0.012 (0.058)	0.033 (0.058)	0.122 (0.079)	0.142 (0.095)	0.085 (0.097)
watersource	0.015 (0.012)	0.010 (0.015)	0.020 (0.014)	-0.007 (0.019)	-0.002 (0.024)	-0.005 (0.024)
maritalstat	-0.002 (0.006)	-0.005 (0.008)	0.002 (0.009)	-0.012 (0.011)	-0.026* (0.013)	-0.005 (0.014)
female	-0.057* (0.034)	-0.055 (0.041)	-0.019 (0.038)	-0.113** (0.056)	-0.096 (0.066)	-0.090 (0.064)
meals	0.038 (0.025)	0.048 (0.035)	0.029 (0.030)	-0.035 (0.043)	-0.012 (0.056)	-0.028 (0.051)
village	-0.005** (0.002)	-0.006** (0.003)	-0.005* (0.002)	-0.009** (0.003)	-0.014*** (0.004)	-0.006 (0.004)
constant	-0.082 (0.128)	-0.124 (0.173)	-0.090 (0.152)	0.294 (0.216)	0.120 (0.280)	0.290 (0.257)
Village FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.012	0.006	0.000	0.037	0.051	0.028
N	593	394	395	600	400	400

Note: 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 4, 5, and 6 is a summary index of seven attitudinal variables that were targeted by the game design. 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

	Males	Females	Males	Females	Males	Females
treatment_dummy	0.177*** (0.062)	0.032 (0.026)				
treatment_comm			0.251*** (0.089)	0.038 (0.031)		
treatment_nocomm					0.147* (0.078)	0.028 (0.030)
hhincome	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
hhsiz	-0.028 (0.021)	-0.005 (0.010)	-0.016 (0.036)	-0.007 (0.013)	-0.045* (0.023)	-0.000 (0.012)
children	-0.000 (0.033)	0.003 (0.014)	0.011 (0.043)	0.012 (0.018)	0.010 (0.038)	-0.010 (0.017)
educ	0.012 (0.016)	0.001 (0.006)	0.023 (0.022)	0.000 (0.008)	0.009 (0.019)	0.005 (0.008)
roof	-0.000 (0.020)	-0.007 (0.008)	0.003 (0.026)	-0.002 (0.011)	0.009 (0.023)	-0.012 (0.010)
electric	0.095 (0.124)	0.028 (0.051)	0.061 (0.138)	0.002 (0.066)	0.218 (0.147)	0.005 (0.064)
watersource	0.060* (0.035)	0.011 (0.012)	0.037 (0.046)	0.006 (0.016)	0.057 (0.040)	0.019 (0.016)
maritalstat	0.014 (0.018)	-0.004 (0.007)	0.019 (0.023)	-0.008 (0.009)	0.021 (0.020)	-0.003 (0.010)
meals	0.127* (0.065)	0.014 (0.028)	0.128 (0.080)	0.023 (0.039)	0.110 (0.079)	0.002 (0.033)
constant	-0.532* (0.317)	-0.040 (0.139)	-0.569 (0.430)	-0.043 (0.193)	-0.599 (0.385)	0.011 (0.168)
Village FE	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

Note: 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. 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

	Males	Females	Males	Females	Males	Females
treatment_dummy	0.211*	0.076*				
	(0.113)	(0.043)				
treatment_comm			0.317*	0.116**		
			(0.161)	(0.049)		
treatment_nocomm					0.188	0.041
					(0.144)	(0.050)
hhincome	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
hhsiz	-0.027	-0.044***	-0.009	-0.032	-0.053	-0.051***
	(0.038)	(0.016)	(0.066)	(0.020)	(0.043)	(0.019)
children	0.023	0.012	0.079	0.010	0.031	-0.001
	(0.059)	(0.023)	(0.076)	(0.029)	(0.068)	(0.029)
educ	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)
electric	0.141	0.131	0.057	0.158	0.336	0.063
	(0.230)	(0.085)	(0.250)	(0.106)	(0.271)	(0.107)
watersource	0.072	-0.017	0.021	-0.010	0.066	-0.015
	(0.064)	(0.021)	(0.083)	(0.026)	(0.074)	(0.026)
maritalstat	0.018	-0.017	0.042	-0.034**	0.019	-0.013
	(0.033)	(0.011)	(0.041)	(0.014)	(0.037)	(0.016)
meals	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 FE	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R <sup>2</sup>	0.035	0.030	0.036	0.046	0.005	0.019
N	77	523	59	341	62	338

Note: 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. 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)
treatment_dummy	0.036 (0.034)		
treatment_comm		0.024 (0.037)	
treatment_nocomm			0.048 (0.041)
hhincome	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
hhsiz	-0.007 (0.013)	-0.014 (0.016)	-0.003 (0.015)
children	-0.003 (0.018)	0.000 (0.022)	-0.006 (0.023)
educ	-0.009 (0.008)	-0.010 (0.010)	-0.007 (0.010)
roof	-0.003 (0.011)	-0.000 (0.013)	-0.004 (0.013)
electric	0.094 (0.068)	0.116 (0.076)	0.089 (0.086)
watersource	0.053*** (0.017)	0.045** (0.020)	0.065*** (0.021)
maritalstat	-0.012 (0.009)	-0.010 (0.011)	-0.012 (0.013)
meals	0.062* (0.037)	0.047 (0.045)	0.049 (0.045)
constant	-0.243 (0.182)	-0.190 (0.223)	-0.222 (0.224)
Adj. $R^2$	0.039	0.032	0.031
N	597	398	398

Note: The dependent variable in each column is a summary index of 14 variable that cannot or should not be affected by exposure to the game. Coefficients are in standard deviations and standard errors are in parentheses. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .