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waste composting

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Priming and social norms to facilitate waste composting [*]

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Abstract

The combination of social norms and nudges has proven to be a powerful tool for inciting people to adopt pro-environmental behaviors. In this study, we implemented nudges that promote pro-environmental behavior still little explored by behavioral economics: collective waste composting. In particular, we designed priming and social norm nudges to incite people looking for information about waste composting possibilities. We set up a field experiment with a two-fold purpose. First, remove the barriers towards collective composting in Lyon by using posters related to priming theory with QR Codes that redirect directly to the website of a local association dedicated to environmental actions. Second, these posters created new social norm mechanisms. Since composting is still practiced by only a minority of people in France, the standard way of combining nudges and social norms is insufficient in this context. Here, we focus on descriptive and injunctive norms with local dimensions. These new norms aimed to make the nudge more efficient by increasing the number of scans. We observed that the scans of the posters allowed for a significant increase in the visits to the website over several months, thus improving information about collective waste composting. Although no significant differences were found between social norms treatments, these results show that the QR Code is a promising tool for implementing nudges.

Declarations of interest: none.
The figures in pages 12-13, 16 and 26-28 should be printed in colors.

1 Introduction

Richard Thaler and Cass Sunstein highlighted that a small adjustment in choice architecture can encourage people to make decisions closer to their intrinsic preferences (2009). They defined a "nudge" as a soft incitement that can change the decisions of individuals towards better, healthier, or more virtuous outcomes for them or for society, without it decreases their own welfare. During the few last years, nudges have been implemented in several domains: energy-saving (Allcott and Rogers, 2014), food choices (Downs et al., 2009), retirement savings (Bernatzi and Thaler, 2001), organ donation (Glazier and Mone, 2019), to name a few. Nudges can rely on several types of mechanics, such as setting a default choice (double-sided printing, Egebark and Ekström, 2016) or improving the clarity of the information (Nutri-score for French food items). This paper contributes to this literature by testing whether a new nudge policy can affect consumers' pro-environmental behavior in a field experiment. Moreover, the study is the first [1] to implement behavioral methods to promote waste composting, providing insights into the nudge theory possibilities towards this pro-environmental behavior. We focus on two nudge strategies: priming and social norms. Following Wilson et al. (2016), priming nudges correspond to "subconscious cues which may be physical, verbal or sensational, and are changed to nudge a particular choice" (p3), and priming interventions might improve the desirable behavior's visibility, accessibility, or availability. For instance, priming nudges have been mainly documented in the literature to foster healthy food choices (Wilson et al., 2016; Friis et al., 2017; Vecchio and Cavallo, 2019). Additionally, nudges can also use the power of social norms. Indeed, several studies have shown that social norms pressure could be a tool to improve pro-social behaviors (Frey and Meier, 2003; Chen et al., 2010). According to Bicchieri (2016), social norms can be defined as unofficial rules that individuals tend to conform to if most people in their reference network conform to it (empirical expectation), and/or if most people in their reference network believe they ought to conform to it (normative expectation).

In particular, social norm nudges have been implemented in pro-environmental behaviors such as energy conservation (Allcott, 2011; Costa and Kahn, 2013), water saving (Goldstein et al., 2008), recycling (Czajkowski et al., 2019), or sustainable consumption (Richter et al., 2018). Indeed, pro-environmental behaviors are an essential issue since literature has highlighted that pro-environmental behaviors tend to be plagued by gaps between intentions and actions (Kollmuss and Agyeman, 2002; Bamberg and Möser, 2007). Social

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[1]To the best of our knowledge.

norm can be used to bridge these gaps. More precisely, social norms can be implemented as nudges that aim to reduce the intention-action gap by using descriptive or injunctive norms. Descriptive norms provide information about behaviors people adopt in a given population, solving empirical expectation uncertainty, while injunctive norms inform people about the behaviors approved by their peers, solving normative expectation uncertainty. Social norm nudges are therefore only efficient if the proportion of people who already act prosocially is above a threshold, otherwise it can produce a boomerang effect (Schultz et al., 2007). A boomerang effect appears when a sufficient part of the population does not practice a desirable behavior. In that case, the descriptive norm incentivizes a deterioration of the behavior for a significant part of the population. Until now, nudges using social norms have been limited to behaviors already practiced by most of the population (except using trending norms: Mortensen et al., 2017; Sparkman and Walton, 2017). Thus, widening that nudge category to other pro-environmental issues seems necessary. Here, we based our norms only on the group of people practicing the desired behavior. Since social norms are informal rules indicating the appropriate behavior within groups (Bicchieri, 2011), highlighting the behavior of a group to people who are also willing to adopt this behavior and thus be part of this group seems a relevant lever to promote desirable behavior.

This paper focuses on waste composting, a behavior still practiced by a minority of people. The literature on interventions to encourage waste composting (or food waste sorting) is relatively recent. In a study, Bernstad et al. (2013) point out the role of accessibility as a key factor for increasing food waste recycling. Also, interventions using leaflets, either stuck on the bins (Shearer et al., 2017) or distributed to households (Linder et al., 2018), have been shown to increase waste composting. Linder et al. (2018) also included an injunctive norm on the leaflet (yet without identifying the effect of the norm). Furthermore, Li et al. (2020) highlighted the role of social influence in decreasing food waste. Finally, the very recent study conducted by Boomsma and van Soest (2021) is the study we are closest to. In a field experiment in the Netherlands, the authors designed an intervention that encouraged organic waste sorting by using local and social norms and creating social learning.

