Social Influence and the Energy Transition

Leveraging social networks and norms

Philipp Tobias Schneider

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Social Influence and the Energy Transition

Leveraging social networks and norms

Sociale beïnvloeding en de energietransitie

Gebruikmaken van sociale netwerken en normen
(met een samenvatting in het Nederlands)

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Chapter 1

SYNTHESIS

1.1 Background

1.1.1 The climate problem and why social influence is important for the challenges of the Dutch government

Climate change is one of the biggest and universal challenges of our time and the 194 countries that agreed to act against anthropogenic greenhouse effects during the Paris agreement in 2015 committed themselves to stimulate pro-environmental behavior among their people (Horowitz, 2016). In order for the Netherlands to reach their goal to transition away from fossil fuels towards renewable energy sources by 2050, Dutch households have to change their energy consumption behavior and make sustainable home investments (Ministry of Economic Affairs and Climate Policy, 2020). Variations of social influence strategies are being used by local municipalities, energy companies, and housing cooperations as a policy instrument to mobilize households to make sustainable home investments and consume less energy (Beauchampet & Walsh, 2021; P. T. Schneider, van de Rijt, et al., 2023).

Social influence refers to the change in people's attitudes or behavior after observing other people's thoughts or behavior (Rashotte, 2007). Meta-analyses have shown that interventions aimed at encouraging resource conservation that were based on insights from social influence theories can be effective, with differences in effectiveness depending on the target group and the type of social influence approach (Abrahamse & Steg, 2013). Yet, long-term effects of social influence incentives and other contexts- apart from energy and waste disposal and water efficiency - remain understudied (Grilli & Curtis, 2021). Besides, social influence interventions such as social feedback have resulted in mixed results with some studies reporting effective change and others reporting small effects (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019). Furthermore, due to a publication bias, with non-significant findings not being published enough and being inadequately represented in the literature, it remains unsure when and how effective social influence incentives are (Abrahamse & Steg, 2013).

This dissertation aims at providing more answers to the question: How do households' energy conservation behavior and sustainability relation investments depend on other households' pro-environmental attitudes and behavior? We do this while taking into account the effects of individual differences as well as social norms and network structures. We specifically argue that sociological network and diffusion theories are being insufficiently applied to the social side of the energy transition. The energy transition provides a clear context where variations of social influence strategies are being applied, yet the fundamental mechanisms related to the effectiveness of social influence processes we investigate are applicable to any context where the adoption of certain behavior or attitudes is desired.

Before we go into our more specific research questions, we provide background information on the psychological mechanisms of social influence as well as the importance of social networks and social norms when studying these social processes. After this, a theoretical review of concepts that will appear in this dissertation, will clarify the societal contribution we aim at. Hereafter, we highlight the scientific challenge we address in more detail. Once this background knowledge has been established, we present the four central questions of this dissertation, the methods we used to investigate them and a table overview of how Chapters 2 through 5 try to answer these questions. We then provide short summaries of each of these chapters and wrap up this synthesis by showcasing our main conclusions and discussion points as well as limitations and ideas for future research.

1.1.2 Psychological mechanisms involved in social influence

Social influence has an exceedingly broad scope, as it can be defined as any form of intended or unintended communication that evokes changes in other people's attitudes, beliefs, motivations, intentions or behaviors, while not using force (Pratkanis, 2007). Theories about social influence processes have already been developed since 1958 when Herbert Kelman proposed three main types of social influence: compliance, identification and internalization (Kelman 1958). He differentiated between compliance referring to a group's influence through rewards or social punishments on others, identification referring to people that identify with others adopting other people's attitudes and behavior, and internalization referring to the attitudes or behavior of others actually becoming another person's own beliefs (Kelman 1958). The strength of this theory was that it recognized that there are different forms of social influence and research fields such as psychology, sociology, communication studies and economics have been broadening the scope of social influence research by investigating topics such as psychological commitment, social proof or normative influence (Gass, 2015).

In psychology, the mechanisms of cognition in our brain have been divided into two systems. *System 1* refers to our fast and effortless thinking that is often based on practical mental short cuts called heuristics and biases, and *system 2* refers to the slow deliberate rational thinking (Kahneman, 2011). As we prefer consistent thoughts to save mental capacity, and system 1 is always first to provide us with a simple way of dealing with an issue, it is up to system 2 to take the effort to rationally decide if it is fine to affirm a quick decision or seek new and missing information (Kahneman, 2011). When decisions are made in a context of intuitive and automatic behavior, people are guided more through stereotypes and prejudices than when decisions happen in a more reflective context (Tutic et al., 2023). The processing of social influence information is similarly

divided into *systematic* and *peripheral* processing with the prior referring to thoughtful and deliberate information processing and the later to more automatic and heuristic information processing (Gass, 2015). Differentiating between intuitive and reflective behavior is also called dual processing and has made substantial contributions to our understanding of our social behaviors (Miles et al., 2023). In the empirical chapters of this dissertation, we will investigate both the systematic and peripheral processing of social influence processes. In Chapter 2, we specifically look at systematic and rational choices of individuals deliberately using the information of their social network to make sustainable investment decisions. Furthermore, in Chapter 5, we design a field experiment to investigate if social influence mechanisms that are found to be effective for encouraging simple and fast decisions are also effective for stimulating more costly investments.

A lot of social influence is said to take place via peripheral processing and within the field of psychology. Here, Robert Cialdini has been the pioneer in researching principles of influence (Gass, 2015). Cialdini (2001) identified the following six universal principles of persuasion: *consistency*, public commitments can result people to be easily influenced into related behaviors; *liking*, we comply more with requests by people we like; *authority*, people in positions of power are more influential than those who are not; *social proof*, people often rely on others' behaviors as a guide for their own behaviors; *scarcity*, things that are perceived as scarce are seen as more valuable; and finally *reciprocity* which refers to the desire to return a favor even when a favor or gift was not requested.

These persuasion tactics utilize people's overload of information in daily life, by addressing the heuristics that people use to make consumption choices. Providing *social proof*, for example, can aid consumers to make a quick decision, as they can feel safer to make a choice when others had already made the same decision as them previously (Cialdini, 2001). Chapter 5 specifically tests the effectiveness of social proof within a costly decision process. People rely on social influence especially in situations with uncertainty, where people base their choices on previous behaviors of others (Bikhchandandi et al., 1992).

The energy transition is a context where people have to make many uncertain decisions, and we will elaborate on concrete examples of how social influence plays an important role for uncertain investment decisions and resource conservation in the empirical Chapters of this dissertation. Before we do this, we will highlight the importance of social networks in this process first.

1.1.3 The importance of networks for social influence

Social influence occurs in all aspects of daily life and often occurs unintended (Gass, 2015). Social networks of people such as neighbors within a neighborhood can influence each other with regard to their sustainable behaviors and investments unintendedly.

However, social networks can also be utilized by policymakers to deliberately initiate and catalyze behaviors (Abrahamse & Steg, 2013). Resource conservation in the form of lower energy usage can, for example, be stimulated among neighbors by providing social comparisons on energy usage (Abrahamse & Steg, 2013; Schneider et al., 2023). In Chapter 3 we study such a relationship between local volunteers providing social comparisons of energy consumption while helping residents to save energy.

A social network consists of people that interact with each other, and one can distinguish two forms of connections within such a social network: *weak* and *strong* ties (Granovetter, 1973). Strong ties refer to people that know each other closely and whose opinions are seen as credible, whereas weak ties are characterized by people that barely know each other. Granovetter (1973) showed that it is important to investigate all forms of social connections among communities. As not only strong ties are influential for the spread of information and behavior in a social network but also weak ties are crucial for a broader spread of behavior and information beyond closely knitted communities of people (Granovetter, 1973). Furthermore, social networks within neighborhoods play a central role for the spread of information at a global level as local clusters of certain decisions can actually lead to global polarization as Axelrod (1997) illustrated in his famous model of the dissemination of culture.

The architecture of social networks can also affect the spread of information, as more centralized network structures or networks with more connections among members can lead to a quicker spread and higher adoption rates of innovations, information and behavior (Buskens, 2002; Buskens & Yamaguchi, 1999; Flache et al., 2017; Friedkin, 2001; Granovetter, 1978; Uzzi et al., 1993). Granovetter (1973) illustrated that there is a difference in who is spreading information among a social network by making the differentiation between weak and strong ties spreading the information. A similar differentiation was made about what information or behavior is being spread in a social network. Centola and Macy (2007) distinguished between information or behaviors that only need one arbitrary contact to transfer information for it to be credible, which they called a *simple contagion*, and information or behavior that require several credible contacts to back up the information before it is being adopted, called a *complex contagion*. This difference between simple and complex contagion can be compared to the idea of weak and strong ties as weak ties seem to be sufficient for the spread of simple contagion and strong ties seem to be essential for the spread of complex contagions.

Social networks play a crucial role within the context of the energy transition as there are simple steps and investments that residents can take, but also complex and costly investments that will require social verification. It is important to investigate which social influence processes are effective for each type of investment decision and

how social networks facilitate the diffusion of such investment decisions. The transition from using gas for cooking and heating towards green electricity can only be successful if we find a way to mobilize everyone to participate (Ministry of Economic Affairs and Climate Policy, 2020). Stimulating homogenous adoption of new and more efficient technologies will therefore remain one of the most pressing challenges of our time. In Chapter 2, we therefore further investigate the importance of social networks for the spread of information and investment decisions. We specifically address a problem of clustered groups within a social network who influence themselves in a counterproductive way. Chapter 5 will showcase why it is important to distinguish between simple and costly investment decisions when utilizing social influence mechanisms.

1.1.4 Types of social norms and their importance for social influence

Cooperation is essential to reach ambitious goals where many people have to work together such as in the energy transition. In order to understand cooperation, social norms have become one of the most interdisciplinary researched topics (Bicchieri, 2006; Cialdini & Jacobson, 2021; Elster, 1989; Przepiorka et al., 2022). Social norms are the unwritten rules of social life, they are the rules that guide our expectations and behavior in social situations (Przepiorka et al. 2022). When people have to choose between their own interest and the interest of the public good, also called a social dilemma, social norms are often seen as one of the few solutions to stimulate people to behave pro-socially (Przepiorka et al. 2022).

When one aims to influence attitudes and behavior of people, then there are two specific types of norms that are of interest, they are called *injunctive* and *descriptive* norms. Injunctive norms can be described as the information that is shared among people about what most people within a group see as what ought to be done in a certain situation and what not ought to be done, and descriptive norms refer to what most other people actually do (Cialdini et al., 1990). Due to the difference in what these two norms communicate, their effects on behavior are also different. Under the right conditions, injunctive norms have been shown to stimulate the increase of behavior that is desired by the group and descriptive norms have been shown to lead people to adopt the average attitudes and behavior of a group (Cialdini et al., 1991). As described above for the differences in effects within social networks depending on if a decision is simple or complex, there are different situations where it is effective to communicate with injunctive or descriptive norms.

There are individual differences in how much people compare themselves with others and how susceptible they are for social influence when they hear about the social

norms of their group (Bearden & Rose, 1990). This character trait is also referred to as social comparison orientation (SCO), which is related to higher levels of empathy and lower self-esteem (Buunk & Gibbons, 2007). As for any transition, it will be important for the energy transition to identify the people that will be susceptible to being influenced to change. While taking personal differences in levels of SCO into account and differentiating between injunctive and descriptive norms we go into more depth about the role that social norms play for social influence in Chapter 4.

1.1.5 Societal context and contributions

The energy transition will require millions of households to insulate and invest in their homes in order for them to be able to switch to sustainable energy alternatives. The current energy transition is however not a new phenomenon. The Netherlands has transitioned from using coal as a primary energy source for heating to using gas, after finding large amounts of natural gas in the north of the Netherlands in the 1950's (Kemp, 2010). The rise of nuclear power at that time led the Dutch government to expect very cheap energy prices in the time ahead, and, in order to still profit from the just found resources, the Netherlands advocated a quick and successful government-induced transition (Kemp, 2010). This past success story of an energy transition is however not comparable to the challenges of today. In the 1950s, Dutch houses were uncomfortable, lacked insulation and were poorly heated, in comparison to international standards (Kemp, 2010). The government had a very clear incentive and homeowners were eager to make investments as they wanted the comfort of central heating and warm water for showers and baths (Kemp, 2010). The current energy transition in the Netherlands from the use of gas for cooking and heating towards the use of sustainable electricity is more difficult. There is a large consensus that climate change is real and that it is human induced and should be dealt with collectively (Steg, 2018). Yet even though gas prices have been increasing after the start of the Ukraine war, there are many uncertainties residents face with regards to which innovative sustainable home-improvements should be made, how financially viable they are, how much inconvenience their implementation brings and how environmentally friendly they really are. We believe more attention and research should be directed towards the social side of this energy transition to understand how to stimulate residents to make sustainable investments. One of the most recent IPCC reports is the first to include a chapter dedicated to the social side of climate mitigation (IPCC, 2022). It is the first to go into more depth on how to reduce people's demand for energy and consumption, while highlighting the unequal demand and consumption that cause climate change (IPCC, 2022). The expertise from fields such as sociology and psychology

will therefore be essential for understanding how people deal with the upcoming societal and environmental challenges. We combine these fields to address the societal challenge of understanding how to stimulate resource conservation and encourage the adoption and spread of the innovations needed for the technical side of the energy transition. We do this by utilizing social influence processes in depth and in different contexts.

