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I do, therefore i think it is normal: the causal effects of behavior on descriptive norm formation and evolution

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ABSTRACT
Social norms theories have guided social science research by predicting how and when social norms influence people’s behavior. However, there are still gaps in our understanding of how social norms are formed, maintained, and changed. It is possible that our own actions shape and perpetuate what we believe is normal. This study tests whether behavior can influence perceptions of what is typical behavior and how this relationship evolves over time. Secondary analysis of data from a multi-round public-goods experiment showed that personal contribution behavior significantly and positively influences perceived descriptive norms; yet, a significant change in the relationship over time was not evidenced. Theoretical and practical implications are discussed.

Theories of social norms have provided a framework for a wide range of social science research, including reasoned action theories and their extensions (Ajzen, 1991; Fishbein & Ajzen, 1975; Yzer, 2013) and the theory of normative social behavior (TNSB; Rimal & Real, 2005). In these theories, the direction of influence between norms and behavior is generally predicted and tested to be that perceived social norms affect subsequent behavior. Guided by these theories, research shows that social norms, or a combination of norms and other factors, can be a crucial social influence in people’s behavioral decisions such as reducing phone-related distracted driving (Lawrence, 2015) and shutting down computers and monitors to conserve energy (e.g., Bator et al., 2014).

Although much is known about the influence of social norms on behavioral decisions, there are still gaps in our understanding of how social norms are formed, maintained, and changed over time. In part, this is because data are rarely available on social norms and behaviors that account for both causality and time to make claims about norm formation and evolution. However, more attention to this issue is both theoretically and practically crucial, as it allows researchers to reconsider social norms in a more dynamic way (Rimal & Lapinski, 2015) and practitioners to better understand and more strategically design social norms-based interventions for behavior change.

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Using data from a multi-round public goods (PG) experiment, this study examines the possibility of reverse causality between perceived norms and behavior. Specifically, we test whether one’s own behavior shapes perceptions of what behavior is prevalent or common in the social midst (i.e., perceived descriptive norms; Cialdini et al., 1990). This study also investigates how the causal impact of behavior on prevalence perceptions evolves over time. The following sections review theories and evidence for the causal relationship between social norms and behavior, propose research questions, introduce the methods, and report and discuss the findings.

Social norm formation and change

Descriptive norms refer to the extent to which a specific behavior is common in a social system (Cialdini et al., 1990). This type of norm is commonly focal in the social sciences (Shulman et al., 2017), as perceived descriptive norms are theorized as a predictor of behavior in various approaches to social norms including focus theory (Cialdini et al., 1990), the social norms approach (Perkins & Berkowitz, 1986), and TNSB (Rimal & Real, 2005). Perceived descriptive norms are most likely to guide subsequent behavior when they are made salient (Cialdini et al., 1990) or combined with other perceptions such as the expectation of positive outcomes resulting from the behavior (Rimal & Real, 2005). The effect of descriptive norms on various health and pro-environmental behaviors is particularly well-known (e.g., Shulman et al., 2017). As such, the social norms approach (Perkins & Berkowitz, 1986) often targets to correct people’s misperceptions about the prevalence of a problematic behavior, such as excessive drinking among college students, to reduce risky behaviors (Smith et al., 2006).

Relative to the effect of descriptive norms, the formation and evolution of descriptive norm perceptions have received less attention (Rimal & Lapinski, 2015). This may be partially because existing theories of descriptive norms and their subsequent extensions (e.g., Chung & Rimal, 2016) fall short of making predictions for what forms and induces changes in perceived descriptive norms. Perceived descriptive norms can be formed through observations (Bandura, 1986), mediated and interpersonal communication about the behavior (Geber et al., 2017; Liu et al., 2019), and the actual prevalence of the behavior at a societal level (i.e., collective norms, Kerr et al., 2019). In addition to these factors, this study argues that one’s own behavior can influence perceived descriptive norms. The following sections review theoretical and empirical reasons.

Behavior can precede self-perception (Bem, 1967; Festinger, 1957), and this may also be the case for normative perceptions. Indeed, the influence of behavior on normative beliefs was theorized for subjective norms, one’s perception of whether important others think one should perform a behavior of interest (Fishbein & Ajzen, 1975). The original theory of reasoned action (TRA) suggested feedback loops between subjective norms and behavior as a possible mechanism for subjective norms’ formation and change over time: subjective norms can influence behavioral intention to perform it and subsequent behavior (Kim & Hunter, 1993). Yet, enacting the behavior can also lead to the formation of new normative beliefs about the behavior (or modify existing ones), based on the reactions and feedback from the people around them, which in turn will influence future intentions and behaviors (Fishbein & Ajzen, 1975, 2010).
Although reasoned action theories and their extensions (e.g., Yzer, 2013) are prominent in social norms research (Shulman et al., 2017), only a handful of studies have reported the influence of behavior on subjective norms formation and evolution, and the evidence is indirect at best. For example, tests of a dynamic theory of reasoned action evidenced the indirect effect of behavior on subjective norms via behavioral intention (Boster et al., 2014). Similarly, Sussman and Gifford (2019) provided evidence for the effect of behavioral intention on subjective norms, rather than the influence of behavior. Others have formulated hypotheses based on the feedback loop between subjective norms and behavior but did not directly test it (Hoewe & Sherrick, 2015).

