IS HABIT A POWERFUL POLICY INSTRUMENT TO INDUCE PROSOCIAL BEHAVIORAL CHANGE?

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February 2021

COWLES FOUNDATION DISCUSSION PAPER NO. 2275

COWLES FOUNDATION FOR RESEARCH IN ECONOMICS
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Is Habit a Powerful Policy Instrument to Induce Prosocial Behavioral Change?

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February 17, 2021

Abstract

Recent literature suggests the power of interventions to change habits. In a dense slum in Nairobi, we adopt best practices from the habit literature to encourage toilet use instead of alternatives that damage community health. Offering subsidies increased toilet usage, effects continue for one month after discounts end, but erode thereafter. Treatments designed to induce habit formation (marketing, time-limited discounts encouraging repetition, discounts for longer periods, targeting 'habitual types') generated no greater persistence. We see some persistent behavior change due to learning about the new toilet option. It appears difficult to induce pro-social behavior without private benefits through habit change.

Keywords: Behavioral Economics, Habit Formation, Kenya, Sanitation.

JEL codes: D91, O12

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1 Introduction

A large literature in psychology and economics explores the importance of habits and habit formation. Habits are behaviors that are performed routinely and undertaken without being preceded by conscious intentions. As characterized in Wood et al. (2002), "only minimal, sporadic thought is required to initiate, implement, and terminate actions that in the past have been repeated in stable contexts." Using student diaries, Wood et al. (2002) classify between a third and a half of all behaviors as habits, in that they occur almost every day and in the same location. More recently, researchers have explored the possibility that intentionally breaking and forming these automatic behaviors can be an important vehicle for behavior change (Verplanken, 2018; Duhigg, 2012) examining habit formation for diet and exercise (Charness and Gneezy, 2009; Royer et al., 2015; Armitage, 2005), study (Stojanovic et al., 2020), handwashing (Hussam et al., 2021), and oral hygiene (Judah et al., 2013).

Under-utilization of hygienic latrines threatens public health in many developing countries. About 15 percent of the world's population, or, one billion people, currently practice open defecation (UNICEF and WHO, 2014). This spreads bacterial, viral, and parasitic infections, including diarrhea, polio, cholera and hookworm. Open defecation (OD) has been identified as a leading cause of child stunting (Spears et al., 2013; Chambers and von Medeazza, 2013; Coffey et al., 2018) and infant death (Hathi et al., 2017), especially in densely populated areas where health externalities are larger.

Clearly, toileting activities are performed routinely, and an individual's toileting practices are likely habitual. When individuals have access to hygienic latrines but routinely practice OD, replacing unhealthy habits with a safer alternative would produce positive public health externalities. In this paper, we use insights on habit change from literatures in psychology and neuroscience to design and experimentally test interventions to encourage 3200 residents of a dense urban slum in Nairobi to

switch from OD to using hygienic latrines regularly.

A key difference between our setting and the settings of much of the habit-intervention literature is that, while the previous literature focuses on behaviors that produce substantial private benefits for the user (i.e. handwashing, exercise, study, and oral hygiene), toilet usage reduces the spread of disease to others. For precisely this reason, habit-formation interventions, if successful, would produce large *social* benefits. Generating *persistent* changes in sanitation behavior using only *short-run* interventions would be an important policy achievement. However, when benefits are largely external, subjects may not be not self-motivated to form a habit (as they likely are for exercise) and thus, the efficacy of habit interventions in the sanitation space is unclear.

We design interventions to encourage regularized, habitual use of a pay-per-use toilet service in Mukuru slum in Nairobi, Kenya. Our partner *Sanergy* provides clean and affordable public toilets in several locations within Mukuru under the brand name *Fresh Life Toilets* (FLT). The waste from FLTs is safely transported outside the community (rather than being dumped in waterways) and then recycled. Photographs in Figure A1 will help readers visualize the context.

In our field experiment, over 3000 potential users of FLTs were provided discount vouchers to use the toilets over a limited period of time. We introduce several types of experimental variation in order to examine what, if any, version of the intervention successfully stimulates habit formation. First, our basic design, like others in the literature, subsidizes toilet use for a period, and then tests whether more intense subsidies lead to greater persistence in toilet use *after* the discounts expire. Second, we varied the time length of the discounts: some subjects were entitled to discounts for one month and some for two months. This part of the design was inspired by findings that more sustained repetition provides an opportunity for more durable habit formation (for example, see Wood et al., 2002; Charness and Gneezy, 2009). Third, we contrast time-limited vouchers (so that the discounts

only apply if used at the same time every day) against discounts that could be used at any time. Our goal was to encourage, in one group, the type of repetition that could be habit-inducing, taking cues from insights in psychology and neuroscience about the importance of repetition of the action in a stable environment (for example, see Danner et al., 2008; Wood et al., 2002; Armitage, 2005).

This variation is useful for identification, because any observed persistence in the post-discount period could be due to either habit formation or because the subsidies provided subjects an opportunity to learn about the new product, and some users liked it and chose to stick with it. This is a common challenge to inference in the economics literature that tries to identify habits. To distinguish between habit and learning mechanisms, we test whether the restrictive, repetitive schedule in the time-limited group produces any greater persistence during the post-discount period.

Additionally, in our marketing treatment, potential users received marketing messages which emphasized the extent to which FLT toilet usage is pleasant and rewarding. This part of the intervention is responsive to the literature suggesting that "habit loops" are encouraged when the routine action results in a reward which encourages repetition. These marketing messages attempted to point out both the pleasantness of the toilets and their social benefits (see Figure A2). Duhigg (2012) summarizes the "habit loop" and describes advertising as a mechanism to associate actions with rewards. Our FLT marketing campaign was designed in partnership with advertising and marketing professionals based at leading firms in New York and globally, deputized to this social impact project.

We collected data during the discount period and continued to track daily usage in this sample for several months after the discounts ended. Both marketing and offering larger discounts with greater schedule flexibility induce significantly more people to try FLTs during the discount period. Furthermore, treated individuals continue using the toilets at a significantly higher rate for a month after the discount is removed. However, their usage decays over time and it becomes statistically

comparable to groups that did not receive the attractive subsidy by the second and third month of the post-discount period. None of the intervention variants designed to cue habitual behavior (the time-limited "habit treatment", the longer period of discounts, or the professional habit-marketing treatment) was successful in generating any greater persistence in our trials. Other researchers have also found a decay in behaviors that they tried to induce through incentives, such as handwashing (Hussam et al., 2021) or exercising (Charness and Gneezy, 2009; Acland and Levy, 2015). We find toilet use behavior to be even more short-lived than these other behavioral changes.

As an additional test of habit formation, we conduct a heterogeneity test focusing on individuals who are identified at baseline to be "habitual types", inspired by similar tests applied in the psychology literature (Wood et al., 2002). We don't see any greater persistence in toilet usage in the post-discount period in the subset of subjects that are habitual types. Instead, we observe that the small subset of individuals that used a different (non-FLT) toilet option very regularly at baseline, who were induced to try the FLT through our marketing and discounts, persist with FLT usage for at least 3 months after the end of our intervention. This subset of users were the ones with the most to *learn* about the newer FLT option. We appear to induce some persistent behavior change by giving people an opportunity to learn. However, this is more akin to "brand switching" from a different toilet provider, as opposed to inducing an entirely new behavior.

Taken together, these results suggest that inducing habit-formation in a setting with limited private rewards, such as this one, may be even more challenging than inducing habit formation in settings with significant private rewards (such as exercise, handwashing, or improved oral hygiene). Thus, while using a short-term intervention to induce long-term behavioral change is extremely attractive from a public health policy perspective, we conclude that it is difficult to replace old habits with new ones in a large-scale, real-world implementation.

2 Literature Review

Economists have examined the puzzle of why the adoption rates for technologies and behaviors with the potential to improve health and welfare often remain low. The literature often tries to explain low adoption of seemingly cost-beneficial products by identifying market failures that deter adoption. These include liquidity or credit constraints for poor households (Tarozzi et al., 2014), lack of understanding of the technology's benefits (Foster and Rosenzweig, 2010), risk aversion (Bryan et al., 2014), self-control problems (Banerjee and Mullainathan, 2010; Duflo et al., 2011), and inefficiently little experimentation given learning externalities (Munshi, 2003; BenYishay and Mobarak, 2019; Beaman et al., 2021).

These papers often model decision-makers as rational actors who compare costs and benefits of a product in deciding whether to adopt. Accordingly, previous literature on sanitation, such as Guiteras et al. (2015), focused on creating economic incentives to invest in latrines. Our study, in contrast, examines habit formation, which is not rooted in models of decision-making that rely on careful cost-benefit calculations. A substantial non-experimental literature in economics has previously studied habits. For example, a large macroeconomics literature typically defines habit as measured persistence of a behavior, such as consumption choices, despite changes in the environment. Early studies include Pollak (1976), Campbell and Cochrane (1999), Fuhrer (2000), and Chapman (1998).

Industrial organization and marketing research explores habit formation, learning, and preferences, largely in the context of brand choice. For example, Bronnenberg et al. (2009) and Bronnenberg et al. (2012) document geographic persistence in brand choice, showing that migrants from a state where Brand A dominates Brand B tend to persistently purchase Brand A when they move to a state where Brand B is dominant. Dubé et al. (2010) structurally model loyalty versus learning in purchasing

behavior and Eizenberg and Salvo (2015) examines brand loyalty in cola consumption.

Psychology experiments have introduced interventions designed to change habits. The canonical design of a habit-formation intervention is, like ours, to incentivize a particular behavior, measure whether behavioral change is induced, and then also whether it persists following the withdrawal of incentives. Charness and Gneezy (2009) induce gym-going behavior amongst students and demonstrate that gym-going persists for a subset after the withdrawal of incentives. Acland and Levy (2015) replicate the results but find substantial erosion in gym-going following a school break.

The most closely-related development paper to our own is Hussam et al. (2021). They provide incentives for handwashing and find an increase in handwashing that persists after incentives are removed. In particular, during the first month after withdrawal of incentives, households that had received incentives continue to wash hands before dinner substantially more than those who had a soap dispenser but no incentives. This desirable behavior, however, erodes over the second and third months following the withdrawal of incentives.

There are two important distinctions between the environments studied in Charness and Gneezy (2009) and Hussam et al. (2021), and our own. Both gym-going and hand-washing have substantial *internal* health benefits to the subject or her family. In our context, the main health benefits to using a FLT accrue to the general public, and are *external* to the user. Second, both gym-going and handwashing remain low-cost even after the withdrawal of incentives; handwashing is a convenient and quick action taken inside the home and gym membership remains free for students (although it entails a time cost). In our experiment, subjects have to walk from their homes and pay to use the FLT, creating a barrier to continuing the behavior.

2.1 Motivation for our Experimental Design

We reviewed literatures in psychology, neuroscience and behavioral economics to design interventions in partnership with local experts at *Sanergy* and advertising and marketing professionals at leading global firms, with interest and expertise on branding and behavior change in developing countries. Our goal was to identify promising strategies that would increase the likelihood of a new FLT habit forming among users.

Duckworth and Milkman (2018) review the behavior change literature and enumerate mechanisms that have been found to be beneficial in engendering longer-run behavioral change. Many of the successful methodologies they identify require the subject to be goal-oriented and are thus, inapplicable to our setting. We adopt mechanisms that they describe as helpful but that do not rely on the goal-orientation of the subject. For example, they discuss the importance of "making behavior change easier", "making good behavior more enjoyable", and "repeatedly rewarding good behavior". While *Sanergy*'s primary focus is to provide a sanitary toilet solution, our marketing of FLTs emphasized their convenience and how pleasant they are relative to other alternatives. For example, the FLT contains design elements that limit unpleasant odors.

The habit-formation literature labels the process of acquiring a habit *acquisition*. Once a habit has been acquired, the action is guided by *automated cognitive processes* rather than being preceded by an elaborate decision processes (Aarts et al., 1998). Importantly, the repetition of the behavior is encouraged when it is followed by a reward and performed in a stable and familiar environment, referred to as 'context cues' in Wood (2017). When the stimulus is no longer followed with a satisfying output, the action can lose automaticity, in a process labeled 'extinction' (Adelman and Maatsch, 1956). Therefore, the repetition, satisfaction of the output, and environmental stability are all important to

create a habit. Because of the importance of cue and repetition, the literature suggests that a habit can be disrupted by a change in setting. (Neal et al., 2011; Acland and Levy, 2015; Armitage, 2005).

Insights from this literature motivate our experimental interventions; we designed them to resemble the positive habit conditions suggested by Duckworth and Milkman (2018) and Duhigg (2012). For acquisition, subjects receive discounts to visit Sanergy FLTs. Pursuant to the literature's emphasis on repetition, we have treatment arms with one-month and two-month discounts to allow for the possibility that habit formation will take a long time to develop. Pursuant to the literature's emphasis on a repetition in a consistent uninterrupted environment, one treatment arm gives larger incentives to visit the toilet at a consistent time every day. We cannot experimentally control the delivery of continuous rewards. We do, however, experimentally vary marketing exposure because, as Duhigg (2012) suggests, advertising has been used as a mechanism to associate actions with rewards. Sanergy's toilets and franchising model were designed to provide the most pleasant toileting experience possible for a dry commercial toilet. Their design reduces odor and they provide soap and water handwashing. Thus, of the available alternatives of which we are aware, Sanergy FLTs stand the best chance of being rewarding enough to encourage habit formation in this difficult environment. Our marketing campaign highlighted these features (see Figure A2).

3 Experimental Design

We divided the subjects into two equal-sized "high discount" and "low discount" groups. The former received a free first usage each day during the treatment period; and the latter received a two Kenyan Shilling (Ksh) discount on the first usage of the day. We varied the length of the intervention. One-third of the subjects had access to the discount for one month and two- thirds of the subjects had

access to the discount for two months.

To encourage environmental stability, we experimentally manipulated the time of the day people would find it cheaper to use the toilet. i.e. if a person wakes up every day at 7am and uses the toilet soon thereafter, it is more likely that a habit is formed. Analogously, a habit is less likely to form if the subject visits the facility at different times on different days. We divided the subjects in two groups: half of them could get the discount any time of the day, and the other half could only get their discount if they use the toilet within a two-hour window that they themselves selected at the beginning of the intervention. We were able to monitor the exact time of use because all subjects had to show the card assigned to them (with a tracker connected to our database) to receive their discount. The FLT operator scanned the card using a smartphone device in their possession. The ID card also avoids misuse of the discounts.

In addition to the experimental variation in prices, all subjects across all treatment groups enjoyed a nominal one Ksh discount for any additional usages each day, as well as for any usage in the post-intervention period. This nominal discount encouraged subjects to use the tracking device to obtain that discount, which allows us to collect more complete data on daily usage. The time-constrained treament groups received the larger discount during their chosen time window but only the nominal discount if they used the toilet outside their assigned time window.

We label the four possible combinations of treatments as follows:

- Group 1: High discount and flexible schedule
- Group 2: High discount and constrained schedule
- Group 3: Low discount and flexible schedule
- Group 4: Low discount and constrained schedule

Note that groups 2 and 3 face a trade-off: steeper discount versus more flexible schedule. The constrained schedule in group 2 is an impediment to trying the toilet, but the repetitive behavior it is designed to induce at the same time each day may be conducive to longer-run habit formation. Therefore, the key test to determine whether repetition in a stable context encourages habit is to compare the *post-discount period usage* of group 2 versus group 3. To empirically distinguish the habit mechanism from a learning story, we endeavored to hold the opportunities for learning during the discount period constant across groups 2 and 3. To do so, we conducted pilots outside our experimental areas to test usage under each treatment arm prior to launching the interventions. We subsequently chose the precise 'high' vs 'low' discount amounts in the experiment such that the overall usage rates *during the discount period* would be similar for groups 2 and 3. This specific approach and test was specified in our pre-analysis plan.[1]

We included a cross-cutting marketing treatment as Duhigg (2012) suggests that advertising can enhance the perception of the rewards associated with a behavior and thus promote habit formation. The marketing campaign included a professionally-designed card that showed the advantages of the FLT relative to alternatives. Advantages emphasized included the provision of tissue, the security of the toilet, the availability of a mirror and hook, the usage of sawdust for a fresh smell, the provision of soap for hand-washing, and the promise of freshly cleaned floors and a friendly attendant. The marketing also included a small gift of a water bottle if the participant used an FLT during the first week, and an SMS reminder.

We conducted a baseline survey with questions on demographic variables, self-reported toilet usage, habitual behavioral measurements, health and happiness. The baseline dates range from August 25,

[1]This also helps address a different concern about measurement error: People in the high discount group may have stronger incentives to remember to bring their card than those in the low discount group. More high-discount uses get recorded as a result. Relying on the comparison between two equally attractive groups (2 and 3) also mitigates this concern.

2015 to September 09, 2015, and subjects received their treatment after completing the questionnaire. The first day of usage ranges from August 26, 2015 to October 18, 2015. Between April 1, 2016 and August 26, 2016, around 7 months after the start of the intervention, we conducted an endline questionnaire with similar questions to those in the baseline plus some additional questions on level of satisfaction, self-reported usage during the intervention, reasons to stop using the toilets, and experiences with the tracking ID. Appendix Table A1 summarizes the most relevant information about the participants. Some of the baseline survey questions were used to identify "habitual types".

4 Context and Data

Our sample consists of 3572 subjects, all located in Mukuru, an informal settlement on the west side of Nairobi, Kenya. Sanergy provides sanitation services through a network of FLT franchisees who operate each toilet as an independent business. Figure A1 show photographs of FLTs in the context where the interventions take place, a franchisee and Sanergy's activities. Sanergy obtained consent from 47 toilet operators to participate in this research study. Our data collection partners, Innovations for Poverty Action - Kenya, randomly pre-selected 80 households in the catchment area of each of the 47 participating operators.[2] The surveyors knocked each household's door one by one, and participation was offered only to the one member of the household who answered. Since men are often away at work, most of the participants were women.

The randomized treatment group assignments were printed on closed envelopes; the only way to learn the assigned group was by opening the envelope after agreeing to participate. The final distribution of the four main treatment groups is: Group 1-High discount, flexible schedule (N=714). Group 2-High

[2]We were able to reach the 80 households in most cases, however in some areas we could not reach the expected sample size.

discount, constrained schedule (N=1085). Group 3, Low discount, flexible schedule (N=1077). Group 4, Low discount, constrained schedule (N=696). We allocated more subjects to groups 2 and 3 because that is a key comparison to identify habit formation. The marketing campaign was delivered to half the subjects cutting across all four treatment groups. One-third of subjects received discounts for one month, and two-thirds for two months.

We tracked usage from April 1, 2015 to August 8, 2016. This allowed for tracking usage up until Day 340 post-intervention (a total of 400 tracking days including the intervention). One concern is that, particularly in the post-intervention period, subjects may cease usage of their tracking devices. We truncated our usage analysis at day 210 to mitigate this problem.

Table 1 shows the percentile distribution of usage during the discount period for both the one-month discount treatment and the two-month discount treatment. Groups 2 and 3, the high discount time-constrained group and the low discount time-unconstrained group, respectively, have very similar usage. As expected, the high discount group with the flexible schedule (Group 1) has the most usage. A substantial number of people in all groups never try the toilet.

Table 1: Total Usage during the discount period

		Percentile						
		30	40	50	60	70	80	90
One-Month Discount	Group 1	1	2.5	5	7	11	17	23
	Group 2	1	1	3	5	8	13	20
	Group 3	1	2	4	6	8	13	22
	Group 4	1	1	2	3	5	9	17
Two-Months Discount	Group 1	1	2	4	9	17	26	39
	Group 2	1	2	4	7	11	20	34
	Group 3	1	1.5	3	7	10	18	33
	Group 4	1	1	2.5	4	7	15	25.5

Figure 1 shows per-capita daily usage over time. As expected from Table A1, the high discount-

unconstrained schedule group has higher daily usage. Almost all subjects have between 0 and 3 usages per day.[3] Overall, daily usage had a low take-up, with initial take-up composed of less than a third of subjects overall. Take-up also decreases over time, similar to other lengthy interventions, such as handwashing in Hussam et al. (2021).

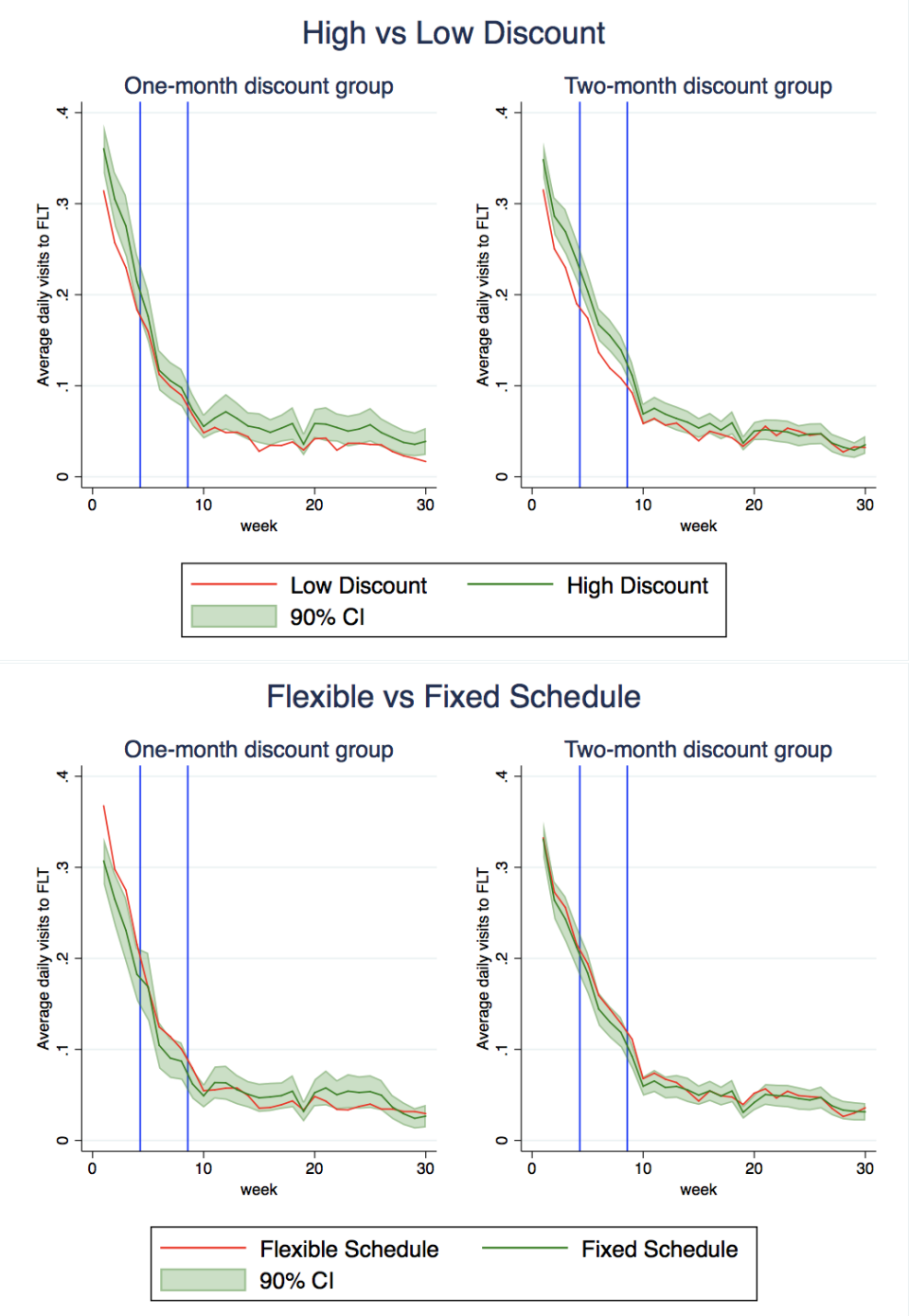
In figure 1, the difficulty in inducing habit change is already observable. Our interventions clearly induced some people to try out the toilet but then gradual attrition is observed. This behavior is consistent with a learning process. Subjects gather information on each visit as to how much they like the FLT, gradually learning about their 'utility' for the FLT relative to their outside option. The upper panels show the modestly higher utilization of the high discount groups (pooled groups 1 and 2) relative to the low discount groups (pooled groups 3 and 4). The lower panel show the lower utilization of the flexible schedule group relative to the fixed schedule group and the similarity of their usage after the end of the discount period. By comparing the right and left panels in the figure, one can see that, although declining throughout, the usage of the two-month discount group is, as expected, higher than the usage of the one-month discount group in the second month.[4]

