Residents' Perceptions of Behavioral Reference Groups for Personalized Normative Messaging Interventions

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ABSTRACT

Reporting normative feedback to residential energy consumers has been found effective at reducing residential energy consumption. Upon receiving normative feedback households tend to modify their use to become in line with group norms. The effect of normative messages is partially moderated by how personally relevant normative reference groups are to the individual. Advanced energy metering technologies capture households' energy use patterns, making it possible to generate highly similar and relevant normative reference groups in a non-invasive manner. Unfortunately, it is not well understood how similar individuals are to other group members. It also remains unknown how much individuals identify with behavioral reference groups. Therefore, this research aims to investigate how households perceive behavioral reference groups used in normative comparisons. Survey questionnaires are collected from 2,008 participants using Amazon Mechanical Turk. It is found that while households' behaviors are more similar when grouped based on energy use profiles than based on geographic proximity, they identify more closely with proximity-based groups. Also, members' group identification increases as individuals have higher similarity in energy use behaviors with other group members. This implies that enhancing the identity of profile-based behavioral reference groups will lead to an increase in norm adherence, and in turn reductions in household energy use.

INTRODUCTION

Approximately 21% of all energy expenditure in the U.S. and 25% in the European Union is attributed to residential energy use (EIA 2018; EC 2018). Occupant behavior is one of the major factors influencing building energy consumption (Bahaj et al. 2007). As a consequence, much attention has been given to behavioral interventions targeting home energy use over the last two decades. One strategy that has shown considerable promise in promoting environmental-friendly behaviors is providing normative feedback messages to households (Anderson et al. 2017). Normative feedback messages inform households of their energy consumption over the previous period and mean energy use data of their reference groups (i.e., group norm).

Normative feedback messaging interventions have been found to be a cost-effective method to promote behavioral changes within a household, and in the aggregate can have a very meaningful impact on energy consumption and pollution. Several large-scale studies in different U.S. cities were able to achieve a two percent reduction in home energy use by only by adding normative feedback messages to energy bills (Allcott 2011). A two percent reduction in consumption applied to the entire residential sector amounts to an enormous net reduction of approximately 1,250 tWh of electricity and 150 million metric tons CO_2 emissions.

It is believed that the effectiveness of normative feedback messages can be further increased by making the behavioral reference groups more personally relevant to the recipients of the messages (Goldstein et al. 2008). Until recently, normative comparison groups have been based on geographic proximity (e.g., street and city) and housing characteristics (e.g., housing size and heating type) (Darby 2006). While the use of housing characteristics is fairly personalized, traditional methods for grouping based on housing characteristics have relied on households' participation to collect data (e.g., surveys and home energy audits). This has made the use of behavioral reference groups based on housing characteristics financially infeasible on a large scale.

Advances in home energy monitoring technology, however, have provided new avenues to create highly relevant behavioral reference groups for normative comparisons in a non-invasive manner. Smart energy meters collect highly granular energy use data and permits the construction of accurate energy use profiles which are derived from household behaviors (Richardson et al. 2010). More explicitly, it is possible to infer when households perform certain behaviors (e.g., turn on and off their HVAC systems). With this information, it is possible to categorize households into various behavioral reference groups based on similarities in energy use profiles (i.e., household energy use behavior). This process for creating these highly personalized behavior reference groups, unlike previous methods, requires little to no manual intervention making it scalable and applicable the residential population as a whole.

Previously, consumer energy profile-based (EP) groups (e.g., people who use most energy at night) have been used to identify representative behavioral patterns of electricity consumers for energy tariff structure modeling (Chicco 2012), building energy use prediction (Song et al. 2017) and renewable electricity generation (Motlagh et al. 2015). Despite the volume of work on creating EP groups two fundamental questions have yet to be answered related to their applicability for use in normative feedback comparisons. First, it is not well understood how similar individuals feel to other members of their EP groups. This is important because while households within EP groups have high levels of similarity in terms of household energy use patterns and behaviors, households may perceive themselves to be similar to other group members (Han et al. 2012). Second, it still remains unknown how much the members of a households identify with EP groups. This is important because a group norm influences individuals' behaviors when they identify with the perceived group (Terry and Hogg 1996; Johnston and White 2003; White et al. 2009).

