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## Correcting misperceptions about trends and norms to address weak collective action — Experimental evidence from a recycling program

Hanna Fuhrmann-Riebel<sup>a,b,\*</sup>, Ben D'Exelle<sup>b</sup>, Kristian López Vargas<sup>c</sup>, Sebastian Tonke<sup>d</sup>, Arjan Verschoor<sup>e</sup>

<sup>a</sup> German Institute of Development and Sustainability (IDOS), Tulpenfeld 6, 53113 Bonn, Germany

<sup>b</sup> University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK

<sup>c</sup> University of California, Santa Cruz, 1156 High Street, Santa Cruz, CA 95064, USA

<sup>d</sup> Max Planck Institute for Research on Collective Goods, Kurt-Schumacher-Straße 10, 53113 Bonn, Germany

<sup>e</sup> University of East Anglia & Norwich Institute for Sustainable Development, Norwich Research Park, Norwich NR4 7TJ, UK

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### ABSTRACT

Finding ways to encourage collective action in contexts where only a minority adopts the desired behavior is central to solving many of today's global environmental problems. We study how correcting people's beliefs about social norms and behavioral trends encourages collective action in a setting where the desired behavior is not yet prevalent. In a field experiment, we test whether low sign-up rates for a recycling program in urban Peru can be increased by providing information (1) that most people regard participation in the program as important, i.e., on the "injunctive norm", (2) on an increasing recent trend in sign-up rates. We find that the effectiveness of the treatments depends on people's prior beliefs: Correcting inaccurate beliefs increases sign-up decisions significantly among people who either substantially underestimate the injunctive norm or who underestimate the positive trend. As this sub-group of people is in the minority in our set-up, we do not observe statistically significant average treatment effects. We further find that the effects of the treatments increase in the level of underestimation. Our evidence demonstrates that belief updating can be used effectively to encourage collective action where it is weak as long as a meaningful number of people underestimates the relevant trends and norms.

### 1. Introduction

One of the biggest challenges to solving today's global problems, such as climate change, pollution or the depletion of natural resources, is that only a minority contributes to the collective action needed to address these problems. Social norms are a crucial component to encourage collective action (Bicchieri and Dimant, 2019; Nyborg et al., 2016; Ostrom, 2000; Ayres et al., 2013), and a growing number of behavioral interventions use information about social norms to change behavior.<sup>1</sup> Since a defining element

\* Corresponding author at: German Institute of Development and Sustainability (IDOS), Tulpenfeld 6, 53113 Bonn, Germany.

E-mail addresses: [hanna.fuhrmann-riebe@idos-research.de](mailto:hanna.fuhrmann-riebe@idos-research.de) (H. Fuhrmann-Riebel), [B.DExelle@uea.ac.uk](mailto:B.DExelle@uea.ac.uk) (B. D'Exelle), [klopezva@ucsc.edu](mailto:klopezva@ucsc.edu) (K. López Vargas), [tonke@coll.mpg.de](mailto:tonke@coll.mpg.de) (S. Tonke), [A.Verschoor@uea.ac.uk](mailto:A.Verschoor@uea.ac.uk) (A. Verschoor).

<sup>1</sup> These interventions have aimed to change health-related behavior (Galizzi et al., 2022), tax compliance (Hallsworth et al., 2017), driving behavior (Chen et al., 2017), charitable contributions (Shang and Croson, 2009; Rokenbach et al., 2021; Bicchieri et al., 2022), voting (Gerber and Rogers, 2009) and pro-environmental behavior (Allcott, 2011; Andor et al., 2020).

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of a social norm is that it is jointly recognized by a population (Krupka and Weber, 2013), it is not surprising that many of these interventions focus on settings where the *majority* has already adopted the desired behavior, and disseminate information thereof. However, much less is known about settings where collective action is weak, i.e., only a small *minority* contributes. In this paper, we use field experimental evidence to study whether in such settings behavior can be changed by providing information about recent behavioral trends and others' approval.

An important mechanism through which information about prevailing social norms can increase support for collective action is the updating of incorrect beliefs about these norms (Bicchieri and Dimant, 2019). For example, if people tend to underestimate how common the corresponding behavior already is, updating their beliefs can induce behavioral change in the direction of the norm (Byrne et al., 2018; Andre et al., 2024). This approach seems unlikely to be effective, however, in a setting when the corresponding behavior is not yet common. Instead, there might be other beliefs that can be exploited to support collective action. First, rather than focusing on what others do (i.e., the “descriptive norms”), one can share information about what others think should be done, or approve of doing (i.e., the “injunctive norms”).<sup>2</sup> This has been found to be effective where people underestimate the prevalence of such injunctive norms (Bursztyn et al., 2020). Second, when there is an *increase* in the number of people who contribute to collective action and people underestimate this increase, sharing information about the positive trend may accelerate the increase in collective action.<sup>3</sup> Using a field experiment, we show that correcting inaccurate beliefs about behavioral trends and injunctive norms by providing actual information about them can be an effective way to encourage collective action even when the majority does not yet adopt such action — i.e., it is not yet normative in the descriptive sense.

We test this approach in the context of recycling. Global waste accumulation is a major contributor to climate change and poses a serious threat to people and ecosystems (UNEP, 2015). Insufficient waste management is particularly problematic in low- and middle-income countries as the infrastructure for waste management is often worse than in developed countries, with large amounts of waste ending up in local dumpsites, threatening people's health and the environment. Recycling is one of the key elements for sustainable waste and resource management.<sup>4</sup> Where the infrastructure is put in place, however, recycling often struggles to pick up, largely due to collective action problems (Harring et al., 2019).<sup>5</sup>

This is also one of the main challenges of the recycling program of the municipality of Miraflores, an upper middle class municipality in Lima, Peru, where our study is conducted.<sup>6</sup> The municipal recycling program is voluntary and offered free of charge. To enroll, an adult member of the household needs to complete a brief form providing contact details to the municipality. Enrolled households are tasked with separating their recyclable materials into a designated bag, which they then need to place on the street on a specified day each week. The bags are then collected by formal recycling trucks.<sup>7</sup> Enrollment of households in this program is still low: at the time of data collection, only 12% of all households living in Miraflores participated in the recycling program. However, the percentage of households participating in the program had doubled between 2017 and 2020, from 6% to 12%, indicating a clear positive trend. In addition, despite the low participation rate, the vast majority of households (97%) in Miraflores believe that it is important for the environment that households participate in the municipality's recycling program. In sum, we have a setting where there is no descriptive norm yet, as indicated by the low participation rate, but there is a clear positive trend and a strong injunctive norm, which we aim to exploit.

To test whether correcting inaccurate beliefs about the injunctive norm and the positive trend in participation rates increases sign-up rates, we conducted a field experiment. From the set of all households living in the municipality, we called a random sample by phone. We used a brief questionnaire that captured basic socio-demographic characteristics and elicited beliefs about the injunctive norm and the recent trend in sign-up rates. Next, participants were randomly assigned to one of four treatments, combining two social influence treatment messages in a factorial design. The first message explained that participation rates had doubled from 6% to 12% over the last three years, while the second message revealed that 97% of the households in Miraflores believed participating in the recycling program was important for the environment. After conveying the treatment message, the interviewer asked the participant whether they wanted to sign up to the program. This design allows us to test whether belief updating on (i) the injunctive norm, (ii) the positive trend, and/or (iii) both together increases sign-up rates. It further allows us to identify whether the two pieces of social influence information reinforce each other in the combined treatment as information about the injunctive norm and the positive trend together may increase expectations that the desired behavior, i.e., participating in

<sup>2</sup> For more information on the distinction made between these two types of social norms, see Krupka and Weber (2013), Hallsworth et al. (2017) and Cialdini et al. (1991).

<sup>3</sup> This change in the behavior of others has also been labeled as “dynamic norms” by psychologists (Sparkman and Walton, 2017; Loschelder et al., 2019; Mortensen et al., 2019; Sparkman et al., 2020). We avoid this terminology in the paper when the behavior is not yet normative in the descriptive sense.

<sup>4</sup> For more information on the environmental benefits of recycling, its impact on GHG emissions and mitigation potential, see UNEP (2015).

<sup>5</sup> The collective action problem of recycling is characterized by the fact that people have to incur individual costs for collective benefit. Individual costs can, for example, refer to the time and effort needed to separate materials and fill recycling bags, while the collective benefit manifests itself as reduced waste accumulation and better environmental quality. This situation creates incentives for individuals to free-ride while still gaining the collective benefit at the expense of others' efforts.

<sup>6</sup> For reference, according to WWF (2018), only 4% of all waste generated in Lima, Peru, is recycled. In Peru, municipalities are responsible for facilitating recycling at the household level, where a large portion of the country's waste is generated (Borasino and Fuhrmann-Riebel, 2022). Such recycling programs are designed to improve waste separation in the household, which is essential for the correct functioning of the recycling process (Dai et al., 2015; Varotto and Spagnolli, 2017).

<sup>7</sup> Note that the district of Miraflores contains both individual dwellings and apartment buildings. Even if only one household in a building decides to join the program, the trucks will collect the recycling bags of that single household, regardless of how many other households in the building are enrolled. Thus, while there is a collective action problem of recycling at a higher level - as explained in footnote 5 - no collective action is needed for households to join the program.

the recycling program, is likely to become normative in the descriptive sense in the future. Combining injunctive norm information with the trend information that also contains information about the still low descriptive norm further helps to prevent a possible “boomerang effect”, i.e., that people who overestimate the current participation rate are less likely to sign up (see, e.g., [Schultz et al. \(2007\)](#) and [Allcott \(2011\)](#)).

Our main finding is that, as hypothesized, the response to information about the injunctive norm and the positive trend depends on people’s prior beliefs. Specifically, the injunctive norm treatment increases sign-up rates only among those who strongly underestimate the injunctive norm. Depending on where we set the threshold of errors in beliefs, for those who believe the norm to be below 90% or 70%, this treatment increases the probability of signing up by 9 to 14 percentage points. Similarly, the positive trend treatment only impacts those that underestimate its targeted beliefs: sign-up rates increase by 15 and 19 percentage points among people who underestimate the positive trend and the current prevalence of behavior, respectively. Furthermore, for both of these treatments, the magnitudes of effects increase with the level of underestimation. Interestingly, the combined treatment only has a consistent effect on the sign-up decision among those that underestimate the descriptive norm, i.e., the low current prevalence in sign-up rates, and this effect also increases with the level of underestimation. We reflect on potential reasons for this finding in the discussion at the end of our paper.

Additionally, we find that giving information about the positive trend increases sign-up rates also among those that underestimate the injunctive norm, which also increases with the level of underestimation of the injunctive norm, as well as within the group that underestimates both social influence indicators. We take this as modest evidence of cross (or indirect) belief updating: that is, people may use the information about the positive trend to update their belief about the injunctive norm.

Finally, we do not find overall average treatment effects on sign-up decisions, which is as expected given the beliefs distribution in our sample. It is likely a matter of statistical power since a sizeable share of the population in our context does not (strongly) underestimate the injunctive norm, positive trend, or current prevalence in sign-up rates. Moreover, tracking people’s official registration five months post our intervention reveals that sign-up choices were consequential for about 10% of the people. We discuss potential reasons for the discrepancy between sign-up decisions and official registrations in more detail towards the end of our paper.

We contribute to three important areas of research. First, ours is one of a few existing papers that combine measuring people’s individual prior beliefs with information treatments that directly aim at correcting them ([Byrne et al., 2018](#); [Bursztyn et al., 2020](#); [Andre et al., 2024](#)). This is in contrast to previous studies that document inaccurate beliefs without correcting them, provide information without measuring baseline beliefs, or measure beliefs only with post-treatment surveys while still interpreting treatment effects as a result of prior inaccurate beliefs ([Byrne et al., 2018](#)). Our findings are in line with the ones of [Bursztyn et al. \(2020\)](#) and [Andre et al. \(2024\)](#), who also report positive treatment effects only among those who underestimate the social norm. Whereas the papers cited investigate the effects of belief updating for (descriptive or injunctive) social norms of the desired behavior, we additionally consider belief updating for a positive trend in this behavior. To the best of our knowledge, there exists no previous study that analyzes the role of prior beliefs in the context of such positive trends.

Second, in doing so, we contribute to the small but growing research area that investigates the influence of messages about positive behavioral trends on the willingness of people to follow the trend. Within this literature, we benchmark the effect of a message about a positive trend against that of a message about an injunctive norm, which has not previously been done in a field experiment. Our paper provides first clean evidence on the impact of providing information about trends where such behavior is not yet normative. While there are other studies providing information about temporal changes in behavior, these papers cannot separately identify the effect of information about the trend and the effect of information about current behavior ([Sparkman and Walton, 2017](#); [Loschelder et al., 2019](#); [Mortensen et al., 2019](#)).<sup>8</sup> In other words, these studies cannot rule out that the effect is driven by belief updating on the descriptive norm, since they do not measure prior beliefs.

Third, we expand evidence on the growing policy-relevant literature studying interventions that use messages leveraging social influence to encourage cooperative, and especially sustainable behavior.<sup>9</sup> Our findings help to elucidate an important aspect of the large heterogeneity commonly observed in this literature across target groups (see, e.g., [Abrahamse and Steg \(2013\)](#) and [Farrow et al. \(2017\)](#) for a meta-analysis and review). In particular, our evidence shows that social influence information is only effective in encouraging desired behavior among people who underestimate (changes in) its prevalence or others’ social approval, even when the behavior is not yet widely adopted.

Taken together, our results are relevant for policy design to promote behavioral change by recommending targeting those whose beliefs would make them more responsive to information. We show that this can be effective even when the desired behavior is not yet normative in a descriptive sense, which makes this recommendation important for promoting desired behaviors that are

<sup>8</sup> For example, [Loschelder et al. \(2019\)](#) use the description “more and more”, which does not provide any descriptive numbers. [Sparkman and Walton \(2017\)](#) present the positive trend only in changes over time (“x% have started to engage in the behavior”). Our approach is more similar to [Mortensen et al. \(2019\)](#), who also provide concrete numbers on the temporal change in the prevalence of desired behavior, but without measuring prior beliefs. Moreover, in their case, the share of people engaging in the target behavior was already at 48%, and thus considerably closer to being widely adopted than in our case.

<sup>9</sup> Examples include energy conservation ([Allcott, 2011](#); [Allcott and Rogers, 2014](#); [Andor et al., 2020](#); [Ayres et al., 2013](#); [Bonan et al., 2020](#); [Nolan et al., 2008](#); [Schultz et al., 2007](#)), water conservation ([Brent et al., 2015](#); [Brick et al., 2023](#); [Datta et al., 2015](#); [Ferraro et al., 2011](#); [Ferraro and Price, 2013](#); [Jaime Torres and Carlsson, 2018](#); [Lede et al., 2019](#); [Myers and Souza, 2020](#); [Schultz et al., 2016](#)), recycling ([Schultz, 1999](#)) or the reuse of towels in hotels ([Goldstein et al., 2008](#)). A study conducted by [Chong et al. \(2015\)](#) also tested the effects of different messages, including descriptive social norms, on the recycling behavior of households in Peru and found no significant effects. Yet, the authors acknowledge that certain features in their design might have been the reason for these null results.