In this study, we designed nudges to encourage collective composting in a field experiment based in Lyon (France). Our approach was based on making information available as a preliminary step before behavior change. To do this, we partnered with a local organization named *Mouvement de Palier*[2]. This organization launches projects related to ecological issues, including collective composting. The objective of the study was two-fold.

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[2]https://www.mouvementdepalier.fr/

First, the objective of implementing priming nudges was to improve access to information about collective composting and facilitate its adoption. These nudges take the form of posters on which are placed QR Codes. QR Codes can be seen as barrier removing and bridge the gap between intention and action. The second purpose was to use local social norms focusing on groups of people who practice waste composting to promote a behavior that most people do not perform.

Thus, this article addresses whether combining priming and social norms promotes a still-emerging behavior, waste composting. The experiment had mixed results. Regarding the first objective, the nudge improved access to information on collective composting through the association's website. These results establish the role of the QR Code as a nudge that removes the barriers by reducing the search costs regarding waste composting. However, treatments using social norms did not have a significant effect compared to the priming treatment.

The paper is structured as follows. The next section provides information about the context of waste composting, particularly in Lyon. In the third section, we discuss the design of the nudges. The fourth section is dedicated to the methodology of the experiment. We present the results of the study in the fifth section. Finally, we discuss the results and conclude the study in the sixth and last section.

2   Context

Over the last decades, pro-environmental behaviors have become more prevalent as the consciousness of individuals with regards to environmental issues has improved. Balundé and al. (2019) defined the concept of pro-environmental behavior based on several definitions: "Pro-environmental behavior can be defined as all possible actions aimed at avoiding harm to and/or safeguarding the environment (Steg and Vlek, 2009), either performed in public (e.g., participation in environmental movements) or private domains (e.g., recycling: Hadler and Haller, 2011)" (p2). Nowadays, more resources have become accessible that encourage pro-environmental behaviors, even in large cities. Collective composting is a great example of these possibilities. Composting is the natural process of decomposition and recycling of organic material into a humus rich soil amendment known as compost (Risse and Faucette, 2017). Composting organic waste reduces the

total quantity of waste by 30%, representing an average of 200kg per household for a year. Mainly developed in rural areas, composting is growing in large cities through collective composts. Nonetheless, in France, only 34% of the population composts its organic waste, although 92% state that waste sorting and composting are essential or important (ADEME, 2020). Thus, a gap between intentions and actions seems to exist. As discussed in the introduction, such gaps often exist in ecological issues.

Furthermore, in France, each municipality must offer a composting solution to its inhabitants by 2024. These composts can be public, for instance, settled near public parks or private buildings. Lyon (France) is an example of a city where a significant part of the citizens is sensitive to such pro-environmental behaviors. During the last decade, hundreds of collective composts have been settled in the town on the initiative of citizens accompanied by the local community (Métropole de Lyon). For instance, in 2021, Métropole de Lyon provided 175 collective composts after providing 156 collective composts in 2020 and 78 in 2019. However, the demand to be a member of these collective composts largely exceeds the available supply. A standard collective compost can welcome 60 households. However, the waiting list of these composts often exceeds that number, thus resulting in saturation since the households who are members of a compost rarely quit it. The solution for reducing that saturation is to create more composts. Nevertheless, even if there are people who want to compost, setting up a compost seems complicated and time demanding to them. People might think they would not gather enough neighbors to launch a compost project, and they are not aware of the possibility of being helped by organizations. To address this saturation issue, we decided to use behavioral sciences and design nudges that ease the setting up of composts and incite people to take action.

3 Nudges design and Hypotheses

The nudge was made up of one or two posters according to the different treatments. The posters were in format A4. Treatment 1 was comprised of one poster, while treatment 2 and treatment 3 were made up of two posters (see Appendix B[3]). The nudge had several dimensions, which were added following these different treatments.

The first poster was identical for the three treatments. It used several well-known tools in the nudge theory: clear information, attractive colors, and a barrier removing. Its first

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[3]Posters are in French, however, a translation of the text is available by contacting the author at alix.rouille@ens-paris-saclay.fr .

purpose was to provide clear and straightforward information about the composting virtues: reducing the waste quantity, the compost creation, and a social link between the members of the collective compost. In addition, the poster was made up of two colors: blue, known to enhance altruistic behaviors, and green, a color that introduces the environmental atmosphere. Using such colors to create a favorable atmosphere towards collective composting corresponds to the priming theory. The second purpose was to inform people that they can create their collective compost project, especially since the organization "Mouvement de Palier" can accompany them during the process. To encourage people interested in composting, we set a QR Code on the poster, redirecting to Mouvement de Palier's website. More precisely, the QR Code redirected people to the Compost Section of the organization, where information about waste composting and how to set up a new collective compost is provided. People could also directly contact the organization to obtain personalized advice about the procedure. Hence, the nudge did not foster adopting waste composting directly, but facilitated access to information regarding waste composting. The nudge encouraged thus a prequel action: obtaining information about waste composting's possibilities.