To the best of the authors' knowledge, no studies to date have investigated how individuals perceive EP groups. Most related works have focused on similarity with other members of geographic proximity-based (GP) groups (i.e., neighbors) that GP have been in practice and can serve as a base group, as well as on identification with

the groups (Lickel et al. 2000; Bernardo and Palma-Oliveira 2013; Bernardo and Palma-Oliveira 2014). Group identification is defined as a psychological attachment to a group, accompanied by a sense of shared values and interests (Gurin et al. 1980; Conover 1984). Therefore, the objective of this research is to investigate how individuals perceive EP behavioral reference groups relative to GP groups. To achieve this objective, an experimental survey is conducted that investigates the perceptions households after receiving a normative feedback message.

ROLE of SOCIAL IDENTITY in GROUP IDENTIFICATION PROCESS

According to social identity theory, individuals classify themselves and others into various social categories (e.g., family, coworkers, and neighbors) in order to construct a positive self-concept (Hogg 2016; Peterson 2004). If a certain behavior is related to a social identity, the norms of the social group influence the behavior, rather than the expectations, and desires of generalized others. From a social identity perspective, identification with groups (IG) moderates the impact of group norms on group members' behaviors (White et al. 2009; Hogg 2016). This has been demonstrated across a wide array of socially significant behaviors such as healthy eating (Åstrøsm and Rise 2001), exercise (Terry and Hogg 1996) and binge-drinking (Johnston and White 2003). Additionally, current empirical and theoretical studies suggest that the similarity with group members (SGM) offers insights into the process of group identification (Zander and Natsoulas 1961; Dignan 1968). Fisher (1998) found that the similarities between fans and their favorite sport teams significantly increase the willingness of individuals to define themselves as group members. It has also been repeatedly found that these two group identity variables, IG and SGM, are influenced by group type (Lickel et al. 2000; Kiuru et al. 2009). Lickel et al. (2000) noted that individuals feel more similar to others in intimacy groups (e.g., family) than in social categories (e.g., citizens of America), task group (e.g., coworkers assigned a project) and loose associations (e.g., neighbors). Understanding how these variables function within the context of normative feedback interventions will permit the design and construction of more effective normative feedback messages. To achieve this goal, a theoretical model is proposed along the following four hypotheses for testing (Fig. 1):

- *Hypothesis 1*: Group type affects an individual's identification with the group.
- *Hypothesis 2*: Group type affects perceived similarity with group members.
- *Hypothesis 3*: Perceived similarity with group members affects an individual's identification with the group.
- *Hypothesis 4*: The effect of group type on individual's identification with the group is mediated by perceived similarity with group members.

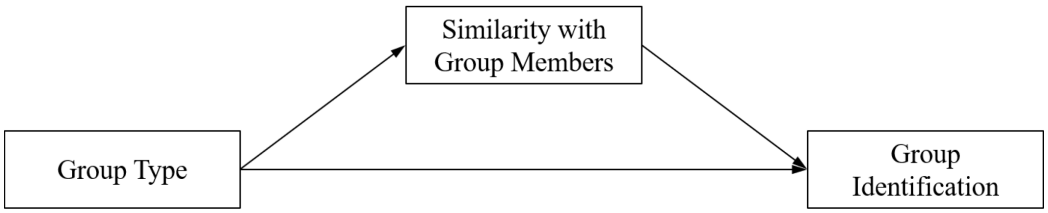


Figure 1. Theoretical model for group identification process

METHOD

Data Collection

2,008 U.S. adults were recruited via Amazon's Mechanical Turk (MTurk) in January of 2019. This study is approved by the institutional review board (IRB) of the University of Michigan. Eighty participants are excluded from the analysis for one of the following three reasons: 1) failed one of two attention checks, 2) unreasonable responses to the two open-ended questions, and/or 3) did not complete the survey, resulting in 1,928 valid observations.