Utilizing social influence processes to stimulate desired attitudes, behavior and cooperation within groups is, however, not limited to the energy transition, and the mechanisms that we study within the context of the energy transition are applicable to other societal challenges as well. Our research is part of the broader SCOOP research program 'Sustainable Cooperation: Roadmaps to a Resilient Society'. SCOOP is a research and training center dedicated to the interdisciplinary study of sustainable cooperation as a key feature of resilient societies (SCOOP, 2019). Our research project is interdisciplinary, combining theories of social influence from psychology (Abrahamse & Steg, 2013), with network theories and diffusion processes from sociology (Centola & Macy, 2007; Granovetter, 1973). As part of the SCOOP program, our studies have been described as an application of social influence and network theories to change individuals' behavior and facilitate sustainable cooperation such that all individuals in a social network contribute towards environmental goals (SCOOP, 2017).

One goal of the SCOOP approach is to develop theory that helps to deal with threats to the cooperation of society in order for the societies to be more resilient (SCOOP, 2019). One of our research papers aims specifically at dealing with the threat of polarization within a society. In Chapter 2 we highlight the problem of local clusters of people within a network forming a so-called local majority. Within a sparsely connected network, a minority of people can perceive themselves as a majority just because they are mainly connected to other people with the same deviant opinions. We propose variations of communication such that these "outsiders" still can be reached by the majority opinions. In Chapter 2, we discuss in more detail how we expected this to be a first step towards making a society more resilient to polarization, and provide other suggestions to deal with the problem of local majorities and ideas for future research. Another aim of the SCOOP approach is to address spillover effects, namely that policy approaches can have wanted as well as unwanted side effects that should be addressed and avoided when possible (SCOOP, 2019). In Chapter 3 we specifically highlight the problem of a unwanted spillover effect when home owners' energy consumption is compared to an average consumption score. We show that when people are made aware that they have been behaving above average in favor of the environment, their efforts to conserve energy can decrease.

As mentioned above, we do not only investigate when social influence processes can be used to stimulate resource conservation, but also aim at encouraging the adoption

and spread of the innovations needed for the technical side of the energy transition. The societal relevance of this thesis also stems from the connection of the project with the ENRGISED project 'Engaging Residents in green energy investments through social networks, complexity and design'(ENRGISED, 2023). ENRGISED has been a collaboration of researchers in the Netherlands studying the social side of the energy transition within neighborhoods by focusing on social influence and the effect of social networks (ENRGISED, 2023). Within this team of researchers, we have focused on identifying and activating people within a network that can start spreading a certain pro-environmental behavior and accelerate the spread of it. The ENRGISED research findings have been combined in a workbook that is being implemented by Dutch municipalities, for example to increase the uptake of subsidies for insolating their homes (ENRGISED, 2023).

The project has also been linked to the Fair Energy Consortium that aims at understanding and conceptualizing a fair and just energy transition. To ensure everyone is willing to participate in the energy transition, understanding citizens' fairness perceptions is vital. The social science research on a fair energy transition has focused on what degree people consider a certain distributive, procedural, or recognitive justice element fair (Bal et al., 2023). Not enough attention has been given to the principles of justice people use when coming to a fairness judgment within the specific context of the energy transition (Bal et al., 2023). This project contributed by investigating the principles for people's sense of justice, suggesting that interdependent decision experiments can be a way of measuring fairness principles for the specific context of the energy transition (Bal et al., 2023).

1.1.6 The scientific challenge

The energy transition has provided specific societal challenges in which social norms and social influence play an important role. Many approaches and methods to encourage pro-environmental behavior, such as education and awareness, outreach and relationship building, and nudges, as well as social influence have been tested (Grilli & Curtis, 2021). Social influence interventions such as social feedback have led to mixed results with some studies promoting their effectiveness and others stating that they are ineffective (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019). This uncertainty stems from past studies prioritizing whether social influence interventions are effective and not inspecting sufficiently how the underlying mechanisms and contextual factors such as the specific norms, the type of comparisons made and network structures shaped the findings (Spandagos et al., 2021). Specifically with regards to the effectiveness of social influence in stimulating pro-environmental attitudes and behaviors, we believe several research questions that address such underlying mechanism remain unanswered.

Social influence mechanisms occur within social networks. When one aims at using social networks to initiate transitions, it is therefore important to understand the social processes underlying the diffusion of attitudes and behaviors. The social network literature has established findings that the way how people are connected with each other within a social network is influential on the diffusion of information and behaviors (Flache et al., 2017; Friedkin, 2001; Granovetter, 1973, 1978; Uzzi et al., 1993). Yet, the social network literature has, in our opinion, not adequately addressed one fundamental difference of what information or behavior is being spread in a social network: something discrete or something continuous. Social influence processes can influence individuals through either yes or no decisions or provide more gradual steps towards a certain option. Threshold models explain a phenomenon where a certain number of people within a group are needed before others join a certain behavior (Granovetter, 1978). This observation of people going from not adopting a behavior to adopting the behavior when a certain amount of others do so, is different to so called models of opinion updating where people within a group have been shown to spread information much more gradually (Friedkin, 2001). These are two separate modeling approaches leading to different results but these approaches have not been systematically compared and we think the key difference is the continuity of the behavior. We believe this difference is overlooked, even though it could be important for addressing the problem of so-called local majorities: a group of connected people in a network with a similar opinion, whose opinion is in the majority in their part of the network, but not in the network as a whole. Within a social network such a group of connected people are less likely to be influenced towards the actual majority opinion. We build upon the findings by Axelrod (1997) that local merging of opinions can lead to global polarization, to show that local clusters of people with a deviant opinion can remain resistant to outside information and stagnate.

How social influence processes can reach those local majorities is a scientific challenge we aim to address. We question to what degree the effectiveness of social influence processes spreading information depends on the type of behavior or attitude that is spreading. More specifically, we investigate if it matters if the type of investment decision is gradual or discrete for a majority opinion and behavior to be adopted by everyone within a social network. Highlighting the problem of local majorities and showcasing fundamental differences between what we call continuous (gradual) and binary (discrete) investment decisions could aid policy makers immensely in deciding how to reach and influence everyone within a community to transition towards desired behaviors.

Beside social network structures, other factors such as individual differences also impact to what degree contacts within a network influence each other's attitudes and

sustainable behaviors. People differ in the degree to which they feel connected to their social surrounding and the degree to which they compare themselves with others, the so-called social comparison orientation mentioned above (Buunk & Gibbons, 2007). People's opinions and behavior have been shown to be influenced by the social rules of our society also called social norms (Bicchieri, 2006; Cialdini & Jacobson, 2021; Elster, 1989; Przepiorka et al., 2022). There are two different types of norms that influence people's attitudes and behaviors, they are called injunctive and descriptive norms, the prior refers to what ought to be done and the later refers to what a number of other people actually do (Cialdini et al., 1990). It has remained a challenge to discover what kind of people follow what kind of norms. We investigate if those who compare themselves more with others and those who are more connected to others do more what ought to be done or follow what most others do.

Not enough research has investigated if established findings translate from low-cost contexts to high-cost contexts, with the risk of policy makers and marketeers overestimating certain research findings. For example, the social influence mechanisms that were found effective when using social proof to increase towel re-use in hotels should be tested in other contexts before being applied to high-cost situations (Goldstein et al., 2007). The low-cost hypothesis suggests that the relationship between environmental concern and pro-environmental behavior decreases with an increase in costs (Diekmann & Preisendörfer, 2003). It seems therefore vital to test if popular social influence mechanisms such as the principles of persuasion from Robert Cialdini remain effective in more costly contexts. In the general methods section, we elaborate why it is especially necessary to highlight the use of social influence mechanisms that might not be effective given a publication bias towards significant findings in scientific journals.

Due to the urgency of the energy transition many new forms of stimulating households to conserve more energy are being implemented. For example, some municipalities and housing cooperations are training volunteers to share their expertise about saving energy, they also give out energy saving gadgets and inform residents on how they compare with regards to energy efficiency (!WOON, 2021). While such initiatives are recommendable due to their use of existing local networks, their newness also brings some uncertainty. When do social comparisons of energy usage result in the wanted resource conservation and when should policy makers be aware of unwanted spillover effects? The so-called boomerang effect for example, suggests that informing individuals that they were doing better and consuming less energy than average results in an undesirable increase in energy consumption as these individuals can then stop their efforts and adapt back to the standard (Rasul and Hollywood, 2012; Schultz et al. 2007, 2018).

We summarize the scientific and societal challenges that we have focused on in this dissertation into four central questions. We aim to contribute to the social influence literature by leveraging social norms and social networks towards a sustainable energy transition.

1.1.7 Four central research questions

Our studies are relevant and applied to the specific context of the energy transition that requires the urgent collaboration and adoption of sustainable behaviors as soon as possible. We elaborate how each of our more fundamental research questions relates to this context with the fourth and last question. We start with presenting the three fundamental research questions that examine when social influence processes impact attitudes and behavior within a social network. After clarifying the different methods we used to answer these questions and providing individual summaries of our empirical chapters, we illustrate how each of our chapters and their belonging sub-questions are connected in Table 1.1 below.

1. To what degree does the effectiveness of social influence processes spreading information depend on social comparison orientation and the type of behavior or attitude that is spreading?
2. How do contacts within a social network influence each other's attitudes and sustainable behaviors?
3. When can social influence processes be less effective and when can unwanted side effects of social influence be expected?
4. What do the answers on the first three questions imply for social influence processes related to the energy transition?

This dissertation combines multiple methods: lab experiments, analyses of surveys and field experiments. Each of these methods has its advantages and disadvantages. Below we discuss the advantages and disadvantages of each of the methods and how combining more of these methods can be beneficial.

1.2 Methods

Social science research has largely relied on less intrusive research methods such as observations, surveys and interviews (Jackson & Cox, 2013). Experimental methods that have been established in the natural sciences are however increasingly seen as the best approach to answering questions of causal relationships (Jackson & Cox, 2013). The design of experimental methods such as lab experiments and field experiments is

more challenging in the social sciences due to human interventions and questions related to the ethics of conducting experiments on people. However, we believe that for the specific aim of encouraging pro-environmental behavior a combination of observational methods and experimental methods would lead to the best possible understanding of the relevant scientific mechanisms. In our research, we separately conduct lab experiments, field experiments and analyze surveys in combination with energy use data. Ideally, future research will be able to build upon our findings and combine these complementary research methods for longitudinal research. We now go over the strengths and weaknesses of the research methods we use.

1.2.1 Lab experiments network structures and investment decisions

Our first central question of this dissertation that aims to dissect the effectiveness social influence processes for different types of attitudes and behaviors requires a strict research method that allows a causal test. A lab experiment lets us strip away irrelevant contextual factors that can influence people's decision making. Overall, our research benefits greatly from its applicability and focus on the energy transition. However, when we aim at deciphering very specific decision behavior, we have to be sure that no other context related elements influence our findings. Even though experimenters can opt to include cover stories to make experiments more similar to real life, most laboratory settings are abstract. Their lack of context can be their strength as well as their weakness. For example, we would not want pro-environmental attitudes to influence certain investment decisions when we systematically compare the effectiveness of a discrete modeling approach (Granovetter, 1978), with a more continuous modeling approach (Friedkin, 2001). As any other contextual factors would limit our ability to make a causal claim about the importance of the type of decision that is being made in reaching homogenous adoption of a appropriate investment decision among a social network. Furthermore, by being able to randomly allocate participants into different experimental groups we are able to ensure that no individual differences influence the decision making as well. Only in a lab experiment can we create variations of social networks by connecting computers in such a way that limits our participants to only seeing the behavior of others we want them to see.

A fictive collaboration within an artificial setting can however only partially replicate large real world social networks and its diverse social connections. Lab experiments therefore also have their disadvantages. They require people to come to a specific location and commit their time to exclusively participate in an experiment. The people who show up for such an experiment get incentivized to participate with

money or do so for the good of science. Both of these reasons lead to a select group of participants. Furthermore people participating in a lab experiment know that they are being observed, which might lead them to act and behave in a more prosocial and socially accepted way (Zizzo, 2010). Another often discussed limitation is that lab experiments are time restricted and only run for a couple of hours (Otten, 2023). This skepticism towards the realness and ability of such fast behavior decisions being able to represent the actual deliberation of more complex and time-consuming decisions and investments is reasonable. However, only a lab experiment allows researchers to replicate a certain part of a decision process that normally takes weeks, months or even years and then have a group of real people make difficult decisions at that time. This is an important feat of lab experiments for our second Chapter, as it allows us to make predictions about the effectiveness of certain decision processes without long waiting times.

1.2.2 Surveys and energy use data

One can argue that observational research methods such as surveys are limited to their use for highlighting relationships and associations (Jackson & Cox, 2013). Observational methods are often restricted from making causal claims because of two issues, first reverse causality and second because of contextual confounding. For example, observational findings might suggest that houses using a lot of energy tend to get solar panels and that these solar panels cause lower energy use. But what if it is the other way around? What if people with high energy bills get solar panels to save money, not because the panels help them to use less energy? This mix-up is called reverse causality – getting things in the wrong order when figuring out what causes what. It might seem like solar panels lead to lower energy use, but in reality, it could be that high-energy users get solar panels to cut costs. Contextual confounding would then refer to the situation where the houses that use a lot of energy are in sunny places where people need more energy for things like air conditioning. Other factors, like the sunny weather, get mixed up with the effects of solar panels. It becomes tricky to figure out what is really causing the change in energy use.