QR Codes provide information very quickly (as Nutri-score does[4]). In this context, the purpose of the QR Code was to ease the decision and to remove the time between the awareness and decision-making periods. As Thaler stated, "if you want to encourage people to do something, you should remove the barriers that impede them.". The QR Code is a convenient tool, as a barrier removing, and as a data collecter (we will discuss data collection later in the presentation). It has recently begun to be used for some nudges (Nudge Challenge 2020 [5]). Thus, we set our first hypothesis as follows:

H1: The nudges incite people who are partial to waste composting to scan the QR Code and visit the Compost Section of the website.

Although it is true that a part of the population is not able to scan a QR Code, a study surveying consumers across the U.S., U.K., Germany, Netherlands, France, and Spain in September 2020 indicates that 86% of the population have scanned a QR Code in the past year (Mobileiron). We can assume that this percentage has increased during the year 2021 through the implementation of the health record pass, meaning that a large part of

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[4]The Nutri-Score is a nutrition label that converts the nutritional value of products into a simple code consisting of 5 letters, each with its own color. Each product is awarded a score based on a scientific algorithm.

[5]http://www.nudgefrance.org/laureats-nudge-challenge-2020-covoiturage/

the French population can now use a QR Code. Nevertheless, to avoid losing people who cannot scan QR Codes, we also indicated the website's address at the bottom of the poster. The second poster was added for the second and third treatments. As we discussed earlier, we could not use the standard descriptive norm (i.e., % of the people are practicing waste composting) since only a minority of French people practices this behavior and thus the effect would backfire (boomerang effect). Therefore, we built a descriptive norm that focused on people who acted virtuously and increased their saliency. Thus, for treatments 2 and 3, maps were included on the poster, indicating the location of the collective composts near the place where the poster was hung. Moreover, instead of social norms, the nudge represented a local norm (Agerström et al., 2016) since each map was customized according to the district where the poster was hung. In this sense, our design is close to the study from Boomsma and van Soest (2021). In addition, the poster was entitled "Your neighbors did it, why not you?" to use the leverage of proximity identification with "virtuous" people.

H2: The addition of a local descriptive norm has a more significant impact on the incitement to scan the QR Code than in treatment 1.

For treatment 3, we implemented an injunctive norm dimension. In addition to the map, we included three testimonies of people who set up a collective compost. These short testimonies highlighted an injunctive norm (here, "what "virtuous" people would approve of being the right thing to do") as they described how the process took place and what the current situation was. Each testimony was illustrated with a picture showing, for instance, the teamwork and the social links brought about by the compost. All the testimonies are real, made by collective compost referents. As the literature has shown (Schultz et al., 2007 ; Habib et al., 2021), we assume that combining a descriptive and an injunctive norm will be the most effective.

H3: The combination of a local descriptive norm and an injunctive norm (testimonies) has a more significant impact on inciting to scan the QR Code than the local descriptive norm alone and the nudge in treatment 1.
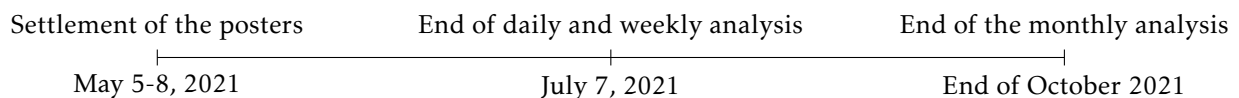
4 Methodology

4.1 Locations the posters

We wanted to hang the posters in strategic places in the city. These places allowed us to target people with a high interest for waste composting and where that interest could be activated. In this vein, we set the posters in two categories of places.

The first category was collective and public composts. These places are relevant since the compost bins are often very visible and attract individuals interested in this approach. Moreover, the members of a public compost might like to set up a collective compost in their building or share information with their friends on the waiting lists. We obtained the permission of 32 referents of collective composts to hang up the posters.

The second category are eco-shops. We assumed a correlation between waste composting and organic product consumption. To demonstrate this, we surveyed inhabitants of Lyon who are part of a collective compost. The sample was comprised of 142 individuals. The survey indicated that 58% of composting practitioners often make their purchases in eco-shops. In comparison, only 18% [6] of French people used eco-shops. Furthermore, 85% of the sample either totally agree (43.7%) or agree (41.5%) that consuming organic products is important, and they estimate their consumption of organic products to an average of 6.7 on a scale from 1 to 10 (10 meaning a total consumption of organic products). Hence, hanging posters that promote collective waste composting in eco-shops seemed relevant to us. After we contacted several eco-shops in the city, we obtained permission to hang up our posters in 10 of them. All the posters were laminated to withstand the weather during the experiment.

Details regarding the characteristics of the places are available in Appendix C. The posters were set up between May 5 and May 8, 2021. The timeline of the experiment is summarized below.

Timeline of the experiment

Settlement of the posters	End of daily and weekly analysis	End of the monthly analysis
May 5-8, 2021	July 7, 2021	End of October 2021

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[6]Baromètre Shopper in-Store Media / IPSOS 2019.

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4.2 Measuring the effects of the Nudges

4.2.1 Website

In order to observe the global effect of the intervention, we compared the number of visits to the website before and during the experiment. We looked at the visits on the compost subpart (where the QR Code is redirecting) and on the website's Home Page. We retrieved daily and weekly data from March 8 to July 7. We also retrieved monthly data from the site's opening to October 31. Moreover, checking these data let us know if some people went directly to the website with their electronic device instead of scanning the QR Code. Our methodology is two-fold. First, we used time series graphs to examine the visiting trends of the Compost Section compared with the Home Page. Second, we conducted an event study that allowed us to determine whether the posters' settlement impacted visits to the Compost Section webpage.