Procedure and Measures

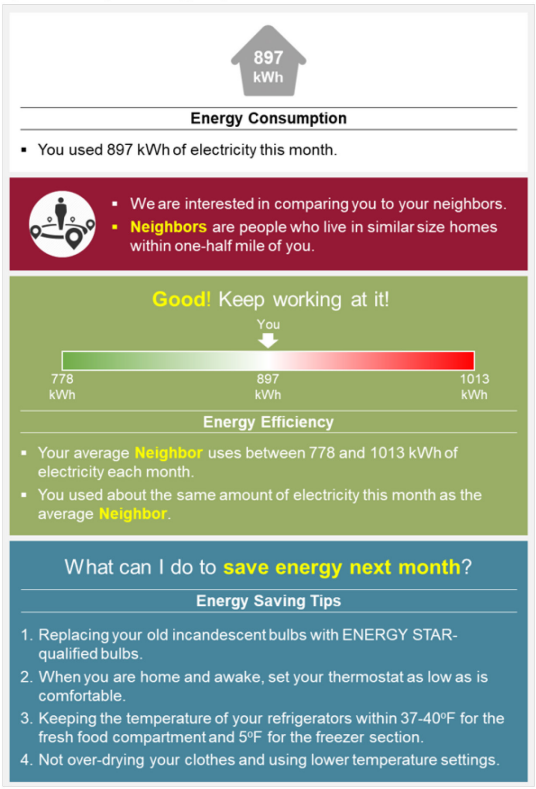
A three-step survey is used to investigate the perception of behavioral reference groups across the two group types, EP and GP.

First, participants are asked to report which state they live in and when they use six high energy-consuming items (e.g., HVAC equipment, washer and dryer, lights) in their residences. These items combined constitute approximately 70% of all household energy expenditures, thus providing a strong basis for estimating their energy use patterns (EIA 2018). Four six hour blocks were given as options as answers to these questions: morning (6 AM – 12 PM), afternoon (12 PM – 6 PM), evening (6 PM – 12 AM) and night (12 AM – 6 AM). These four blocks are used as it has been found this structure makes behavioral patterns of electricity consumers the most distinguishable (Smith et al. 2012; Kwac et al. 2014).

Second, participants are randomly assigned to either the GP or EP groups and received different normative messages depending on to which group they are assigned (Fig. 2). Both normative messages include information about participant's energy consumption (white box), description of behavioral reference groups (red box), normative feedback and injunctive norm (green box), and energy saving tips (blue box). The amount of energy shown in the white and green boxes is based on the U.S. average consumption, rather than their actual electricity use (EIA 2017). For the normative comparison, participants in the GP groups are asked to imagine that they are being compared with energy consumption of neighbors who live in similar size homes within one-half mile of them. Participants in the EP groups are also asked to imagine that they are being compared with other households who exhibit similarities in energy use behavior and have similar size homes. A cluster analysis of the members in the EP group is performed in order to assign each individual into specific representative behavioral patterns (e.g., night owls in Fig. 2-b) based on each one's self-report of energy use behavior. Individuals are assigned to one of six energy use classification groups based on typical profile patterns found in Song et al. (2019) (for complete details on the clustering procedure please see Song et al. (2019)).

Third, participants answer a series of seven-point Likert scale questions about how they perceive behavioral reference groups, listing strongly disagree (1) to strongly agree (7) (Table 1). The multi-item scales are used to demonstrate the reliability and validity of the questionnaire. The SGM scale includes four items (Fisher and Wakefield 1998) that generate a one-factor solution (all loadings > 0.861) and averaged to create a composite score ($\alpha = 0.947$). The IG scale is formulated from four items (Branscombe et al. 1993; Luhtanen and Crocker 1992) that are also loaded on one factor (all loadings > 0.817) and averaged to create a composite score ($\alpha = 0.935$).