Lab experiments have the advantage that the time and order of events is clear, and due to random allocation of participants confounding factors and alternative causal orders can be excluded. However, survey research has also many benefits. First of all, survey research is able to access large numbers of participants, as it does not require participants to be physically or simultaneously active. Nor do surveys require experimenters observing the behavior of the participants. Especially online surveys have numerous advantages, such as being inexpensive, quicker than traditional mail and being globally accessible all the time (Tuten et al., 2002). We combine survey data with actual

behavior, by analyzing both the responses to a survey that was distributed in the German speaking part of Switzerland in 2016 and the actual electricity consumption of these households. Combining these two forms of data allows us to analyze how people that say that they compare themselves a lot with others and feel connected to others use electricity.

Reviews of methods to encourage pro-environmental behaviors have rightfully criticized that not enough research is done to investigate whether behavior change approaches are successful over extended periods of time (Grilli & Curtis, 2021). Surveys such as the European Social Survey provide extensive experiences in studying long-term trends of climate views, attitudes towards renewable energy and behavioral intentions (Marquart-Pyatt et al., 2019). Longitudinal surveys could therefore be a very applicable for studying whether pro-environmental behavior change approaches are successful over extended periods of time.

Even though one could argue that surveys might be perceived as more anonymous due to being less intrusive as they can be filled in at people's own time and comfort, they also have to deal with socially desirable responding (Tuten et al., 2002). There can be an observer bias like for example the so-called Hawthorne effect, where people act in a socially desirable way when they are aware of their answers or behavior being observed (Adair, 1984). Nevertheless, it seems logical that one of the best ways to investigate people's attitudes is to ask peoples actual thoughts and view actual behavior in a real context in which they are not aware of potential research going on. Our last research method, field experiments, is another way for researchers to circumvent that participants are aware of being observed.

1.2.3 Field experiments

Much of the research that studies social influence processes within the context of pro-environmental behavior is based on field experiments which has clear advantages with regard to the applicability and how realistic and interpretable the results of this research are for policy makers (Abrahamse & Steg, 2013). Various behavior change approaches have been tested using field experiments, showing interventions to be effective in encouraging pro-environmental behaviors (Grilli & Curtis, 2021). This contextual relevance and external validity is especially important for our fifth Chapter. Given that we want to examine if social influence mechanisms such as social proof are effective in a more complex and costly decision scenario, we gain credibility by testing an actual behavior in the real world. However, when research aims at being realistic it becomes very difficult to study very expensive investment decisions using field experiments. For

example, one can imagine that it is more difficult to test if social proof mechanisms are capable of encouraging multi-thousand euros sustainable home investments than testing what kind of pro-environmental or normative information convinces hotel guests to reuse their towel (Goldstein et al., 2007). Certain individual investment decisions are more costly than others and the big businesses such as banks that facilitate such costly investments are very careful to allow independent others to conduct research on the social influence processes they use. Furthermore, certain pro-environmental investment decisions such as the investment in a new electric heating system remain too rare to be studied at scale at the moment. Lab experiments and surveys allow us to study specific attitudes and investment behavior before they are happening in the specific contexts. It is significantly harder to keep environmental factors stable in field experiments. Similarly, it is ethically very difficult to manipulate people in important real-life situations.

To address the individual issues of each research method we prefer a combination of methods for conducting pro-environmental research. Testing related hypotheses using different research methods provides potentially more convincing support for the findings, because the different methods have other weaknesses and strengths. We also envision studying social influence mechanisms in different contexts to get robust evidence before generalizing and applying mechanisms to different contexts. Although we take into account the context of decision situations to some extent in this thesis, it is important to investigate if our findings translate to other contexts. For example, low-cost and high-cost pro-environmental investments might need different approaches of social influence.

Furthermore our studies' reliability would benefit from replications, which is why we make our own code and own data available. Research findings gain credibility by being replicated. Future research should not be discouraged by non-significant results. There is a publication bias within the scientific world that should be addressed by journals and the scientific community at large (Franco et al., 2014). Social sciences studies that find significant results are much more likely to be published in scientific journals (Franco et al., 2014). This can become a problem when it prevents policy makers and marketeers accesses to an objective overview of research findings in a certain field. Certain findings can then be overestimated.

1.3 Chapter summaries

We now summarize the four main chapters of this dissertation. In Chapter 2 we test if continuous investment decisions are more effective in spreading a correct investment choice than binary decisions. We do this using a lab experiment. In Chapter 3 we take an in-depth look at trained volunteers that help other residents to safe energy. These

volunteers are called energy coaches and we use energy consumption data to investigate if they are effective in encouraging the decrease of energy use among the residents they visited. For Chapter 4, we combine and analyze existing survey and energy data to see if people who compare themselves more with others and those who feel more socially connected to others have different pro-environmental attitudes and behaviors. Finally, Chapter 5 includes our field experiment in which we test if a banks' marketing strategy of utilizing social proof is effective in attracting people to search further information for larger home improvements. The principle of social proof has established itself as reliable, yet research that tests it in more costly and complex decisions had been lacking. Table 1.1 at the end of these chapter summaries provides an overview of our central research questions, the methods we used and our context-specific applied research questions.

The chapters were written as articles for interdisciplinary journals and can be read independently form each other and in any order. Since all chapters address scientific problems related to social influence, social norms and use the context of the energy transition, some overlap between chapters is unavoidable.

1.3.1 Chapter 2. The diffusion of binary versus continuous behavior on social networks

We offer a first theoretical and empirical analysis of whether the decision being made is continuous or binary affects the likelihood of everyone within a social network coming to a correct final investment decision. Binary decisions are decisions that people can either do or not do such as purchasing green energy or a new heating system. Continuous investment decisions are more gradual such as investments in insolation or turning down a thermostat. Within the network literature there are binary diffusion models and continuous models of opinion updating. Threshold models have illustrated that sometimes a discrete number of people within a group are needed before others join a certain behavior (Granovetter, 1978) whereas models of opinion updating have been shown that information can spread much more gradually (Friedkin, 2001). We created a model that compares binary and continuous decision-making systematically. We run simulations on social networks that vary in density and clustering, to examine if the degree to which an investment decision spreads among a network group depends on the continuity of the behavior.

We then create an investment game in which we are able to compare these two types of investment behaviors within a laboratory experiment. 222 participants in groups of 6 played our game in several different variations of networks. The networks varied in how many ties there were and the extent of clustering in the network. We identified a specific problem of information getting stuck within a social network, when people are clustered

together and only have access to the decisions of a few people around them. We call these small groups of people within a social network that are mainly connected to themselves a local majority. As these participants are mainly connected to people with similar opinions as themselves, they can perceive their own views as a majority even though they are a minority. When these clustered participants receive misguided information they get stuck in their views and investment decisions hindering the convergence towards an optimal investment behavior of everyone within the social network. We predicted that gradual investments that can be taken step by step would reach the local majorities and allow everyone within these social networks to make the correct investment decisions. However, we do not observe a difference in the amount of correct investment decisions made whether a decision process is binary or continuous. Making investment decisions continuous will not result in greater homogenous adoption among a social network. The problem of the local majorities remains. In order to utilize social diffusion processes that reach everyone, policy makers will have to investigate different options. Even though it is difficult, policy makers might have to focus on increasing the number of social connections of people at the end of a network.

1.3.2 Chapter 3. Are visits of Dutch energy coach volunteers associated with a reduction in gas and electricity consumption?

Energy coaches in the Netherlands are volunteers that want to help other residents improve the energy efficiency of their homes and save energy and money. They offer advice on sustainability investments and subsidies in a less formal and more approachable way than professionals that need to make money. Energy coaches can offer a resident an analysis of their home and compare their consumption with similar others to advise them on how to make their home more energy efficient. Comparing residents' energy consumption with a comparable average score has however been associated with unwanted side effects. The so-called boomerang effect shows that individuals consuming less energy than average can start to increase their energy consumption again after hearing that they have been doing better than the standard (Rasul and Hollywood, 2012; Schultz et al. 2007, 2018). It therefore seems vital to not only examine if new policy approaches such as the energy coaches are associated with an energy reduction among residents, but also for whom the social influence mechanisms they utilize lead to the desired outcome.

In collaboration with the independent non-profit housing cooperation !WOON, we were able to compare the energy consumption of 248 households before and as well as a year after the visit of an energy coach. We found that a visit of an energy coach was associated with a reduction in energy consumption. The reduction in gas and electricity

consumption by 8.4% and 6.3% respectively is better than the energy consumption trends of Dutch households in the same years from 2018 to 2019 that increased in gas consumption by 2.4%, and decreased in electricity consumption by 2.5%. Even though it has to be assumed that the residents who signed up for an energy coach were already intrinsically motivated to reduce their energy consumption, our results remain encouraging for the energy coach approach. A deeper analysis into the social comparison information that the energy coaches provided revealed the importance of social influence mechanisms within the energy transition. Informing residents that they were using more energy than others was associated with a decrease in energy consumption. Yet, informing those who consumed less energy than average was associated with an undesirable increase in energy consumption. Our results therefore suggest that the visit of an energy coach was associated with a reduction in energy consumption, but only for those who were told by the energy coach that they were consuming more energy than comparable others. We can only speculate that those hearing that they are consuming less energy than comparable others lose their incentive to limit their energy consumption. It is certainly important for future policy advisors to choose wisely what social comparison information they provide their residents with.

1.3.3 Chapter 4. How do social comparison orientation and social connectedness relate to social norms on electricity consumption and environmental concern

Social norms are the unwritten rules of our society. There are two types of social norms that influence people: injunctive and descriptive norms (Cialdini et al., 1990). Injunctive norms refer to the expectations of people about what ought to be done in a certain situation and descriptive norms refer to what other people are actually doing. Both norms can influence people to behave pro-environmentally. The relationship between social norms and sustainable attitudes and behaviors has been studied extensively, yet, the moderators that influence the strength of the effects of injunctive and descriptive social norms on pro-environmental behavior remain understudied (Saracevic & Schlegelmilch, 2021). These moderators can help clarifying unexplained variations as to why certain individuals opt for altruistic, environmentally friendly actions while others lean towards more self-interested behaviors (Chuang et al., 2016).

We investigated if people who feel more socially connected to the people in their surroundings and those who compare themselves more with others follow injunctive and descriptive norms with regards to pro-environmental attitudes and electricity consumption. We analyzed electricity consumption data and answers to a survey of 1050 participants in the German speaking part of Switzerland. The survey included

questions about social connectedness, social comparison orientation and environmental concern. With regards to attitudes, we observe that higher levels of social comparison orientation are positively associated with levels of environmental concern and that those with higher levels of social comparison orientation have environmental concern levels more similar to people with comparable household sizes and house sizes. Similarly, higher feelings of local social connectedness are positively associated with levels of environmental concern. We do not observe an association between descriptive norms of environmental concern for higher levels of social connectedness. We do not observe the expected association between social comparison orientation nor social connectedness and electricity consumption. This implies that social norms have a stronger impact on shaping less costly attitudes as opposed to more costly actions. When it comes to actually changing behavior, it appears that relying solely on norms may not be a sufficiently motivating factor.

1.3.5 Chapter 5. Social proof is ineffective at spurring costly pro-environmental household investments

In the last chapter, we investigate if findings of the effectiveness of a social influence mechanism in one context can be translated to another context. One of the most popular marketing and persuasion techniques is social proof (Fenko et al., 2017). It takes advantage of the fact that people are more likely to behave a certain way when a certain amount of others before them have done so already (Cialdini, 2001). Social proof has been shown to be an effective tool in encouraging smaller pro-environmental behaviors such as getting hotel guest to reuse their towels (Goldstein et al., 2007). We question if such persuasion techniques also work well for costly, uncertain investments. Within the social network literature, a clear distinction is made between simple and complex adoption processes. The prior referring to behaviors that easily spread from one person to another whereas the latter requires several credible sources before that sort of behavior is adopted (Centola & Macy, 2007). We argue that people might be easily swayed by social proof information for small expenses, but for big investments, they could be more careful.

We conducted two field experiments to explore the impact of social proof on customer reactions to calls for action on a bank's sustainable home improvement website. We differentiate between two types of online social proof information, a personalized testimonial text of a past customer and a similar text that conveyed that many people had previously utilized the bank's sustainable home improvement services. We collaborated with one of the biggest banks of the Netherlands to create websites that

apart from our manipulations were identical. These websites promoted sustainable home improvement services and the banks services to get solar panels respectively. They could be accessed by their customers through a link that was shared in the banks' newsletter that is sent to half a million customers. The two field experiments that we conducted suggest that social proof does not effectively increase the number of clients considering larger pro-environmental household investments. Given the popularity of social proof as a persuasion technique, our results are an important contribution to the literature and marketeers. They show that that social influence techniques such as social proof should be investigated in different contexts, before being implemented for encouraging action towards making a more complex decision.