**Table 1**  
Experimental conditions.

	Injunctive norm message	Positive trend message
Control group (A)	–	–
Injunctive norm treatment (B)	✓	–
Positive trend treatment (C)	–	✓
Combined treatment (D)	✓	✓

currently only engaged in by a minority. As noted, this is the case for many pro-environmental behaviors, which makes these findings particularly timely and relevant in light of the environmental challenges we are facing.

The rest of the paper proceeds as follows. We introduce the experimental design, including the experimental procedures and research hypotheses, in Section 2. Then, Section 3 presents a description of the data and the main results. We end the paper with a discussion and conclusion in Section 4.

## 2. Experimental design

The core of the study is three-fold: (1) eliciting prior beliefs about the injunctive norm and positive trend, (2) delivering information treatments about the norm and the trend, and (3) eliciting households' decisions to sign up for the recycling program. All three core activities were implemented via a single phone survey detailed below.

For the first core activity, belief elicitation, we used an incentivized mechanism to elicit people's prior beliefs about the positive trend and the injunctive norm regarding participation in the recycling program. We define beliefs about the trend as the difference between people's beliefs about current participation in the recycling program and participation three years ago. This calculation is based on the responses to these two questions<sup>10</sup>:

- Belief about current participation: "Out of every 100 households in Miraflores, how many do you think are currently participating in the municipality's recycling program? All numbers between 0 and 100 are allowed". (integer 0–100)
- Belief about participation three years ago: "How many out of every 100 households in Miraflores do you think were participating in the program three years ago (end of 2017)? Again, all numbers between 0 and 100 are allowed". (integer 0–100)

We then measured respondents' beliefs about the injunctive norm on the idea that recycling is important. We collected both first-order and second-order beliefs. First-order beliefs refer to whether the respondent considers recycling important and second-order beliefs to the degree that the respondent thinks others regard recycling as important. We use the following questions:

- First-order belief about the importance of recycling: "Do you think that it is important for the environment that households in Miraflores participate in the municipality's recycling program?" (yes, no, don't know)
- Second-order belief about injunctive norm: "We asked 100 households in Miraflores to answer the same question we just asked you, so whether it is important for the environment that households in Miraflores participate in the municipality's recycling program. How many of those 100 do you think said yes? All numbers between 0 and 100 are allowed". (integer 0–100)

For the second core activity of our experiment, participants were randomly assigned to one of four experimental conditions that combine two treatments in a  $2 \times 2$  between-subject design, where one treatment corresponds to the positive trend and the other to the injunctive norm. Table 1 summarizes this design.

We define positive trend information as information about how participation levels have developed over time, in our case over the last three years. In contrast to descriptive norm information that would only focus on the current level of participation, the positive trend treatment thus conveys information about participation levels for two points in time, and highlights the positive increase in numbers.

The treatment messages were proposed by the authors and fine-tuned with inputs from our local partners and officials from the municipality. The English versions of the two types of messages are as follows:

- Injunctive norm message: "Of the 100 households in Miraflores we asked, 97% think that it is important for the environment that households participate in the municipality's recycling program!"
- Positive trend message: "The number of households in Miraflores that are participating in the municipality's recycling program has doubled, from 6% to 12%, over the last three years!"

The treatment messages were directly followed by the third core activity, eliciting the decision of whether the household signs up for the recycling program. The sign-up decision was measured as a binary variable (yes/no) and is our main outcome variable. We presented the invitation to sign up as follows:

"If you like, you now have the chance to sign up to the recycling program of the municipality. Would you like to sign up to the recycling program?"

<sup>10</sup> The full set of survey questions is provided in Section A of the Online Appendix.

The enumerator then recorded the sign-up decision. As far as respondents were concerned who answered “yes” to this question, they had at that moment in time signed up to the program. In the days that followed the interview, they were contacted by the municipality for completing the registration process.

### 2.1. Experimental procedure

Before we conducted the actual experiment, we deployed an initial pre-intervention survey with 100 households in Miraflores to measure the prevalence of the injunctive norm regarding recycling in the municipality. In this brief survey, we asked participants their first-order beliefs about the importance of recycling (whether they considered it important that households in Miraflores participate in the municipality’s recycling program, asked in the same wording as the question presented above). These responses, combined with information from the municipality about the participation rate in the recycling program, allowed us to design the treatment messages we discussed above.

Our actual experiment was conducted via phone surveys through a survey company in February and March 2021. Participants were recruited from the official database of the municipality of Miraflores, which contains all households registered in the district with respective phone numbers and addresses. Enumerators called households in a randomly generated order. We programmed the survey using the software SurveyCTO, which enumerators then used to fill in the responses. The software allowed us to monitor incoming data in real time and apply quality checks promptly when needed.

The protocol for the survey was as follows (see Fig. 1). When a respondent answered the call, enumerators first explained who they were and stated that they were conducting a survey in collaboration with the municipality’s recycling program. Enumerators then asked whether the household was already enrolled in the program. If so, they thanked the respondent and ended the call, as we were interested in the households that were not yet part of the program. If a household was not enrolled yet, the survey continued, and enumerators informed respondents that the data would be treated with confidentiality and analyzed anonymously. Respondents were informed that they could win a prize (one of 15 gift cards of 50 Soles each) for completing the survey and were asked to give their verbal consent to participate in the study.<sup>11</sup>

If the respondent agreed to participate in the study, the enumerator continued with the survey and briefly explained the recycling program. Enumerators proceeded with the first core activity of the experiment; that is, we elicited people’s prior beliefs about the trend and the injunctive norm regarding participation in the recycling program in the district and their personal first-order beliefs about the importance of recycling. We incentivized respondents to provide their beliefs by offering them the opportunity to win another gift card of 10 Soles for each question where their belief was correct, in addition to the incentive for participation.

For use as control variables, we then collected demographic information about the respondent and the household and asked some general questions. These general questions also served as buffer questions between the beliefs questions and the treatment messages. Specifically, we aimed to reduce the potential effect of any lingering thoughts in respondents’ minds resulting from having just been asked their beliefs about a trend in recycling on the injunctive norm treatment message, and vice versa.

In the next step, the treatment messages were conveyed, following the treatment design described above. Respondents were randomly assigned to one of the four conditions (A-D).

After conveying the treatment messages and asking for people’s sign-up decisions, we elicited people’s post-treatment beliefs about future norms in recycling behavior and personal and collective response efficacy. We further collected information on additional control variables that are related to recycling and were therefore asked after the sign-up decision to not influence the respondents’ decisions.

Finally, we collected the contact details for the household (in case the household wanted to sign up for the program) and informed the participants that they would be notified whether they won the gift cards after the completion of the data collection. This was also the moment where respondents were informed that they would be contacted by the municipality within the following days to officially complete the registration process.

### 2.2. Hypotheses

We hypothesize that the effectiveness of our treatments will depend on the distribution of individual prior beliefs about the positive trend and/or the injunctive norm, depending on the treatment. All hypotheses presented in this paper were pre-registered at the AEA RCT Registry (AEARCTR-0007063). In particular, we expect the message in the injunctive norm treatment B to be more effective among those people that previously underestimate the injunctive norm, in the positive trend treatment C among those people that previously underestimate the positive trend, and in the combined treatment D among those people that previously underestimate both the positive trend and the injunctive norm.

These hypotheses are straightforward applications of the principle of belief updating regarding current injunctive social norms and plausible future descriptive social norms (Bicchieri and Dimant, 2019). When people learn that more people than expected think recycling is important (injunctive norm treatment B), they perceive more strongly that signing up for the program is the expected action — i.e., the strength of the injunctive norm increases. When they learn that the number of other people who participate in the

<sup>11</sup> Gift cards could be used in the department store Saga Falabella. The incentives were chosen based on discussions with local partners in Peru and represented 50 local currency units (Soles or PEN), which, at the time, was approximately 15 USD. Using data from household surveys, we estimate the average daily wage in urban Peru ranges between 15 USD and 20 USD.

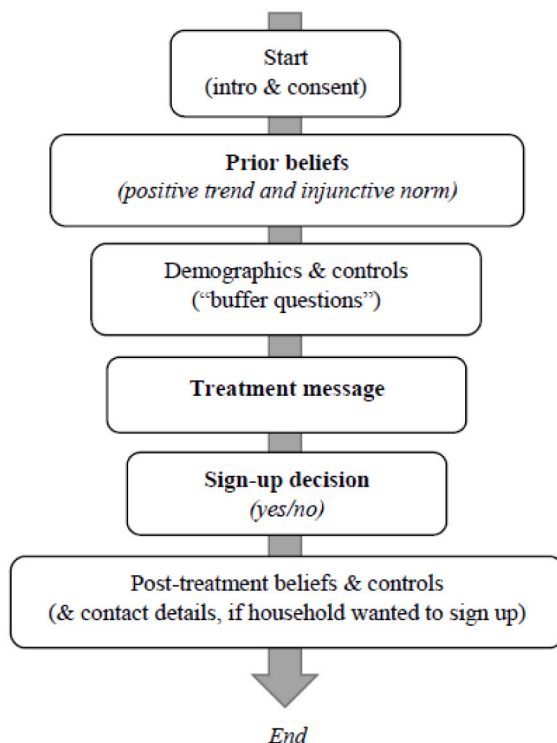


Fig. 1. Experimental procedure.

program is increasing more than expected (positive trend treatment C), it is plausible that they adjust their estimated likelihood of this behavior becoming a future descriptive social norm, which may influence current behavior. And when they learn about both pieces of information (combined treatment D), the two mechanisms at once are expected to be at work. As a consequence, people with prior beliefs as described are more likely to sign up to the recycling program. Concretely, this leads to the following hypotheses based on individual level belief updating:

**Hypothesis 1 (H1: Belief Updating on Injunctive Norm).** The sign-up rate among people who underestimate the injunctive norm is higher in the injunctive norm treatment B than in the control group A.

**Hypothesis 2 (H2: Belief Updating on Positive Trend).** The sign-up rate among people who underestimate the positive trend is higher in the positive trend treatment C than in the control group A.

**Hypothesis 3 (H3: Belief Updating on Positive Trend and Injunctive Norm).** The sign-up rate among people who underestimate both the positive trend and the injunctive norm is higher in the combined treatment D than in the control group A.<sup>12</sup>

We further acknowledge that the positive trend treatment C as well as the combined treatment D also convey information about the low current participation rate. We therefore expect the effect of the message in treatment C and treatment D to be particularly effective among those people that previously underestimate the current participation rate, which leads to a fourth hypothesis:

**Hypothesis 4 (H4: Belief Updating on Current Participation).** The sign-up rate among people who underestimate the current participation rate is higher in the positive trend treatment C and in the combined treatment D than in the control group A, respectively.

In a setting where most people underestimate the injunctive norm, positive trend, and current participation rate, respectively, we would therefore anticipate positive average treatment effects, as also hypothesized in our pre-analysis plan. Conversely, if most people were to overestimate the relevant information, we would not anticipate substantial average treatment effects.

<sup>12</sup> Even though not pre-registered, we will further analyze whether hypotheses 1 and 2 also hold for the combined treatment D, that is, whether the sign-up rate among people who either underestimate the injunctive norm or the positive trend is higher in the combined treatment D than in the control group A.

**Table 2**  
Prior beliefs.

Belief type	True value	Belief mean	Share that underestimate	N
Current participation	12%	35.31%	23.23%	1511
Past participation	6%	22.31%	28.36%	1520
Trend (current minus past)	6%	13.04%	38.14%	1505
Injunctive norm	97%	80.21%	67.13%	1582

Notes: The table shows the true value, mean and percentage of people that underestimate the true value of the respective belief type. The remaining percentage of people thus overestimate or are correct about it.

### 3. Results

#### 3.1. Descriptives

##### Demographics

In total, 1709 people participated in our study.<sup>13</sup> Our sample consists of 38.0% male, 61.7% female and 0.3% diverse people. The average age is 53.7 years, with a minimum age of 18 and a maximum age of 95. Most of our participants are either the head of the household (58.9%) or their spouse (26.1%). 59.4% of our participants hold either a technical university or university degree, which reflects the upper-middle class nature of the district where we conducted this study. The mean number of household members is 2.9 people, and the average number of children per household is 0.4. Most participants (67.4%) state that they themselves bear responsibility within the household for recycling, while 62.0% of the households indicate that they already recycle through other ways than the municipality's recycling program, which is therefore clearly an important control variable. Table A.1 in Appendix A shows that individual characteristics are mostly balanced across the different experimental conditions, confirming that the randomization was successful.

Throughout the paper, when we use control variables in our analyses, we include gender (whether the respondent is female), whether the household has children, whether the respondent is the household head, level of education (whether the respondent has a technical university or university degree), level of patience,<sup>14</sup> whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways than the municipality's recycling program.<sup>15</sup>

##### Prior beliefs

Looking at the distribution of individual prior beliefs, we find that, on average, people overestimate current and past participation rates in the recycling program, as well as (although less strongly) the trend in participation rates (see Table 2). By contrast, on average, people underestimate the injunctive norm.<sup>16</sup> The average beliefs distribution is mostly balanced across treatment groups, as shown in Table A.2 in Appendix A.<sup>17</sup>

We should also note that 97.7% of the people in our sample answered the first-order injunctive norm beliefs question positively, i.e., whether they think that it is important for the environment that households participate in the municipality's recycling program, which is very similar to the 97% obtained from our pre-intervention survey.

Fig. 2 shows the differences between individual beliefs and true values for the current participation, past participation, positive trend, and injunctive norm, respectively. A difference of zero means that people's guess is correct, below zero means that people underestimate the true value, and above zero that they overestimate it. We present a correlation matrix of the different beliefs in Appendix B (Table B.1).<sup>18</sup>

<sup>13</sup> The database of the municipality contained roughly 40,000 registered addresses with respective phone numbers. Of the households that were called, 3040 picked up the phone. Of those 3040 households, 2442 said they were not participating in the recycling program. Of those 2442 eligible households, 1711 agreed to participate in our study. We aimed for a total sample of at least 1600 households, as pre-registered, based on power calculations, and slightly over-sampled to have some buffer in case of data issues. Two submissions had to be excluded because enumerators had entered an unidentifiable household ID in two cases, which led to a final sample of 1709 households.