a) Proximity-based group



b) Profile-based group

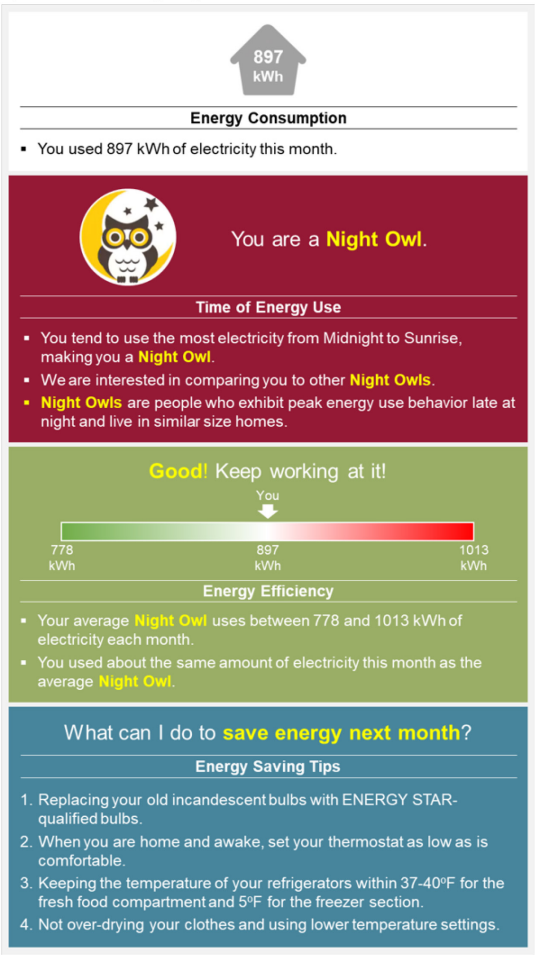


Figure 2. Normative feedback messages for proximity- and profile-based groups

Analytical Procedure

To test the proposed hypotheses, an ordinary least squares (OLS) regression is implemented in the PROCESS macro for SPSS by Hayes (2013). This is useful to not only examine the moderation or mediating effects of independent variables on the dependent variables but also to make a statistical inference about the moderated mediation effect (Hayes 2013).

Table 1. Measures, Item Loadings, and Reliability

Survey Items	Factor Loading*	Reliability (α)
Similarity with Other Households		0.947
I have a lot in common with this person	0.861	
I have attitudes that are similar to those held by this person	0.887	
This person and I are alike in a lot of ways	0.929	
I am similar to this person	0.936	

Group Identification		0.935
I identify strongly with the members of this group	0.817	
Being a member of this group is an important part of who I am	0.865	
I feel strong ties with other group members	0.943	
I feel a sense of solidarity with other group members	0.917	

* An exploratory factor analysis was conducted using principal axis factoring and oblimin rotation because it is assumed that the factors are correlated each other.

RESULTS and DISCUSSIONS

Results of Hypothesis Testing

Survey results are analyzed using OLS regression with group type coded as a dummy variable (GP = 0) (Table 2). Model 1 investigates the relations between group type and SIM. Regressing group type on SGM (Model 1) group type is found to be statistically significant so we fail to reject hypothesis 1, however, it should be noted that while statistically significant the explanatory capability of group type of SGM is limited (R^2 = 0.022, *F-statistic* = 40.226, *p*-value < 0.001). The EP groups have a higher mean value of SGM (*mean* = 4.64, *std. dev.* = 1.25) than the GP groups (*mean* = 4.26, *std. dev.* = 1.33) (Fig. 3-a).

Table 2. Effect of group type and similarity with group members on group identification

	Model			
Explanatory variable	**1[a]**	**2[b]**	**3[b]**	**4[b]**
Group type	0.375*	-0.345*		-0.611*
	(0.590)	(0.068)		(0.054)
Similarity with other households			0.674*	0.707*
			(0.021)	(0.207)
Adjusted R^2	0.022	0.013	0.344	0.385

Note: *N* = 1928. Standard error terms are in parentheses.
[a] Outcome: Similarity with other households, [b] Outcome: Group identification
* *p*-value < 0.001

To test hypothesis 2, the effect of group type on IG, Model 2 regresses group type on IG. Group type is found to have a statistically significant effect, this time on IG, so we fail to reject hypothesis 2. As with the relationship between group type and SIM, group type on IG also has limited explanatory capability (R^2 = 0.013, *F-statistic* = 25.682, *p*-value < 0.001). Energy profile-based group participants identify less with their assigned behavioral reference groups than proximity-based participants (*mean* = 3.05, *std. dev.* = 1.50 vs. *mean* = 3.40, *std. dev.* = 1.48) (Fig. 3-b).

Hypothesis 3, perceived similarity with group members affects an individual's identification with the group is tested using Model 3, regressing SGM on IG. Similarity with group members is found to have a significant effect on an individuals perceived identification with their group (R^2 = 0.344, *F-statistic* = 1011.732, *p*-value < 0.001), so