1.4 Overview of the contribution of each Chapter

Table 1.1 below provides the overview of the chapters in the order they were written. The central questions 1-3 are the theoretical questions of this dissertation. The fourth central question of this dissertation applies our research towards the specific context of the energy transition.

Table 1.1. Overview of the contribution of each chapter

Theoretical research questions 1-3	**Chapter**	**Sub-questions to answer the more applied research question** 4. What do the answers on the first three questions imply for social influence processes related to the energy transition?	Methods
1. To what degree does the effectiveness of social influence processes spreading information depend on social comparison orientation and the type of behavior or attitude that is spreading?	**2 and 4**	Does it matter whether the type of decision is binary or continuous for the spread of information among a social network?	Lab experiment
		Are those who compare themselves more with others and those who feel more connected to the people around them more susceptible to adapting to what others do or what a group should be doing?	Survey data and household energy data
2. How do contacts within a social network influence each other's attitudes and sustainable behaviors?	**2, 3 and 4**	When can minorities view themselves as a majority and only consider the views of local others?	Lab experiment
		Are energy comparisons and saving advices from volunteers associated with residents' energy consumption?	Data from energy coaches
3. When can social influence processes be less effective and when can unwanted side effects of social influence be expected?	**3 and 5**	When is social influence information counterproductive?	Data from energy coaches
		Are social influence techniques like social proof still effective when the decision situation becomes more costly?	Field experiment

1.5 Conclusion and discussion

1.5.1 General conclusions

In this thesis, we have contributed to the knowledge about mechanisms behind social influence processes and obtained concrete insights into some applications toward the energy transition. Social influence remains an important part in any transition, as no government has enough resources to individually convince and subsidize all its residents to act and contribute sufficiently. Within the energy transition, social influence mechanisms have been increasingly popular among policy makers as governments recognize the importance of the human dimensions within energy saving behavior (Spandagos et al., 2021). The starting point of our investigation was that a consensus on the effectiveness of interventions based on social influence has not been made, as some interventions have been found effective in certain settings while not in others (Spandagos et al., 2021). This lack of consensus is attributed to past studies focusing on if the social influence interventions were successful in reaching their goal, rather than also investigate the underlying conditions and the contexts shaping the findings (Spandagos et al., 2021). Other issues besides the mixed results within the social influence literature include a publication bias and missing research on long term effects (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019).

Our contribution focuses on social influence mechanisms in different contexts and took into account the effects of individual differences as well as social norms and network structures. We expand the current literature by relating psychological mechanisms involved in social influence with sociological aspects. Furthermore, we investigate if the differences in the degree to which people compare themselves and how connected they feel to their surroundings are related to norm following. We use Centola and Macy's (2007) differentiation between simple and complex decisions and apply it to social influence mechanisms. Just as Centola and Macy (2007) explained that there are differences between behavior and attitudes that require only a little encouragement and those that require convincing of several credible others, we suggest that the effectiveness of social influence mechanisms depend on the complexity of the context in which they are applied. We tested if social influence mechanisms such as social proof shown effective in low cost scenarios are applicable to high cost behavior situations. Relatedly we examined if the underlying factor of decisions being continuous or binary impact a social influence process towards unified adoption or if they foster polarization within social networks.

Our research is applied to the energy transition as it provides a specific context in which variations of social influence mechanism will be needed to make everyone adopt the

necessary behavior changes. Our societal aim was to gain more insights into how social influence mechanisms can aid the mobilization of households for a sustainable energy transition. We apply our research findings to the energy transition after highlighting how each of our empirical chapters aims at answering one of our first three central research questions. We end this section with the limitations and ideas for future research.

1.5.2 Conclusions for our first central research question

Our first central research question - to what degree does the effectiveness of social influence processes spreading information depend on social comparison orientation and the type of behavior or attitude that is spreading- can be divided into two sub questions. First, it addresses people's individual differences in their susceptibility to adapting to social norms and second the fundamental difference of information and behaviors being continuous or binary. People differ in the degree to which they feel connected to the people around them and in the amount they compare themselves, which is called social comparison orientation (SCO) (Buunk & Gibbons, 2007). We investigated if these individual differences are associated with injunctive or descriptive norm following, where the prior refers to what people believe a group should be doing and the latter to what others actually do. By analyzing both survey data as well as actual energy use data of 1050 Swiss households, we find that naturally occurring social norms within a society have an impact on shaping attitudes, but do not seem to be directly associated with changes in behavior. Those who compared themselves more with others and those who reported higher levels of local social connectedness had higher levels of environmental concern and were more similar in their attitudes to those with comparable household sizes and house sizes. Yet, neither of these individual traits was associated with a difference in electricity consumption. This can be linked to the attitude behavior gap that emphasizes that people can have pro-environmental attitudes but sometimes not act on them, because of various reasons such as a lack of efficacy or perceived risks of purchasing sustainably (Park & Lin, 2020). We conclude that it is important to research the underlying mechanisms of social influence interventions as relying on naturally developing norms may not be a sufficiently motivating factor.

Beside individual difference, social network structures themselves can also impact the effectiveness of social influence processes. The second part of our first central question focuses on the spread of information in a social network. Social influence processes can influence behavior as well as attitudes. Our results demonstrate that the ability of gradual processes allowing nuanced forms of information spreading does not result in gradual behaviors being superior for the use of social influence mechanism to

reach everyone within a connected network. Our lab experiment kept all other factors equal to specifically test if continuous decisions are indeed better in reaching everyone within a network than binary decisions. However, our results falsify our predictions and a social influence process of continuous behavior is not significantly better in reaching everyone within a social network. Within the context of the energy transition this suggests that policy makers will have to focus on other approaches to optimize the spread of sustainable home improvement investments. The continuity of investment decisions does not lead to improvements in rates of adoption compared to binary decisions.

1.5.3 Conclusions for our second central research question

Our second central research question - how do contacts within a social network influence each other's attitudes and behaviors - can again be divided into two sub questions. First, we looked at the specific case of minorities that view themselves as a majority, prioritizing the views of local others. Second, we observed the impact of energy comparisons and saving advices from volunteers on residents' energy consumption.

Being able to reach and encourage all residents within a community is a pressing problem with regards to the diffusion of behaviors among social networks. Based on the model of the dissemination of culture by Axelrod (1997) where local convergence can generate global polarization, the results of our lab experiment show that when people are clustered together and only have access to the decisions of a few people around them they can form a local majority of deviant information. Being connected to people with similar opinions as themselves, people can start to view their own views as a majority even when they are the minority of the entire social network. This can become a very challenging problem for an adoption process when these clusters of people stick to their deviant information as they do not perceive themselves as a minority. By illustrating this specific problem, we take the first step towards addressing it. Increasing social cohesion and the number of social connections of otherwise internally clustered groups might be one way of addressing the problem of the local majorities, as our findings of no difference between continuous and binary behaviors' ability to spread to everyone within a network did not provide a more practical alternative.

Even though the effectiveness of social influence approaches on energy conservation is one of the most studied contexts within energy social sciences (Abrahamse & Steg, 2013), to our knowledge we were the first to investigate the specific instrument of the energy coaches. In contrast to more common energy conservation approaches as information provision through communication of the local authorities or energy suppliers, these local volunteers combine several advantages. Similar to the successful

block leader approach (Abrahamse & Steg, 2013), there is a higher chance of people relating to these locals. Our results indicate that a visit of such a local volunteer who is intrinsically motivated to help people save energy and become more sustainable is associated with an reduction in energy consumption. Energy coaches have an array of possibilities to stimulate residents to act. This makes it difficult to know exactly why a visit of an energy coach is associated with a reduction in energy consumption. It is important to test if such a frequently applied approach is effective, yet it seems vital to discover the underlying aspects to why it is effective. One of these aspects is the social comparison information that energy coaches provide to the residents that they visit. By differentiating between those informed that they were using more energy than others and those that were informed that they consumed less energy than average, we illustrate the importance of the social influence information provided. Our results suggest that the visit of an energy coach was associated with a reduction in energy consumption, but only for those who were told by the energy coach that they were consuming more energy than comparable others.

1.5.4 Conclusions for our third central research question

Contacts within a social network influence each other's attitudes and behavior in both desired as well as undesired ways. Which brings us to our third central question - when can social influence processes be less effective and when can unwanted side effects of social influence be expected? We again divided this question into two sub questions. First, we want to know when social influence information is counterproductive, and second, are social influence techniques like social proof still effective when the decision situation becomes more costly?

As mentioned above the energy coaches' social comparison information was associated with a reduction in energy consumption, but only for those who were told by the energy coach that they were consuming more energy than comparable others. Those who were told that they are consuming less than average and thus were already behaving better than others with regards to saving money and behaving pro-environmentally did not reduce their energy consumption but even increased it. We observed a boomerang effect were residents who were consuming below the comparison average adapt to the standard of similar other residents and thereby consume *more* energy (Rasul and Hollywood, 2012; Schultz et al. 2007, 2018). We can only speculate why exactly people adapt their behavior in this way. Yet, our findings certainly indicate that policy makers have to take into consideration that providing social influence information to residents can have wanted but also unwanted side effects. In the future research section, we will

discuss how the related underlying mechanism could be investigated by providing residents not the average but a more ambitious future energy goal.

To examine if social influence techniques like social proof remain effective when the decision situation becomes more costly, we collaborated with one of the largest banks in the Netherlands. We created several websites that promoted sustainable home improvement services and the banks services to get solar panels respectively. After aiding the bank in developing two types of social proof manipulations, and comparing the amounts views and the amount of clicks made on the calls for action on the banks' websites we have to conclude that social proof does not effectively increase customer behaviors. The number of clients considering the banks' services were not significantly different, irrespectively of the social proof manipulation being present or not. Our results have a broader implication than the specific case of social proof and its effectiveness on stimulating behaviors on a bank's website. Our results highlight that social influence techniques such as social proof should be investigated in several contexts, before being implemented to encourage action towards making a more complex decision.

We conclude that our research revealed that individual differences as well as social norms and network structures are important contextual factors to be considered when studying the effectiveness of social influence mechanisms. With regards to underlying conditions shaping the effectiveness of social influence findings, we trust previous research has shown the importance of the visibility of behaviors to others be more important than the effort they require for them to be effective (Abrahamse & Steg, 2013). Our results contribute to this line of reasoning by highlighting the importance of the complexity of the context in which social influence mechanisms are being applied. Established research findings in simple low-risk conditions should be replicated in more complex decision situations before being recommended to be applied in the field. Just as Centola and Macy (2007) showed that complex behavior and attitudes require convincing of several credible others, we suggest a combination of social influence mechanisms and other interventions such as economic incentives might be needed for more complex behavior conditions.

1.5.5 Conclusions for our fourth central research question

Our findings and research efforts for the first three central research questions show that social influence processes can play an important factor within the energy transition. They can aid in encouraging and activating residents to act sustainably, yet, the context in which they are applied seems crucial for their success. The energy transition is a context in which people are asked to make decisions not only for their own self-interest,

but also to contribute to a more general cause. By focusing on one context, the results of the more applied chapters in this thesis might in particular hold for the energy transition context. We note that there is not a straightforward way of improving social influence processes to reach everyone within a social network to make sustainable home improvement investments. Neither should social comparisons of energy consumption be made carelessly as they can result in unwanted spillover effects. People differ in their social comparison orientation and the degree to which they feel connected to others. Yet, those who compare themselves more with others and those who feel more connected with others are only more susceptible to social norms with regards to pro-environmental attitudes not behaviors. Finally, the energy transition will require small behavior changes as well as larger investments by home owners. Our research highlights that social influence mechanisms found effective for the prior have be tested in more costly contexts before being applied.

1.6 Limitations and future research

1.6.1 General limitations

Our research has some general theoretical and methodological limitations. We have used a combination of different methodologies in our four empirical studies. We address more theoretical behavioral insights in controlled settings as well as in the field influence processes. Yet, these methods did not address the same questions or the same social influence mechanisms. Only our field experiment in Chapter 5 tests twice if the social proof mechanism is effective in a comparable setting. Therefore, robustness of the findings can still be improved by extended studies on the studied questions also with the different research methods. With the exception of Chapter 4, our research has been applied to the energy transition within the Netherlands. This implies that it is difficult to generalize the findings to other countries, especially countries that are organized quite differently from the Netherlands. Certainly given our recommendations of taking into account contextual factors, more research should be conducted in more diverse settings. We will end with some more specific limitations and ideas for future research for each of our central research questions.

1.6.2 Limitations and ideas for future research for our first central research question

Our effort to answer our first central research question - to what degree does the effectiveness of social influence processes spreading information depend on social comparison orientation and the type of behavior or attitude that is spreading- includes several limitations and could be improved by future research.