4.2.2 QR Codes

As we said earlier, the QR Codes allow us to obtain results in real-time. Importantly, setting a different QR Code to each poster enabled us to isolate the effect of these posters and observe the difference for each site, treatment, category of place, etc. Therefore, using the QR Codes data, we were able to measure the impact of social norms on the number of scans.

5   Results

This section presents the results of the experiment. The first subpart of the section treats the evolution of the organization website's visits over time. We investigated the impact of the posters' settlement on the Compost Section of the website compared to the Home Page Section. We first looked at this using graphs and then conducted an event study to observe whether the effect was significant. Then, we looked at the relationship between scans made by people and the number of visits to the two web pages. Thus, this subpart provides insights regarding the first hypothesis. The second subpart presents the results of the analysis by treatment, which corresponds to the second and third

hypotheses. We proceeded to non-parametric tests to determine whether there were significant differences in the number of scans between treatments. Finally, the third subpart is dedicated to analyzing scans by location category (i.e., shops or collective composts). We also performed non-parametric tests to investigate whether there are significant differences according to the category of place where the poster is hung. The results are summarized in the last subpart of this section.

5.1 Website

We collected data from the organization's website daily, weekly, and monthly. In addition, we compared the number of visits to the site's Home Page with the Compost Section's page, where the QR Codes redirect.

5.1.1 Daily data

We compared the number of visits for the two web pages per day from two months before the experiment (5th March) to two months after (5th July). The data are smoothed to facilitate the analysis. Figure 1a represents the smoothed daily data, and Figure 1b represents smoothed daily data with standardized variables. The Home Page's visits are in blue, and the Compost Section's visits are in red. Figure 1a indicates that, while the number of visits to the Home Page slowly decreased from March to July, probably owing to the third wave of Covid-19 and the third national lockdown, the number of visits to the Compost Section began to increase at the start of May. The daily number of visits to the Compost Section increased by 156% during the experiment (5th May to 5th July), compared to the period before (5th March to 5th May), and the number of visits to the Home Page decreased by 25% during the same period.

Then, we standardized the data to point out the differences in trends between the Home Page and the Compost Section[7]. Thus, the data are standardized in Figure 1b and highlight the reverse trend of the website's two pages that appears at the beginning of the experiment.

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[7]A standardized variable (sometimes called a z-score or a standard score) is a variable that has been rescaled to have a mean of zero and a standard deviation of one.
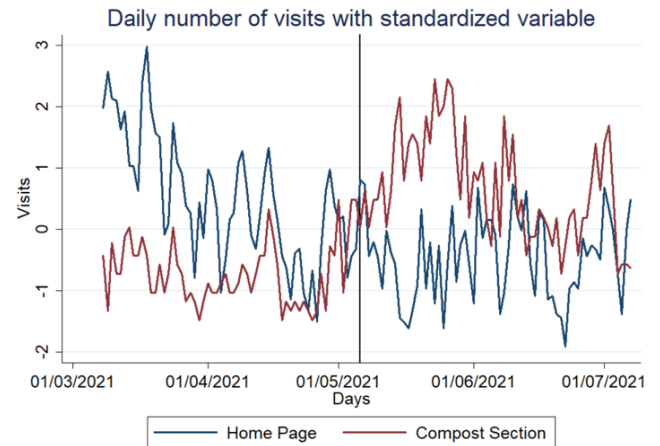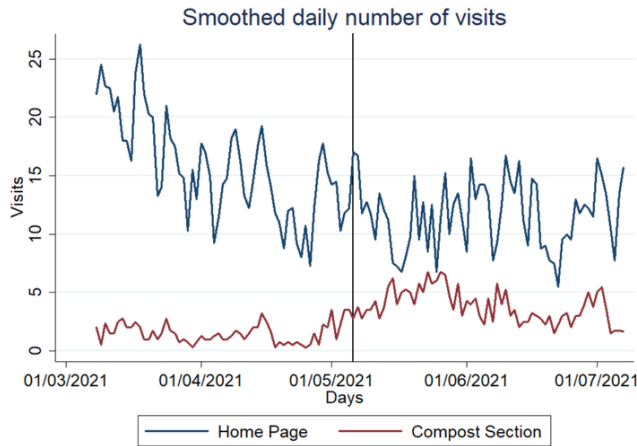
Figure 1a and Figure 1b