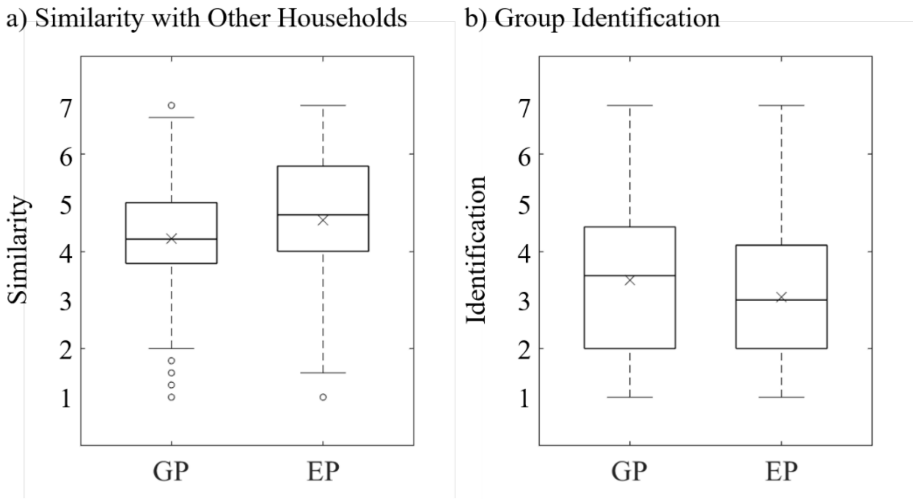


Figure 3. Similarity with other households and group identification by group type (The symbol × in boxplots indicates the sample mean)

we fail to reject hypothesis 3. Unlike the previous two results though, SGM explains a significant portion of the variance in IG. As individuals feel more similar to other group members, they identify more with their assigned groups.

To test hypothesis 4, Model 4 regresses group type and SGM on IG. Both variables have significant direct effect on IG and contribute to explaining a meaningful portion of the variance in IG (R^2 = 0.385, *F-statistic* = 301.716, *p*-value < 0.001). Considering both the effect of group type on SGM in the Model 1 and the effect of SGM on IG in the Model 4 are statistically significant, the indirect (i.e., moderating) effect via SGM is demonstrated. In addition, since the 95% confidence intervals of the indirect effect of group type on IG via SGM do not include zero, SGM significantly moderates the effect of group type on IG (b = 0.265, 95% CI = 0.182 to 0.346). Therefore, we fail to reject hypothesis 4.

Discussions

The results of this study show that individuals feel more similar to other households in their reference groups when in EP groups (i.e., more personalized groups) than they do when in GP groups. This can be expected by the fact that the occupants' behavior is based on their lifestyle rather than where they live (Santin et al. 2009). Thus, the EP groups that are created based on energy use profiles (i.e., a proxy of lifestyle) cause individuals to feel more similar to other households in their reference groups than they do when their reference group is composed of others who simply live near them.

Secondly, it was found that individuals are less likely to identify with the EP groups (i.e., more personalized groups) than with the GP groups. These results are understandable as even though the members of the GP reference group are not directly neighbors, they live in close proximity to the individual, and neighbors (i.e., GP groups) are a well-recognized social group (e.g., family and sports team) (Lickel et al. 2000; Ufkes et al. 2012). In contrast, participants are not as familiar with terminology (e.g., energy profile) and who would be in their EP reference groups. In other words, it is possible the EP groups had lower levels of IG because of the recency of being grouped

this way. Thus, it may be difficult for participants to have as much sense of belonging to the EP groups as they do with the GP group.

Although personalizing behavioral reference groups based on daily use patterns indirectly improves the IG via SGM, this indirect effect is lower than the direct effect of group type on IG (0.265 vs. -0.611). Meanwhile, these results indicate that to encourage individuals to strongly identify with the EP groups, it is necessary to consider other group identity variables in the group identification process. Given these findings, it seems evident that in order to enhance the identification of individuals more personalized behavioral reference groups (EP groups) geographic proximity to other members, or some new alternative grouping method, should be used in tandem. Additionally, while group type and SGM explain a meaningful percentage of the variance in IG (i.e., approximately 35%), clearly other important variables are yet to be identified and should be explored in future work. One possible variable to consider is group entitativity. Campbell (1958) discovered that as groups become more entitative, individuals are more likely to identify with the groups. Understanding what and how other variables influence IG will allow interveners to design more effective normative feedback messages and further reduce household energy consumption.

CONCLUSION

This study investigates the perception of behavioral reference groups in normative feedback messaging interventions. Based on social identity theory, four hypotheses of the group identification process are generated and tested. The results of hypothesis testing indicate that when compared to the geographic proximity-based reference groups, individuals feel more similar to other households in energy profile-based reference groups; however, they are less likely to identify with the energy profile-based groups.

This research contributes to the literature by investigating the current status of SGM and IG across different types of behavioral reference groups used in normative feedback interventions. Also, the positive impact of SGM on IG suggests that providing normative messages using reference groups based on higher similarities can contribute to improving the identification of members of the groups. This will enable interveners to intensify the impact of group norms on behavioral intention, thus promoting households' pro-environmental behaviors to reduce energy consumption. Future research should investigate the role of other group identity variables in the group identification process.

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