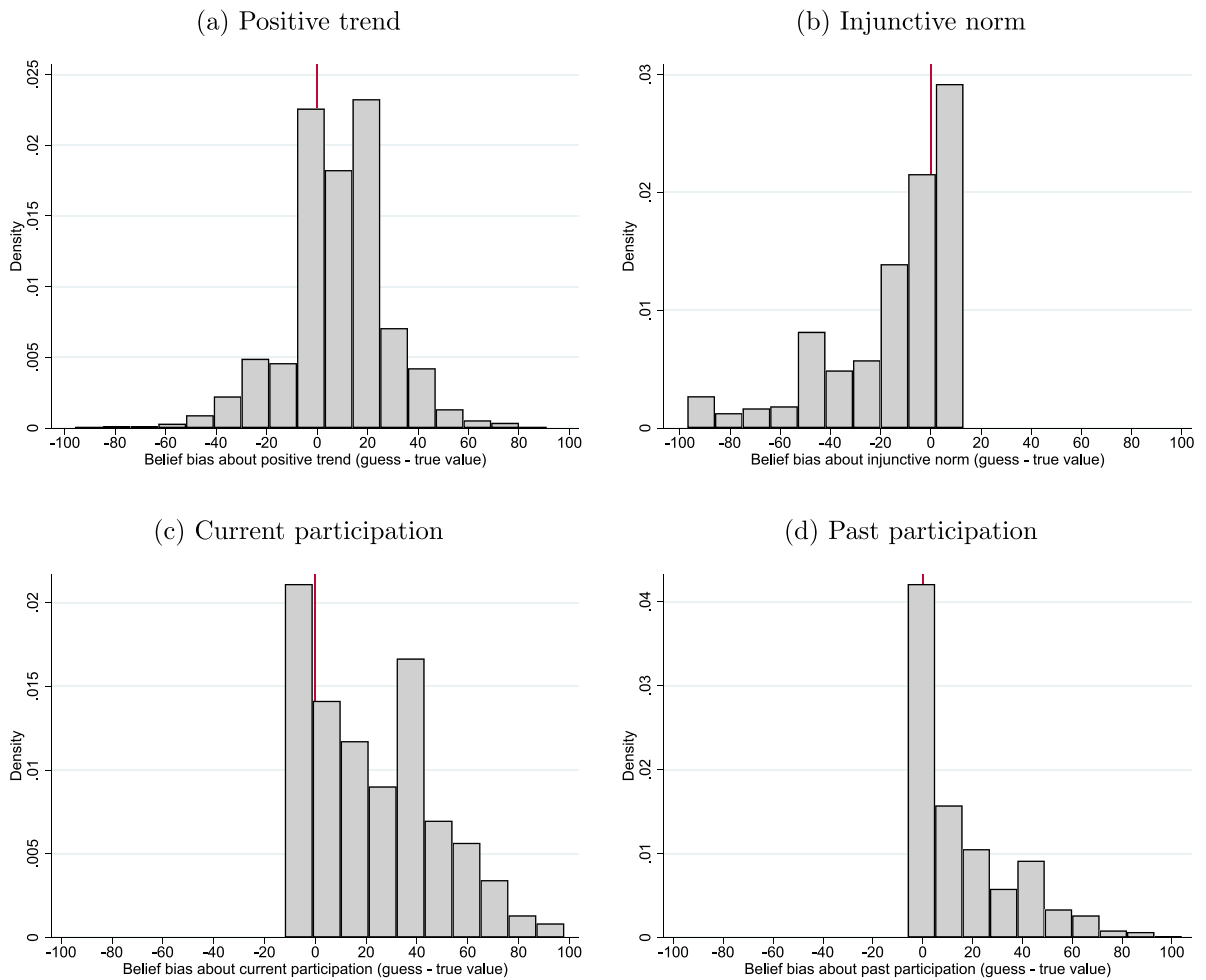
<sup>14</sup> Research has shown that time preferences matter for sustainable plastics consumption in Peru (Fuhrmann-Riebel et al., 2021).

<sup>15</sup> Correlations of these control variables with beliefs are presented in Section B of the Online Appendix.

<sup>16</sup> Even though it may seem surprising that we observe systematic misperceptions about an injunctive norm that is seemingly universally agreed on, this finding is in line with other studies and often referred to as "pluralistic ignorance" (Bursztyjn et al., 2020; Andre et al., 2024).

<sup>17</sup> Enumerators were instructed to enter "99" for the beliefs whenever a participant preferred not to answer the beliefs question. Therefore, all "99" entries were recoded as missing values. This led to 198 missing values for the belief about current participation, and 189 missing values for the belief about past participation. In the case of the injunctive norm belief, this approach led to a small measurement issue as "99" was very close to the true value of 97. Therefore, there is a risk that "99" entries did not always mean that the person did not want to answer the question. Hence, we only recoded "99" entries for the injunctive norm belief as missing values when the other beliefs had "99" entries as well (mostly people either answered all or no beliefs questions), which led to 127 missing values. The remaining 26 "99" entries for the injunctive norm belief all had reasonable entries for the other beliefs, supporting our assumption that in those cases the "99" was actually people's true belief.

<sup>18</sup> Unsurprisingly, beliefs about the current and past participation rate are correlated, as well as with beliefs about the positive trend, given that the latter is calculated as the difference between the other two beliefs. Interestingly, the trend and injunctive norm beliefs are also positively correlated with each other, so people who under(over)estimate the trend also tend to under(over)estimate the injunctive norm.



**Fig. 2.** Biases in beliefs (estimates minus true value). *Notes:* Individual errors in beliefs are calculated as the difference between, respectively, the true value of the positive trend, injunctive norm, current participation and past participation, and the respondent's belief of these values. The red line indicates an error of zero, meaning that the participant's estimate was correct. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

### 3.2. Overall treatment effects

The main focus of our paper rests on treatment effects based on prior beliefs about the various social influence indicators (see hypotheses in Section 2.2). Nonetheless, we first look at the average effects of our injunctive norm and positive trend information treatments on the whole sample, which was pre-registered as well. We find that, in total, 70.39% of the participants (1203 out of 1709 people) said that they would like to sign up to the recycling program during our phone survey. There is no statistically significant difference in people's sign-up decisions between the different treatment groups and the control group (see Table 3). Fig. C.1 and Table C.1 in Appendix C report the proportion of equality tests and the regression analysis (using OLS) with the full list of control variables, respectively.<sup>19</sup> It is worth noting that these results are not necessarily inconsistent with our pre-registered hypotheses, since we hypothesized that the overall effectiveness of our treatments depends on the distribution of individual prior beliefs.

### 3.3. Treatment effects based on individual prior beliefs

We now turn to our main set of pre-registered analyses<sup>20</sup>: the heterogeneous treatment effects based on individual prior beliefs about the injunctive norm and/or trend. In these exercises, we use tests of equality of proportions, OLS regressions, and logistic regressions as robustness checks, and present these analyses both with and without covariates.

<sup>19</sup> Table C.1 in the Online Appendix presents the regression analysis under the logistic model.

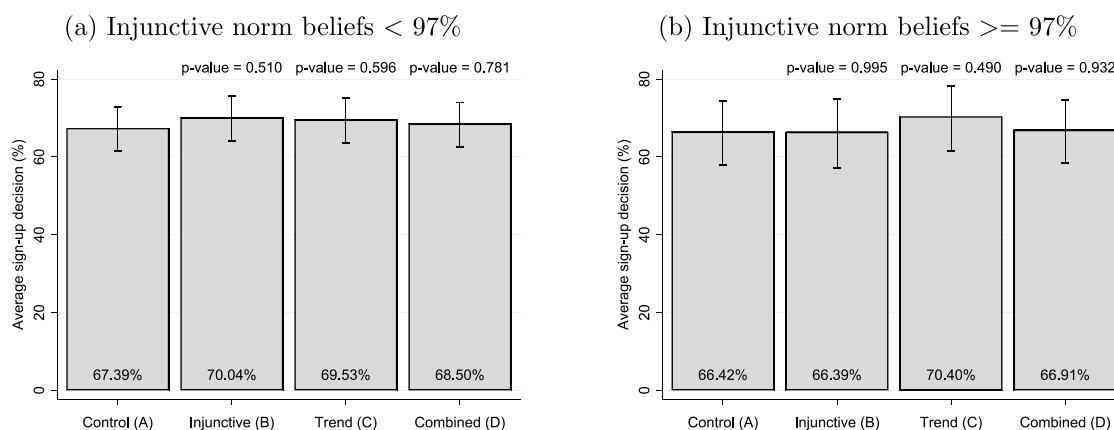
<sup>20</sup> Other pre-registered analyses that are not presented in the main paper can be found in Section E of the Online Appendix.



**Table 3**  
Average treatment effects on households' sign-up decision.

	(1)	(2)
Injunctive (B)	0.013 (0.031)	0.017 (0.029)
Trend (C)	0.018 (0.031)	0.022 (0.029)
Combined (D)	-0.008 (0.031)	0.006 (0.028)
Constant	0.698*** (0.022)	0.138*** (0.045)
Controls		✓
Adjusted R <sup>2</sup>	-0.001	0.143
Observations	1709	1709

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Column (1) includes treatment dummies alone; column (2) adds control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively. For the regression table with the full list of control variables see Table C.1 in the Appendix, for the robustness check with logit regressions see Table C.1 in the Online Appendix.



**Fig. 3.** Heterogeneity in average sign-up decisions between people who under- or overestimate the injunctive norm. Notes: Average sign-up decision of people who under- or overestimate the injunctive norm, comparing the different treatments B-D with the control group A.  $n(3(a)) = 1026$ ,  $n(3(b)) = 520$ . P-values are obtained from testing for equality of proportions, comparing treatments B, C and D with treatment A, respectively. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

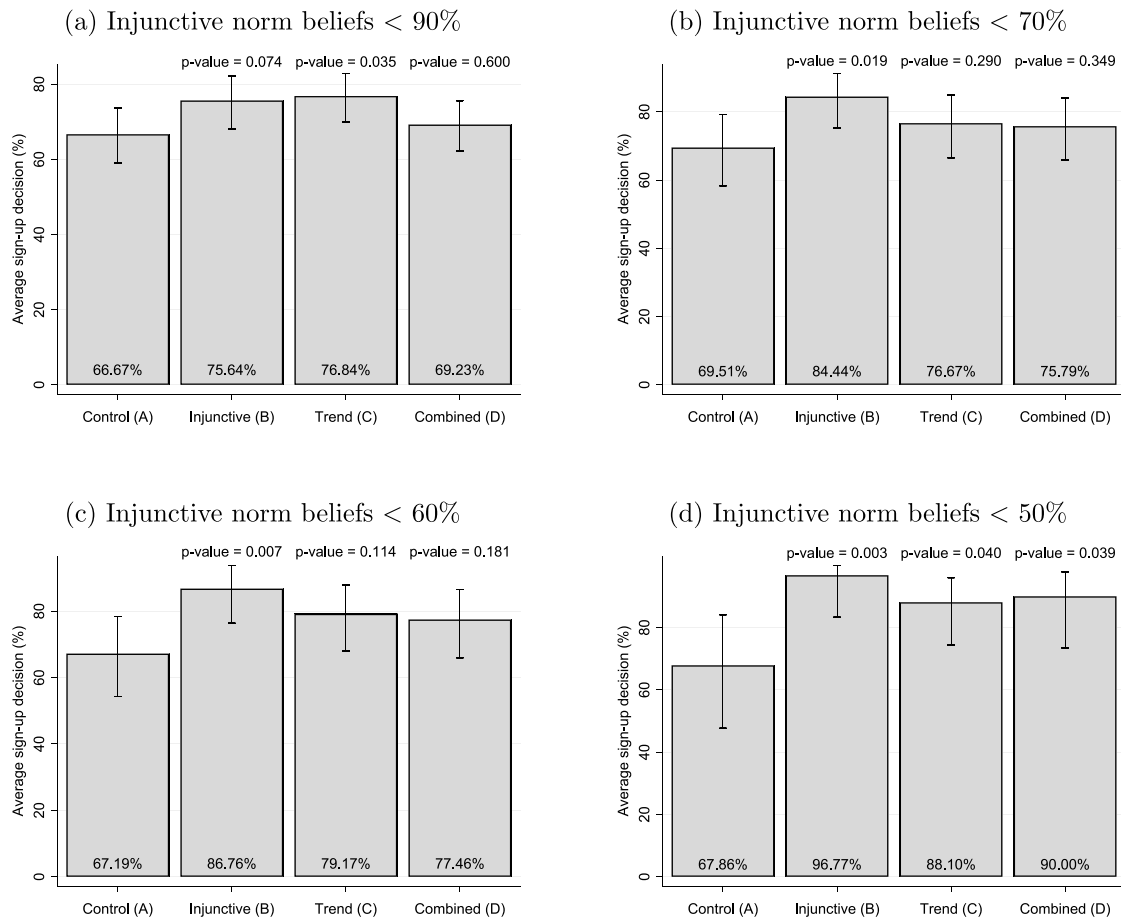
**Beliefs about the injunctive norm**

We start by analyzing whether people’s beliefs about the injunctive norm regarding participation in the recycling program play a role in their response to the intervention. We find a slight tendency that correcting beliefs in the injunctive norm treatment B has a positive effect on people’s sign-up decision for those who underestimate the 97 percent approval (67.36% in the control group vs. 70.04% in the treatment group), however this difference is not statistically significant (Fig. 3(a)). For those who overestimate or are correct about the injunctive norm, there is no statistically significant difference in sign-up decisions either (Fig. 3(b)). Similarly, the positive trend and combined treatments do not have an impact on the decision to sign up, either among those that underestimate or those that overestimate the injunctive norm (see Figs. 3(a) and 3(b)). Table C.2 in the Appendix A and Table C.2 in the Online Appendix confirm these findings using OLS and logistic regressions, respectively.

When we look at those who underestimate the injunctive norm more strongly in Fig. 4, however, the difference in sign-up decisions between the injunctive norm treatment B and the control group A increases and becomes statistically significant. For those who underestimate the injunctive norm only slightly more and expect it to be below 90%, sign-up decisions increase significantly by 9 percentage points, from 66.67% to 75.64% (see Fig. 4(a)). This is consistent with our hypothesis H1 regarding the injunctive norm treatment for people who underestimate it more strongly.<sup>21</sup>

We note that for the combined treatment D, the difference becomes statistically significant when people underestimate the injunctive norm even more strongly and expect it to be below 50% (see Fig. 4(d)). In general, we find that the difference in sign-up

<sup>21</sup> It should be noted that lowering the threshold for the injunctive norm beliefs was not specified in our pre-analysis plan.



**Fig. 4.** Heterogeneity in average sign-up decisions between people who underestimate the injunctive norm more strongly. *Notes:* Average sign-up decision of people who underestimate the injunctive norm more strongly, comparing the different treatments B-D with the control group A.  $n(4(a)) = 699$ ,  $n(4(b)) = 357$ ,  $n(4(c)) = 275$ ,  $n(4(d)) = 131$ . P-values are obtained from testing for equality of proportions, comparing treatments B, C and D with treatment A, respectively. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

decisions becomes larger the more strongly people underestimate the true value, although the respective sample sizes become quite small.<sup>22</sup>

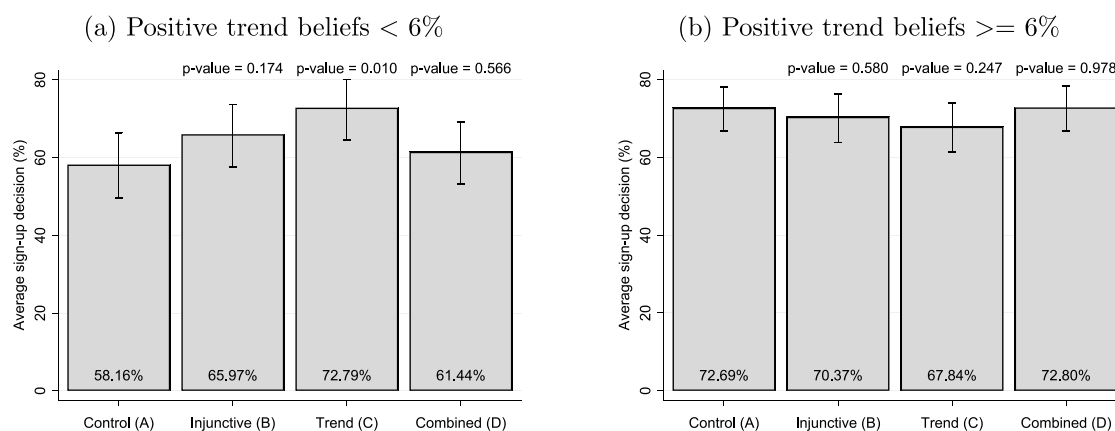
Interestingly, we also find that the sign-up rate for people in the positive trend treatment C increases significantly compared to the control group when people underestimate the injunctive norm more strongly, even though the positive trend treatment message does not contain any direct information about the injunctive norm. This suggests that people may exhibit cross or indirect belief updating, which may be due to the correlation of beliefs (Table B.1). That is, the information disclosed about one social influence indicator might also update the belief regarding another one. It should be noted that analyses on cross-belief updating were not pre-registered and are thus exploratory.