5.1.2 Weekly data

We also collected weekly data during the same period. Weekly data allow for analyzing smoother trends. As the experiment began after a week had past, the data are very slightly lagged. Before the experiment (8th March to 2nd May), the weekly number of visits to the Compost Section was, on average, 11.5. By contrast, during the experiment (3rd May to 11th July), the average number of visits was 25.4 per week, thus more than twice as much.
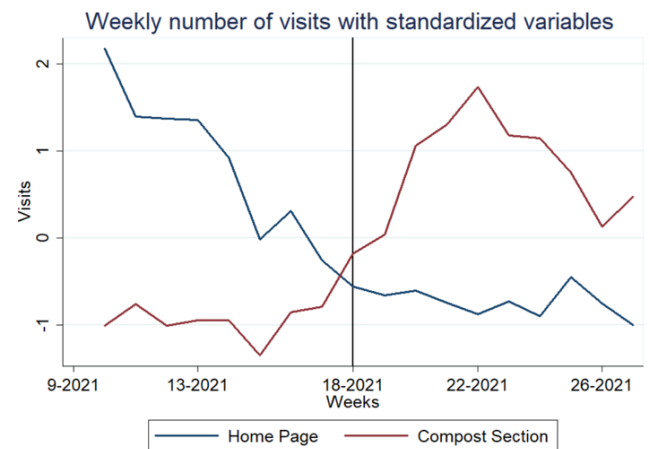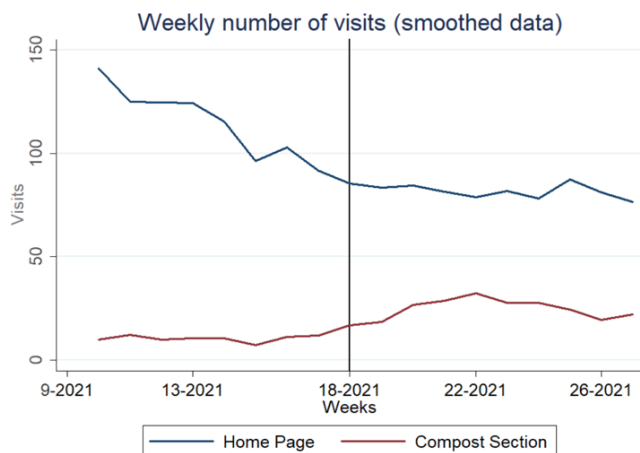

Figure 2a and Figure 2b

According to Figure 2a, we can confirm that the gap between the curves decreased during the experiment period. In addition, we see a peak of the Compost Section's visits

towards weeks 20 and 22. In the same way as Figure 1b, Figure 2b shows that standardized data make the reversing trends of the two web pages more explicit. This figure points out that the increase in the Compost Section's visits is not related to a global improvement of the organization's visibility yet comes from an external factor: the posters.

5.1.3 Monthly data

Regarding monthly data, we retrieved data over a longer period, allowing us to extend the analysis duration to October 7. We stopped the analysis at this date because eco-shops were required to keep the poster(s) for three months. Nevertheless, some kept it longer. Figure 3 shows the figures of the two web pages since the organization's website was created. We can see that, although the curve of the Home Page had several peaks and deeps, the figures of the Compost Section are linear during the time until the implementation of the experiment. Furthermore, at that exact moment, the numbers of visits to the Home Page are at their lowest point since August 2020. The visits to the Home Page return to their previous level on September 2021, a growth triggered by increased activities (not especially related to collective composting). Conversely, the Compost Section maintained a regular number of visits, supported by the experiment, as we will see in Figure 4.
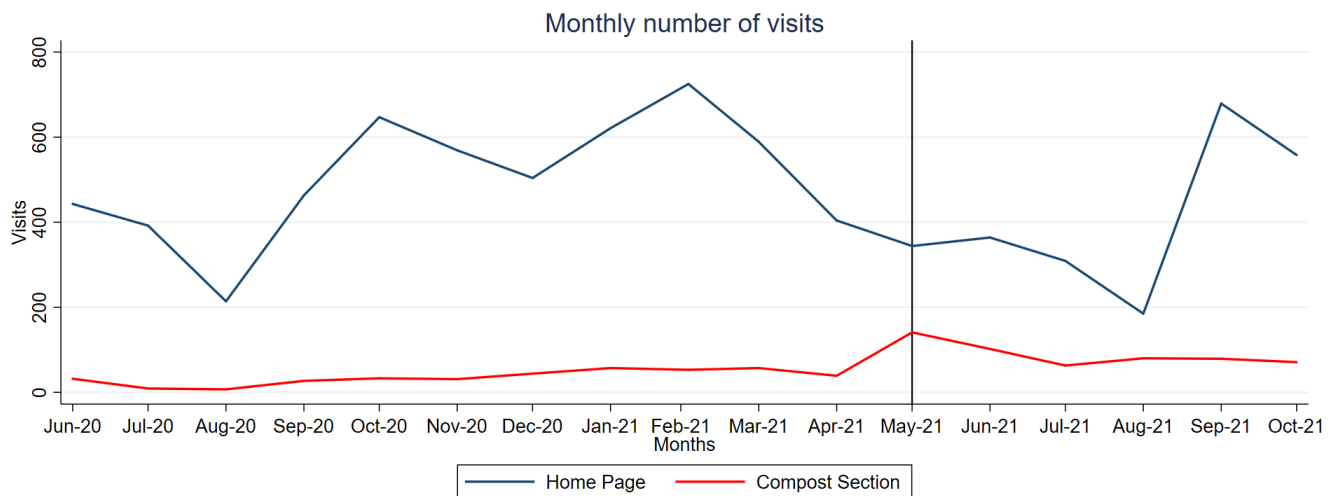