First, Chapter 4 - which examines the association between social comparison orientation as well as social connectedness on environmental concern and electricity consumption in a natural occurring setting - makes several assumptions. We investigate people's individual differences and their susceptibility to adapting to social norms while assuming that people believe that they ought to do something against climate change. Even though it is fair to say that the people who participated in the survey and shared their electricity consumption were aware of the climate crisis, it remains an assumption that people are aware of the actions that they can take against climate change. We assume an injunctive norm, suggesting that people ought to lower their energy and more specifically their electricity consumption, to help with addressing CO_2 emissions. Future research should test which social norms are active within the social networks of participants. One simple improvement, for example, would be to measure the social norms by asking participants about them. Another factor with regards to norm following is if norms are being enforced. We do not know if people sanction behavior that is not in accordance to an injunctive norm of acting pro-environmentally. Punishment has been shown to be one of the most important and effective forms of ensuring cooperation within groups (Balliet et al., 2011). A field experiment that investigates what kinds of sanctions or punishments are acceptable within the context of norm following and sustainable behaviors would be very interesting. Our empirical study in chapter 4 is also limited by the fact that we cannot be sure with whom participants actually compared themselves. Future research should address this by making actual comparison groups, or ask participants whom they are comparing themselves with. Knowing who is most susceptible to what kind of social influence information is something that could help with the spread of behavior and attitudes among social networks (Akbarpour, Malladi, and Saberi 2020).

The second part of our first central research question addresses the effectiveness of behavior spreading among a social network depending on the behavior being continuous or binary. Our limitations and recommendations for future research are specifically directed at our lab experiment as we aimed at investigating a specific yet fundamental difference in the diffusion process. We recommend a replication study of our lab study as we included several different network structures, had a limited number of participants and conducted our research during the corona pandemic. Our data collection took one entire year from October 2020 until October 2021. Studying only one network structure could increase the power of the participants available. On the other hand more variations of larger networks would improve our current study design, by making it more realistic to real world social networks. Additionally, a replication study could highlight the importance of people's investment decisions to the other people participating in the lab

study. Furthermore, it would be novel for future research to compare the speed of spread in a social network for the two different types of decisions that we tested. One could then not only compare if discrete or gradual investment reaches everyone within a network but also which type of decision reaches a certain threshold of participants the fastest. This would require also larger networks and more rounds in the experiment to facilitate a longer diffusion process.

1.6.3 Limitations and ideas for future research for our second central research question

Our attempt to answer our second central research question - how do contacts within a social network influence each other's attitudes and behaviors - also entails several limitations and possibilities for future research.

Our findings of Chapter 3, that a visit of an energy coach is associated with above-average consuming residents to consume less energy, require more follow-up research. We cannot rule out that it is just much more difficult for below-average energy consuming households to consume even less energy as we do not have a control group in this study. To include a control group of similar households would greatly benefit the credibility that the effect of energy coaches is really causal. Future research should investigate the effects of what social comparison information is provided to residents. Our analysis without a control group and potential confounding variables, e.g., related to who actually is prepared to let an energy coach come into their house, can only suggest an association. A control group might be created if people who want energy coaches to visit them cannot all be served and a random choice can be made for which households are actually visited.

The limitations and recommendations for answering our first central research question with regard to our lab experiment are similar for our second central research question. A replication study of Chapter 2 could benefit from more statistical power by recruiting more participants in a shorter period of time. For us this was not possible due to the corona crisis. One could also optimize the social network structures included such that the issue of local majorities occurs more often. In the current experiment the specific problem of the local majority only occurs in a certain number of cases. Given that we show that situations where local majorities form they create a problem for diffusion processes, future research could increase its power by letting all participants play in a local majority situation. Future research could then actually check if our recommendations of increasing the number of ties and social connections within a social network help with reaching homogenous adoption. Furthermore, our experiment was limited to four decision rounds per game.

1.6.4 Limitations and ideas for future research for our third central research question

We had some interesting findings related to our third central research question - when can social influence processes be less effective and when can unwanted side effects of social influence be expected – but also several limitations can still be addressed in future research.

Our findings of Chapter 3 related to social comparisons and a boomerang effect require more empirical support. Our study did not have a control group. We can therefore not compare the increase in energy consumption of below-average consuming residents after hearing they had been using less energy than average with a control group. This observed association should therefore be replicated in a field experiment to be able to test if there is a causal relationship. One could for example compare the changes in energy consumption of residents that did get a visit of an energy coach with those who signed up for such a visit but did not yet get it. Furthermore, future research should investigate if the influence of social comparisons of energy consumption is different depending on to whom people are compared to. One could compare residents' energy consumption not to a certain average household, but to a more ambitious ideal consumption pattern or the consumption of the most sustainable 10% of residents. Combined with a control group such research could be very beneficial for policy makers to ensure that they can avoid ineffective policies or even ones that create unwanted side effects.

The results of our field experiments demonstrating the ineffectiveness of social proof highlight that social influence techniques should be investigated in several contexts. Certain behavior might require more convincing from several credible others or how information is exactly portrayed on a website might matter for the effect it has on people opening such a website. Future research on the effectiveness of social proof as a persuasion technique could, for example, benefit greatly from a lab experiment that gradually increases the costs of behavior to understand when social proof is effective and when it is not effective. Our field experiment only focused on the effectiveness of social proof, which is just one of the above discussed six principles of persuasion utilized by marketeers (Cialdini, 2001). Future research should examine if Cialdini's other universal principals of persuasion remain effective in influencing more costly decisions or if they can lead to unwanted side effects. Our final Chapter 5 tests the effectiveness of social proof for stimulating costly pro-environmental behavior in a context where participants are orientating themselves before making an actual investment. This should be extended to contexts where actual investments are possible, to make such research even more realistic. Our data is limited to clicks and page views and we cannot generalize that social proof is ineffective. However, our study is an important contribution to the literature

as it questions the effectiveness of a very popular social influence technique for more complex decisions.

1.6.5 Limitations and ideas for future research related to our fourth central research question

The first three central research questions highlight that the context of social influence processes are important for their success. The specific context of the energy transition is just one general context to which they can be applied. To better understand the logic behind the influence processes, it would definitely be useful to study similar mechanisms in other contexts to get more knowledge on how the energy transition process is different from other social influence contexts. Furthermore, future research should highlight when its research findings are context dependent, to avoid that policy makers or marketeers generalize the application of mechanisms to different context. The specific problem of the local majorities illustrates a more general challenge for the energy transition. The norm to act against climate change is not shared by everyone and climate change deniers also influence each other. Policy makers will have to invest in ways to connect individuals at the outskirts of social networks with more well-connected others. The energy transition requires cooperation with people having to make uncertain investments today to avoid future climate problems, and one of the biggest dangers to the success of such cooperation is the spread of misinformation (Van Lange & Rand, 2022). The problem of the local majorities highlights that once a local group perceives themselves and their opinions as the majority even though they are a minority, then it does not matter if information reaches them in a gradual or a discreet manner. They can get stuck on that wrong information. Policy makers and scientists will have to address this problem in future research by investigating ways to increase the effectiveness of social influence through social networks.

Chapter 2

THE DIFFUSION OF BINARY VERSUS CONTINUOUS BEHAVIOR ON SOCIAL NETWORKS [1]

[1] A slightly different version of this chapter has been published as Schneider, P. T., Buskens, V & van de Rijt, A. (2023). The diffusion of binary versus continuous behavior on social networks. *Advances in Group Processes* 40: 91-113. Schneider carried out the investigation, wrote the original draft, and conceptualized the research and conducted the formal analysis. All authors were responsible for the methodology and review & editing of the writing. For this study, we use the data from the lab experiment we conducted in the ELSE Lab at Utrecht University. We provide the data and code at https://osf.io/seqn3.

Abstract

Diffusion studies investigate the propagation of behavior, attitudes or beliefs across a networked population. Some behavior is binary, e.g., whether or not to install solar panels, while other behavior is continuous, e.g., wastefulness with plastic. Similarly, attitudes and beliefs often allow nuance, but can become practically binary in polarized environments. We argue that this property of behavior and attitudes - whether they are binary or continuous - should critically affect whether a population becomes homogenous in its adoption of that behavior. Extant models show that only continuous behavior converges across a network. Specifically, binary behavior allows local convergence, as multiple states can be local majorities. Continuous behavior becomes uniform across the network through a logic of communicating vessels. We present a model comparing the diffusion of both types of behavior and report on a laboratory experiment that tests it. In the model, actors have to distribute an investment over two options, while a majority receives information that points to the optimal option and a minority receives misguided information that points towards the other option. We predict that when adjacent persons receive misguided information this can hinder convergence towards optimal investment behavior in small networked groups, especially when subjects cannot split their investment, i.e. binary choice. Results falsify our theoretical predictions: Although investment decisions are significantly negatively affected by local majorities only in the binary condition, this difference with the continuous condition is not itself significant. Binary and continuous behavior therefore achieve comparable incidences of optimal investment in the experiment. The failure of the theoretical predictions appears due to a substantial level of error in decision-making, which prevents local majorities from locking in on a suboptimal behavior.

Keywords: Diffusion, Continuous, Binary, Innovations, Local Majority, Social Networks

2.1 Introduction

Diffusion studies on the propagation of behavior across social networks can be instrumental to understanding and potentially addressing key social problems of our time, such as the demand for large scale adoption of pro-environmental behavior (Flache et al., 2017). Research utilizing social influence approaches (Abrahamse & Steg, 2013) addresses the question of how existing social networks can be used to deliberately initiate and catalyze such transitions. For these approaches to be successful, it is vital to understand the social processes underlying the diffusion of behavior, attitudes or beliefs across a networked population. Social influence can be described as a force that guides individuals' opinions, attitudes, beliefs and behaviors towards those of others (Flache et al., 2017). This process is especially prominent in situations with uncertainty where people can infer their choice from others' prior decisions (Bikhchandandi et al., 1992).

Research on social networks has addressed how different network structures affect information diffusion in social networks (Flache et al., 2017; Friedkin, 2001; Granovetter, 1973, 1978; Uzzi et al., 1993). Most research within the opinion dynamics and social influence literature has considered beliefs or opinions as either binary or continuous without paying much attention to the impact of this difference. It is a largely unresearched question whether social influence processes are fundamentally different when individuals influence each other through binary either-or decisions or when their choices provide more gradual information on the support for one or the other opinion. Yet, as we will show, a comparison of extant models suggests that continuous processes tend to converge on a network-wide behavior while binary processes often get trapped in dense sub-networks. If true, this would suggest the importance of having more continuous ways to communicate information and beliefs on efficient options between people in a network, rather than that people only have binary information on their neighbors beliefs or investment behavior. Potentially, simply asking if someone contributes is less effective for the spread of a decision within a networked group than asking how much they contribute. This can lead to insight for policy makers or designers of diffusion strategies on the importance of making sure that more nuanced information can be exchanged.

Previous research has come to the general conclusion that one can average with continuous opinions, yet binary opinions only allow for adoption of the most common opinions among neighbors (Flache et al., 2017). Much of this argumentation has been based on the famous model of the dissemination of culture by Axelrod (1997) who illustrated how local convergence can generate global polarization. We share this interest for the problem of small groups converging on a minority behavior forming a local

majority of persistent diversity. A local majority is a group that is small in comparison to the larger group they belong to, but clustered together in such a way that their views can form a majority in their direct surrounding. We want to investigate if these local majorities of clustered information are more problematic in a binary investment process. More specifically we argue that adopt-or-not-adopt threshold models (Granovetter, 1978) generate clusters receiving misguided information to form a stable local majority, whereas models of opinion updating (Friedkin, 2001) do not, as they allow a more nuanced form of information spreading. To theoretically isolate the effect of binary behavior we bring together these two modeling approaches in a simple model in which we vary binary and continuous investment processes but keep everything else constant.

We test our prediction with a novel experiment that closely matches our theoretical model. Participants can invest in an uncertain investment opportunity about which they receive some information, while they are connected in a network. Depending on the experimental condition they must either invest all or nothing or they can split their investment. Their investments are then observed by network neighbors. These observations influence investment behavior in a next investment round. In this way we experimentally test and compare the social influence process through binary decision behavior with a social influence process allowing continuous decision behavior. Following Axelrod (1997) and Flache et al. (2017), we predict that, on the one hand, binary investment behavior can stabilize in locally converged subgroups that adopt different types of investment behavior, while some of the subgroups get 'stuck' in investment behavior that is inefficient, because they cannot access all the information available in the network. On the other hand, continuous investment behavior is expected to become uniform across the network through a logic of communicating vessels, meaning that continuous investment behaviors are able to display more nuanced information with regards to how confident a decision is.

Summarizing, we address the following research question: To what extent does the continuity of investment behavior increase the chance of convergence to investment behavior that is efficient compared to binary investment behavior in a network where everyone starts with an ambiguous signal about what the efficient investment behavior is?

1.1.1 Continuous versus binary models

We see two types of models in the literature, those based on continuous opinions and those based on the spread of discrete behaviors, with these properties producing different outcomes. The existing social influence literature focusing on situations where over

the course of several rounds people update their continuous scale attitudes (Becker et al., 2017; DeGroot, 1974; Friedkin, 2001; Lorenz et al., 2011), predicting network-wide convergence on a universal opinion. The spread of discrete behaviors is instead studied in threshold models or models of behavioral contagion (Centola & Macy, 2007; Granovetter, 1978; Rogers, 1983). These models generally predict convergence only in local pockets, with different behaviors remaining present in the network. When comparing them thoroughly it becomes more apparent that the basic property of behaviors and attitudes being binary or continuous is indeed fundamental in determining global versus local convergence.