*Beliefs about the positive trend*

We now center on people’s prior beliefs about the positive trend in participation rates in the recycling program. First, as expected, we find that the positive trend treatment C has a significant positive effect on people’s sign-up decision when they underestimate the trend. The rate of sign-up increases from 58.16% in the control group to 72.79% in the treatment group (see Fig. 5(a)). Additionally, we note that the positive trend treatment C is the only treatment that significantly impacts the sign-up decision among those who underestimate the trend. Also, none of the treatments have a significant effect among those who correctly estimate or overestimate the six percentage points change in the participation rate.<sup>23</sup> We can thus confirm our hypothesis H2 for the positive trend treatment C.

<sup>22</sup> Table C.3 in the Appendix A confirms the findings using OLS regressions, and Table C.3 in the Online Appendix provides an additional robustness check using logistic regressions.

<sup>23</sup> Table C.4 in the Appendix A shows that these results are robust when using OLS regressions. We provide a further robustness check with logistic regressions in Table C.4 of the Online Appendix.



**Fig. 5.** Heterogeneity in average sign-up decisions between people who under- or overestimate the positive trend. *Notes:* Average sign-up decision of people who under- or overestimate the positive trend, comparing the different treatments B-D with the control group A.  $n(5(a)) = 574$ ,  $n(5(b)) = 931$ . P-values are obtained from testing for equality of proportions, comparing treatments B, C and D with treatment A, respectively. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

**Fig. 5** further shows that among people in the control group, the sign-up rate is significantly higher when people already have more optimistic beliefs about the trend in participation rates in the recycling program (58.16% in **Fig. 5(a)** vs. 72.69% in **Fig. 5(b)**,  $p = 0.003$  from testing for equality of proportions). Moreover, correcting people's beliefs when people underestimate the trend in the positive trend treatment C raises sign-up rates to similar levels as for people in the control group who already have more optimistic beliefs in advance (72.79% in treatment C in **Fig. 5(a)** vs. 72.69% in the control group A in **Fig. 5(b)**,  $p = 0.983$  from testing for equality of proportions). These findings provide additional evidence that individual beliefs about a trend in the participation of others matter for people's own decision to sign up to the recycling program.

#### Beliefs about the current participation rate

Since the positive trend treatment C and the combined treatment D convey information about both the positive trend in participation rates (increase by six percentage points) and the current participation rate (12%), we also investigate heterogeneous treatment effects with regards to beliefs about the current participation rate. As expected, we find that correcting people's beliefs in the positive trend treatment C has a significant positive effect on people's sign-up decision for those who underestimate the current participation rate of 12 percent (**Fig. 6(a)**). The sign-up rate increases from 49.43% in the control group to 68.67% in the treatment group. We find a similar pattern for the combined treatment D, where the average sign-up decision for those who underestimate the current participation rate increases from 49.34% in the control group to 63.73% in the treatment group (**Fig. 6(a)**). Also here, there is no statistically significant difference in people's sign-up decision for those who overestimate or are correct about the current participation rate for any of the two treatments (**Fig. 6(b)**). The injunctive norm treatment B does not lead to any significant changes in sign-up decisions.<sup>24</sup> This evidence is consistent with our hypothesis H4 for both the positive trend treatment C and the combined treatment D.<sup>25</sup>

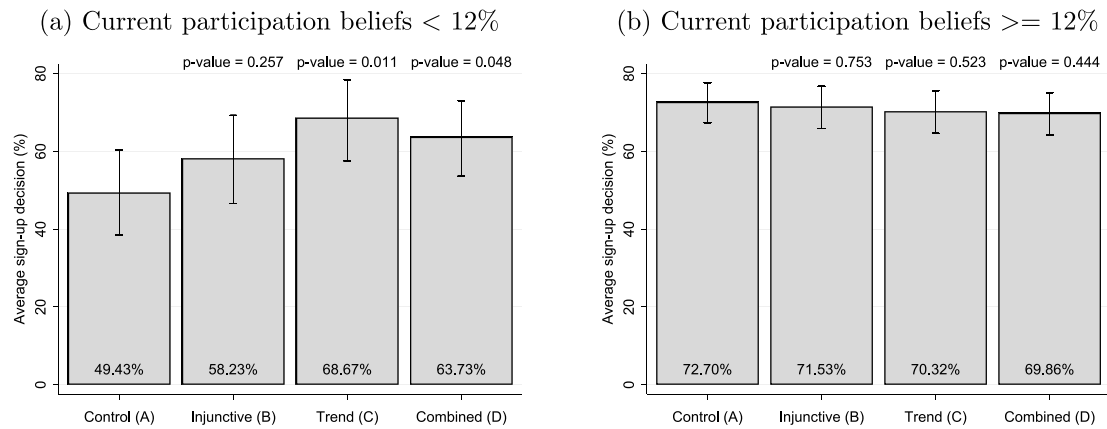
As for people's beliefs about the trend in participation rates, we find that among participants in the control group, the average sign-up decision is significantly higher when people already have more optimistic beliefs about the current participation rate in the recycling program (49.43% in **Fig. 6(a)** vs. 72.70% in **Fig. 6(b)**,  $p = 0.000$  from testing for equality of proportions). Moreover, correcting people's beliefs when they underestimate the current participation rate in the positive trend treatment C increases sign-up rates again to similar levels as for people in the control group who already have more optimistic beliefs in advance (68.67% in treatment C in **Fig. 6(a)** vs. 72.70% in the control group A in **Fig. 6(b)**,  $p = 0.470$  from testing for equality of proportions).

#### 3.4. Treatment effects based on multiple prior beliefs

We have looked at the responses to our treatments based on the under- or overestimation of each belief individually. We now investigate different beliefs jointly, which is especially relevant for the combined treatment D that addresses multiple beliefs at the same time.

<sup>24</sup> These findings are robust to using OLS regressions (see **Table C.5** in the **Appendix A**). We provide a further robustness check with logistic regressions in **Table C.5** of the **Online Appendix**.

<sup>25</sup> Even though we did not pre-register any hypotheses on heterogeneous treatment effects based on beliefs about the past participation rate in the recycling program, we recognize that the positive trend treatment and the combined treatment also convey information about it. While conceptually this should be less relevant for people's decision to sign up to the program, we present the analysis on the comparison of average sign-up decisions between people who under- or overestimate the past participation rate nonetheless in **Section D.1** of the **Online Appendix**.



**Fig. 6.** Heterogeneity in average sign-up decisions between people who under- or overestimate current participation. *Notes:* Average sign-up decision of people who under- or overestimate current participation, comparing the different treatments B-D with the control group A.  $n(6(a)) = 351$ ,  $n(6(b)) = 1160$ . P-values are obtained from testing for equality of proportions, comparing treatments B, C and D with treatment A, respectively. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

First, we evaluate treatment effects in the four possible scenarios of under- versus overestimation of the positive trend and the injunctive norm. We find that the only treatment where the sign-up decision does increase significantly compared to the control group for people who underestimate both types of social influence is the positive trend treatment C (see Fig. C.2(a) in the Appendix A: 59.00% in A vs. 73.74% in C,  $p = 0.028$  from testing for equality of proportions). In all other scenarios, where people either underestimate one and overestimate the other type of social influence (Figs. C.2(b) and C.2(c)), or where people overestimate both types (Fig. C.2(d)), there is no statistically significant effect.<sup>26</sup>

We perform a similar analysis with the combination of positive trend beliefs and injunctive norm beliefs with a threshold of 90% for the latter (since the injunctive norm treatment only showed an effect on people's sign-up decision for those who underestimated the injunctive norm more strongly).<sup>27</sup> The results are similar, and again we find that the only treatment that exhibits a significant effect is the positive trend treatment C, and only for the sub-sample of households that underestimates both social influence indicators.<sup>28</sup> Therefore, we cannot confirm our hypothesis H3 for the combined treatment D.

We provide the same analyses for the combination of beliefs about the current participation rate and the injunctive norm (see Tables C.8 and C.9 in the Appendix A for OLS regressions, and Tables C.8 and C.9 in the Online Appendix for logistic regressions). We find that both the combined treatment D and the positive trend treatment C have a significant positive effect on people's sign-up decision among those who underestimate the current participation rate and either underestimate or overestimate the injunctive norm. In contrast, the injunctive norm treatment B does not have an impact on any of the four groups. As before, we repeat this analysis and use 90% as a threshold for the injunctive norm, which reveals similar findings. Some of these effects only become significant when covariates are added, while others lose significance to their addition.

### 3.5. Regression analysis

The previous analysis has two potential limitations that we aim to address in this section. First, since beliefs are correlated (see Table B.1 in the Appendix A), the analysis should account for the degree of underestimation of all types of beliefs jointly. This is particularly important as receiving information about one indicator might correct the beliefs about another — i.e., there might be cross or indirect belief updating. For example, as information about the recent trend contains information about the current and past participation rate, we need to control for beliefs about the current participation to identify the effect of belief updating on the trend. The correct analyses of the impact of correcting one belief would thus involve controlling for the degree of underestimation of the other beliefs.

Second, the previous analysis has not fully addressed whether the behavioral response to receiving the correct information depends on people's degree of underestimation of (changes in) the participation rate in the municipality's recycling program and the injunctive norm. We conjecture that the information has a higher impact on those who underestimate the social influence indicators more strongly since the updates to their beliefs are larger. To test this, we use a continuous measure of people's individual errors in beliefs, which is defined as their reported estimate minus the true value ( $individual\ error = participant's\ estimate - actual\ value$ ). For easier interpretation of the results, we define the measure for underestimation as the negative of the belief error, and set this

<sup>26</sup> We can confirm these results using OLS regressions as shown in Table C.6 in the Appendix A, and when we use logistic regressions (Table C.6 in the Online Appendix).

<sup>27</sup> Lowering this threshold for the injunctive norm was again not pre-specified in our pre-analysis plan.

<sup>28</sup> The results can be found in Table C.7 of the Appendix A using OLS, and in Table C.7 of the Online Appendix using logistic regressions.

variable as zero when an individual overestimates the indicator. That is, the primary variable of interest in our analysis is the degree of underestimation, formally defined as  $\max\{0, -\text{error}\}$ . This means that, for example, if someone believes the injunctive norm to be at 80% while its actual value is 97%, the underestimation is 17; if a person believes the injunctive norm is at 98%, her underestimation equals 0.

The results of this regression analysis, reported in Table 4, show that the main messages are consistent with the previous analyses and further add a richer view of belief updating on the various social influence indicators.<sup>29</sup> First, we present the impact of our treatments on those who underestimate the level of the injunctive norm. The interaction between the underestimation level of the injunctive norm and the injunctive norm treatment B is significant and positive (see columns (1) and (2) of Table 4). For reference, a 10 percentage point increase in the downward bias of the injunctive norm increases the impact of the information about the injunctive norm on the probability of sign-up by 4 percentage points. This result is robust to adding the degree of error in other beliefs, as shown in columns (9) and (10). Hence, these findings are consistent with our conjecture: higher levels of belief updating about the injunctive norm lead to a higher probability of sign-up in the injunctive norm treatment B.

Interestingly, we also find that the interaction of the underestimation level of the injunctive norm with the positive trend treatment C is significant and positive (see columns (1) and (2)). The effect of receiving information about the positive trend in participation rates increases by 2 percentage points when the underestimation degree of the injunctive norm increases by 10 percentage points. However, once we control for the degree of underestimation of the other beliefs, this coefficient is significant only at the 10% level. We interpret this as mild evidence in favor of cross-updating: people update their belief about the injunctive norm after receiving information about the positive trend in participation rates. As noted before, all analyses on cross-belief updating were not pre-registered and are thus exploratory.

We perform a similar analysis for the underestimation degree of the positive trend. As expected, we find that the effectiveness of the positive trend treatment increases with the degree of underestimation of the recent trend in participation rates. For reference, a 10 percentage point increase in the downward bias raises the impact of the information about the positive trend on people's sign-up decision by 7 percentage points (see columns (3) and (4) of Table 4). The results remain robust when controlling for the other errors in beliefs (columns (9) and (10)).

On the other hand, and consistent with our previous analysis, the degree of underestimation of the current participation rate significantly interacts with the combined treatment D. The more an individual underestimates the current participation rate, the higher the impact of receiving the information in the combined treatment. The treatment effect is highly sensitive to the underestimation degree: a 10 percentage point increase in the downward bias of the current participation raises the impact of the combined treatment by 15–19 percentage points (columns (5)–(10)). This result is robust to adding covariates and other prior beliefs. In addition, and as noted before, the impact of the positive trend treatment C also increases with the underestimation degree of the current participation rates. The magnitude of sensitivity to the error level is also high: when the downward bias increases by 10 percentage points, the effect of the intervention increases by 21–25 percentage points. While the interaction term remains significant when we control for other prior beliefs, it loses significance when covariates are included.

Our initial claim that each treatment effect depends on the underestimation degree of the intervention's targeted beliefs thus holds for the injunctive norm treatment B and the positive trend treatment C. However, while the combined treatment D provides information about all three social influence indicators, its impact depends only on the underestimation degree of the current participation rate.

Finally, we find that the degree of underestimation of the positive trend or the current participation in the program correlates with individuals' own sign-up decisions. That is, the more pessimistic people are (either regarding the recent trend in sign-up rates or the current participation), the less likely they are to sign up. This does not hold for the injunctive norm.

### 3.6. Participants' official registration

Our intervention targets people's decision to sign up for the recycling program during the phone interview. We have focused our analysis on that decision because, based on the agreement with the municipality and from the respondents' perspective, that was an actual enrollment decision. The municipality explicitly authorized us to inform the respondent that we were contacting them on behalf of the authority and to ask directly whether they wanted to enroll in the recycling program. Due to a legal restriction, the municipality also required one final step to make the enrollment official. They would contact households themselves via email or WhatsApp and provide a URL for the household to fill out a form to confirm the enrollment. Importantly, respondents were informed about this final step only at the end of the interview. In theory, the municipality planned this contact a few days after the interview, yet we were not able to access the records of the exact contact dates and follow-ups with households. Five months after the intervention, one in 10 households completed the official registration (118 out of 1203). We report average treatment effects on people's official registration in Fig. C.3 and Table C.11 in Appendix C.5 and find no significant differences between the groups.<sup>30</sup> Also, given the low number of registered respondents, we lack the statistical power to conduct heterogeneity analyses using people's prior beliefs.

We acknowledge that this low rate calls for caution in interpreting our results. At the same time, we take the fact that people's sign-up decisions were consequential for 10% of all households as a reassuring signal that we were indeed measuring people's actual

<sup>29</sup> For the regression table with the full list of control variables see Table C.10 in the Appendix A, and for a robustness check with logistic regressions see Table C.10 in the Online Appendix.