Figure 3

5.1.4 Econometric method

Once we had seen the trends of the results, we examined them more precisely with econometric methods. Our methodology relies on an event study comparing the number of visits to the Compost Section webpage at different points in time. Table 1 presents the econometric results of the event study. Note that for all tables, the observations indicated correspond to a number of months. We created a dummy variable, *Posters*, equal to 0 before the experiment and equal to 1 once the experiment started. The equation of the model is as follows:

$$Y_t = \alpha + \beta D_t + \epsilon_t \quad \text{with } D_t = \begin{cases} 1 & \text{if } Posters = 1 \\ 0 & \text{otherwise} \end{cases}, \tag{1}$$

where Y_t is the outcome variable (i.e., number of visits to the Compost Section webpage) at time t, and βD_t is the dummy variable indicating whether the posters have been set up (i.e., the event). According to the event study's results (Table 1), posters' settlement positively affects the number of visits to the Compost Section (B=53.97, p=0.000), which confirms insights from the figures. Note that the results are similar for daily and weekly periods (from 5th March to 5th July, Tables 9 and 10, see Appendix A). In addition, we used a Difference in difference (DiD) analysis to confirm the results. DiD is designed to control both for pre-treatment differences between the treatment and the control group and for trends over time that are unrelated to the intervention (Gertler et al., 2016). This statistical technique has been used to evaluate the efficiency of similar methods of interventions (Kallbekken and Sælen, 2013; Linder et al., 2018). Here we set the visits to the Home Page as the control variable condition and the visits to the Compost Section as the treatment variable. The results are presented in Appendix A and confirm the difference between the two groups (Table 11).

Table 2 shows the result of the Shapiro-Wilk test and indicates that the data come from a normally distributed population. Then, a pre-event regression reveals in Table 3 that the visits to the Home Page Section positively increase the visits to the Compost Section (B=0.092, p=0.005). Thus, the Home Page Section seemed to be the main way to enter the Compost Section during the pre-event period.

Table 4 shows the regression results of scans and Home Page visits on Compost Section visits. The number of scans positively affects the Compost Section's visits (t=5.41, p=0.012). In contrast to the pre-event period, the Home Page's visits no longer impact

the dependent variable during the post-event period. Indeed, while the Home Page visits tend to decrease during this period, the Compost Section's visits increased largely. This phenomenon is illustrated in Figure 3. These results confirm that the posters were the main driver of increasing visits to the Compost Section during the experiment.

Hence, we can reject any claim that Compost Section visits increased during the experiment period because of a global improvement in the organization's website and rather conclude that the experiment positively impacted the Compost Section's activity. Since the results reveal that posters incited people to scan the QR Code and thus visited the Compost Section of the website, the hypothesis H1 is validated.

Table 1: Event Study: Regression analysis

Compost Section	Obs	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]
Posters	17	53.967	10.959	4.92	0.000***	[30.611 ; 77.328]
const	17	35.364	6.511	5.43	0.000***	[21.487 ; 49.241]

Table 2: Shapiro-Wilk W test for normal data

Variable	Posters	w	V	z	Prob>z
residuals	17	0.952	1.011	0.022	0.491

Table 3: Regression analysis; pre-event

Compost Section	Obs	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]
Home Section	11	.092	0.025	3.64	0.005***	[.035 ; .149]
const	11	-11.278	13.278	-0.85	0.418	[-41.316 ; 18.759]

Table 4: Regression analysis; post-event

Compost Section	Obs	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]
Home Section	6	-0.015	0.028	-0.55	0.621	[-.103 ; .073]
Scans	6	2.187	0.405	5.41	0.012**	[.900 ; 3.474]
const	6	18.216	19.503	0.93	0.419	[-43.848 ; 80.279]

Figure 4 displays the curves of the visits to the Compost Section and the number of scans until the end of October 2021. We see that the curves follow the same pattern. The number of scans corresponds to 40% of the Compost Section's visits, with a peak at 46% in September and a deep at 33% in July. Furthermore, as discussed in the nudges design part, it confirms that posters also encourage people to visit the Compost Section of the organization without using the QR Codes, resulting in an indirect increase in visits.

In addition, note that the experiment had been run mostly during a curfew restriction in France: 7 pm until 19th May, and 9 pm until 9th June. Thus, we could expect more significant results without these curfew restrictions.

Figure 4

5.2 Analysis by treatment

The 42 posters had been scanned more than 180 times between May 5th and October 6th. To analyze the differences between the three treatments, we removed the duplicate scans (several scans from the same person), for a total of 157 scans.

Descriptives statistics of the scans per treatment are detailed in Table 5.

Table 5: Descriptive statistics					
Average number of scans per treatment					
Treatment	Posters	Scans	Means	Stv.Dev	Median
Treatment 1	14	50	3.57	2.38	4
Treatment 2	13	47	3.62	3.38	3
Treatment 3	15	60	4.00	3.14	4

To observe the potential differences between the three treatments, we first checked for the normality of the distribution with the Shapiro-Wilk test. As shown in Table 6, we can reject the normality hypothesis for these data. Thus, non-parametric tests were run.

We performed a Kruskal-Wallis test to determine whether there are differences between treatments, meaning a different number of scans across treatments[8]. This test was performed to determine whether samples originate from the same distribution by comparing two or more independent samples of equal or different sample sizes. The Kruskal-Wallis test (Table 7) results demonstrate that there are no significant differences between the treatments (χ^2 = 0.197, p = .9060, df = 2). We also performed Mann-Whitney tests and obtained similar results. Therefore, we cannot conclude that local norms have an effect of inciting people to scan the QR codes of the posters. Hypotheses H2 and H3 are therefore invalidated.