Importantly, subjective and perceived descriptive norms are conceptually and empirically distinct (Park & Smith, 2007): subjective norms are a person’s perceptions of significant others’ expectations about performing a behavior, whereas perceived descriptive norms refer to a person’s perceptions about the prevalence of a particular behavior. In addition, the reverse causality or feedback loop between norm perceptions and behavior has not been theorized for descriptive norms. Nonetheless, literature across various fields suggests that one’s own behavior can also shape one’s prevalence perceptions, especially when the behavior is more socially undesirable than desirable (i.e., a practice that is culturally acceptable and approved; Crowne & Marlowe, 1960). In particular, evidence is fairly consistent that people who engage in a socially undesirable behavior tend to overestimate the frequency/prevalence of the behavior in their referent group compared to themselves (e.g., Mäkelä, 1997; Neighbors et al., 2006; Park et al., 2011; Segrist et al., 2007).

Cognitive dissonance theory (Festinger, 1957) provides one explanation for the overestimation of socially undesirable behaviors in others. It suggests that a person experiences cognitive dissonance when their self-relevant perception and their own behaviors are inconsistent. Cognitive adjustments are one way that they reduce dissonance (McGrath, 2017), including overestimating the prevalence of behavior and evaluating it as normal rather than deviant (i.e., a false consensus effect; Ross et al., 1977). Given that people generally want to maintain a consistent and positive self-concept (Aronson, 1969), they are likely to experience cognitive dissonance if they have engaged in a socially undesirable behavior. Exaggerating the prevalence of the negative behavior in the social system justifies one’s own action and reduces the dissonance.

What is less clear is what occurs when the behavior of interest is socially desirable. Empirical evidence for overestimation of prevalence perceptions is mixed and theories for why one’s own behavior might influence prevalence perceptions are more ambiguous. Some evidence shows that people overestimate the prevalence of their own positive behavior in their referent group (Suls et al., 1988). This may result from ingroup biases which cause people to favor their own group over other groups, possibly due to a salient self-concept as a group member under conditions of intergroup interaction (Tajfel, 1978; Tajfel & Turner, 1979, 2004). In addition, given that people tend to interact more often with those similar than dissimilar to themselves (McPherson et al., 2001), individuals who do socially desirable behaviors may be more frequently exposed to people also conducting such behaviors, which can contribute to the overestimation of the prevalence of their behavior in a society in general. Or, people may simply want to assure themselves that they belong to a majority and are not associated with a minority (Martin et al., 2008).
On the other hand, people also underestimate the prevalence of their own socially desirable behavior in their group (e.g., the false uniqueness effect; Monin & Norton, 2003; Suls & Wan, 1987). Underestimation may occur because one simply does not believe that he/she is in the majority (Mullen & Hu, 1988) or feels unique in a positive way (Suls et al., 1988). False uniqueness may be culturally bound as some cultural groups place more value on individual exceptionality and emphasizing the self in self-promotion (Ellis & Wittenbaum, 2000; Park, 2012).

In sum, potential reverse causality between perceived descriptive norms and behavior is expected, when considering classical theories suggesting that behavior can precede self-perceptions (Bem, 1967; Festinger, 1957) and some evidence showing the effect of behavior on prevalence perceptions (e.g., Neighbors et al., 2006). Nonetheless, while evidence is fairly consistent for an overestimation tendency regarding socially undesirable behaviors, literature is inconclusive about how enacting socially desirable behavior might influence perceived descriptive norms. To address this gap, the current research examined whether one's own socially desirable behavior plays a role in their perception of what is typical behavior. Due to competing evidence, this study proposed the following research question:

**RQ1:** Does personal behavior influence perceived descriptive norms (i.e., prevalence perceptions) when controlling for other potential influences on normative perceptions?