<sup>30</sup> Table C.11 in the Online Appendix details a robustness check on this analysis using logistic regressions.

**Table 4**  
Heterogeneous treatment effects based on the level of underestimation of the various indicators of social influence.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Injunctive (B)	-0.047 (0.042)	-0.046 (0.039)	0.007 (0.038)	0.019 (0.035)	0.009 (0.036)	0.025 (0.034)	0.003 (0.039)	0.024 (0.037)	-0.062 (0.047)	-0.042 (0.045)
Trend (C)	-0.021 (0.042)	-0.014 (0.039)	-0.014 (0.037)	-0.004 (0.035)	-0.010 (0.036)	0.013 (0.034)	-0.040 (0.039)	-0.017 (0.037)	-0.080* (0.046)	-0.058 (0.044)
Combined (D)	-0.027 (0.041)	-0.014 (0.037)	0.024 (0.036)	0.031 (0.033)	-0.013 (0.035)	-0.003 (0.033)	0.003 (0.038)	0.009 (0.036)	-0.025 (0.045)	-0.016 (0.042)
Underestimation of injunctive norm	0.000 (0.001)	-0.001 (0.001)							0.001 (0.001)	-0.000 (0.001)
Injunctive (B) × Underestimation of injunctive norm	0.004*** (0.001)	0.004*** (0.001)							0.003** (0.001)	0.004*** (0.001)
Trend (C) × Underestimation of injunctive norm	0.002* (0.001)	0.003** (0.001)							0.002 (0.001)	0.002* (0.001)
Combined (D) × Underestimation of injunctive norm	0.002 (0.001)	0.002 (0.001)							0.001 (0.001)	0.001 (0.001)
Underestimation of positive trend			-0.006** (0.003)	-0.006*** (0.002)			-0.004 (0.003)	-0.005** (0.002)	-0.004 (0.003)	-0.005** (0.002)
Injunctive (B) × Underestimation of positive trend			0.001 (0.004)	-0.000 (0.003)			0.002 (0.004)	0.001 (0.003)	0.003 (0.004)	0.002 (0.003)
Trend (C) × Underestimation of positive trend			0.008** (0.004)	0.007** (0.003)			0.007* (0.004)	0.007** (0.003)	0.007* (0.004)	0.007** (0.003)
Combined (D) × Underestimation of positive trend			-0.002 (0.004)	-0.001 (0.003)			-0.003 (0.004)	-0.002 (0.003)	-0.003 (0.004)	-0.002 (0.003)
Underestimation of current participation					-0.035*** (0.007)	-0.018*** (0.006)	-0.033*** (0.007)	-0.015** (0.006)	-0.034*** (0.007)	-0.016** (0.006)
Injunctive (B) × Underestimation of current participation					0.001 (0.010)	-0.007 (0.008)	0.000 (0.010)	-0.007 (0.008)	-0.001 (0.009)	-0.008 (0.008)
Trend (C) × Underestimation of current participation					0.025** (0.010)	0.014* (0.008)	0.022** (0.010)	0.011 (0.008)	0.021** (0.010)	0.011 (0.008)
Combined (D) × Underestimation of current participation					0.017* (0.010)	0.015* (0.008)	0.019* (0.010)	0.017** (0.008)	0.018* (0.010)	0.016** (0.008)
Constant	0.668*** (0.029)	0.083* (0.051)	0.701*** (0.026)	0.123** (0.051)	0.725*** (0.025)	0.153*** (0.053)	0.742*** (0.027)	0.166*** (0.054)	0.726*** (0.032)	0.168*** (0.056)
Controls		✓		✓		✓		✓		✓
Adjusted R <sup>2</sup>	0.012	0.172	0.012	0.174	0.034	0.169	0.043	0.181	0.062	0.191
Observations	1582	1582	1505	1505	1511	1511	1505	1505	1505	1505

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. The level of underestimation is calculated as the difference between the participant's guess minus the true value of the respective indicator. Columns (1) and (2) look at interactions of treatments with degrees of underestimation of the injunctive norm; columns (3) and (4) at interactions of treatments with levels of underestimation of the positive trend; and columns (5) and (6) at interactions of treatments with underestimation about the current participation rate. Columns (7) and (8) combine the latter two; columns (9) and (10) include all interaction terms together. Columns (1), (3), (5), (7) and (9) are without, columns (2), (4), (6), (8) and (10) with control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively. For the regression table with the full list of control variables see Table C.10 in the Appendix, for the robustness check with logit regressions see Table C.10 in the Online Appendix.

decision to join the program. By the timing of the information provided to respondents, the decisions made during the phone call are the closest measure to the relevant behavior in our setting. The significant gap between the responses to our sign-up question and the official sign-up rates is most likely due to other factors different than intention-action misalignment. We have several conjectures but acknowledge that the data that is available to us is limited to study them. First, despite the information we provided at the end of the call, the respondents might have thought they were already signed up when the municipality reached out and decided not to act on that additional communication. Second, the reading rate of our text messages and emails might have been low, and the municipality staff might not have followed up sufficient times in their attempts to contact each household to overcome the potentially low reading rate. The single dispatch might have arrived at a time unsuitable for the respondents when they could not allocate time or mental capacity to act upon it. Third and finally, perhaps the social norm interventions were most persuasive right after we corrected participants' misperceptions and not much later. Respondents could have changed their minds when asked to register a few days after the phone interview.

#### 4. Discussion and conclusion

In this paper, we demonstrate that problems of weak collective action can be addressed by updating inaccurate beliefs about positive trends in others' behavior as long as a meaningful number of people underestimates the relevant trends and norms. We benchmark the effects of positive trend information against that of injunctive norms and show that both are effective to encourage behavior separately when people underestimate the trend or strongly underestimate the norm, while combined information proves

less effective. Our findings are relevant for addressing some of today's biggest challenges, including solving the climate crisis, which require finding ways to encourage collective action at a massive scale in contexts where only a small minority undertakes the desired behavior.

We find that the overall effectiveness of the intervention depends on the distribution of people's prior beliefs. In our case, the people among whom we find effects, i.e., those who underestimate the positive trend or more strongly underestimate the injunctive norm, are in the minority and thus, we do not find a significant average treatment effect overall. This is likely the result of the relative size of sub-populations and the statistical power this entails as the group among whom we find treatment effects is relatively small, which explains why these effects do not show up for the sample as a whole.

Our findings suggest that we would likely find larger average treatment effects in contexts where the majority underestimates the pertinent norms, or when systematically targeting the subgroup that underestimates the respective norms. This interpretation is in line with the results of [Bursztyn et al. \(2020\)](#) and [Andre et al. \(2024\)](#), who also report a significant increase in their respective target behaviors (only) among the people who underestimate the (injunctive or descriptive) social norm information they receive. The difference between our study and these two studies is that in both ([Bursztyn et al., 2020](#)) and [Andre et al. \(2024\)](#) the people who underestimate the pertinent norms are in the majority, which explains why they do find an average treatment effect, while we do not. For the majority who overestimate, we consistently – in line with the two studies cited – do not find any significant treatment effects, i.e., we also do not find evidence for any potential boomerang effect of our intervention. We therefore interpret our findings taken as a whole positively: the treatments lead to a positive behavioral response among those whose beliefs are initially pessimistic and corrected upwards, but not to a negative response among those whose optimistic beliefs are corrected downwards. Taken together, these results provide an important explanation for the large heterogeneity commonly observed among social influence information treatments across different target groups ([Abrahamse and Steg, 2013](#); [Farrow et al., 2017](#)).

We add to the small literature showing that individual-level belief updating can explain heterogeneous responses to information about social influence ([Byrne et al., 2018](#); [Bursztyn et al., 2020](#); [Andre et al., 2024](#)). While the literature so far has focused on updating beliefs about injunctive norms or descriptive norms (i.e., the prevalence of the desired behavior), we are the first to document the importance of individual-level belief updating in the context of positive trends in others' behavior. Moreover, we do so in a setting where the desired behavior is not yet widely adopted and show the potential of social information to address collective action problems even when currently only a small proportion of others engage in the target behavior. We further show that the effect of belief updating increases in the level of underestimation, i.e., the more strongly people underestimate the particular indicator regarding which they receive information, the greater is the effect of the treatment messages that directly correct those beliefs.

Interestingly, we find that the combined treatment does not have a significant positive effect among those who underestimate both the trend and the injunctive norm. However, it does have a significant effect among households that underestimate the current prevalence of participation, and this effect also increases with the level of underestimation. There can be different reasons for these findings. One possible explanation is that people's limited ability to process multiple pieces of information at once may play a role. In this scenario, individuals may focus on the information about the current prevalence of behavior as it is the simplest piece of information contained in the combined treatment. Another factor may be that information about the high injunctive norm may put special emphasis on the still low descriptive norm, which may lead to the perception of hypocrisy (if everyone supports it, why does nobody do it?). Finally, it may be that the two messages are addressing different, and potentially conflicting, channels: while the injunctive norm message may trigger the response to do what the majority approves of, the positive trend message may activate the sense of wanting to belong to the new, progressive group of people that is engaging in the behavior.

Measuring individual-level prior beliefs about multiple social influence indicators further allows us to explore the indirect impact of the interventions due to cross-updating — i.e., updating beliefs about an indicator upon receiving information about another indicator. We find modest evidence for cross-belief updating: people may use the information about the positive trend to update their beliefs about the injunctive norm. Particularly, information about the positive trend increases sign-up rates among those that underestimate the injunctive norm, which increases with the underestimation level of the injunctive norm, and within the group that underestimates both social indicators.

Our results provide evidence on how information about others' values and changes in behavior affect people's conduct, and how misperceptions about what others value and do can prevent people from engaging in the desired behavior themselves. These findings have important policy implications. For policymakers aiming to promote new sustainable behaviors, it may be worth gathering information on beliefs about various indicators of social influence among the population first. Suppose the majority of people either underestimate the positive trend in the target behavior or the social approval by other people. In that case, our results suggest that communication strategies that inform people about this trend or norm will be effective in motivating people to engage in the behavior. Based on our findings, these communications should rather address only one type of social influence individually instead of combining the two. If it is impossible to gather information about beliefs among the target population first, our results also suggest that including the positive trend or injunctive norm information in communication strategies will not do any harm. We do not find any evidence for potentially negative effects among those who overestimate the positive trend or injunctive norm.

Another aspect that is relevant to policy making is that the study focused on people's decision to enroll in a recycling program during a phone interview, which, from the respondents' perspective at the moment of the question, can be considered an actual enrollment decision. The municipality's additional requirement to directly contact households afterward with a URL to officialize the enrollment was revealed only at the end of the call. Five months post-intervention, 10% of households (118 out of 1203) filled out the official form. Several factors might explain the discrepancy between the answer in the phone call and the official confirmation, and we could not access sufficient administrative records to study this issue in depth. There could have been a

misunderstanding about the process (namely that the households already thought they were registered), delays in contact by the municipality, ineffective communication methods, or even changing sentiments post-interview. We acknowledge our limitation in fully exploring these possible factors. At the same time, we take the 10% follow-through rate of people's sign-up decisions as a positive signal that we were indeed capturing people's actual decision to join the program during the phone survey. From a policy perspective, our study highlights the importance of making the enrollment process immediate and of low effort once we have been able to capture the attention of the household. Capturing the household's attention a second time proved challenging.

Finally, it is worth reflecting that our study took place during the COVID-19 pandemic. We acknowledge that it is possible that people's behavior during that period might have been different relative to normal times. In particular, one might expect people to be more cooperative, which could inflate the response to our messages. Interestingly, however, existing literature documents that cooperative behavior remained unchanged or even decreased during the COVID-19 pandemic (see, e.g., [Buso et al. \(2020\)](#) and [Vriens et al. \(2024\)](#)). We therefore believe that decisions in our study are unlikely to be inflated compared to normal times.

In sum, our evidence on the effectiveness of interventions aimed at updating people's beliefs regarding positive trends in behavior and injunctive norms to encourage collective action when it is still weak is promising. As long as (i) a meaningful number of people have started to engage in the behavior recently, or a large share of the population approves of the desired action, and (ii) misperceptions of the size of indicators of social influence are relatively common, providing the correct information about such indicators can be used effectively to encourage new sustainable behaviors.

### CRediT authorship contribution statement

**Hanna Fuhrmann-Riebel:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Ben D'Exelle:** Writing – review & editing, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Kristian López Vargas:** Writing – review & editing, Resources, Methodology, Data curation, Conceptualization. **Sebastian Tonke:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Arjan Verschoor:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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### Appendix A. Balance tests

See [Tables A.1](#) and [A.2](#).

### Appendix B. Beliefs correlation table

See [Table B.1](#).



**Table A.1**  
Individual characteristics by treatment group.

Variable	(1)		(2)		(3)		(4)		(5)		T-test			F-test for joint orthogonality
	Treatment A		Treatment B		Treatment C		Treatment D		Total		Difference			
	N	Mean/SE	N	Mean/SE	N	Mean/SE	N	Mean/SE	N	Mean/SE	(1)–(2)	(1)–(3)	(1)–(4)	
Age	322	52.717 (0.860)	293	53.174 (0.907)	292	55.110 (0.974)	333	53.826 (0.845)	1240	53.686 (0.447)	-0.457	-2.392*	-1.108	1.314
Female	451	0.619 (0.023)	406	0.638 (0.024)	409	0.599 (0.024)	443	0.612 (0.023)	1709	0.617 (0.012)	-0.019	0.020	0.007	0.455
Household members	302	2.907 (0.075)	275	3.193 (0.095)	276	2.949 (0.089)	303	2.878 (0.073)	1156	2.978 (0.042)	-0.285**	-0.042	0.029	2.932**
Number of children	321	0.371 (0.039)	296	0.426 (0.044)	288	0.354 (0.044)	314	0.357 (0.040)	1219	0.377 (0.021)	-0.055	0.017	0.014	0.631
Household head	451	0.581 (0.023)	406	0.549 (0.025)	409	0.609 (0.024)	443	0.614 (0.023)	1709	0.589 (0.012)	0.032	-0.028	-0.033	1.525
(Technical) University	451	0.596 (0.023)	406	0.594 (0.024)	409	0.582 (0.024)	443	0.605 (0.023)	1709	0.594 (0.012)	0.003	0.015	-0.009	0.159
Patience	451	7.510 (0.117)	406	7.384 (0.130)	409	7.499 (0.124)	443	7.102 (0.133)	1709	7.372 (0.063)	0.126	0.011	0.408**	2.335*
Responsibility for recycling	451	0.674 (0.022)	406	0.709 (0.023)	409	0.643 (0.024)	443	0.670 (0.022)	1709	0.674 (0.011)	-0.035	0.031	0.004	1.374
Recycling through other ways	451	0.625 (0.023)	406	0.638 (0.024)	409	0.609 (0.024)	443	0.607 (0.023)	1709	0.620 (0.012)	-0.013	0.016	0.018	0.376
F-test of joint significance (F-stat)											0.873	1.092	1.450	
F-test, number of observations											521	512	551	

Notes: The values displayed for t-tests are the differences in the means across the groups. The values displayed for F-tests are the F-statistics. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent level.