Table 6: Shapiro-Wilk W test for normal data

Variable	Posters	w	V	z	Prob>z
residuals	42	0.92244	3.183	2.444	0.00726

Table 7: Number of scans per treatment: Kruskal-Wallis test

Treatment	Posters	Rank Sum
Treatment 1	14	295.00
Treatment 2	13	269.00
Treatment 3	15	339.00

χ^2 =	0.194	probability =	0.9075
χ^2 with ties =	0.197	probability =	0.9060

5.3 Analysis by location category

As we discussed earlier, the posters were hung in two categories of locations: organic shops and collective composts. Although the location distribution is not well-balanced (32 collective composts and 10 organic shops), it seems relevant to investigate whether one type of location performed better. The Kruskal-Wallis test (Table 8) shows that the difference between location categories is not statistically significant (χ^2 = 0.257, p = .6125, df = 1). Therefore, there was no effect of the type of location on the number of scans. This could be partly due to the previously mentioned lack of balance in the observations of the two categories.

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[8]The Kruskal-Wallis test is considered the non-parametric equivalent of the one-way analysis of variance (ANOVA).

Table 8: Number of scans per type of location: Kruskal-Wallis test

Category	Posters	Rank Sum
compost	32	705.00
Shop	10	198.00

χ^2 =	0.252	probability =	0.6156
χ^2 with ties =	0.257	probability =	0.6125

5.4 Summary of the results

The main results hold in three points. First, the event study reveals an increase in the Compost Section's visits after the settlement of posters. We have established that this increase is related to the intervention since the results showed a positive effect of scans on the number of visits. In addition, the Home Page visits did not increase during the same period, demonstrating no generalized increase in the website's visits. Therefore, these results indicate that the posters allowed easier access to information related to collective composting through the organization's website. Consequently, hypothesis H1 is validated. These results also confirm the relevance of priming theory in that framework.

Second, the results report no effects of adding dimensions of social norms to the posters compared to the baseline poster. Thus, in that framework, descriptive and injunctive norms were not found to incite more people to scan QR Codes, invalidating hypotheses H2 and H3. Since the posters were in format A4, an excess of information on the second poster might explain these results. In particular, the testimonies could have been difficult to read by bystanders.

Finally, the results showed no effect of the type of location of the posters. Nevertheless, we cannot generalize that finding since the number of observations between the type of location was not well-balanced.

6 Conclusion

This study aimed to encourage people with pro-environmental intentions to scan the QR Code on posters to obtain information about how adopting waste composting. Waste composting is a pro-environmental behavior, growing in large cities such as Lyon. In fact, a national french law will compel all cities by 2024 to provide their inhabitants with a waste composting solution. However, even if towns such as Lyon or Paris are

willing to provide collective composts, the information is sometimes not easy to find. People with pro-environmental intentions may be discouraged and postpone their aim to adopt waste composting. The objective of this nudge was to remove the barriers (i.e. reduce information search costs) and create a favorable atmosphere towards collective composting, using priming theory. The QR code redirected people to the Compost Section of the organization *Mouvement de Palier*, where information about waste composting and how to set up a new collective compost is provided. The results show that, while the global statistics of the website dwindled during the same period (-25%), the posters increased the visits to the website's Compost Section (+156%). These results were achieved despite the presence of curfews in France during this period.

Thus, posters with straightforward information and a QR Code can act as a nudge to inform people and ease the adoption of virtuous behaviors. Therefore, we expect that people would be more likely to start composting their waste after undertaking this prequel action (obtaining information about composting behavior).

The second purpose of this study was to implement social norms to promote a behavior practiced by a minority of people. To avoid a potential boomerang effect (Schultz et al., 2007), we first created a descriptive norm highlighting people who already compost their waste through a district map. Second, the injunctive norm was represented by testimonies of people who are settled in their collective composting. Thus, these norms were rather local than social since they focused on a group in the same location as the nudged people. Unfortunately, we did not find a significant effect of these local norms on the number of scans.

Nevertheless, the findings of this experiment contribute to the literature since it is one of the first study that has implemented behavioral sciences and the nudge approach to incite people to compost their waste, therefore providing insights about the tools that can promote this pro-environmental behavior. Moreover, we suggest our results are particularly relevant as they come from a field experiment. The experiment is quite easy to replicate in other cities wherever at least one organization that offers to help people compost their waste. Besides, QR Codes are a promising tool for setting up a nudge. They are easy for individuals to use, and allow the experimenter to obtain reliable data about the number of people who used it.

The power of local norms combined with the nudge approach could be implemented in other ways to incite people to practice waste composting. Indeed, since this paper is the first one combining priming and social norms on this topic, it opens the door to other ideas of nudges to improve the practice of waste composting, a behavior with a real positive impact on the environment. Replications of the experiment in other areas and

with different posters could improve comprehension and strengthen the external validity of waste composting nudging.

Limitations

This study measures the effect of the nudge on access to information regarding collective composting and not the impact on the rate of people adopting waste composting. Indeed, since existing collective composts are saturated, we focused on inciting citizens to get informed about the possibilities of setting up a compost. The number of new collective composts set up in Lyon in 2021 increased. However, we cannot claim that our intervention has driven that increase. An objective for future studies would be to directly encourage the creation of collective composts by citizens. A solution could be to lead the project in partnership with the town hall if they provide the composting material to have better data access. Another advantage of conducting a project in partnership with the town hall is that if they are responsible for the composts' materials, they may have facilities to also promote the existence of the project. In addition, it is possible that some of the individuals who scanned the QR Code did more out of curiosity rather than being truly interested in adopting waste composting. Data revealing individuals' time on the website could have brought insights about their intentions. Unfortunately, those data are not available. Finally, in this study, we restricted the intervention to places correlated with waste composting (collective composts, eco shops) to target individuals who are more likely to have such behavior. An extension of the project could add neutral places to increase the scope of the intervention and compare the efficiency of the posters based on whether their location is related to an environmental issue. This could be helpful to measure the potential selection bias caused by the location choice.