Also, little is known about the dynamic nature of the relationship between behavior and perceived descriptive norms over time, arguably due to both the lack of dynamic theories and reliance on cross-sectional study designs of social norms research (Shulman et al., 2017). We argue that the overall effect of behavior on perceived descriptive norms, in general, will be attenuated over time as people learn about the actual prevalence of the behavior (i.e., collective norms) in various ways (e.g., the observation of what others do). In other words, one's own behavior is likely to be most influential when other cues or drivers of perceived descriptive norm formation are limited and when norms are ambiguous. In such a situation, one's behavior is most available to us and easily accessible. In addition, believing oneself to be normal, or at least not deviant, is preferable to most people (c.f. Goffman, 1963) which is likely to cause us to evaluate our own behaviors positively and consistent with normative expectations. However, as people learn about collective norms over time, the effect of one’s own behavior on perceived descriptive norms is expected to decline; as more information comes in from the social system, we will add those cues about prevalence to our consideration of our own actions to make a judgment of how typical a behavior is in our social midst, unless we have reasons to over/underestimate the prevalence of the behavior (e.g., false consensus or uniqueness). To the best of our knowledge, this relationship pattern has not been theorized and has rarely been reported. Hence, the following research question was also proposed (**ceteris paribus**):

**RQ2:** How does the influence of personal behavior on perceived descriptive norms evolve over time.
Method

Overview of the full study design and outcomes

This study involves secondary analysis of data from a 2 (sorted vs. unsorted conditions) \times 2 (incentive vs. non-incentive conditions) between-subject experimental public goods (PG) game that tested how financial incentives for enacting a behavior moderate the effect of norms on behavior (Lapinski et al., 2017). While Lapinski et al. (2017) tested primary hypotheses focusing on the influence of perceived descriptive norms on behavior and several moderators on the relationship including financial incentives (e.g., the effect of perceived descriptive norms on behavior with and without financial incentives), this study tests secondary research questions exploring the possibility of reverse causality (i.e., the effect of behavior on perceived descriptive norms).

Participants were recruited through the Agricultural Economics Experimental Lab online recruiting system at Michigan State University. This system has a large representative subject pool and recruits by sending out random e-mail invitations. Researchers informed participants that the study was about decision making and participants ultimately received between $23 to $38 as compensation for participation based on individual earnings. Participants (\(N = 192\)) played multiple rounds of a computer-based PG game where they decided whether (and how much) to invest their private resources (i.e., tokens) in their private accounts or contribute to the public account. Prior to the main experiment, there was an initial round to measure participants’ contribution level. Participants who were in the sorted conditions were grouped according to their contribution level to the public account in the initial round (i.e., highest four contributors in one group, next four highest contributors in another group, etc.), whereas those in the unsorted treatments were grouped randomly. Sorting participants based on their initial public account contribution level was expected to mitigate the well-known natural decline in public account contribution over rounds.

Excluding the initial sorting round, participants played a total of 18 rounds (6 rounds \times 3 phases) in groups of four. In each round, participants were given 20 tokens and decided how many tokens to contribute to a public account, with the remaining tokens kept in their private account. They could maximize the group’s collective outcomes by contributing all their tokens to the public account, while they could increase their individual benefits by keeping them in their private account: A personal contribution of one token into the public account yielded 1.6 tokens in total and each member in the group received 0.4 tokens, while an investment of one token into a private account yielded only one token that went to the person who invested it. Hence, contributing to the group account (regardless of the amount) is for the greater good, less selfish and a more socially desirable behavior than contributing to a private account. The total contributions of all four group members were disclosed after each round.

Participants in the incentive treatments (randomly assigned) received a financial incentive to promote the public account contribution during Phase 2. Individuals who contributed a token to the public account received an extra 0.6 tokens in addition to 0.4 tokens received by default. Thus, the participant with this incentive earned the same return from contributing to the public account as from investing in the private account. This incentive was removed in Phase 3 of the study.
Using multiple regression analyses, Lapinski et al. (2017) showed that perceived descriptive norms significantly predicted personal contribution behavior. However, the strength of this relationship was attenuated when financial incentives were given, and even after the incentives were removed in Phase 3. Lapinski et al. (2017) also found that perceived descriptive norms changed throughout the multiple rounds of the PG game, and the changes in prevalence perception were positively driven by the group members’ actual contribution behavior from the prior round. The study was reviewed and qualified as exempt from Michigan State University’s institutional review board (IRB#: x12-335e).

Measurement

Main variables

Self-administered surveys were conducted four times during the experiment (after participants’ contribution decisions) to measure the participants’ perceived descriptive norms and group identification (after the first round and after the sixth round in Phase 1, and after the sixth round in Phases 2 and 3). Other variables were measured based on direct observation of their behavior. Measurement analysis for all variables at each time point is presented in prior research; only unidimensional scales were included in the analysis (Lapinski et al., 2017). The experimental design and the study variables are illustrated in Figure 1. The descriptive statistics and correlations among the study variables are presented in Table 1.