In the first strand of models, individuals' opinions are formed in a multifaceted process where opinions of other persons enter into the process of opinion formation (Friedkin & Johnsen, 1990). Dynamic opinion models such as the Hegselmann-Krause model argue that reaching opinion consensus due to repeated averaging of opinions among agents is not straightforward as agents normally neither fully adopt nor strictly disregard opinions of other agents but take into account others opinions with different weights given the more complex process of opinion formation (Hegselmann & Krause, 2002). These opinion dynamic models are based on the social learning process of the DeGroot model (DeGroot, 1974), that has inspired influence models such as Friedkin's (2001) model of norms, that let individuals opinions and behaviors converge by a process of continuous averaging. In such models, everyone's final opinion is a weighted average of the starting opinions in the network. Hegselmann-Krause agree that in the classical case of equal confidence in others and constant weights put on the opinions of others the reaching of a consensus is typical in the continuous decision process (Hegselmann & Krause, 2002). These models focusing on opinions and attitudes therefore argue that individuals opinions stabilize and converge by a process of continuous averaging and adaptation. Note that, e.g., Hegselmann and Krause (2002) also specify variants of these models on more contested opinions that do not predict convergence (see Flache et al. 2017 for an overview). We think these extensions apply less to our context, because they study explicitly contested issues in which individuals adapt their opinion away from others who think very different, while in our experiment there is clearly one best and one worst situation.

The second strand of models address situations where individuals are deciding between two alternatives, such as adopting or not adopting an innovation (Rogers, 1983), based on some threshold number of other people moving first before people are convinced to behave or invest in a certain way (Granovetter 1978). Such models study the existence of a critical mass and how collective action can be coordinated (Macy,

1990), and explain how diffusion of binary behavior might depend on external factors. In these discrete models actors are not aware to what degree a person is in favor or against a certain option. All people who are in favor of some option communicate just that one option, even if there are much more nuanced differences in the degree to which they favor that option over another. The model of the dissemination of culture by Axelrod (1997) generates local convergence, with some neighborhoods settling on a different behavior than others. In the model, small connected groups can form a majority locally and become resistant to change.

The above review suggests that previous models of continuous behaviors tend to generate behavioral convergence and those of binary behaviors tend to generate behavioral differentiation: Continuous opinions allow for a form of averaging, compared to binary opinions which only allow for adoption of the most common opinions among neighbors (Flache et al., 2017). However, the models we reviewed also differ in various kinds of other ways. In order to theoretically isolate the effect of binary versus continuous choice on behavioral convergence we now introduce a simple unified model.

2.2 Theoretical model

We create an influence model in which actors are organized in a network and have to decide what the best choice out of two investment options is, while having ambiguous information about what the best option is. If all actors would pool all information, they would know what the best option is. However, as they can only observe investment behaviors of their neighbors and therefore only have local information, misdirected information can be concentrated locally. Actors in that part of the network might then get stuck in suboptimal behavior. By allowing diffusion of either binary or continuous investment information, we can theoretically test whether such suboptimal outcomes are more likely in parts of the network when social influence is based on binary behavior.

We use four networks (see Figure 2.1). The networks vary by both clustering – the prevalence of closed triads – and density – the average number of ties. Clustering impacts the possibility for information to remain closed off in a corner of a network. Network density affects the speed of information spread (Buskens & Yamaguchi, 1999; Granovetter, 1973; Uzzi et al., 1993). In all networks, actors have either two or three connections with others (i.e. degree 2 or 3). Density is lowest in network 1 (average degree is 2), intermediate in networks 2 and 3 (average degree is 7/3) and highest in network 4 (average degree is 3). Networks 2 and 3 vary in clustering while having the same degree distribution.

We develop a decision model that we can simulate over these four networks. Within a network, each actor has to decide how to distribute 10 points over two options. In the binary condition they must invest either 0 or 10 points, while they can freely distribute the 10 points in the continuous condition. The two options are represented by two possible vases that are filled with black and white balls. The vases can be seen in Figure 2.2 below. One of the two vases is the actual vase that is selected by the computer. We call this vase the "correct" vase. One of the two possible vases has two black balls and four white balls; the other vase has four black balls and two white balls. The balls from one of the two vases are distributed among the actors in the network, without replacement. Actors who receive a black ball can infer that the likelihood they received this ball from the vase with a majority of black balls is 2/3.

Figure 2.1. Network 1 through 4

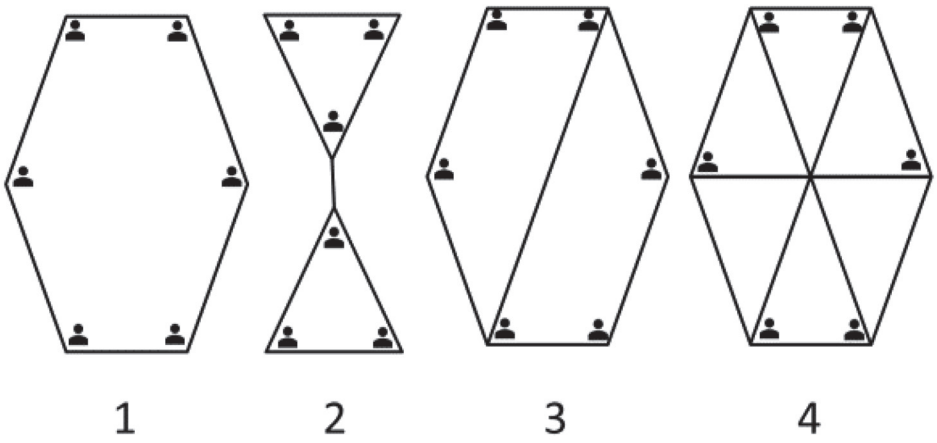
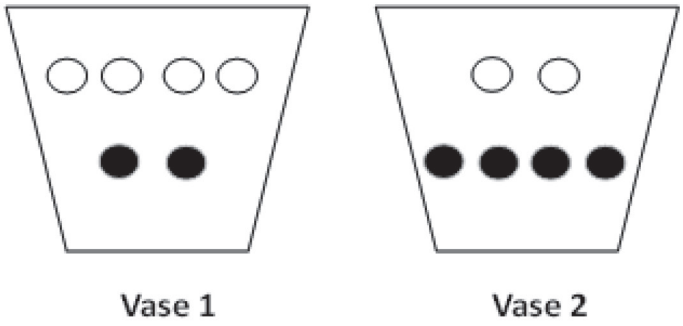


Figure 2.2. Example of the vases 1 and 2



From this starting point our model proceeds as follows: [1]

1. Each actor receives a ball with a color that provides their initial private information as explained above.
2. Each actor makes an investment decision, either investing 10 points in one vase or 10 points in the other vase in the binary condition or freely allocating the points among the vases in the continuous condition.
3. Each actor sees the initial investment decisions of all network neighbors and makes a second investment decision.
4. Each actor sees the second investment decisions of all network neighbors and makes a third investment decision.
5. Each actor sees the third investment decisions of all network neighbors and makes a fourth and final investment decision.

Each actor gets to keep the points invested in the correct vase while points invested in the other vase are lost. For the binary decision condition, the model assumes that each actor starts with investing in the vase that has a majority of balls that is the same as the color of the ball the actor received. After observing the investments of their neighbors, actors invest in the vase that is most often invested in by themselves and their neighbors together. So if someone with two neighbors invests in the vase with a majority of black balls, but both neighbors invest in the other vase, this actor will start to invest also in the other vase. If a person has three neighbors and there is a tie in terms of investments, so two neighbors invest in one vase and this focal actor and the last neighbor invest in the other vase, this actor will invest in the vase in accordance with their previous investment. This decision process continuous until the fourth and final investment has been made by every actor.

For the continuous condition, we assume that the actors start investing in each of the vases with a proportion of the investment that is equal to the likelihood that this is the actual vase from which the balls are drawn. Given the two vases the balls can be drawn from, this implies that actors invest 2/3 of the total possible investment in the vase that has the majority of balls in the color of the ball the actor received and 1/3 of the investment in the other vase. For the second investment, actors average the proportions of their own investment and that of their neighbors, for each of the vases, which will be their new proportions to invest. From the third investment onward, we assume that actors

[1] This is a simplified version of a decision situation which can be found in other experiments such as the multi-armed bandit problem (Hofstra et al., 2015), for which Vriens and Corten (2018) explained that the typical individual learning strategies of exploration and exploitation are not always possible under certain conditions resulting in individuals to rely on social learning.

start to make more decisive investment decisions towards the extremes. The motivation for this decision is that because the average increasingly includes global information, actors should be increasingly confident what the majority ball in the vase was and will thus predominantly invest in that vase. This is done according to the following formula, where "average" is the average over own and neighbors' investments in the previous round and c is the parameter used for capturing the confidence of the actors:

$$\text{investment(round)} = \frac{\text{average}^{1+(\text{round}-2)c}}{\text{average}^{1+(\text{round}-2)c} + (1-\text{average})^{1+(\text{round}-2)c}}.$$

In the main simulations, we use a parameter $c = 2$. In round 2 this leads to an investment decision that equals the average. E.g. an average of .67 observed in round 1 produces an investment of $0.67^1 / (0.67^1 + 0.33^1) = 0.67$ in round 2. In round 3, where the average is more likely to indicate the correct vase, confidence in making the right decision is greater: an average of 0.67 in round 2 is in round 3 transformed into an investment decision of $0.67^3 / (0.67^3 + 0.33^3) = 0.89$, while 0.33 produces an investment of 0.11 such that the sum remains 1. Note that if the average = 0.5, the value remains 0.5, which is in accordance with that people who find it equally likely that one or the other ball is the majority ball will not adapt their conviction in either direction.

In Figure 2.3 we illustrate the simulations, to show that the binary and continuous decision conditions can lead to different outcomes. Two neighboring actors in network 1 with the minority information that are in the binary decision condition will keep investing in the same vase. They will do so as they form a local majority of minority information, whereas the remaining four individuals make a different choice and invest in the correct vase. By contrast, in the same situation of network 1 with clustered minority information of two neighboring actors the continuous decision process provides more nuanced information to the actors and allows a convergence towards the correct investment decision. The continuous decision process communicates to connected actors not only if an actor is investing but also to what degree they are investing. Resulting in all actors in the network to eventually invest into the correct vase.

Using this theoretical model, we conducted simulations to reproduce the diffusion process in our four networks distinguishing between the binary and the continuous scenario. We run this process by randomly distributing the six balls in the network for 10000 times and recording the proportion correct final investment by all actors, i.e., the proportion of points that were invested by the group into the vase that was indeed the vase from which the balls were drawn in the last round of the simulation. We split

the simulation results by our four networks, by whether the decision was continuous or binary and by whether there was a local majority of minority balls. As explained earlier a local majority refers to two neighboring nodes receiving the two minority balls. Table 2.1 shows that in case of no local majority in all conditions actors quickly converge on investing in the correct vase. However, if there is a local majority this does not happen, especially in the binary condition. Looking in more detail at the simulation, the local majorities insist on choosing the wrong vase even if one would go beyond four rounds of investments. In the continuous condition, there is still convergence in networks 1, 3 and 4 and only in network 2, the clustered actors also stick to the wrong vase if indeed the minority balls are given to two nodes in the same group of three. Following the literature indicating that density should speed up the process of information (Granovetter, 1973), or behaviors (Buskens & Yamaguchi, 1999; Uzzi et al., 1993) spreading among a networked group, we control and check for such an effect in the analyses. Our simulations, however, do not indicate a clear density effect. Therefore we do not formulate hypotheses about density. We check for density effects in the experiment by including dummy variables per network in the analyses. Below is an overview of our simulations used to derive our hypotheses.

Figure 2.3. Local majorities and the diffusion process

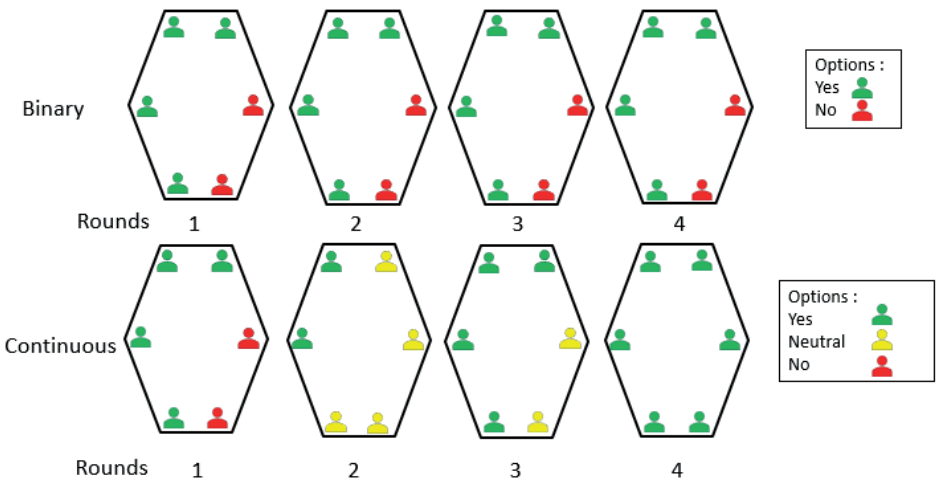


Table 2.1. Simulated average proportion correct final investment per network, per condition and depending on whether the initial balls with the minority color where given to two connected actors (local majority).