**Table A.2**  
Beliefs distribution by treatment group.

Variable	(1)		(2)		(3)		(4)		(5)		T-test			F-test for joint orthogonality
	Treatment A		Treatment B		Treatment C		Treatment D		Total		Difference			
	N	Mean/SE	N	Mean/SE	N	Mean/SE	N	Mean/SE	N	Mean/SE	(1)–(2)	(1)–(3)	(1)–(4)	
Current participation	391	34.463 (1.187)	360	35.239 (1.214)	366	37.044 (1.355)	394	34.589 (1.200)	1511	35.306 (0.619)	-0.776	-2.581	-0.126	0.913
Past participation	393	21.952 (1.045)	364	22.508 (1.079)	365	22.841 (1.140)	398	21.977 (1.061)	1520	22.305 (0.540)	-0.557	-0.889	-0.026	0.159
Positive trend	390	12.533 (1.027)	360	12.772 (1.102)	363	14.245 (1.111)	392	12.681 (1.095)	1505	13.042 (0.541)	-0.239	-1.712	-0.148	0.531
Injunctive norm	413	82.031 (1.066)	376	80.213 (1.237)	381	78.648 (1.324)	412	79.806 (1.157)	1582	80.205 (0.597)	1.819	3.383**	2.226	1.399
F-test of joint significance (F-stat)											0.850	2.453*	0.811	
F-test, number of observations											750	753	782	

Notes: The values displayed for t-tests are the differences in the means across the groups. The values displayed for F-tests are the F-statistics. \*\*\*, \*\*, and \* indicate significance at the 1, 5, and 10 percent level.

**Table B.1**  
Beliefs correlation table.

Variables	Current participation	Past participation	Positive trend	Injunctive norm
Current participation	1.000			
Past participation	0.574 (0.000)	1.000		
Positive trend	0.571 (0.000)	-0.344 (0.000)	1.000	
Injunctive norm	0.175 (0.000)	0.091 (0.000)	0.111 (0.000)	1.000

Notes: Pairwise correlations of beliefs about the current participation, past participation, positive trend and injunctive norm. Significance of each correlation in parentheses.

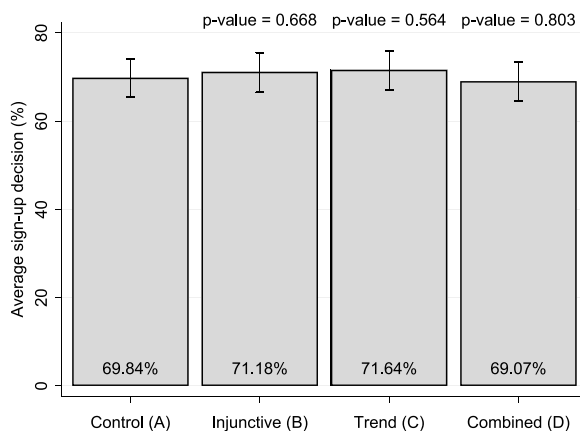


Fig. C.1. Average sign-up decision by treatment group. Notes: P-values are obtained from testing for equality of proportions, comparing the different treatments B, C and D with the control group A, respectively. N(A) = 451, N(B) = 406, N(C) = 409, N(D) = 443. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

Table C.1  
Average treatment effects on households' sign-up decision.

	(1)	(2)
Injunctive (B)	0.013 (0.031)	0.017 (0.029)
Trend (C)	0.018 (0.031)	0.022 (0.029)
Combined (D)	-0.008 (0.031)	0.006 (0.028)
Female		0.029 (0.023)
Children		0.071*** (0.021)
Household head		0.107*** (0.023)
(Technical) University		0.100*** (0.022)
Patience		0.046*** (0.004)
Responsibility for recycling		0.184*** (0.026)
Recycling through other ways		-0.133*** (0.025)
Constant	0.698*** (0.022)	0.138*** (0.045)
Adjusted R <sup>2</sup>	-0.001	0.143
Observations	1709	1709

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Column (1) includes treatment dummies alone; column (2) adds control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

## Appendix C. Results

### C.1. Average treatment effects

See Fig. C.1 and Table C.1.

### C.2. Treatment effects based on individual prior beliefs

#### C.2.1. Beliefs about the injunctive norm

See Tables C.2 and C.3.

**Table C.2**  
Heterogeneous treatment effects: under- vs. overestimation of the injunctive norm.

	Injunctive norm beliefs < 97%		Injunctive norm beliefs ≥ 97%	
	(1)	(2)	(3)	(4)
Injunctive (B)	0.026 (0.040)	0.031 (0.037)	-0.000 (0.059)	-0.003 (0.054)
Trend (C)	0.021 (0.040)	0.033 (0.037)	0.040 (0.058)	0.042 (0.053)
Combined (D)	0.011 (0.040)	0.020 (0.036)	0.005 (0.057)	0.025 (0.052)
Female		0.007 (0.029)		0.056 (0.043)
Children		0.024 (0.027)		0.050 (0.039)
Household head		0.087*** (0.029)		0.179*** (0.042)
(Technical) University		0.145*** (0.029)		0.101*** (0.039)
Patience		0.041*** (0.005)		0.048*** (0.007)
Responsibility for recycling		0.258*** (0.034)		0.183*** (0.047)
Recycling through other ways		-0.096*** (0.031)		-0.145*** (0.047)
Constant	0.674*** (0.028)	0.073 (0.058)	0.664*** (0.040)	0.061 (0.081)
Adjusted R <sup>2</sup>	-0.002	0.166	-0.005	0.162
Observations	1062	1062	520	520

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate the injunctive norm about participation in the recycling programme; columns (3) and (4) to those who are correct about or overestimate it. Columns (1) and (3) include treatment dummies alone; columns (2) and (4) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

**Table C.3**  
Heterogeneous treatment effects: stronger underestimation of the injunctive norm (below 90%, 70%, 60% and 50%).

	Injunctive norm beliefs < 90%		Injunctive norm beliefs < 70%		Injunctive norm beliefs < 60%		Injunctive norm beliefs < 50%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injunctive (B)	0.090* (0.050)	0.097** (0.045)	0.149** (0.064)	0.159*** (0.058)	0.196*** (0.072)	0.199*** (0.064)	0.289*** (0.087)	0.270*** (0.085)
Trend (C)	0.102** (0.048)	0.105** (0.044)	0.072 (0.064)	0.077 (0.059)	0.120* (0.071)	0.124* (0.063)	0.202** (0.082)	0.241*** (0.081)
Combined (D)	0.026 (0.047)	0.044 (0.043)	0.063 (0.064)	0.080 (0.058)	0.103 (0.071)	0.132** (0.064)	0.221** (0.088)	0.212** (0.088)
Female		-0.045 (0.035)		-0.083* (0.045)		-0.097** (0.049)		-0.031 (0.062)
Children		-0.040 (0.032)		0.003 (0.042)		-0.015 (0.047)		0.118* (0.061)
Household head		0.068* (0.035)		0.056 (0.046)		0.025 (0.050)		0.064 (0.063)
(Technical) University		0.103*** (0.035)		0.099** (0.044)		0.066 (0.049)		0.085 (0.064)
Patience		0.047*** (0.006)		0.042*** (0.007)		0.045*** (0.008)		0.025** (0.010)
Responsibility for recycling		0.200*** (0.041)		0.222*** (0.055)		0.239*** (0.062)		0.155* (0.081)
Recycling through other ways		-0.063* (0.036)		-0.080* (0.046)		-0.104** (0.050)		-0.087 (0.062)
Constant	0.667*** (0.034)	0.142** (0.067)	0.695*** (0.047)	0.216** (0.085)	0.672*** (0.052)	0.217** (0.089)	0.679*** (0.063)	0.271* (0.141)

(continued on next page)

Table C.3 (continued).

	Injunctive norm beliefs < 90%		Injunctive norm beliefs < 70%		Injunctive norm beliefs < 60%		Injunctive norm beliefs < 50%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Adjusted R <sup>2</sup>	0.005	0.169	0.007	0.186	0.016	0.222	0.065	0.152
Observations	699	699	357	357	275	275	131	131

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who believe the injunctive norm about participation in the recycling programme to be below 90, columns (3) and (4) to those who believe it to be below 70, columns (5) and (6) to those who believe it to be below 60, and columns (7) and (8) to those who believe it to be below 50. Columns (1), (3), (5) and (7) include treatment dummies alone; columns (2), (4), (6) and (8) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

Table C.4

Heterogeneous treatment effects: under- vs. overestimation of the positive trend.

	Positive trend beliefs < 6%		Positive trend beliefs ≥ 6%	
	(1)	(2)	(3)	(4)
Injunctive (B)	0.078 (0.057)	0.017 (0.047)	-0.023 (0.042)	-0.000 (0.041)
Trend (C)	0.146** (0.057)	0.119** (0.048)	-0.048 (0.042)	-0.022 (0.040)
Combined (D)	0.033 (0.056)	0.044 (0.046)	0.001 (0.041)	0.001 (0.039)
Female		0.060* (0.037)		-0.001 (0.033)
Children		-0.018 (0.033)		0.071** (0.030)
Household head		0.152*** (0.038)		0.116*** (0.032)
(Technical) University		0.096*** (0.035)		0.122*** (0.030)
Patience		0.070*** (0.006)		0.019*** (0.006)
Responsibility for recycling		0.173*** (0.041)		0.236*** (0.037)
Recycling through other ways		-0.074** (0.037)		-0.143*** (0.036)
Constant	0.582*** (0.040)	-0.155** (0.068)	0.727*** (0.029)	0.335*** (0.066)
Adjusted R <sup>2</sup>	0.008	0.322	-0.001	0.087
Observations	574	574	931	931

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate the trend in participation in the recycling programme; columns (3) and (4) to those who are correct about or overestimate it. Columns (1) and (3) include treatment dummies alone; columns (2) and (4) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

C.2.2. Beliefs about the positive trend

See Table C.4.

C.2.3. Beliefs about the current participation

See Table C.5.

C.3. Treatment effects based on multiple prior beliefs

See Fig. C.2, Tables C.6–C.9.

C.4. Regression analysis

See Table C.10.

**Table C.5**  
Heterogeneous treatment effects: under- vs. overestimation of the current participation.

	Current participation beliefs < 12%		Current participation beliefs $\geq$ 12%	
	(1)	(2)	(3)	(4)
Injunctive (B)	0.088 (0.076)	0.021 (0.058)	-0.012 (0.038)	0.003 (0.036)
Trend (C)	0.192** (0.075)	0.124** (0.057)	-0.024 (0.037)	-0.005 (0.036)
Combined (D)	0.143** (0.071)	0.145*** (0.055)	-0.028 (0.037)	-0.022 (0.036)
Female		-0.002 (0.044)		0.030 (0.029)
Children		0.019 (0.040)		0.043 (0.026)
Household head		0.148*** (0.046)		0.111*** (0.029)
(Technical) University		0.100** (0.044)		0.108*** (0.027)
Patience		0.069*** (0.006)		0.026*** (0.005)
Responsibility for recycling		0.285*** (0.050)		0.188*** (0.033)
Recycling through other ways		-0.149*** (0.046)		-0.099*** (0.031)
Constant	0.494*** (0.052)	-0.174** (0.076)	0.727*** (0.026)	0.278*** (0.061)
Adjusted $R^2$	0.012	0.432	-0.002	0.078
Observations	351	351	1160	1160

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate the current participation in the recycling programme; columns (3) and (4) to those who are correct about or overestimate it. Columns (1) and (3) include treatment dummies alone; columns (2) and (4) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

**Table C.6**  
Heterogeneous treatment effects: under- vs. overestimation of the positive trend and the injunctive norm combined.

	Positive trend beliefs < 6% & Injunctive norm beliefs < 97%		Positive trend beliefs < 6% & Injunctive norm beliefs $\geq$ 97%		Positive trend beliefs $\geq$ 6% & Injunctive norm beliefs < 97%		Positive trend beliefs $\geq$ 6% & Injunctive norm beliefs $\geq$ 97%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injunctive (B)	0.097 (0.067)	0.025 (0.057)	0.039 (0.106)	-0.006 (0.084)	-0.029 (0.052)	0.006 (0.049)	-0.018 (0.074)	-0.016 (0.072)
Trend (C)	0.147** (0.067)	0.118** (0.057)	0.142 (0.112)	0.156* (0.089)	-0.071 (0.052)	-0.034 (0.050)	-0.010 (0.069)	0.000 (0.068)
Combined (D)	0.054 (0.067)	0.048 (0.057)	-0.003 (0.103)	0.056 (0.082)	-0.027 (0.051)	-0.017 (0.048)	0.053 (0.070)	0.031 (0.069)
Female		0.042 (0.044)		0.111 (0.068)		-0.025 (0.041)		0.032 (0.056)
Children		-0.016 (0.041)		-0.018 (0.060)		0.069* (0.036)		0.083 (0.052)
Household head		0.133*** (0.046)		0.190*** (0.070)		0.074* (0.040)		0.172*** (0.056)
(Technical) University		0.117*** (0.044)		0.065 (0.061)		0.154*** (0.039)		0.110** (0.053)
Patience		0.064*** (0.007)		0.081*** (0.010)		0.019*** (0.007)		0.016 (0.011)
Responsibility for recycling		0.192*** (0.051)		0.134* (0.071)		0.287*** (0.047)		0.172*** (0.062)
Recycling through other ways		-0.045 (0.045)		-0.149** (0.069)		-0.153*** (0.043)		-0.130** (0.065)
Constant	0.590*** (0.047)	-0.138 (0.084)	0.561*** (0.077)	-0.191 (0.118)	0.742*** (0.036)	0.313*** (0.082)	0.700*** (0.048)	0.345*** (0.115)

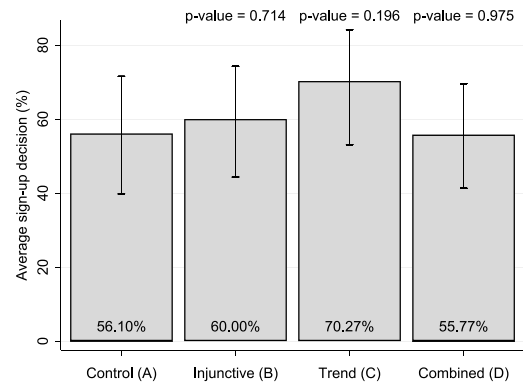
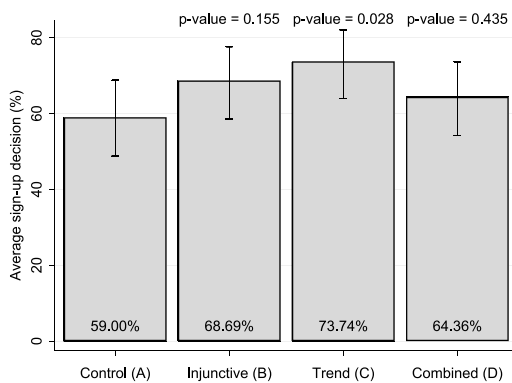
(continued on next page)

Table C.6 (continued).

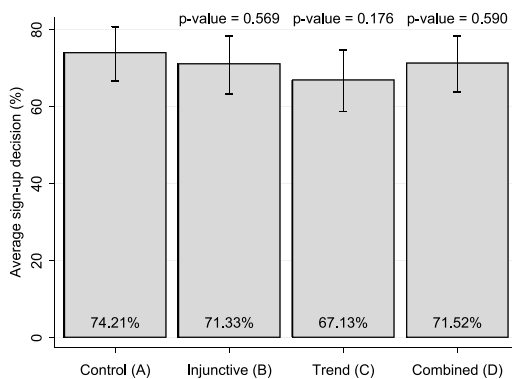
	Positive trend beliefs < 6% & Injunctive norm beliefs < 97%		Positive trend beliefs < 6% & Injunctive norm beliefs ≥ 97%		Positive trend beliefs ≥ 6% & Injunctive norm beliefs < 97%		Positive trend beliefs ≥ 6% & Injunctive norm beliefs ≥ 97%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Adjusted R <sup>2</sup>	0.006	0.281	-0.004	0.387	-0.002	0.103	-0.006	0.052
Observations	399	399	175	175	610	610	321	321

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate both the positive trend and the injunctive norm about participation in the recycling programme; columns (3) and (4) to those who underestimate the positive trend and overestimate or are correct about the injunctive norm; columns (5) and (6) to those who overestimate or are correct about the positive trend and underestimate the injunctive norm; and columns (7) and (8) to those who overestimate or are correct about both the positive trend and the injunctive norm. Columns (1), (3), (5) and (7) include treatment dummies alone; columns (2), (4), (6) and (8) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

(a) Positive trend beliefs < 6% & Injunctive norm beliefs < 97%      (b) Positive trend beliefs < 6% & Injunctive norm beliefs ≥ 97%



(c) Positive trend beliefs ≥ 6% & Injunctive norm beliefs < 97%



(d) Positive trend beliefs ≥ 6% & Injunctive norm beliefs ≥ 97%

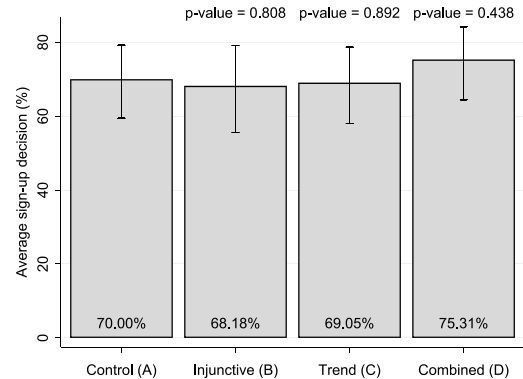


Fig. C.2. Heterogeneity in average sign-up decisions between people who under- or overestimate the positive trend and the injunctive norm combined. Notes: Average sign-up decision of people who under- or overestimate the positive trend and the injunctive norm combined, comparing the different treatments B-D with the control group A. N(C.2(a)) = 399, n(C.2(b)) = 175, n(C.2(c)) = 610, n(C.2(d)) = 321. P-values are obtained from testing for equality of proportions, comparing treatments B, C and D with treatment A, respectively. Graphs show the average sign-up decision by treatment, with 95% confidence intervals for proportions.

C.5. Participants' official registration

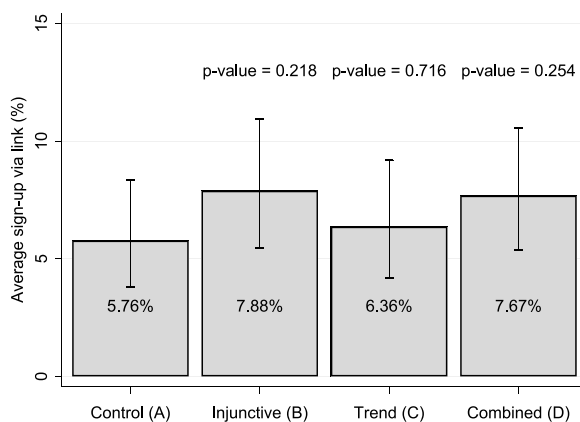
See Fig. C.3 and Table C.11.

**Table C.7**

Heterogeneous treatment effects: under- vs. overestimation of the positive trend and the injunctive norm (threshold = 90%) combined.

	Positive trend beliefs < 6% & Injunctive norm beliefs < 90%		Positive trend beliefs < 6% & Injunctive norm beliefs ≥ 90%		Positive trend beliefs ≥ 6% & Injunctive norm beliefs < 90%		Positive trend beliefs ≥ 6% & Injunctive norm beliefs ≥ 90%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injunctive (B)	0.142* (0.080)	0.082 (0.070)	0.034 (0.079)	-0.021 (0.064)	0.034 (0.064)	0.080 (0.062)	-0.072 (0.056)	-0.069 (0.054)
Trend (C)	0.250*** (0.078)	0.220*** (0.068)	0.039 (0.083)	0.039 (0.067)	-0.020 (0.063)	0.013 (0.061)	-0.073 (0.055)	-0.053 (0.053)
Combined (D)	0.067 (0.075)	0.063 (0.065)	-0.006 (0.081)	0.041 (0.065)	-0.022 (0.062)	0.008 (0.059)	0.017 (0.055)	-0.005 (0.053)
Female		-0.017 (0.052)		0.120** (0.052)		-0.043 (0.049)		0.025 (0.044)
Children		-0.064 (0.048)		0.015 (0.047)		-0.009 (0.044)		0.120*** (0.040)
Household head		0.133** (0.053)		0.177*** (0.053)		0.041 (0.048)		0.169*** (0.043)
(Technical) University		0.113** (0.053)		0.086* (0.048)		0.090* (0.047)		0.143*** (0.040)
Patience		0.061*** (0.008)		0.079*** (0.008)		0.035*** (0.009)		0.009 (0.008)
Responsibility for recycling		0.149** (0.061)		0.165*** (0.057)		0.207*** (0.058)		0.249*** (0.050)
Recycling through other ways		-0.002 (0.052)		-0.113** (0.053)		-0.116** (0.051)		-0.162*** (0.051)
Constant	0.591*** (0.055)	-0.059 (0.099)	0.573*** (0.057)	-0.234** (0.093)	0.745*** (0.045)	0.325*** (0.096)	0.716*** (0.037)	0.352*** (0.093)
Adjusted R <sup>2</sup>	0.031	0.283	-0.009	0.350	-0.005	0.087	0.002	0.093
Observations	274	274	300	300	395	395	536	536

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate both the positive trend and the injunctive norm (below 90) about participation in the recycling programme; columns (3) and (4) to those who underestimate the positive trend and overestimate or are correct about the injunctive norm (above or equal to 90); columns (5) and (6) to those who overestimate or are correct about the positive trend and underestimate the injunctive norm (below 90); and columns (7) and (8) to those who overestimate or are correct about both the positive trend and the injunctive norm (above or equal to 90). Columns (1), (3), (5) and (7) include treatment dummies alone; columns (2), (4), (6) and (8) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.



**Fig. C.3.** Average sign-ups via registration link by treatment group. Notes: P-values are obtained from testing for equality of proportions, comparing the different treatments B, C and D with the control group A, respectively. N(A) = 451, N(B) = 406, N(C) = 409, N(D) = 443. Graphs show the average sign-ups via registration link by treatment, with 95% confidence intervals for proportions.

**Table C.8**  
Heterogeneous treatment effects: under- vs. overestimation of the current participation and the injunctive norm combined.

	Current participation beliefs < 12% & Injunctive norm beliefs < 97%		Current participation beliefs < 12% & Injunctive norm beliefs ≥ 97%		Current participation beliefs ≥ 12% & Injunctive norm beliefs < 97%		Current participation beliefs ≥ 12% & Injunctive norm beliefs ≥ 97%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injunctive (B)	0.100 (0.090)	0.017 (0.071)	0.050 (0.142)	0.034 (0.104)	-0.006 (0.046)	0.013 (0.044)	-0.025 (0.066)	-0.022 (0.064)
Trend (C)	0.179** (0.088)	0.068 (0.070)	0.208 (0.143)	0.279*** (0.103)	-0.034 (0.046)	-0.003 (0.045)	-0.006 (0.064)	-0.003 (0.062)
Combined (D)	0.156* (0.086)	0.102 (0.069)	0.127 (0.127)	0.256*** (0.093)	-0.042 (0.046)	-0.028 (0.044)	-0.001 (0.064)	-0.013 (0.062)
Female		-0.027 (0.054)		0.082 (0.082)		0.019 (0.036)		0.042 (0.051)
Children		0.055 (0.051)		-0.074 (0.072)		0.028 (0.032)		0.078* (0.046)
Household head		0.136** (0.055)		0.178* (0.091)		0.078** (0.036)		0.157*** (0.050)
(Technical) University		0.105* (0.056)		0.111 (0.079)		0.140*** (0.035)		0.091* (0.047)
Patience		0.064*** (0.008)		0.080*** (0.012)		0.025*** (0.007)		0.028*** (0.009)
Responsibility for recycling		0.315*** (0.062)		0.284*** (0.090)		0.222*** (0.041)		0.144*** (0.054)
Recycling through other ways		-0.133** (0.055)		-0.226** (0.096)		-0.089** (0.037)		-0.129** (0.055)
Constant	0.525*** (0.062)	-0.142 (0.098)	0.429*** (0.095)	-0.298** (0.129)	0.731*** (0.032)	0.254*** (0.075)	0.718*** (0.045)	0.290*** (0.105)
Adjusted R <sup>2</sup>	0.008	0.392	-0.005	0.492	-0.002	0.086	-0.007	0.058
Observations	242	242	109	109	769	769	391	391

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate both the current participation rate and the injunctive norm about participation in the recycling programme; columns (3) and (4) to those who underestimate the current participation rate and overestimate or are correct about the injunctive norm; columns (5) and (6) to those who overestimate or are correct about the current participation rate and underestimate the injunctive norm; and columns (7) and (8) to those who overestimate or are correct about both the current participation rate and the injunctive norm. Columns (1), (3), (5) and (7) include treatment dummies alone; columns (2), (4), (6) and (8) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

**Table C.9**  
Heterogeneous treatment effects: under- vs. overestimation of the current participation and the injunctive norm (threshold = 90%) combined.

	Current participation beliefs < 12% & Injunctive norm beliefs < 90%		Current participation beliefs < 12% & Injunctive norm beliefs ≥ 90%		Current participation beliefs ≥ 12% & Injunctive norm beliefs < 90%		Current participation beliefs ≥ 12% & Injunctive norm beliefs ≥ 90%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Injunctive (B)	0.149 (0.109)	0.065 (0.087)	0.041 (0.103)	0.006 (0.077)	0.059 (0.056)	0.092* (0.054)	-0.065 (0.050)	-0.067 (0.048)
Trend (C)	0.309*** (0.103)	0.132 (0.085)	0.054 (0.106)	0.118 (0.080)	0.026 (0.056)	0.059 (0.054)	-0.063 (0.050)	-0.061 (0.048)
Combined (D)	0.172* (0.099)	0.114 (0.081)	0.106 (0.099)	0.187** (0.074)	-0.032 (0.055)	-0.008 (0.052)	-0.025 (0.051)	-0.039 (0.049)
Female		-0.143** (0.063)		0.124** (0.062)		0.005 (0.043)		0.041 (0.040)
Children		0.037 (0.060)		-0.018 (0.055)		-0.065* (0.038)		0.121*** (0.036)
Household head		0.113* (0.063)		0.201*** (0.066)		0.062 (0.043)		0.152*** (0.039)
(Technical) University		0.079 (0.065)		0.102* (0.061)		0.088** (0.041)		0.127*** (0.036)
Patience		0.059*** (0.008)		0.080*** (0.009)		0.039*** (0.008)		0.019*** (0.007)
Responsibility for recycling		0.352*** (0.073)		0.208*** (0.070)		0.138*** (0.050)		0.217*** (0.044)
Recycling through other ways		-0.084		-0.182***		-0.053		-0.137***

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Table C.9 (continued).

	Current participation beliefs < 12% & Injunctive norm beliefs < 90%		Current participation beliefs < 12% & Injunctive norm beliefs ≥ 90%		Current participation beliefs ≥ 12% & Injunctive norm beliefs < 90%		Current participation beliefs ≥ 12% & Injunctive norm beliefs ≥ 90%	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.528*** (0.076)	-0.052 (0.119)	0.471*** (0.070)	-0.296*** (0.101)	0.726*** (0.040)	0.266*** (0.087)	0.728*** (0.034)	0.288*** (0.085)
Adjusted R <sup>2</sup>	0.037	0.404	-0.010	0.451	0.000	0.090	-0.001	0.086
Observations	163	163	188	188	507	507	653	653

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. Columns (1) and (2) are restricted to those who underestimate both the current participation rate and the injunctive norm (below 90) about participation in the recycling programme; columns (3) and (4) to those who underestimate the current participation rate and overestimate or are correct about the injunctive norm (above or equal to 90); columns (5) and (6) to those who overestimate or are correct about the current participation rate and underestimate the injunctive norm (below 90); and columns (7) and (8) to those who overestimate or are correct about both the current participation rate and the injunctive norm (above or equal to 90). Columns (1), (3), (5) and (7) include treatment dummies alone; columns (2), (4), (6) and (8) add control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

Table C.10

Heterogeneous treatment effects based on the level of underestimation of the various indicators of social influence — full table with covariates.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Underestimation of injunctive norm	0.000 (0.001)	-0.001 (0.001)							0.001 (0.001)	-0.000 (0.001)
Injunctive (B)	-0.047 (0.042)	-0.046 (0.039)	0.007 (0.038)	0.019 (0.035)	0.009 (0.036)	0.025 (0.034)	0.003 (0.039)	0.024 (0.037)	-0.062 (0.047)	-0.042 (0.045)
Trend (C)	-0.021 (0.042)	-0.014 (0.039)	-0.014 (0.037)	-0.004 (0.035)	-0.010 (0.036)	0.013 (0.034)	-0.040 (0.039)	-0.017 (0.037)	-0.080* (0.046)	-0.058 (0.044)
Combined (D)	-0.027 (0.041)	-0.014 (0.037)	0.024 (0.036)	0.031 (0.033)	-0.013 (0.035)	-0.003 (0.033)	0.003 (0.038)	0.009 (0.036)	-0.025 (0.045)	-0.016 (0.042)
Injunctive (B) × Underestimation of injunctive norm	0.004*** (0.001)	0.004*** (0.001)							0.003** (0.001)	0.004*** (0.001)
Trend (C) × Underestimation of injunctive norm	0.002* (0.001)	0.003** (0.001)							0.002 (0.001)	0.002* (0.001)
Combined (D) × Underestimation of injunctive norm	0.002 (0.001)	0.002 (0.001)							0.001 (0.001)	0.001 (0.001)
Female		0.026 (0.024)		0.025 (0.025)		0.024 (0.024)		0.025 (0.024)		0.027 (0.024)
Children		0.027 (0.022)		0.035 (0.022)		0.038* (0.022)		0.038* (0.022)		0.037* (0.022)
Household head		0.124*** (0.024)		0.118*** (0.025)		0.122*** (0.025)		0.120*** (0.025)		0.123*** (0.025)
(Technical) University		0.115*** (0.023)		0.103*** (0.024)		0.106*** (0.024)		0.105*** (0.024)		0.101*** (0.023)
Patience		0.045*** (0.004)		0.044*** (0.004)		0.039*** (0.005)		0.041*** (0.004)		0.041*** (0.004)
Responsibility for recycling		0.211*** (0.028)		0.229*** (0.028)		0.219*** (0.028)		0.224*** (0.028)		0.204*** (0.029)
Recycling through other ways		-0.091*** (0.025)		-0.123*** (0.024)		-0.114*** (0.024)		-0.119*** (0.024)		-0.099*** (0.025)
Underestimation of positive trend			-0.006** (0.003)	-0.006*** (0.002)			-0.004 (0.003)	-0.005** (0.002)	-0.004 (0.003)	-0.005** (0.002)
Injunctive (B) × Underestimation of positive trend			0.001 (0.004)	-0.000 (0.003)			0.002 (0.004)	0.001 (0.003)	0.003 (0.004)	0.002 (0.003)
Trend (C) × Underestimation of positive trend			0.008** (0.004)	0.007** (0.003)			0.007* (0.004)	0.007** (0.003)	0.007* (0.004)	0.007** (0.003)
Combined (D) × Underestimation of positive trend			-0.002 (0.004)	-0.001 (0.003)			-0.003 (0.004)	-0.002 (0.003)	-0.003 (0.004)	-0.002 (0.003)
Underestimation of current participation					-0.035*** (0.007)	-0.018*** (0.006)	-0.033*** (0.007)	-0.015** (0.006)	-0.034*** (0.007)	-0.016** (0.006)
Injunctive (B) × Underestimation of current participation					0.001 (0.010)	-0.007 (0.008)	0.000 (0.010)	-0.007 (0.008)	-0.001 (0.009)	-0.008 (0.008)
Trend (C) × Underestimation of current participation					0.025** (0.010)	0.014* (0.008)	0.022** (0.010)	0.011 (0.008)	0.021** (0.010)	0.011 (0.008)

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Table C.10 (continued).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Combined (D) × Underestimation of current participation					0.017*	0.015*	0.019*	0.017**	0.018*	0.016**
					(0.010)	(0.008)	(0.010)	(0.008)	(0.010)	(0.008)
Constant	0.668***	0.083*	0.701***	0.123**	0.725***	0.153***	0.742***	0.166***	0.726***	0.168***
	(0.029)	(0.051)	(0.026)	(0.051)	(0.025)	(0.053)	(0.027)	(0.054)	(0.032)	(0.056)
Adjusted R <sup>2</sup>	0.012	0.172	0.012	0.174	0.034	0.169	0.043	0.181	0.062	0.191
Observations	1582	1582	1505	1505	1511	1511	1505	1505	1505	1505

Notes: OLS regressions with dependent variable equal to sign-up decision = yes. The level of underestimation is calculated as the difference between the participant's guess minus the true value of the respective indicator. Columns (1) and (2) look at interactions of treatments with degrees of underestimation of the injunctive norm; columns (3) and (4) at interactions of treatments with levels of underestimation of the positive trend; and columns (5) and (6) at interactions of treatments with underestimation of the current participation rate. Columns (7) and (8) combine the latter two; columns (9) and (10) include all interaction terms together. Columns (1), (3), (5), (7) and (9) are without, columns (2), (4), (6), (8) and (10) with control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

Table C.11  
Average treatment effects on sign-ups via registration link.

	(1)	(2)
Injunctive (B)	0.021	0.022
	(0.017)	(0.017)
Trend (C)	0.006	0.007
	(0.017)	(0.017)
Combined (D)	0.019	0.021
	(0.017)	(0.017)
Female		-0.018
		(0.014)
Children		0.012
		(0.012)
Household head		0.011
		(0.014)
(Technical) University		0.044***
		(0.013)
Patience		0.007***
		(0.002)
Responsibility for recycling		0.019
		(0.016)
Recycling through other ways		-0.010
		(0.015)
Constant	0.058***	-0.031
	(0.012)	(0.027)
Adjusted R <sup>2</sup>	-0.001	0.014
Observations	1709	1709

Notes: OLS regressions with dependent variable equal to sign-up via link = yes. Column (1) includes treatment dummies alone; column (2) adds control variables for gender, whether the household has children, whether the respondent is the household head, level of education, level of patience, whether the respondent is responsible for recycling within the household and whether the household already recycles through other ways. Standard errors in parentheses. \*\*\*, \*\*, \* indicate significance levels at 1, 5, and 10%, respectively.

### Appendix D. Supplementary data

Supplementary material related to this article can be found online at <https://doi.org/10.1016/j.jeem.2024.103046>.

### References

Abrahamse, Wokje, Steg, Linda, 2013. Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environ. Change* 23 (6), 1773–1785.

Allcott, Hunt, 2011. Social norms and energy conservation. *J. Public Econ.* 95 (9), 1082–1095.

Allcott, Hunt, Rogers, Todd, 2014. The short-run and long-run effects of behavioral interventions: Experimental evidence from energy conservation. *Amer. Econ. Rev.* 104 (10), 3003–3037.

Andor, Mark A., Gerster, Andreas, Peters, Jörg, Schmidt, Christoph M., 2020. Social norms and energy conservation beyond the US. *J. Environ. Econ. Manage.* 103, 102351.

Andre, Peter, Boneva, Teodora, Chopra, Felix, Falk, Armin, 2024. Misperceived social norms and willingness to act against climate change. *Rev. Econ. Stat.* (forthcoming).

Ayres, Ian, Raseman, Sophie, Shih, Alice, 2013. Evidence from two large field experiments that peer comparison feedback can reduce residential energy usage. *J. Law Econ. Organ.* 29 (5), 992–1022.

Bicchieri, Cristina, Dimant, Eugen, 2019. Nudging with care: The risks and benefits of social information. *Public Choice* 191, 443–464.

- Bicchieri, Cristina, Dimant, Eugen, Gächter, Simon, Nosenzo, Daniele, 2022. Social proximity and the erosion of norm compliance. *Games Econ. Behav.* 132, 59–72.
- Bonan, Jacopo, Cattaneo, Cristina, d'Adda, Giovanna, Tavoni, Massimo, 2020. The interaction of descriptive and injunctive social norms in promoting energy conservation. *Nat. Energy* 5, 900–909.
- Borasino, Elena, Fuhrmann-Riebel, Hanna, 2022. New kids on the recycling block: The role of supermarkets and bodegas for sustainable consumer behaviour in Lima. *Circ. Econ. Sustain.* 2, 857–881.
- Brent, Daniel A., Cook, Joseph H., Olsen, Skylar, 2015. Social comparisons, household water use, and participation in utility conservation programs: Evidence from three randomized trials. *J. Assoc. Environ. Resour. Econ.* 2 (4), 597–627.
- Brick, Kerri, De Martino, Samantha, Visser, Martine, 2023. Behavioural nudges for water conservation in unequal settings: Experimental evidence from Cape Town. *J. Environ. Econ. Manage.* 121, 102852.
- Bursztyn, Leonardo, González, Alessandra L., Yanagizawa-Drott, David, 2020. Misperceived social norms: Women working outside the home in Saudi Arabia. *Amer. Econ. Rev.* 110 (10), 2997–3029.
- Buso, Irene Maria, De Caprariis, Sofia, Di Cagno, Daniela, Ferrari, Lorenzo, Larocca, Vittorio, Marazzi, Francesca, Panaccione, Luca, Spadoni, Lorenzo, 2020. The effects of COVID-19 lockdown on fairness and cooperation: Evidence from a lablike experiment. *Econom. Lett.* 196, 109577.
- Byrne, David P., Nauze, Andrea La, Martin, Leslie A., 2018. Tell me something I don't already know: Informedness and the impact of information programs. *Rev. Econ. Stat.* 100 (3), 510–527.
- Chen, Yan, Lu, Fangwen, Zhang, Jinan, 2017. Social comparisons, status and driving behavior. *J. Public Econ.* 155, 11–20.
- Chong, Alberto, Karlan, Dean, Shapiro, Jeremy, Zinman, Jonathan, 2015. (Ineffective) messages to encourage recycling: Evidence from a randomized evaluation in Peru. *World Bank Econ. Rev.* 29 (1), 180–206.
- Cialdini, Robert B., Kallgren, Carl A., Reno, Raymond R., 1991. A focus theory of normative conduct: A theoretical refinement and reevaluation of the role of norms in human behavior. *Adv. Exp. Soc. Psychol.* 24, 201–234.
- Dai, Y.C., Gordon, M.P.R., Ye, J.Y., Xu, D.Y., Lin, Z.Y., Robinson, N.K.L., Woodard, R., Harder, M.K., 2015. Why doorstepping can increase household waste recycling. *Resour. Conserv. Recycl.* 102, 9–19.
- Datta, Saugato, Miranda Montero, Juan Jose, Zoratto, Laura De Castro, Calvo-Gonzalez, Oscar, Darlingm, Matthew, Lorenzana, Karina Josephine Orduna, 2015. A Behavioral Approach to Water Conservation: Evidence from Costa Rica. *World Bank Policy Research Working Paper Series*, 7283.
- Farrow, Katherine, Grolleau, Gilles, Ibanez, Lisette, 2017. Social norms and pro-environmental behavior: A review of the evidence. *Ecol. Econ.* 140, 1–13.
- Ferraro, Paul J., Miranda, Juan Jose, Price, Michael K., 2011. The persistence of treatment effects with norm-based policy instruments: Evidence from a randomized environmental policy experiment. *Amer. Econ. Rev.* 101 (3), 318–322.
- Ferraro, Paul J., Price, Michael K., 2013. Using nonpecuniary strategies to influence behavior: Evidence from a large-scale field experiment. *Rev. Econ. Stat.* 95 (1), 64–73.
- Fuhrmann-Riebel, Hanna, D'Exelle, Ben, Verschoor, Arjan, 2021. The role of preferences for pro-environmental behaviour among Urban middle class households in Peru. *Ecol. Econ.* 180, 106850.
- Galizzi, Matteo M., W. Lau, Krystal, Miraldo, Marisa, Hauck, Katharina, 2022. Bandwagoning, free-riding and heterogeneity in influenza vaccine decisions: An online experiment. *Health Econ.* 31 (4), 614–646.
- Gerber, Alan S., Rogers, Todd, 2009. Descriptive social norms and motivation to vote: Everybody's voting and so should you. *J. Polit.* 71, 178–191.
- Goldstein, Noah J., Cialdini, Robert B., Griskevicius, Vladas, 2008. A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *J. Consum. Res.* 35 (3), 472–482.
- Hallsworth, Michael, List, John A., Metcalfe, Robert D., Vlaev, Ivo, 2017. The behavioralist as tax collector: Using natural field experiments to enhance tax compliance. *J. Public Econ.* 148, 14–31.
- Harring, Niklas, Jagers, Sverker C., Nilsson, Frida, 2019. Recycling as a large-scale collective action dilemma: A cross-country study on trust and reported recycling behavior. *Resour. Conserv. Recycl.* 140, 85–90.
- Jaime Torres, Mónica M., Carlsson, Fredrik, 2018. Direct and spillover effects of a social information campaign on residential water-savings. *J. Environ. Econ. Manage.* 92, 222–243.
- Krupka, Erin L., Weber, Roberto A., 2013. Identifying social norms using coordination games: Why does dictator game sharing vary? *J. Eur. Econom. Assoc.* 11 (3), 495–524.
- Lede, Ellin, Meleady, Rose, Seger, Charles R., 2019. Optimizing the influence of social norms interventions: Applying social identity insights to motivate residential water conservation. *J. Environ. Psychol.* 62, 105–114.
- Loschelder, David D., Siepelmeier, Henrik, Fischer, Daniel, Rubel, Julian A., 2019. Dynamic norms drive sustainable consumption: Norm based nudging helps Café customers to avoid disposable to-go-cups. *J. Econ. Psychol.* 75, 102146.
- Mortensen, Chad R., Neel, Rebecca, Cialdini, Robert B., Jaeger, Christine M., Jacobson, Ryan P., Ringel, Megan M., 2019. Trending norms: A lever for encouraging behaviors performed by the minority. *Soc. Psychol. Personal. Sci.* 10 (2), 201–210.
- Myers, Erica, Souza, Mateus, 2020. Social comparison nudges without monetary incentives: Evidence from home energy reports. *J. Environ. Econ. Manage.* 101, 102315.
- Nolan, Jessica M., Schultz, P. Wesley, Cialdini, Robert B., Goldstein, Noah J., Griskevicius, Vladas, 2008. Normative social influence is underdetected. *Personal. Soc. Psychol. Bull.* 34 (7), 913–923.
- Nyborg, Karine, Anderies, John M., Dannenberg, Astrid, Lindahl, Therese, Schill, Caroline, Schlüter, Maja, Adger, W. Neil, Arrow, Kenneth J., Barrett, Scott, Carpenter, Stephen, Chapin, F. Stuart, Crépin, Anne-Sophie, Daily, Gretchen, Ehrlich, Paul, Folke, Carl, Jager, Wander, Kautsky, Nils, Levin, Simon A., Madsen, Ole Jacob, Polasky, Stephen, Scheffer, Marten, Walker, Brian, Weber, Elke U., Wilen, James, Xepapadeas, Anastasios, de Zeeuw, Aart, 2016. Social norms as solutions. *Science* 354 (6308), 42–43.
- Ostrom, Elinor, 2000. Collective action and the evolution of social norms. *J. Econ. Perspect.* 14 (3), 137–158.
- Rockenbach, Bettina, Tonke, Sebastian, Weiss, Arne R., 2021. Self-serving behavior of the rich causes contagion effects among the poor. *J. Econ. Behav. Organ.* 183, 289–300.
- Schultz, P. Wesley, 1999. Changing behavior with normative feedback interventions: A field experiment on curbside recycling. *Basic Appl. Soc. Psychol.* 21 (1), 25–36.
- Schultz, P. Wesley, Messina, Alyssa, Tronu, Giuseppe, Limas, Eleuterio F., Gupta, Rupanwita, Estrada, Mica, 2016. Personalized normative feedback and the moderating role of personal norms: A field experiment to reduce residential water consumption. *Environ. Behav.* 48 (5), 686–710.
- Schultz, P. Wesley, Nolan, Jessica M., Cialdini, Robert B., Goldstein, Noah J., Griskevicius, Vladas, 2007. The constructive, destructive, and reconstructive power of social norms. *Psychol. Sci.* 18 (5), 429–434.
- Shang, Jen, Croson, Rachel, 2009. A field experiment in charitable contribution: The impact of social information on the voluntary provision of public goods. *Econ. J.* 119 (540), 1422–1439.
- Sparkman, Gregg, Howe, Lauren, Walton, Greg, 2020. How social norms are often a barrier to addressing climate change but can be part of the solution. *Behav. Public Policy* 5 (4), 528–555.
- Sparkman, Gregg, Walton, Gregory M., 2017. Dynamic norms promote sustainable behavior, even if it is counternormative. *Psychol. Sci.* 28 (11), 1663–1674.
- UNEP, 2015. United nations environment programme: Global waste management outlook.

- Varotto, Alessandra, Spagnoli, Anna, 2017. Psychological strategies to promote household recycling. A systematic review with meta-analysis of validated field interventions. *J. Environ. Psychol.* 51, 168–188.
- Vriens, Eva, Szekeley, Aron, Lipari, Francesca, Antonioni, Alberto, Sánchez, Angel, Tummolini, Luca, Andrighetto, Giulia, 2024. Assessing the effects of pandemic risk on cooperation and social norms using a before-after Covid-19 comparison in two long-term experiments. *Sci. Rep.* 14, 3356.
- WWF, 2018. 'Almost 90% of the garbage generated daily is not recycled'.