Perceived descriptive norms

The dependent variable was operationalized as perceived prevalence of contribution behavior in a participant’s group. This variable was measured by three items derived from previous social norms research where validity and reliability evidence was established (Lapinski et al., 2014), using a 5-point Likert-type scale. The items were ‘The majority of people in my group are playing this game cooperatively,’ ‘I think that most people in my group are cooperative,’ and ‘It seems like most people in this group do not behave cooperatively’ (reverse scored). Higher scores indicate greater prevalence perception of contribution in a group (α = .90 to .94 across time).

![Figure 1](image_url)

**Figure 1.** Illustration of the experimental design.

Note. PCB = Personal contribution behavior; PDN = Perceived descriptive norms; GI = Group identification; M = Mean value for the period
Table 1. Descriptive statistics and correlations among variables.

<table>
<thead>
<tr>
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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
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<th>8</th>
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<td>Personal</td>
<td>Group</td>
<td>Perceived</td>
<td>Lagged</td>
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<td>condition</td>
<td>norms</td>
<td></td>
<td>contribution</td>
<td>identification</td>
<td>descriptive</td>
<td>perceived</td>
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<td>.12**</td>
<td>-.05</td>
<td>.09*</td>
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<tr>
<td>7</td>
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<td>.02</td>
<td>.09*</td>
<td>-.18**</td>
<td>.08*</td>
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<tr>
<td>8</td>
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<td>.01</td>
<td>-.10*</td>
<td>-.05</td>
<td>-.05</td>
<td>.19**</td>
<td>.44**</td>
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<td>768</td>
<td>768</td>
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<td>768</td>
<td>576</td>
<td></td>
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<tr>
<td>M</td>
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<td>10.70</td>
<td>4.23</td>
<td>3.11</td>
<td>3.24</td>
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<td>.</td>
<td>7.06</td>
<td>1.35</td>
<td>1.10</td>
<td>1.09</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
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<td>1</td>
<td>1</td>
<td>60</td>
<td>3</td>
<td>20</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Note. * p < .05, ** p < .01.

**Time**

Time was operationalized by using the four time points when the surveys were administered and had four values from 0 to 3: Time 0 = the first round in Phase 1, Time 1 = from the second to the sixth round in Phase 1, Time 2 = from the first to the sixth round in Phase 2, and Time 3 = from the first to the sixth round in Phase 3.

**Personal contribution behaviors**

The independent variable was operationalized as the actual (for Time 0) or averaged (from Time 1 to Time 3) number of tokens participants contributed to the public account. Because there were four survey time points, the main analysis included four contribution behaviors: Personal contribution behavior 1 = the first contribution behavior in Phase 1, Personal contribution behavior 2 = the mean contribution behavior for Phase 1 excluding the first contribution, Personal contribution behavior 3 = the mean contribution behavior for Phase 2, and Personal contribution behavior 4 = the mean contribution for Phase 3.

**Covariates**

For rigorous causality testing, the main analysis included several covariates that have been theorized or evidenced to influence perceived descriptive norms (i.e., collective norms) and shown to moderate the relationship between descriptive norms and behavior in previous literature (i.e., group identification; Rimal, 2008). Given that the original study (Lapinski et al., 2017) found a significant effect of perceived descriptive norms on contribution behavior, this study created a time lagged variable of perceived descriptive norms and added it as a covariate in the main analysis. In addition, to account for the original experimental design, this research also controlled the effects of the experimental manipulations.

**Collective norms**

Collective norms were operationalized as the actual (for Time 0) or averaged (from Time 1 to Time 3) number of tokens that a participant’s group members contributed to the public account in the prior rounds, excluding the participant’s own contribution.
Collective norms at the following four time points were used for the analysis: Collective norms 1 = the amount of tokens that one's group members contributed in the first round in Phase 1; Collective norms 2 = the mean amount of tokens that one's group members contributed in Phase 1 excluding the first round; Collective norms 3 and 4 = the mean amount of tokens that one's group members contributed in Phases 2 and 3, respectively.

**Group identification**

Group identification was operationalized as perceived similarity with group members. This was measured by four items drawn from previous research (Rimal, 2008) using 7-point Likert-type response scales (1 = not at all similar, 7 = extremely similar). The question asked: ‘On the whole, how similar do you think most people in this group are to you?’, followed by the items ‘in their values’, ‘in the way they think’, ‘intellectually,’ and ‘in their behaviors.’ Higher scores indicate greater perceived similarity with the other group members (α = .86 to .91 across time).

**Lagged perceived descriptive norms**

This variable was identical measurements of the dependent variable, measured at an earlier time point (Time\_–1).

**Experimental conditions**

Incentive and sorting manipulations were dichotomized to represent the participants in the treatment condition and those in the control condition: Incentive 0 = the participants in the control condition; Incentive 1 = the participants in the incentive condition; Sorting 0 = the participants in the control condition; Sorting 1 = the participants in the sorted condition.

**Analysis**

Given that the surveys were conducted four times, individual idiosyncrasy over the course of the experiment was expected. Therefore, multilevel modeling with Restricted Maximum Likelihood (REML) estimation was employed; REML can produce less biased estimates than maximum likelihood estimation, particularly when the number of groups is small (Boedeker, 2017). Independent variables in the data were assigned into two levels: The Level 1 (individual level) variables included individual’s contribution behavior, group identification, lagged perceived descriptive norms, and time. The Level 2 (group level) variables were collective norms and experimental manipulations. To estimate the changes in perceived descriptive norms at an individual level, the model regressed Level 1 indicators, while controlling for Level 2 indicators. Personal contribution behavior, group identification, lagged perceived descriptive norms were group-mean centered; collective norms were grand mean centered for the sake of interpretation (Enders & Tofghi, 2007; Hofmann & Gavin, 1998). The data from 192 participants (768 observations) were analyzed. A stepwise approach was used: A null model (Model 1) included a random intercept without any predictors. The covariates were included in the second model (Model 2). The main variables were entered next (Model 3), and the interaction terms were entered in the final model (Model 4). These models include random effect variances for intercepts and slopes of lower-level variables but did not include the
covariance between intercepts and slopes (see Appendix A for the model specification). Both statistical significance and effect sizes (i.e., standardized coefficients) were used to interpret the results.

Results

RQ1 explored whether personal behavior would influence perceived descriptive norms. It was found that the effect of participants’ own contribution behaviors on their perceived descriptive norms was significant and positive, $y = .02$, standardized coefficient $= .08$, $p < .05$ (Model 3). That is, the more participants contributed to the public account, the more they thought that the contribution behavior was common in their group. The effect size was smaller than the other significant predictor. Group identification exerted a significant positive impact on perceived descriptive norms ($y = .34$, standardized coefficient $= .24$, $p < .001$); those who perceived greater similarity with other group members reported greater prevalence perceptions of contribution behaviors in their group.

RQ2 examined how the influence of personal contribution behavior on perceived descriptive norms changed over time. The interaction effects of personal contribution behavior and time on perceived descriptive norms were not statistically significant, $y = -.02$, standardized coefficient $= -.08$, $p = .19$ (Model 4). Altogether, the data showed that the impact of personal contribution behavior on perceived descriptive norms remained stable during the experiment, and significant changes in perceived descriptive norms over time as a function of participants’ own contribution behavior were not evidenced. The results are summarized in Table 2.

Discussion

After decades of research, the influence of social norms on human behavior is nearly axiomatic in the social sciences. Guided by several theories of social norms that predict how perceived social norms affect behavior, the influence of social norms on various types of behaviors is well established. Yet, despite their long history in theories and empirical research, little is known about the formation and evolution of social norms. The unique conditions of a theory-driven public goods experiment – multiple rounds to simulate time, potential for covariation, and rigorous control of extraneous factors – provide a robust test of the ways in which a person’s own socially desirable behavior influences their perceived descriptive norms and how this relationship evolves over time. The findings showed that the effect of behavior on perceived descriptive norms was significant and positive while controlling for possible extraneous variables. Yet, the evolution of descriptive norm perceptions as a function of one’s own behavior was not evidenced. In the following sections, the results are discussed with theoretical and practical implications for social norms research.

One’s own behavior can lead one to believe that a behavior is normal. Although the effect size was smaller than the other variables (e.g., group identification), the nature of the design and analysis gives us confidence that the evidence is robust; this study even controlled the effect of (lagged) perceived descriptive norms on behavior, which has been theorized and evidenced in the social norms literature (Manning, 2009). This reverse
Table 2. Multilevel model results for the effects of study variables on perceived descriptive norms.

<table>
<thead>
<tr>
<th></th>
<th>Model 1 (Null model)</th>
<th>Model 2 (Random slopes model with only covariates)</th>
<th>Model 3 (Random slopes model with main variables)</th>
<th>Model 4 (Random slopes model including interactions)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>y (SE)</td>
<td>y (SE) Standardized</td>
<td>y (SE) Standardized</td>
<td>y (SE) Standardized</td>
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<tr>
<td><strong>Level 2</strong></td>
<td></td>
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</tr>
<tr>
<td>Intercept</td>
<td>3.11 (.06)***</td>
<td>3.17 (.15)***</td>
<td>3.16 (.14)***</td>
<td>3.16 (.15)***</td>
</tr>
<tr>
<td>Sorting condition</td>
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<td>−.13 (.13)</td>
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<td>Incentive condition</td>
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<td>.01 (.12)</td>
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<td>.00 (.00)</td>
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<td>Collective norms * Time</td>
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<td><strong>Level 1</strong></td>
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<tr>
<td>Time</td>
<td>−.03 (.04)</td>
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<td>−.02 (.04)</td>
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<td>.34 (.06)***</td>
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<td>Lagged perceived descriptive norms</td>
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<td>.05 (.05)</td>
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<td>.40 (.04)***</td>
<td>.39 (.04)***</td>
<td>.37 (.04)***</td>
</tr>
<tr>
<td>Intercept (r_{00})</td>
<td>.51 (.07) ***</td>
<td>.53 (.09)***</td>
<td>.50 (.09)***</td>
<td>.52 (.09)***</td>
</tr>
<tr>
<td>Time (r_{11})</td>
<td>.00 (.00)</td>
<td>.00 (.00)</td>
<td>.00 (.00)</td>
<td>.00 (.00)</td>
</tr>
<tr>
<td>Group identification (r_{22})</td>
<td>.15 (.05)**</td>
<td>.16 (.05)**</td>
<td>.17 (.05)**</td>
<td>.17 (.05)**</td>
</tr>
<tr>
<td>Lagged perceived descriptive norms (r_{33})</td>
<td></td>
<td></td>
<td>.09 (.04)*</td>
<td>.09 (.04)*</td>
</tr>
<tr>
<td>Contribution (r_{44})</td>
<td></td>
<td>.00 (.00)</td>
<td>.00 (.00)</td>
<td>.00 (.00)</td>
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<tr>
<td>Contribution * Time (r_{55})</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall model fit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>−2 Restricted Log Likelihood</td>
<td>2177.01</td>
<td>1556.90</td>
<td>1558.86</td>
<td>1567.71</td>
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<tr>
<td>ICC</td>
<td>.42</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Notes. y indicates the unstandardized coefficients for fixed effect; SE indicates standard errors; The dependent variable: Perceived descriptive norms; ICC = \( \frac{\hat{\tau}_{00}}{\hat{\tau}_{00} + \hat{\sigma}^2} \) where \( \hat{\tau}_{00} \) is the estimated intercept variance and \( \hat{\sigma}^2 \) is the estimated residual variance; * p < .05, **p < .01, *** p < .001.
causality observed for perceived descriptive norms and behavior is in line with the arguments in both classical theories suggesting that behavior can precede self-perceptions (e.g., Bem, 1967) and relatively recent literature calling attention to the effect of behavior on norm formation (Rimal & Lapinski, 2015). Also, this finding is meaningful to the inconclusive literature on this topic; it provides additional evidence of the overestimation tendency for socially desirable behavior.

Unlike subjective norms in the original TRA (Fishbein & Ajzen, 1975), the reverse causality or feedback loop between descriptive norms and behavior has not been discussed in the theories of social norms that incorporate descriptive norms as a main predictor of behavior (e.g., focus theory; Cialdini et al., 1990; TNSB; Rimal & Real, 2005). The effect of one’s own behavior on prevalence perceptions found in this study also sheds light on the possibilities of feedback loops in those theories, allowing future research to reconceptualize the relationship between descriptive norms and behavior in a more dynamic manner (Rimal & Lapinski, 2015).

There was not a discernable trend in prevalence perceptions as a function of one’s own behavior. This may imply the robust and stable influence of behavior on perceived descriptive norms over time. However, we expected the overall declining effect of behavior on perceived descriptive norms over the course of the experiment, as participants were repeatedly exposed to collective norms. In fact, a significant interaction effect between behavior and time on perceived descriptive norms was found among participants considered to have accurately perceived norms based on collective norms in a post hoc analysis. Also, the interaction between collective norms and time on perceived descriptive norms was statistically significant ($\gamma = .01$, standardized coefficient $= .12$, $p < .01$) and the pattern analysis of the interaction between collective norms and time on perceived descriptive norms showed that the influence of collective norms on descriptive norms formation increased over time as we argued (see, Figure 2). Given that the effect of behavior on descriptive norms formation and how it changes over time are a largely under-studied area, more research is needed to draw a proper conclusion about the relationship and to expand the purview of social norms research.

Group identification was significantly and positively associated with perceived descriptive norms. This can be understood in the context of in-group bias resulting from a group-derived self-concept (Tajfel, 1978; Tajfel & Turner, 1979, 2004). It is possible that the participants’ perceived similarity and the group-based experiment contributed to participants defining themselves as a group member, rather than a sole individual, and therefore they showed a propensity to favor their in-group members regardless of their actual behavior. When considering mixed evidence on the moderating role of perceived similarity on the relationship between perceived descriptive norms and behavior (e.g., Carcioppolo & Jensen, 2012; Rimal, 2008), it may be fruitful for future research to continue to investigate the influence of perceived similarity, not only as a strengthening factor for normative conformity, but also as a contributor to the perceived norm itself, ultimately leading to norm consistent behavior.

The causal effect of behavior on perceived descriptive norms formation may have practical implications when promoting socially desirable behaviors using social norms. The social norms approach (Perkins & Berkowitz, 1986) communicates
messages about positive behaviors that are prevalent in a particular group, which shapes or modifies people’s normative perceptions and results in subsequent behavior change (Smith et al., 2006). Given that descriptive norms are usually the cornerstone for this approach, understanding how these perceptions are formed can allow us to design more strategic communication interventions for a given issue. The finding of this study suggests that people who conduct socially desirable behavior are more likely to overestimate the prevalence of the behavior around them, which in turn arguably reinforces their existing behavior. Thus, more attention may be needed for those who do not perform the behavior, who are likely to underestimate the prevalence of it around them. For example, in addition to communication campaigns that highlight what most others do, creating actual opportunities for them to engage in a behavior (e.g., providing alternative transport and persuading people to adopt it to reduce carbon footprint) may enhance the overall effect of social norms interventions, given that conducting behavior can increase people’s perceived prevalence of the behavior in their referent group. It also bolsters the idea that in some cases, short-term behavioral incentives to kick-start behaviors, might help boost longer-term behavior change efforts because of the changes in social norms.
Limitations and future research

This study is not without limitations. First, the findings may have limited external validity. Yet, our purpose was to maximize internal validity to test the theoretical relationships. Analyzing multi-round data on well-controlled, systematically designed lab experiments was necessary as a rigorous test of the research questions. In addition, we believed that the socially desirable nature of contribution behavior in PG games was well-suited for this research. Given that the formation and evolution of norms have received less attention than the effects of norms, future research is strongly encouraged to theorize and test the formation and evolution of perceived norms in various experimental designs and contexts to expand the purview of social norms literature.

Second, this study investigated the influence of one’s own behavior on perceived descriptive norms. Questions remain regarding other types of norms, such as whether our effects would hold for perceptions of what behavior is socially approved (i.e., perceived injunctive norms; Cialdini et al., 1990). We focused on descriptive norms because they function as the main predictor of behavior in various theories, are commonly studied (Shulman et al., 2017), and because our minimal groups paradigm means injunctive norm formation would be more difficult to study.

Figure 3. The interaction between contribution behavior and time on perceived descriptive norms among participants who were considered to have correctly perceived norms (post hoc). Note. Colored areas represent 95% confidence intervals; Time 0 is not shown for ease of presentation.
However, it is important to note that perceived injunctive norms often guide behavior and may have a stronger effect on some behaviors than perceived descriptive norms (Rhodes et al., 2020), but the formation of injunctive norm perceptions is not well understood. It is possible that one’s own behavior, specifically based on the direct or indirect feedback of others (e.g., rewards or punishments because of the action), could shape/revise their perceived injunctive norms. Future research is encouraged to shed light on this relationship.

Conclusion

This research provides evidence for how one’s prevalence perceptions are formed by one’s own behavior. This relationship was investigated by simulating evolutionary conditions in the form of a short experiment. The data show that one’s own socially desirable behavior significantly and positively influence perceptions of what is normal behavior. However, there was not a discernable trend in perceived descriptive norms as a function of behavior. This study points to the critical need for more longitudinal and experimental studies of social norms with the focus of the formation and evolution of social norms.

Notes

1. Due to the declining nature of contribution over time in public goods games, the current research also included the interaction between collective norms and time as a covariate.
2. Given that the experiment was group-based, idiosyncratic differences between groups were also tested for random effects. The current research compared the model fits between when group effects were controlled and not controlled. The model including group effects as random effect did not significantly increase the model fit, $\chi^2 (1) = 1.93, p = .17$. Therefore, group effect was not included as a random effect.
3. The null model (i.e., Model 1) was estimated to examine whether multilevel modeling was necessary. The intraclass correlation (ICC) for perceived descriptive norms was $42, p < .001$; in other words, the data showed that participants in the same group reported more similar perceived descriptive norms than did others from different groups. Thus, multilevel modeling was considered more appropriate than a single level analysis method (Lee, 2000).
4. The significant intercept variance suggested that even after controlling the effect of the main variable and covariates, perceived descriptive norms within the same individual were non-independent, $r_{00} = .50, p < .001$.
5. At the suggestion of a reviewer, we created an ‘accuracy’ variable and conducted a post hoc analysis to further investigate the interaction between contribution behavior and perceived descriptive norms over time. We dichotomized collective norms and perceived descriptive norms based on their grand means, then assigned a 0 for values below the mean and a 1 for values above the mean to each variable. By matching the two scores, we created an accuracy variable (i.e., matched = ‘accurate’, unmatched = ‘inaccurate’). We divided the participants into groups based on their accuracy and ran the multilevel analysis for each group. A significant interaction effect between contribution behavior and time on perceived descriptive norms was only found in the accurate group (395 observations), $y = -.04$, standardized coefficient = -.17, $p < .05$. In other words, for those who were considered to have accurately perceived norms based on their group members’ actual contributions, the effect of one’s own behavior on perceived descriptive norms decreased over time (see, Figure 3 for the interaction plot). This finding is consistent with our argument for RQ2 but should be regarded with caution as the groups (i.e., the accurate vs. inaccurate groups) were arbitrarily dichotomized.
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Disclosure statement

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References


### Appendix A Model Specification in Multilevel Modeling

<table>
<thead>
<tr>
<th>Model</th>
<th>Level</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model 1</td>
<td>Level 1</td>
<td>$PDN_i = \beta_{b1} + e_i$</td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>$\beta_{b2} = \gamma_{00} + u_{b2}$</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>$PDN_i = [\gamma_{00} + u_{b2}] + e_i$</td>
</tr>
<tr>
<td>Model 2</td>
<td>Level 1</td>
<td>$PDN_i = \beta_{b1} + \gamma_{10} \text{Time} + \beta_{b2} \text{GL} + \beta_{b3} LPDN_i + e_i$</td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>$\beta_{b2} = \gamma_{00} + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + u</em>{b2} \beta_{b2} = \gamma_{10} + u_{b2} \beta_{b2} = \gamma_{20} + u_{b2} \beta_{b2} = \gamma_{30} + u_{b2} \beta_{b2}$</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>$PDN_i = [\gamma_{00} + u_{b2}] + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + \gamma</em>{10} + u_{b2} \text{Time} + \gamma_{20} + u_{b2} \text{GL} + \gamma_{30} + u_{b2} \text{LPDN}_i + e_i$</td>
</tr>
<tr>
<td>Model 3</td>
<td>Level 1</td>
<td>$PDN_i = \beta_{b1} + \gamma_{10} \text{Time} + \beta_{b2} \text{GL} + \beta_{b3} LPDN_i + \beta_{b4} \text{PCB} + e_i$</td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>$\beta_{b2} = \gamma_{00} + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + u</em>{b2} \beta_{b2} = \gamma_{10} + u_{b2} \beta_{b2} = \gamma_{20} + u_{b2} \beta_{b2} = \gamma_{30} + u_{b2} \beta_{b2} = \gamma_{40} + u_{b2} \beta_{b2}$</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>$PDN_i = [\gamma_{00} + u_{b2}] + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + \gamma</em>{10} + u_{b2} \text{Time} + \gamma_{20} + u_{b2} \text{GL} + \gamma_{30} + u_{b2} \text{LPDN}<em>i + \gamma</em>{40} + u_{b2} \text{PCB} + e_i$</td>
</tr>
<tr>
<td>Model 4</td>
<td>Level 1</td>
<td>$PDN_i = \beta_{b1} + \gamma_{10} \text{Time} + \beta_{b2} \text{GL} + \beta_{b3} LPDN_i + \beta_{b4} \text{PCB} + \beta_{b5} \text{Time} \cdot \text{PCB} + e_i$</td>
</tr>
<tr>
<td></td>
<td>Level 2</td>
<td>$\beta_{b2} = \gamma_{00} + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + u</em>{b2} \beta_{b2} = \gamma_{10} + u_{b2} \beta_{b2} = \gamma_{11} \text{CN}<em>i + \gamma</em>{12} \text{Time} + u_{b2} \beta_{b2} = \gamma_{20} + u_{b2} \beta_{b2} = \gamma_{30} + u_{b2} \beta_{b2} = \gamma_{40} + u_{b2} \beta_{b2} + \gamma_{50} + u_{b2} \beta_{b2}$</td>
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<tr>
<td></td>
<td>Combined</td>
<td>$PDN_i = [\gamma_{00} + u_{b2}] + \gamma_{01} \text{CN}<em>i + \gamma</em>{02} \text{Sorting}<em>i + \gamma</em>{03} \text{Incentive}<em>i + \gamma</em>{10} + u_{b2} \text{Time} + \gamma_{11} \text{CN}<em>i + \gamma</em>{12} \text{Time} + u_{b2} \text{GL} + \gamma_{20} + u_{b2} \text{LPDN}<em>i + \gamma</em>{40} + u_{b2} \text{PCB} + \gamma_{50} + u_{b2} \text{Time} \cdot \text{PCB} + e_i$</td>
</tr>
</tbody>
</table>

Note. PDN indicates perceived descriptive norms; PCB indicates personal contribution behavior; CN indicates collective norms; GL indicates group identification; LPDN indicates lagged perceived descriptive norms.