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Appendix A:

Table 9: Event Study: Regression analysis (weekly data)					
Compost Section	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]
Posters	15.15	3.032	5.00	0.000***	[8.722 ; 21.578]
const	10.25	2.260	4.53	0.000***	[5.459 ; 15.041]

Table 10: Event Study: Regression analysis (daily data)					
Compost Section	Coef.	Std. Err.	t	P> |t|	[95% Conf. Interval]
Posters	2.314	.400	5.79	0.000***	[1.523 ; 3.105]
const	1.483	.289	5.12	0.000***	[.910 ; 2.056]

Difference in differences analysis:

Equation of the model:

$$Y_t = \alpha_t + \beta_1 * [\text{Time}] + \beta_2 * [\text{Treated}] + \beta_3 * [\text{Time * Treated}] + \epsilon_t \ , \qquad (2)$$

with Time = $\begin{cases} 1 & \text{after the experiment} \\ 0 & \text{before the experiment} \end{cases}$, with Treated = $\begin{cases} 1 & \text{if treated} \\ 0 & \text{if control group} \end{cases}$.

Time * Treated = DID

Table 11: Difference in differences analysis				
Outcome variable	Visits	Std. Err.	t	P> |t|
Before				
Control	506.455			
Treated	35.364			
Difference	-471.091	47.666	-9.88	0.000***
After				
Control	406.500			
Treated	89.333			
Difference	-317.167	64.540	4.91	0.000***
Diff in diff	153.924	80.234	1.92	0.065*

Appendix B:

Figure 5: Poster common to all treatments

Figure 6: Second poster for Treatment 2

Figure 7: Second poster for Treatment 3

Appendix C:

Association	Name	District	No. Treatment	No. QR code	Number of Members (Households)	Poster(s) setting up	Number of scans until 10/07
Mjc Confluence	Terrasse Saône du CELP	2	1	1	31	May 7	1
Mjc Confluence	Gilibert	2	3	21	25	May 7	1
Mjc Confluence	Sainte Blandine	2	2	11	49	May 7	0
Mjc Confluence	Confluence	2	1	2	25	May 7	8
Compost Gensoul	Gensoul	2	3	22	60 (full)	May 8	3
Volterre	Bir Hakeim	3	2	12	70 (full)	May 7	2
Volterre	Bir Hakeim sud	3	3	23	55	May 7	5
Volterre	Briand	3	3	24	55	May 7	4
Volterre	Pelloux	3	3	25	55	May 7	3
Volterre	Sainte Marie Perrin	3	1	3	55	May 7	4
Volterre	Voltaire	3	2	13	55	May 7	5
Coccinelles sans soucis	les coccinelles 1	3	1	10	140	May 6	3
Coccinelles sans soucis	les coccinelles 2	3	3	26	70 (20 active households)	May 6	0
Commandant Arnaud	Commandant Arnaud	4	2	14	60	May 7	11
La ferme Croix-Rousse	La ferme Croix-Rousse	4	1	4	60	May 5	2
Parc Mairie 5e	Parc Mairie 5e	5	3	27	60 (full)	May 6	4
Cité internationale	Cité internationale	6	3	28	24	May 5	1
Jardin des Partages	Jardin des Partages	6	1	5	70 households (full)	May 8	5
Jardin des Emeraudes	Jardin des Emeraudes	6	2	15	60	May 7	1
Quai de serbie	Quai de serbie	6	3	29	72 (full)	May 7	2
Vitton Compost	Vitton Compost	6	1	6	70 (full)	May 7	3
Edgar Quinet	Edgar Quinet	6	2	16	60	May 8	9
Quai de l'Europe	Quai de l'Europe	6	2	17	60	May 8	5
Emir	Composteur Stalingrad	7	2	18	52	May 8	3
Emir	Raspail	7	1	44	60 (full)	May 5	2
Emir	Jules Guesdes	7	2	19	70 (full)	May 8	0
Emir	Bulard	7	1	7	60 (full)	May 6	3
L'or vert du 8e	Lumière	8	1	8	60	May 6	4
L'or vert du 8e	L'or vert des pirates	8	3	30	60	May 6	6
L'or vert du 8e	Faubourg	8	2	20	60	May 6	4
L'or vert du 8e	4	8	3	50	60	May 6	10
	Parc les Eglantiers	9	3	31	10	May 5	8
Shops							
Biocoop	Villeurbanne	69100 Villeurbanne	2	36		May 6	4
Biocoop	Vendôme	3	3	40		May 6	9
Biocoop	Brotteaux	6	1	32		May 7	9
Biocoop	Lumière	8	3	41		May 6	0
Biocoop	Valmy	9	2	37		May 5	3
L'épicerie équitable	Lyon Guillotière	7	2	39		May 6	0
	3 ptits pois	7	1	33		May 6	2
day-by-day	Lyon 6	6	3	42		May 6	4
day-by-day	Lyon 2	2	1	34		May 5	3
Vrac en vrill'	Villeurbanne	69100 Villeurbanne	1	35		May 6	1

Figure 8: Posters location