Using the baseline survey, we examine the existence of habitual "types", individuals who are strongly habit-prone. We investigate whether these individuals are more susceptible to the habit-inducing components of our interventions. In particular, we ask people about their preferences over different types of beverages. Participants rank their most-consumed non-water beverages (tea, coffee, soda, juice, etc.). We then ask whether the participants would switch to their second-choice beverage if it were available for free. We investigate whether our treatments generate any greater persistence among the 48% of people who report that they would only drink their first-choice beverage even if

[3]Only one person had 4 valid usages in one unique day.

[4]The declining pattern could also be produced by measurement issues such as users losing their cards over time, but the 1-month to 2-month discount comparison for days 31-60 suggest that people were responsive to discounts. We will control for a time trend in our regression analysis, and study effects pre- vs post- discount periods

Figure 1: Usage by Treatment



Comparison of daily visits by treatments. The vertical blue lines indicate the end of the one-month and two-month periods. The upper panel depicts the two high discount treatments (groups 1 and 2) versus the two low discount treatments (groups 3 and 4). The Lower panel depicts the two flexible schedule treatments (groups 1 and 3) versus the two fixed schedule treatments (groups 2 and 4).

the second-choice beverage was available for free. Our intention to examine heterogeneity by habitual types was specified in our pre-analysis plan.

A second issue that we investigate using the baseline survey is the potential for learning by individuals completely inexperienced with FLTs. In particular, in the baseline survey, respondents are asked to rank their usage of various waste relief options. We examine the set of individuals who report always using a particular alternative and that alternative is not a FLT. We find that 362 of our 3572 respondents fit into this category. The questions and coding details are explained further in the appendix.

5 Results

We analyze the effects of the treatment on usage during and after the intervention. Table 2 presents the results from a probit specification in which each observation is at the day-subject level. The dependent variable takes the value of one if the subject used the toilet at least once that day and zero otherwise. Low, time-constrained discount is the omitted category. We control for indicators for whether the subject received the marketing treatment and the two-month (instead of 1-month) discount. Since one can clearly notice a decline in usage over time, we also included a linear time trend.

Column (1) examines the usage decision during the discount period. This specification includes one month of observations for those with the one month discount period and two months of observations for those with the two month discount period. For all specifications, errors are clustered by user. Column (1) indicates that larger discounts on a flexible schedule induced usage, with group 1 displaying the highest usage rate, followed by groups 2 and 3.

Column (2) displays the effect of the treatment groups on the first month of the post-discount period

Table 2: Decision to use FLT today, by treatment group

	(1)	(2)	(3)	(4)
	During discount	Post M1	Post M2	Post M3
High-discount, unconstrained (group 1)	0.075***	0.028***	0.009	0.007
	(0.012)	(0.009)	(0.008)	(0.007)
High-discount, constrained (group 2)	0.043***	0.019**	0.010	0.002
	(0.011)	(0.008)	(0.007)	(0.006)
Low-discount, unconstrained (group 3)	0.040***	0.024***	0.004	-0.002
	(0.011)	(0.008)	(0.007)	(0.007)
Two months discount	-0.001	0.002	-0.001	-0.000
	(0.007)	(0.006)	(0.005)	(0.005)
Marketing	0.017**	0.003	0.004	0.002
	(0.008)	(0.006)	(0.005)	(0.005)
Days since discount began	-0.003***	-0.001***	-0.000**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Mean of dep. variable, control group (group 4)	0.123	0.040	0.032	0.031
SD of dep. variable, control group (group 4)	0.329	0.196	0.177	0.174
p-value: Group 2 = Group 3	0.775	0.400	0.374	0.412
Observations	178290	107160	107160	107160

Probit specifications. Observations are at the individual-day level. The dependent variable takes the value of 1 if the subject uses the toilet in a specific day, and 0 otherwise. Errors were clustered by user. Robust standard errors are displayed in parentheses. The coefficients are the marginal effects of a probit. * p< 0.05, ** p< 0.01, *** p< 0.001.

(days 31 to 60 for the one-month discount group and days 61 to 90 during for the two-month discount group). The coefficient for groups 1-3 are positive and statistically significant. Toilet usage persists for a month after the withdrawal of incentives. The fact that we control for the negative slope shows that this positive effect does not come from just the very first days of the post-discount. The persistence is not perfect, in that, for example, the coefficient for the high-discount, constrained group is roughly half of what it was during the discount period. The persistence is consistent with both "habit formation" over this short run period and with some users experimenting with, and learning about, the suitability of the FLT option in their lives.

The initial toilet usage of group 2 (high discount, time constraint) and group 3 (low discount, no time constraint) is very similar, as shown by the coefficients for group 2 and group 3 in Column (1). Furthermore, as previously shown in table 1, the thirtieth through ninetieth percentiles of usage for group 2 and 3 are extremely similar, both for the one- month discount group and for the two-month discount group. Thus, if time-delimiting the discount and imposing repetition encouraged habit formation, conditional on a similar usage during the treatment, we would observe the coefficients for groups 2 and 3 diverge during the post-discount period. Instead, there is no significant difference in the first post-discount month between groups 2 and 3 (p-value testing equality of coefficients shown in the table). Thus, time-constraining discounts to encourage regular usage does not make a person more likely to develop a habit and continue usage, as the psychology of habit-formation might predict.

Columns (3) and (4) of table 2 show no persistence in any group beyond the first post-discount month. One can observe that there is only a small and statistically insignificant residual positive propensity to use FLTs by groups 1 to 3 relative to the excluded group. Columns (3) and (4), again, show no difference between groups 2 and group 3. Thus, while we succeed in inducing a short-lived behavioral change, we do not succeed in producing a long-run habit change.

As seen in column (1), the marketing campaign had a small but statistically significant positive effect on usage during the discount period. In principle, the marketing could have made consumers enjoy the features of the toilet more, reinforcing habit formation. However, Columns (2)-(4) suggest that marketing had no significant continued effect on usage past the discount period. Appendix table A2 replicates the above results but using time fixed-effects rather than a linear time trend. The coefficient estimates are very similar, except that the dummy variable for the two-month discount group now partially captures the negative slope with respect to time.

Table 3: Decision to use FLT at least once

	(1)	(2)	(3)
	Ever used	Date first used	Used once
Marketing	0.123***	-2.796***	0.0674***
	(0.0144)	(0.543)	(0.0172)
Mean of dep. variable, no marketing	0.668	6.436	0.096
SD of dep. variable, no marketing	0.471	14.324	0.294
Observations	3572	2701	2701
Sample	All	Users	Users

User-level probit specifications in columns 1 and 3, OLS in column 2. Robust standard errors are displayed in parentheses. The coefficients in columns 1 and 3 are the marginal effects of a probit. * p< 0.05, ** p< 0.01, *** p< 0.001.

We have established that marketing only has a positive and significant impact on toilet usage during the discount period. We undertake additional specifications to better understand these impacts. Table 3 estimates specifications in which there is a single observation for each subject (not subject-days as before). We created three subject-level variables, used as dependent variables in the three columns: (1) an indicator variable that takes the value of one if the subject has used the FLT at least once during our study; (2) for the subset of the individuals who used the toilet at least once, the day-of-sample of the first usage; and (3) for the subset of the individuals who used the toilet at least once, and indicator that takes the value of one if the individual used FLT *only* once. The probit specification in column

(1) shows that the marketing treatment has a large effect on encouraging subjects to try the toilet at least once. Column (2) shows an OLS specification using the day-of-sample that individuals first used the toilet as the dependent variable. The sample consists of the subset of subjects who used the toilet at least once. The negative coefficient for the marketing indicator suggests that individuals exposed to marketing try the toilet earlier than those that were not exposed to marketing. Column (3) is a probit specification for the subset of subjects who have used the FLT at least once. It shows that, among subjects who used the toilet at least once, subjects in the marketing treatment are more likely than those unexposed to marketing to use the toilet only once. In combination with the results in Table A2, the results suggest that the individuals who were exposed to the marketing campaign were disproportionately likely to be individuals who tried the toilet but used it only used it once. These results strongly suggest that the marketing treatment encouraged subjects to try the toilet but did not enhance the subject's continued usage probability.[5]

We also conduct a heterogeneity test focusing on individuals who are identified at baseline to be "habitual types". We investigate whether our treatments generate any greater persistence among the 48% of people who report that they would only drink their first-choice beverage even if the second-choice beverage was available for free. The results for this subgroup are virtually identical to the results for the full sample (see appendix Table A4 for construction of the variables and appendix Table A5 for the subsample results).

[5]As the marketing treatment is randomized across all treatment groups, results are nearly identical when other independent variables are included in the specification.

Table 4: Decision to use FLT today (respondents habituated to a non-FLT toilet)

	(1)	(2)	(3)	(4)
	During discount	Post M1	Post M2	Post M3
High-discount, unconstrained (group 1)	0.068***	0.062***	0.183***	0.162***
	(0.026)	(0.023)	(0.046)	(0.048)
High-discount, constrained (group 2)	0.043*	0.053**	0.172***	0.153***
	(0.025)	(0.021)	(0.045)	(0.047)
Low-discount, unconstrained (group 3)	0.022	0.038*	0.169***	0.152***
	(0.025)	(0.023)	(0.044)	(0.047)
Two months discount	0.029*	0.007	0.010	0.011
	(0.017)	(0.014)	(0.013)	(0.010)
Marketing	0.039*	-0.000	-0.009	-0.015
	(0.020)	(0.011)	(0.011)	(0.010)
Days since discount began	-0.002***	-0.000*	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Mean of dep. variable, control group (group 4)	0.061	0.003	0.000	0.000
SD of dep. variable, control group (group 4)	0.240	0.054	0.000	0.000
p-value: group 2 = group 3	0.384	0.302	0.839	0.964
Observations	17790	10860	10860	10860

Probit specifications estimated on the subset of baseline respondents habituated to a non-FLT toilet. Observations are at the individual-day level. The dependent variable takes the value of 1 if the subject uses the toilet in a specific day, and 0 otherwise. Errors were clustered by user. Robust standard errors are displayed in parentheses. The coefficients are the marginal effects of a probit. * $p< 0.05$, ** $p< 0.01$, *** $p< 0.001$.

5.1 Learning versus Habit Formation

The persistence we observe for one month post-discount is consistent with short-lived habit formation, but also with some users learning about a new technology and liking it. To further examine the learning hypothesis, we conduct a heterogeneity test that was not pre-specified. We investigate whether our intervention increased FLT usage for the subset of individuals who had more to learn about FLT and discover their preference relative to their prior strategy.

In our baseline survey, we ask individuals about their current waste elimination procedures. Subjects ranked various relief alternatives (non-FLT commercial toilet, OD, etc.) and reported the frequency of their usage of these alternatives. Table 4 shows discount-period and post-discount treatment effects for the small subset (about 10%) of users who report that they "always" use a particular toileting option that is not FLT. The majority of this group report using an alternative commercial toilet.[6]

The results for the subgroup that always used non-FLT toilets are quite distinct from the overall sample. Overall FLT usage is about half of that of the full sample. This is not surprising as this group reported having a well-established toileting strategy and thus may have little incentive to try FLTs. However, in this group, the estimated effect of receiving either the high discount or the unconstrained low discount is statistically significant for the three months post-discount (compared to the low-discount, constrained-schedule group). Providing discounts therefore appears to have succeeded in creating some long-term switchers. The strong effects observable only for this group is consistent with individuals unfamiliar with FLTs taking advantage of the discounts to learn about them and ultimately choosing to continue using them. This is more akin to "brand switching". Evidently our interventions overcome "brand persistence" noted in the marketing literature. Unfortunately, inducing switchers from other commercial toilets (as opposed to from OD) likely produces minimal public health benefits.

[6]While open defecation or "flying toilet" usage is widely practiced, very few subjects admit to this.

6 Conclusions

We conducted a large field experiment to design and test habit-formation strategies to encourage toilet use. We were not able to recreate the promising habit formation effects that have been observed in experimental trials in psychology. Many of the limitations of conducting a field trial under real-world conditions in a developing country may have undermined our ability to produce habit change among subjects. While FLTs are better than other toilet options in the Mukuru slum, it is still challenging for operators to provide a consistently attractive, high-quality service in that environment. Profit margins for operators are low, limiting investments in maintenance. Users may sometimes experience long lines during busy hours, which undercuts repetitive actions in a stable environment required for habit formation. The absence of tangible private benefits to consistent usage may be demotivating.

Habit formation is an appealing strategy to induce desirable behavior if a short intervention can produce long-term results. If habit change could be induced in contexts like this, it would a powerful tool for public health. Unfortunately, in our context, despite adopting many best practices in the habit formation literature, our interventions failed to produce durable behavioral change, except for the small group who were (plausibly) unfamiliar with the toilets. In developing new product dissemination strategies, implementers may wish to pay special attention to subsets of users who have more to learn. Giving people opportunities to experiment with a new product sometimes leads to positive learning and persistent behavior change.

While the literature suggests that habit change is challenging in all circumstances, our results suggest that habit change may be particularly challenging in circumstances in which the benefits to habit change are pro-social rather than private.

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Appendix - Online Only

Table A1: Summary Statistics

Observations	3572	
Female (%)	2551	(71.42%)
Minimum Age	12	
Age 25th percentile	23	
Age 50th percentile	27	
Age 75th percentile	34	
Maximum Age	80	
Average GPS Distance to nearest FLT in meters	30.55	
Average Self-Reported Income in USD (in Ksh)	122.60	(12623.45)

Table A2: Decision to use FLT today with day fixed effects

	(1)	(2)	(3)	(4)
	During discount	Post M1	Post M2	Post M3
High-discount, unconstrained (group 1)	0.075***	0.028***	0.009	0.007
	(0.012)	(0.009)	(0.008)	(0.007)
High-discount, constrained (group 2)	0.043***	0.019**	0.010	0.003
	(0.011)	(0.008)	(0.007)	(0.006)
Low-discount, unconstrained (group 3)	0.040***	0.024***	0.004	-0.002
	(0.011)	(0.008)	(0.007)	(0.007)
Two months discount	-0.002	-0.060***	-0.015**	-0.011*
	(0.007)	(0.007)	(0.007)	(0.006)
Marketing	0.017**	0.003	0.004	0.002
	(0.008)	(0.006)	(0.005)	(0.005)
Day fixed effects	Yes	Yes	Yes	Yes
Mean of dep. variable, control group (group 4)	0.123	0.040	0.032	0.031
SD of dep. variable, control group (group 4)	0.329	0.196	0.177	0.174
p-value: group 2 = group 3	0.777	0.399	0.374	0.406
Observations	178290	107160	107160	107160

Table A2 replaces the time trend with day fixed effects from table 2. Results for the variables of interest are similar to our main specifications. Observations are at the individual-day level. The dependent variable takes the value of 1 if the subject uses the toilet in a specific day, and 0 otherwise. Errors were clustered by user. Robust standard errors are displayed in parentheses. The coefficients are the marginal effects of a probit. * p< 0.05, ** p< 0.01, *** p< 0.001.

Subsample Analysis

Habitual Types. Prior to our experiment, we conducted a baseline survey of all treatment groups. The baseline survey asked a variety of questions about toilet habits, other habits, income, household structure and health. Using this survey, we can examine the relationship between baseline survey responses and eventual toileting behavior across treatment groups.

We examine the pre-intervention beverage habits of subjects as a measure of general habitualness. We constructed a dummy variable that defines which users are habitual in their beverage consumption. In order to do so, we will use a few questions from the baseline questionnaire depicted in table A3. Question $Q1$ asks respondents to rank their most consumed beverages. Questions $Q2$ and $Q3$ ask for the frequency of usage for the top two most used methods. Finally, $Q4$ asks whether the respondent would swap the stated rank between option one and two, if option two was free. We define a non-FLT habitual user as follows:

- If the answer to $Q4$ was 'no,' then $Bev\_Hab = 1$.
- If the answer to $Q4$ was 'yes,' then $Bev\_Hab = 0$.

That is, if the respondent stated they would consume their second highest ranked option if it were free instead of paying the usual price for consuming their highest ranked option.

Table A5 repeats our main specification, using the subset of individuals who identify themselves as "habitual" using the beverage questions in the baseline survey. These results look extremely similar to the overall results.

Table A3: Questions used to create the beverage habitual types

Q1. What beverages do you usually consume? (Tick all that apply, and rank)	Tea
	Coffee
	Soda
	Juice
	Soup
	Other
Q2. Consider your highest ranked option. How frequently do you consume it?	Always
	Most of the time
	Sometimes
	Rarely
Q3. Consider your second highest ranked option. How frequently do you consume it?	Always
	Most of the time
	Sometimes
	Rarely
Q4. If your second highest ranked option is free, would you consume it instead of paying the usual price for consuming your highest ranked option?	Yes
	No

Table A4: Beverage habit distribution

If your second highest ranked option is free, would you consume it instead of paying the usual price for consuming your highest ranked option?	Frequency	Percentage
Yes ($Bev\_Hab = 0$)	1,361	38.1%
No ($Bev\_Hab = 1$)	1,704	47.7%
N/A ($Bev\_Hab = .$)	507	14.2%
Total	3,572	100.0%

Table A5: Decision to use FLT today (respondents habituated to their highest ranked beverage choice)

	(1)	(2)	(3)	(4)
	During discount	Post M1	Post M2	Post M3
High-discount, unconstrained (group 1)	0.075***	0.024*	0.011	0.005
	(0.017)	(0.012)	(0.011)	(0.010)
High-discount, constrained (group 2)	0.035**	0.020*	0.010	-0.003
	(0.016)	(0.011)	(0.011)	(0.009)
Low-discount, unconstrained (group 3)	0.042***	0.024**	0.007	-0.003
	(0.016)	(0.012)	(0.011)	(0.009)
Two months discount	-0.004	0.002	-0.003	-0.010
	(0.010)	(0.008)	(0.008)	(0.007)
Marketing	0.024**	0.004	0.001	0.001
	(0.012)	(0.008)	(0.007)	(0.006)
Days since discount began	-0.003***	-0.001***	-0.000***	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Mean of dep. variable, control group (group 4)	0.132	0.040	0.030	0.031
SD of dep. variable, control group (group 4)	0.338	0.195	0.171	0.175
p-value: group 2 = group 3	0.606	0.640	0.727	0.964
Observations	84660	51120	51120	51120

Probit specifications estimated on the subset of baseline respondents habituated to their highest ranked beverage choice. Observations are at the individual-day level. The dependent variable takes the value of 1 if the subject uses the toilet in a specific day, and 0 otherwise. Errors were clustered by user. Robust standard errors are displayed in parentheses. The coefficients are the marginal effects of a probit. * p< 0.05, ** p< 0.01, *** p< 0.001.

Commercial non-FLT Users. As discussed in the main text, we examine the pre-intervention toileting habits of subjects. We constructed a dummy variable that defines which users always use a particular non-FLT alternative. In order to do so, we will use a few questions from the baseline questionnaire depicted in table A6. Question $Q1$ asks respondents to rank their most used methods for defecation. Questions $Q2$ and $Q3$ ask for the frequency of usage for the top two most used methods. We define a non-FLT habitual user as follows:

1. If the first choice to $Q1$ was not FLT, and the answer to $Q2$ was 'always,' then $Toi\_Hab = 1$.

2. If the second choice to $Q1$ was not FLT, and the answer to $Q3$ was 'always,' then $Toi\_Hab = 1$.

3. Else, $Toi\_Hab = 0$.

That is, if the respondent stated as 'always' using any of the top two choices, and that choice is not FLT.

Results for the 362 individuals who report always using a particular alternative to the FLT are presented in the main text in Table 4.

Table A6: Questions used to create the non-FLT habitual types

Q1. What are the most common options you use for relieving yourself? (Please rank the top three options according to frequency of use)	Commercial FLT
	Commercial non-FLT
	Privately owned toilet
	Fresh Life plot-toilet
	Other shared plot-toilet
	Neighbor's toilet
	Free public toilet
	Toilet at work
	Toilet at school
	Open area
	Flying toilet
	Other
Q2. Consider your highest ranked option. How frequently do you use it?	Always
	Most of the time
	Sometimes
	Rarely
Q3. Consider your second highest ranked option. How frequently do you use it?	Always
	Most of the time
	Sometimes
	Rarely

Table A7: Non-FLT sanitation methods that respondents report they *always* use

Sanitation Method	Frequency	Percentage
Commercial non-FLT	297	82.0%
Privately owned toilet	9	2.5%
Fresh Life plot-toilet	1	0.3%
Other shared plot-toilet	24	6.6%
Neighbor's toilet	7	1.9%
Free public toilet	4	1.1%
Toilet at work	13	3.6%
Toilet at school	1	0.3%
Open area	3	0.8%
Flying toilet	3	0.8%
Other	0	0.0%
Total	362	100.0%

Figure A1: Context

Left panel: A street in the Mukuru settlement where the interventions take place
Right panel: A Sanergy franchisee pictured with the FLT toilet business she operates

A comparison of the Sanergy *Fresh Life* Toilet and another toilet in operation in Mukuru

Sanergy's toilet emptying truck that takes waste out of Mukuru

Figure A2: Marketing

Marketing materials and iconography developed by Sanergy, Populist and GRID Impact