Network	Binary		Continuous	
	Local majority	No local majority	Local majority	No local majority
1	.67	1	.84	.94
2	.57	1	.69	.96
3	.67	1	.90	.95
4	.67	1	.97	.96

Table 2.1 shows that local majorities hinder the social influence process and predominantly in the binary condition. While local majorities also slow down consensus formation in the continuous scenario, only in the clustered network 2 disagreement is persistent under our assumptions even in the continuous scenario. This brings us to the following hypotheses:

H1: In networks in which a local majority receives the minority ball, fewer people will invest in the correct vase than in networks without a local majority receiving the minority ball.

H2: The difference between a local majority and no local majority is larger in the binary condition than in the continuous condition.

H3: In the more clustered network 2, a local majority receiving the minority ball leads to fewer people investing in the correct vase than when the same scenario occurs in another network.

2.3 Methods

2.3.1 Design of the experiment

We compare the diffusion of a binary and a continuous behavior in a computerized experiment in the Experimental Laboratory for Sociology and Economics (ELSE) at Utrecht University. We assigned 222 participants to groups of 6. Each group played 8 "investment games" following our theoretical model. The composition of the groups did not change over the 8 games, but group members could not identify who was who in a subsequent game. 114 participants started playing the investment games in each of the four different networks making continuous investment decisions. This is followed by the playing of another four investment games in each of the networks, this time making binary decisions. 108 participants started with making binary decisions and then made continuous investment decisions.

Participants were embedded in a social network of six participants but had to make an individual investment decision with an uncertain outcome. Participants were informed that they had to choose how they would like to invest their points in one of two vases, with one being the correct one and the other option being wrong, closely following our theoretical model. Every point invested in the right vase was added to the payoff of the participant. Every point not invested in the right vase was lost for the participant. 10 points earned by the participant had a value of 50 euro cents. Since each participant played eight games with four investment rounds each, they could earn up to 320 points, which would equal to 16.00 euros. Each participant received a minimum of 5 euros for participating even if they earned less than 100 points.

The vases, which can be seen in Figure 2.2 above, are essential to the game and show a distributions of black and white balls, and they are the information available to each participant in each group. The white and black balls represent the possible distributions of balls. Each participant of a group of six received one of the six balls from either vase 1 or vase 2 at the beginning of the game, and knew that all participants received one ball from one vase without replacement. This ball provided all participants with some information about which of the two vases is applicable to their group. Each participant knew that the six balls from the vase applicable to them had been distributed to their group randomly without replacement. The participants' task was to speculate what vase applies to their group. Each participant was informed that they could not see all participants' decisions but only their own decisions and the ones of the participants they were connected to, their network neighbors. Given our four network structures (see Figure 2.1), a participant saw the investment decisions of either two or three other participants they were connected to in their group. The participants were not informed about the specific network structure they found themselves in, only that they were playing in a group consisting of six participants.

The color of the ball that a participant received provided them with the initial predisposition as to which of the two vases was likely to be the correct one, as in each vase there was a clear majority of white or black balls. Given that the ball color was the only initial information a participant had, we would expect a participant receiving a white ball to invest into vase 1 and a participant receiving a black ball to first investment into vase 2. Participants were then told that each game consisted of four rounds. In the binary condition, the participant could then decide to invest 10 points into vase 1 or 10 points into vase 2. After participants saw the decisions of the participants they were connected to, they again had to decide where they wanted to invest 10 points. The participants repeated this procedure for another three rounds until the first game

was finished. The same procedure was followed in the continuous condition, with the difference being that participants were able to choose any number from 0 up to and including 10 to invest in either vase. The remaining amount was automatically invested in the other vase. All participant groups played all four networks in a randomized order. In order to test the importance of the difference between the continuous and the binary diffusion processes within networked groups especially for groups with local majorities receiving the minority ball, we ensured that there was a sufficient number of cases where two adjacent persons received the minority balls. We accomplished this by not drawing individual balls uniformly randomly from the vase (which would lead to a large majority of cases without a local majority), but instead weighting the probability of each draw such that distributions with and without local majorities occurred about equally often.

2.3.2 Variables

The dependent variable is *proportion correct final investment:* the proportion of points invested by a group in the correct vase at the end of each of the four rounds of the game.

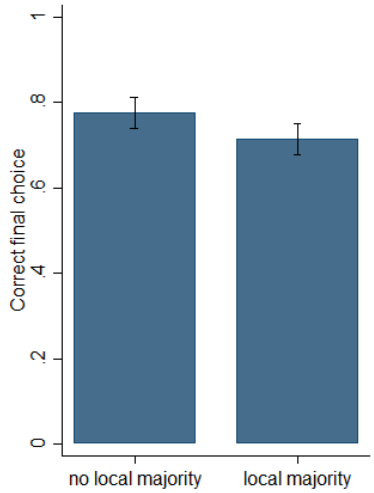
Independent variables: *local majority:* dummy variable indicating whether two connected actors received the two minority balls (1) or not (0); *continuous:* dummy variable whether the decision process was continuous (1) or binary (0); *network X*: dummy variables for the network in which the decision process took place with $X = 1, 2, 3, 4$.

2.4 Results

2.4.1 Local majorities

Given that 222 participants played the investment game eight times, we have 1776/6 = 296 group level observations. The participants were equally spread among local and no local majorities with 140 group level observations (47.3%) where there was no local majority and 156 observations (52.7%) where adjacent persons received the minority balls. Figure 2.4 shows *Proportion correct final investment* for these two situations. Participants were significantly less successful in investing in the correct vase if a local majority received the minority balls initially ($N = 296$, Mann-Whitney ranksum test, $z = 2.51$, $p = .012$). Thus, the proportion of correctly invested points in a networked group is significantly less when there is a local majority situation in their networked group than when they play the game without adjacent participants receiving the minority information at the beginning of the game. This supports hypothesis one.

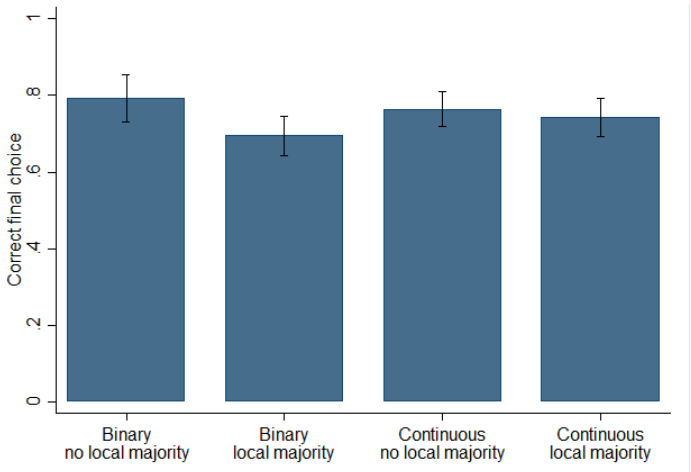
Figure 2.4. Average proportion correct final investment with and without a local majority in a network of six participants.



2.4.2 Binary versus continuous diffusion

When comparing the binary and continuous decision process for local majority and no local majority situations, we observe the difference in the success rate for investing in the final round for the binary decision process ($N = 148$, Mann-Whitney ranksum test, $z = 2.54$, $p = .011$), but not for the continuous decision process ($N = 148$, Mann-Whitney ranksum test, $z = .84$, $p = .402$) as can be seen in Figure 2.5 below.

Figure 2.5. Comparing the average proportion of correct final investment of participants making binary or continuous choices for groups starting with and without a local majority.



This suggests that diffusion for the continuous decision process is more resilient to local majorities than the binary decision process. To make these observations more precise we do a multivariate analyses and have a closer look at the specific differences for each network, between the conditions and ball distributions with and without a local majority. Figure 2.6 illustrates the proportion correct final investment, when separating the local and no local majority situation and comparing the continuous and the binary decision process for each network. Here we are especially interested in network 2 as it is the network with clustering. We do not find a difference in proportion correct final investment, when separating by the local majority situation and comparing the continuous and the binary decision process by each network. We do not find such a difference when comparing the binary vs the continuous decision process for groups of participants playing in a local majority in network 2 ($N = 39$, Mann-Whitney ranksum test, $z = -.97$, $p = .334$). This test however only indicated that there is no significant difference if participants played in the continuous or binary condition for when there are situations of local majority, however when we look at the conditions separately we do find a difference. Looking at the binary decision process specifically, we do see that there is a significant difference between the local and no local majority situation in network 2 ($N = 37$, Mann-Whitney ranksum test, $z = 2.46$, $p = .014$). Though when we look at the at the continuous decision process specifically, we do not see a difference between the local and no local majority situation in network 2 ($N = 37$, Mann-Whitney ranksum test, $z = 0.96$, $p = .337$).

A linear regression analysis is done to further test if the effect of local majorities holds and to see if there is a significant difference between the binary and the continuous decision process when there is a local majority. Because the same group of participants played eight games, we need to correct for clustering of observations over these groups. We do not correct for the session level, because the different groups within sessions do not interact with each other. As it can be seen in table 2.2 below, Model 1 is testing the main effect of a local majority and the continuous decision process. There is a significant effect of local majorities, which supports our first hypothesis (H1) that local majorities cause about 6% less points invested in the final round into the right vase ($B = -.063$, $p = .015$). There does not seem to be a significant difference between the continuous and the binary decision process in general ($B = .011$, $p = .658$). Model 2 adds the interaction between being in a local majority situation and whether people are in the continuous or binary condition to test hypothesis 2. Although the proportion investment in the correct vase is 8% higher with a local majority for the continuous process compared to the binary process (H2), the difference is not significant ($B = .084$, $p = .174$). When checking for a density effect we do observe that the proportion of points invested into the correct vase in the last decision round is significantly higher in the denser network 4 when compared

to the less dense network 1 (B = .11, p = .001). Note that networks 2 and 3, which have average densities are as expected also between networks 1 and 4. Model 3 tested whether the effect of local majority is different for the clustered network 2. The negative effect of local majority is only marginally significantly stronger in network 2 compared to the other networks jointly although it tends in the right direction (B = -.096, p = .075). Also if we include interactions of local majority with all networks separately, no significant differences are found (analysis not reported). We therefore do not find support for our third hypothesis (H3).

Figure 2.6. Comparing the average proportion correct final investment among all networks with binary and continuous investments and with and without a local majority.

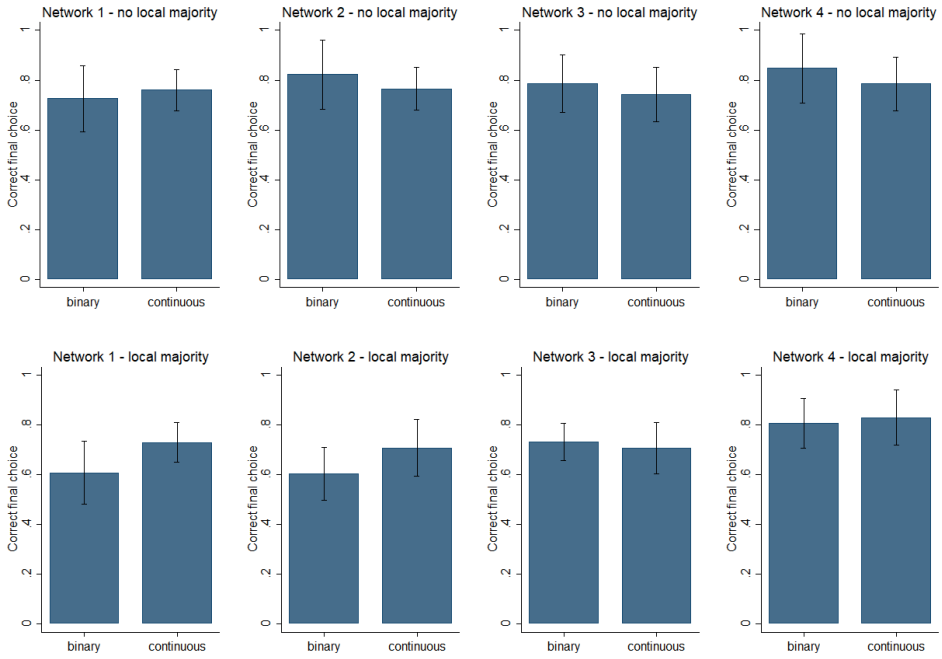


Table 2.3 below shows the actual average proportion correct final investment, per network, per condition and depending on whether the initial balls with the minority color where given to two connected actors (local majority). This table can be compared to the simulated data of table 2.1. For completeness, Figure A.3. in the Appendix A.2 shows an overview of how points invested into the correct vase develop over rounds, illustrating that convergence on the correct vase is hindered mostly with a local majority for the binary decisions in networks 1 and 2. Table 2.3 also illustrates that the largest deviations from the simulation can be found for the cases within a local majority in which the

proportions invested in the correct vase are considerably lower than predicted. This reduces the differences between the networks with and without local majority, which might help understand the weak effects found in our analyses. We return to this point in the discussion.

Table 2.2. Regression of the proportion correct final investment per group by local majority, continuous vs binary decision process and the network (standard errors are corrected for clustering over observations, 8 observations per group)

	Model 1		Model 2		Model 3	
Local Majorities	-.063*	(.024)	-.105**	(.038)	-.056	(.041)
Continuous	.011	(.026)	-.033	(.044)	-.030	(.044)
Continuous x local majority			.084	(.061)	.083	(.060)
Network 1	(ref)		(ref)		(ref)	
Network 2	.016	(.036)	.015	(.036)	.018	(.036)
Network 3	.039	(.029)	.039	(.029)	-.010	(.038)
Network 4	.112***	(.032)	.114**	(.032)	.065	(.040)
Network 2 x local majority					-.096	(.053)
Intercept	.729***	(.037)	.754***	(.041)	.775***	(.045)
R^2	.055		.063		.075	

Note. $N = 296$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ (two-sided)

Table 2.3. (Actual) average proportion correct final investment per network, per condition and depending on local majority.

Network	Binary		Continuous	
	Local majority	No local majority	Local majority	No local majority
1	.61 (.062)	.73 (.063)	.73 (.038)	.76 (.041)
2	.60 (.052)	.82 (.066)	.71 (.054)	.77 (.041)
3	.73 (.037)	.79 (.054)	.71 (.049)	.74 (.052)
4	.81 (.050)	.85 (.063)	.83 (.052)	.78 (.053)

2.5 Conclusion and discussion

Small groups sometimes fail to converge on optimal behavior forming a local majority of persistent suboptimal behavior. To our knowledge, we are the first to directly investigate in a systematic laboratory experiment if these local majorities are more problematic in a binary influence process than in a continuous influence process. More specifically, we compare two well-known families of models, namely binary diffusion models (Granovetter, 1978) which permit clusters of failed adoption, with models of opinion updating (Friedkin, 2001) in which convergence to consensus is practically

inevitable in connected networks. We created a simple model in which we compare binary and continuous investment processes. Based on our simulations of this model, it was predicted that the phenomenon of local majorities where adjacent persons receive misguided information indeed hinder the diffusion toward optimal investments in a networked group predominantly in binary diffusion processes. Our results are in line with the prediction that local majorities hinder investments in the best option. Our results however are not in line with our other theoretical predictions: the binary process does not exhibit significantly less optimal investments with local majorities than the continuous.

When comparing the decision process among the clustered network 2 and the other three networks the negative effect of local majority is not significantly stronger in network 2 compared to the other networks jointly. When checking for a density effect we do observe that the proportion of points invested into the correct vase in the last decision round is significantly higher in the denser network 4 when compared to the less dense network 1. For policy makers it can be noted that it does not seem critical whether a decision process is binary or continuous. However, local majorities are problematic and we provide evidence that they hamper the spread of a correct investment.

The failure of our theoretical predictions might be related to the empirical decision process of human participants being more noisy than the simulated agents. The substantial level of deviations of the participants compared to was modelled prevents local majorities from locking in on a suboptimal behavior. On the other hand, it also slows down the diffusion to the optimal situation when no local majorities are present. Our macro level behavioral assumptions do not take into consideration that an initial bias favoring one of two options can survive over an extended period of further sampling (Harris et al., 2020). Similarly it has been shown that there is a form of noise in social networks that prevents populations reaching consensus, due to a endogenous noise where agents desire to maintain some uniqueness in their opinions and actions (Stern & Livan, 2021). Our experiment is sensitive to such forms of noise. Our simulations did not include any noise, but when we update our simulations to incorporate noise our new predictions fit better with the empirical observations and reflect the average proportion of points invested in the correct option per network, per condition and depending on local majority. Table A.3. in Appendix A.2 shows results for an updated simulation that includes decision noise. This table also illustrates that differences between conditions attenuate with noise, which might be an explanation that most predicted differences are not significant in the experiment.

A limitation to our research is that our data collection had months between experiments due to the corona epidemic forcing us to close the ELSE lab for several months in 2020 and 2021. Data collection started in October 2020 and took until October

2021. The experiment could not be too extensive and that was one of the reasons that we limited the number of decision rounds per game to four, while due to the noise in the process a longer period to reach consensus might have been illustrative. Future research should investigate if more power in the form of more participants playing and more rounds of investing within each decision game, could provide the continuous decision process more time for achieving homogenous adoption. Additionally, it would be interesting to observe which diffusion process is quicker in achieving homogenous adoption. Is binary quicker when people are well connected as it leaves no availability for ambiguous answers?

Chapter 3

ARE VISITS OF DUTCH ENERGY COACH VOLUNTEERS ASSOCIATED WITH A REDUCTION IN GAS AND ELECTRICITY CONSUMPTION? [1]

[1] A slightly different version of this chapter has been published as Schneider, P.T., van de Rijt, A., Boele, C., Buskens, V. Are visits of Dutch energy coach volunteers associated with a reduction in gas and electricity consumption? *Energy Efficiency*. 2023, 16, 42. Schneider carried out the investigation, wrote the original draft, and conceptualized the research and conducted the formal analysis. Boele, C. carried out preliminary analyses. All authors were responsible for the methodology and review & editing of the writing. For this study, we use existing data owned and provided by the housing cooperation !WOON.

Abstract

In a number of European countries, local municipalities, housing cooperatives, and citizen-based initiatives have been training energy coaches to help citizens improve the sustainability of their homes. These local volunteers offer an analysis of a citizen's home to advise on how to make it more sustainable, comparing citizens' consumption patterns with similar others'. While energy coaches are widely employed, evidence on the effectiveness of energy coaches and their approach is lacking. We collaborated with a housing cooperation that trains and provides tools for energy coaches in the Netherlands, comparing the electricity and gas consumption of households before the visit of a local energy coach and their consumption 1 year later. Our results suggest that the visit of an energy coach was associated with a reduction in energy consumption, but only for those who were told by the energy coach that they were consuming more energy than comparable others.

Keywords: energy coach; energy consumption; boomerang effect; social norms

3.1 Introduction

Reducing greenhouse gas emissions to mitigate the negative effects of climate change is a central objective of this generation and ingrained in the policy of the United Nations (United Nations, 2015). Many European countries such as the Netherlands are still largely reliant on the consumption of natural gas for cooking and heating houses (Dehullu, 2017), but want to drastically change this by 2050 (Ministry of Economic Affairs and Climate, 2019, 2020). Transitioning away from natural gas can seem complex and costly for households, however, the prior step of insolating and energy-efficiency investments specifically in the residential sector is less costly and provides several direct benefits. Still, despite financial incentives that shorten the payback period of energy-efficiency investments, increased home comfort and reduced environmental impact, the uptake of energy-efficiency investments in the residential sector remains too low, and most European countries like the Netherlands are unlikely to reach their goal to reduce their greenhouse gases by 49% in 2030 compared to 1990 (Ministry of Economic Affairs and Climate, 2019).

There are various reasons why citizens oppose the transitioning away from using gas for heating and cooking, with only one of them being that some citizens are afraid that the transition from natural gas to new energy sources will cost a lot of money (De Koning, Kooger and Casper 2020). The substitution of natural gas with alternative energy sources and the insolating of all homes requires the involvement and acceptance of citizens and businesses as they are the key to a successful neighborhood approach (De Koning, Kooger and Casper 2020). Municipalities have used strategies that build on research findings showing that feedback on energy consumption results in energy savings and awareness (Weiss and Guinard, 2010). However, there is also evidence that not all forms of providing feedback to household about their energy usage will result in substantial energy savings (Buchanan et al., 2015; Schultz et al., 2015). Providing energy usage feedback through smart meters or other in-home displays might be gaining global popularity, yet it seems vital to further investigate and develop feedback mechanisms that take into account user engagement and unintended consequences of feedback (Buchanan et al., 2015). Households might prefer information and cost-framed feedback, but these do not seem to lead to reduced energy usage, whereas normatively framed feedback does seem to reduce consumption (Schultz et al., 2015). Another popular way of providing feedback to residents is through training intrinsically motivated volunteers to help encourage others to behave more sustainably and equip them with the tools to give feedback on residents' consumption behaviors. Municipalities and housing corporations have been training and mobilizing volunteers to act as so-called energy coaches (!WOON, 2021).

A trained energy coach can give various sorts of advice on energy consumption, energy saving and investments, such as how to insulate a house (Bongers and Holtappels, 2019; Ozawa-Meida et al., 2017; Rotmans, 2011). Energy coaches can draw up a personal advisory report for the residents based on the data obtained by the energy coach during a home visit. This includes the energy consumption, the wishes of the residents and the condition of the house that the energy coach determines during the home visit (Bongers and Holtappels, 2019). These advisory reports include a wide range of information, such as possible investments in sustainability, subsidies for this and the time frame in which the investment could be recouped (Bongers and Holtappels, 2019).

Advice about the technical energy efficiency of a house is not new, as energy audits have been available and administered for decades. However, the uptake of such paid services has been low, although it was carried out by experts that focus on energy efficiency (Ingle et al., 2012). Relatedly, home energy efficiency investments have been considerably below levels that seem reasonable following a technological economic perspective (Ingle et al., 2012). Energy coaches provide their information in a less formal and more approachable situation as they are local volunteers trying to help and not professionals who need to earn money providing a service. While some energy coaches give advice on how adjustments in the home or behavioral changes can lead to lower energy consumption, other energy coaches also provide a comparison of the energy consumption of the inhabitants compared to that of other similar households (Bale, 2016; !WOON, 2021).

We argue that social comparison information may be critical for the success of energy coaches in lowering energy consumption. Given the vast amount of successful studies utilizing social influence in the field of pro-environmental behavior (Abrahamse and Steg, 2013), we want to investigate if the visits of energy coaches are associated with a decrease in energy usage and to what degree social comparisons play a role in this. Case studies in the field of marketing on domestic electricity consumption showing that feedback on electricity consumption for individuals as well as social norm feedback can lead to reductions of consumption of about three percent, suggest that individual feedback might be sufficient by itself and field experiments in the energy domain should be careful combining intervention elements as the impact of social norms information might be confounded with that of individual feedback (Harries et al., 2013; Vesely et al., 2022). Research from behavioral economics shows that non-monetary interventions such as social comparisons have the potential to significantly reduce energy consumption of private households, yet that it is crucial to evaluate the impact and effect sizes of such interventions before implementing policy interventions (Andor and Fels 2018). Similar meta-analyses of the effectiveness of incentivizing lower electricity consumption,

show that monetary, informational and behavioral incentives can achieve reduced electricity consumption, however they do not always produce significant effects and on average achieve 2-4% of energy reduction (Buckley, 2020). Our research on energy coaches contributes to this understanding by investigating a very popular energy saving program that has until now not been explored adequately. Although our study contains a convenience sample of self-selected households and does not have a control group, we think it is vital to explore the effect of social comparison information in this context. In particular, we argue that it is important to explore whether the limited effects of social comparisons might gain in effectiveness by energy coaches providing information to the right people who are interested in saving energy and by providing that information in a salient and personal way.

Besides the desired effect of residents consuming less energy when they are made aware of the fact that they are consuming more than comparable others, there is also an undesirable effect, which in the social comparison literature is called the 'boomerang' effect. The boomerang effect refers to individuals who are consuming below the norm and then adapt to the standard of similar individuals and thereby consume *more* energy (Rasul and Hollywood, 2012; Schultz et al. 2007, 2018). It seems therefore essential to not only look whether energy coach visits are associated with a general reduction in energy consumption but differentiate between residents initially consuming more and residents initially consuming less. The boomerang effect can easily be confounded with a 'regression to the mean' effect. A 'regression to the mean' effect refers to a common statistical phenomenon that, due to random variability, scores that are initially above average tend to decline and scores below average tend to go up again. Therefore, we do additional analyses to disentangle social influence effects from a regression-to-the-mean effect.

To evaluate the relationship between energy coaches and lower energy consumption we test the prediction that the change in consumption at least partially depends on the social comparison energy coaches provide to the resident. We use both smart meter data and hand-filled consumption of the electricity and gas consumption before a visit and after a visit of an energy coach. In the time span between 2017 and 2019, 3888 households signed up and were visited by such an energy coach. We do not have any demographic or profile information about the energy coaches nor do we know about their level of competence in the field of sustainability. Yet we know that the housing cooperation !WOON provided a mandatory one-day training on energy efficiency advice and how to use a certain tablet that helps to calculate individual home improvement advice. Additionally, !WOON provided the opportunity to get home improvement gifts such as LED lamps, so that anyone interested in becoming an energy coach could provide

the same valuable information and gifts to local households. Once an energy coach is trained they are asked to be available for a minimum of one hour per week to help other locals save energy. Of the 3888 home visits that took place in the cities of Amsterdam and Haarlem we received 467 gas or electricity measurements that will be discussed in the methods section. We investigate if utilizing energy coaches is associated with lower gas (m^3) and electricity (kWh) consumption of the households they helped one year after the visit. We differentiate between households that were told by the energy coach that they have been consuming more gas or electricity than comparable households and those households who were told by the energy coach that they have been consuming less gas or electricity than comparable households.

3.2 Theory

Energy coaches provide information on how to reduce energy consumption and when this information and advice is applied, then this should be noticeable in terms of reduced subsequent energy consumption. Several studies found that environmentally conscious attitudes have a positive impact on environmentally conscious behavior (Bissing-Olson et al., 2013; Clark, Kotchen and Moore, 2003; López-Mosquera, Lera-Lopez and Sanchez, 2015; Meinhold and Malkus, 2005; