Using reminder messages to increase recycling behaviour in Peru

Pre-analysis Plan

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Abstract

The municipality of Miraflores in Lima, Peru, has established a recycling programme, in which households can participate voluntarily and free of charge. Although households sign up to the programme voluntarily, few recycle regularly, pointing towards a gap between people's intention to recycle and their actual recycling behaviour. Reminders can help people to follow through with their intentions by addressing the problem of limited attention. In this study, we conduct a randomized controlled trial (RCT) to test whether sms reminders can increase recycling behaviour of households. In particular, we will contrast the effect of continuous vs. interrupted vs. restarted reminders on households' recycling behaviour. We will measure recycling behaviour of households over 12 weeks in total. While the first three weeks will serve as a baseline measure, the subsequent nine weeks will be our intervention period where households will be randomly assigned to either i) a control group that does not receive any reminders, ii) a group that receives continuous reminders over the whole nine weeks (continuous treatment), iii) a group that receives reminders only for the first three weeks (interrupted treatment), iv) or a group that receives reminders for the first three weeks and for the last three weeks, with a three weeks' pause in between (restarted treatment). Our design will allow us to analyse the effects of continuous reminders on households' recycling behaviour, persistence of reminder effects after the intervention has ended, as well as restart effects when the intervention is taken up again. We will further observe whether our intervention has positive spillover effects on the recycling behaviour of neighbouring households.

1 Introduction

The municipality of Miraflores in Lima, Peru, has established a recycling programme, in which households can participate voluntarily and free of charge. Households separate their recyclable materials at home and collect them in a separate bag, which they then need to place outside their house on the street on a specific day per week to be collected by formal recyclers. A main challenge for the programme to be successful is that many of the registered households do not recycle regularly.

Since people sign up to the recycling programme voluntarily, we can expect that they have a general interest and intention to recycle – otherwise, people could simply refrain from signing up in the first place. Thus, if people who have voluntarily signed up to the programme do not recycle regularly, they may still intend to do so, but there seem to be certain factors that prevent them from following through with it. As a result, we see a gap between people's intention to recycle and their actual recycling behaviour. The fact that people have trouble to follow through with good intentions is a common observation in many domains, from health-related behaviours like exercising or sticking to diets, over completing important application forms in time to financial decision-making (Rogers et al., 2015).

An important reason why people fail to fulfil their intentions can be the problem of limited attention (Karlan et al., 2016). In the case of the recycling programme in Miraflores, the recycling bags are collected once or twice a week (depending on the zones) by formal recyclers, always on the same day(s) at approximately the same time. Thus, paying attention to this specific day and time period to place the recycling bags outside on the street is crucial for people to participate successfully. However, attention is a limited resource and people may simply forget about the recycling truck passing by on certain days. This idea is also linked to the concept of "mental bandwidth", introduced by Mullainathan and Shafir (2013), which refers to the limited amount of cognitive capacity and executive control that we have available for completing different tasks.

Research has shown that sending timely reminders can help to overcome the problem of limited attention, thereby facilitating people to follow through with their intentions, for example in the context of personal savings (Karlan et al., 2016), loan payment (Cadena and Schoar, 2011), gym attendance (Calzolari and Nardotto, 2016) or dental health prevention (Altmann and Traxler, 2014).

In this study, we conduct a randomized controlled trial (RCT) to test whether simple reminder messages can increase recycling behaviour of households. Our reminders aim to shift people's attention to the recycling programme, which we expect to result in increased recycling activity. In particular, we will contrast the effects of continuous vs. interrupted vs. restarted reminders on households' recycling behaviour. While the timing and content of reminders has been varied in previous studies, to our knowledge this is a novel design that has not been tested yet. Especially for behaviours that require regular engagement such as recycling, it is important to understand whether continuous reminders are needed and effective to successfully encourage behaviour over a longer time period, or whether initial reminders might be enough to induce some form of habit formation (Charness and Gneezy, 2009) that may persist even after the intervention has ended, or whether stopping and restarting the intervention might be more effective to capture people's attention over time and eventually lead to higher recycling activity. Our design will allow us to analyse the effects of continuous reminders on households' recycling behaviour, persistence of reminder effects after the intervention has ended, as well as restart effects when the intervention is taken up again.

We will measure households' recycling behaviour over a total time period of 12 weeks. While the first three weeks will serve as a baseline measure, the subsequent nine weeks will be our intervention period where households will be randomly assigned to either i) a control group that does not receive any reminders, ii) a group that receives continuous reminders over the whole nine weeks (continuous treatment), iii) a group that receives reminders only for the first three weeks (interrupted treatment), iv) or a group that receives reminders for the first three weeks and for the last three weeks, with a three weeks' pause in between (restarted treatment).

In addition to analysing the recycling behaviour of our sample of households, we will measure whether our intervention has "social spillover effects" on neighbouring households. This means, we will observe whether neighbouring households of treated households will increase their recycling activity as well in response to increased recycling activity of the treated households. Since the recycling behaviour in our study context is very visible to neighbours - given that the bags are placed outside on the street - we expect neighbours to be reminded about the programme as well the more households in their surroundings participate actively. The spillover question is motivated by the literature on peer effects and social networks, which shows that the behaviour of relevant peers influences our own decision making across different domains (see e.g. Bandiera et al., 2010; Bursztyn et al., 2014; De Giorgi et al., 2010; Duflo and Saez, 2003; Fortin and Yazbeck, 2015). We may decide to report the social spillover results in a separate paper.

A benefit of sms reminders lies in their low implementation costs, which is especially important for studies conducted outside a high-income country context where financial resources may be limited. Our intervention will generate important new insights on how such a low-cost tool can be used most effectively to encourage pro-environmental behaviour in our study region and beyond.

2 Experimental Design

2.1 Sampling

There are 7183 households officially registered in the recycling programme (end of March 2021). Of those 7183 households, 3480 are registered with a unique address.[1] Since the district of Miraflores contains single family houses as well as apartment buildings, two households being registered with the same address means that those households are living in the same building. In our study, we focus on registered households with a unique address only. This means, we include single family houses as well as apartment buildings where only one household is registered. We do so, because in the case of apartment buildings, the bags per building are collected jointly, which makes it impossible to identify to which household the bags belong if there is more than one household registered in the same building.[2]

When households register for the recycling programme, they are asked to leave a phone number as contact details. Households can decide whether they register with a landline or a cell phone number. Since sending reminders via sms requires access to cell phone numbers, we focus on those households of which cell phone numbers are available. Of the 3480 households that are registered with a unique address, this is the case for 1392 households. These 1392 households constitute our overall sample. It should be noted that we cannot be sure that all 1392 cell phone numbers will still be valid. Thus, our overall sample might be slightly smaller based on how many numbers will still be up to date.

2.2 Treatment groups

We will randomly distribute our sample into four groups of equal size. Given that our overall sample consists of 1392 households, this means there will be 348 households per group. The randomization will be done at the individual household level. The four groups will consist of three treatment groups and one control group, which will receive the reminders during the intervention period as follows (after a three weeks' baseline period):

i) **Control group (T0):** does not receive any reminders
ii) **Continuous treatment group (T1)**: receives continuous reminders over the whole nine weeks
iii) **Interrupted treatment group (T2)**: receives reminders only for the first three weeks
iv) **Restarted treatment group (T3):** receives reminders for the first three weeks and for the last three weeks, with a three weeks' pause in between

The following table provides an overview of our design.

[1] Unique means that no other household is registered with the same address in the programme.
[2] In apartment buildings, the bags are usually collected in a shared space and then taken outside on the street by the caretaker or doorman of the building.

	Baseline			Intervention								
	B1	B2	B3	I1	I2	I3	I4	I5	I6	I7	I8	I9
Control												
Continuous				x	x	x	x	x	x	x	x	x
Interrupted				x	x	x						
Restarted				x	x	x				x	x	x

Table 1: Study design overview.

The treatment variation based on blocks of three weeks is chosen given the irregular nature of households' recycling behaviour. From pre-covid data (until February 2020) from the municipality we know that only few households recycle regularly every week (or even more than once a week, if the bags are collected twice). Most households recycle irregularly, and rather every second or third week, on average. Some households that are registered do not recycle at all. We do not have any data on households' recycling behaviour afterwards, as the municipality had to stop all measurements due to the pandemic. However, during a one-week pilot that we did in the beginning of May 2021, only 13% of all enrolled households recycled in that week, confirming the irregularity in recycling behaviour from pre-covid times.[3]

The treatment message of the sms reminder will contain a friendly greeting from the municipality and a simple reminder for people to put their recycling bags outside on that day. The message will be formulated in Spanish.

2.3 Experimental procedure and data collection

The district of Miraflores is distributed into 14 zones, based on which the recycling programme is organized. Recycling bags are collected on Mondays to Fridays in the mornings and afternoons, and on Saturdays in the mornings. There are always two recycling trucks operating in two different zones at the same time. In some zones (6 out of 14), the bags are collected once a week; in the other zones (8 out of 14), they are collected twice a week.

To keep track of households' recycling behaviour, we will accompany the recycling trucks that are responsible for collecting the recycling bags on their daily routes over a total time period of 12 weeks. There will be four people doing the measurement of households' recycling behaviour in total – two people will accompany the trucks in the mornings, two other people in the afternoons. The four people (enumerators) will follow the recycling trucks by bike.[4] The recording of households' recycling behaviour will be done through audio recordings via headsets.[5] Enumerators are instructed to record the following details: street name, house number, house type (single family house or apartment building), and number of bags. The audio recordings will be transcribed to an excel sheet afterwards. All enumerators are provided a cyclers insurance for the period of data collection and are experienced in riding a bicycle. They are further instructed to wear a helmet as well as face masks at all times (which will be provided to them).

The reminders will be sent to households in the early mornings of the collection days via sms through a Peruvian sms provider system. This will be adjusted based on the different zones and respective collection days (e.g. if a household lives in a zone where the bags are collected on Wednesdays, the reminders will be sent on Wednesdays in the early morning). For better comparability, we will send

[3] This percentage is based on the number of addresses that recycled as a fraction of all enrolled addresses.
[4] Due to covid, being in the recycling truck with the recyclers is not possible for our people.
[5] Our pilot showed that writing down the addresses while cycling does not work.

reminders to all households only once a week, regardless of whether the bags are collected once or twice a week in the respective zones. In the cases where there are two collection days per week, the reminders will be sent in the morning of the first collection day of the week. This way, it will also be possible for us to analyse whether recycling behaviour will be different on days where no reminder is sent, or whether one reminder per week might be enough to encourage recycling behaviour on both days.

2.4 Hypotheses

We formulate the following hypotheses for our study.

Primary outcomes:

H1 (initial reminder effect): We expect households in all three treatment groups to recycle more during the first three weeks of our intervention period (where all treated households receive a weekly reminder) than households in the control group, on average (compare weeks I1-I3 between all treatment groups and the control group).

The motivation for this hypothesis is that the reminders will address people's limited attention about the recycling programme, which will result in higher recycling activity.

H2 (continuous treatment effect): We expect households in the continuous treatment group to recycle more during our whole intervention period than households in the control group, on average (compare weeks I4-I6 and I7-I9 between the continuous treatment and the control group). However, we expect this effect to decrease over time, so that it will be smaller in weeks I7-I9.

The motivation here is again that the reminders will address people's limited attention about the recycling programme, which will result in higher recycling activity throughout the whole intervention period. However, we expect that the reminder effect will decrease over time, as the attention that people place on the reminders will diminish after a while as people get used to receiving the messages.

H3 (interrupted treatment / persistence effect): We expect that the initial reminder effect will persist for a while, so that households in the interrupted treatment group will still recycle more in the subsequent three weeks than households in the control group (I4-I6) albeit less so, though that this effect will fade away in the course of the remaining three weeks (I7-I9) when the reminders are not reinforced (compare weeks I4-I6 and I7-I9 between the interrupted treatment and the control group).

The motivation for this hypothesis is that the initial reminders will induce some form of habit formation in recycling behaviour, though that this effect will fade away over time when the reminders are not reinforced.

H4 (restarted treatment effect): As for the interrupted treatment group, we expect that the initial reminder effect will persist for a while, so that households in the restarted treatment group will still recycle more in the subsequent three weeks than households in the control group (I4-I6) albeit less so. We then expect recycling behaviour to increase again during the last three weeks (I7-I9) when the reminders will be sent again (compare weeks I4-I6 and I7-I9 between the restarted treatment and the control group).

The motivation for this hypothesis is that the initial reminders will induce some form of habit formation in recycling behaviour as in H3, and that the reinforcement of the reminders in the last three weeks will prevent that the reminder effect diminishes over time.

H5 (continuity vs. restart effect): We expect households in the restarted treatment group to recycle more during the last three weeks (I7-I9) than households in the continuous treatment group (compare weeks I7-I9 between the restarted treatment and the continuous treatment group).

The motivation for this hypothesis is that the restarted reminder will capture people's attention better than the continuous reminder so that it will be more effective in the long run.

The following table summarizes the hypotheses for the different blocks of three weeks:

		Intervention period	
Treatment comparison	**I1-I3**	**I4-I6**	**I7-I9**
Continuous (T1) vs. control (T0)	T1>T0 (H1)	T1>T0 (H2)	T1>=T0 (H2)
Interrupted (T2) vs. control (T0)	T2>T0 (H1)	T2>=T0 (H3)	T2=T0 (H3)
Restarted (T3) vs. control (T0)	T3>T0 (H1)	T3>=T0 (H4)	T3>T0 (H4)
Continuous (T1) vs. restarted (T3)			T1<T3 (H5)

Table 2: Hypotheses overview for primary outcomes.

Secondary outcomes:

H6 (social spillover effect): If our reminder treatments will have a positive effect on recycling behaviour of treated households compared to the control group, on average, we expect surrounding neighbours of treated households to recycle more than surrounding neighbours of households in the control group, on average.

The motivation for this hypothesis is that neighbouring households of treated households will be reminded about the programme as well when seeing more households in their close surroundings starting to recycle, and that such peer effects will increase the recycling behaviour of neighbours, too.

2.5 Measurement of variables

Primary outcomes:

We will measure households' recycling behaviour during our intervention period in the following two ways:

- As a binary variable per week: whether there is a recycling bag outside the house on the collection day (yes/no)
- As a count variable per week: the total number of bags that are recycled by a household on the collection day

Secondary outcomes:

We aim to exploit geographical data to analyse spillovers of our intervention to neighbouring households. Conditional on finding the expected treatment effects, we will measure whether neighbouring households of treated households will recycle more than neighbouring households of households in the control group. Neighbouring households will be defined as dyads, i.e. pairs of neighbours of treated households or control households. Moreover, we may explore spillover effects on more aggregate levels such as street blocks.

3 Empirical Strategy

3.1 Outcome variables

Primary outcomes:

Our primary outcomes will be the recycling behaviour of our sample of households during the intervention period. This means every week:

- Whether a household recycles on the collection day (yes/no)
- How many bags are recycled by a household per collection day (count variable)

For the analysis, we will look at the behaviour each week as well as at aggregate measures over blocks of three weeks and over the whole intervention period.

In the cases where there are two collection days per week, we will focus on recycling behaviour on the first collection day every week (the one on which the reminders will be sent) for our analysis.

Secondary outcomes:

Conditional on finding the expected treatment effects, our secondary outcomes will be the social spillover effects of our intervention on neighbouring households during the intervention period. We will use the same outcome variables defined above, though applied to the neighbours.

3.2 Planned specifications

Average treatment effects

We will compare the recycling behaviour of households during our intervention period between the different treatment groups and the control group. We will analyse whether our reminder treatments have a positive effect on the recycling behaviour of treated households during our intervention period compared to the control group, on average. To do so, we will use regression analyses with the different treatments as dummy variables. Our dependent variables will be i) whether a household recycles per week and ii) how many bags are recycled by a household per week. We will look at behaviour each week as well as at aggregate measures over blocks of three weeks and over the whole intervention period. Additional specifications will include controls for the house type, the zones, and the sign-up year.

We will further analyse whether our intervention has positive spillover effects on the recycling behaviour of neighbouring households. We will use dyads, i.e. direct pairs of neighbouring households, as the unit of analysis and may further explore effects on more aggregate levels such as street blocks.

Heterogeneous treatment effects

We will analyse heterogeneous treatment effects of our reminder treatments based on different variables, including the house type (single family house or apartment building), the sign-up year to the programme (2015-2021), and the zone the household lives in (1-14). We may also look at different sub-groups based on households' recycling behaviour during the baseline period.

3.3 Power calculations

Different power calculations have been performed using the two proportions command (chi-squared test, two-sided) in Stata, assuming a power of 0.8 and a significance level of 0.05. For our calculations, we use different effect size scenarios based on different base levels, which seem realistic based on pre-

covid and pilot data (between 5% and 20% participation per week). For example, with our four groups of 348 households each, we will be able to detect an increase of 10 percentage points from all base levels between 5% and 20%, or an increase of eight percentage points from a 10% base level or of seven percentage points from a 5% base level (among other scenarios). We consider our calculations to be conservative estimates since regression analysis will allow us to estimate our treatment effects more efficiently. We calculate conservatively since we cannot be sure that all cell phone numbers will still be valid, so that we have to account for some buffer for potential attrition (we expect that around 10% attrition might be realistic).

For the spillover analysis, our statistical power will be even higher if we use dyads as our unit of analysis since it will multiply the number of observations by the number of neighbours that we include, which will allow us to detect even smaller effect sizes than the scenarios outlined above.

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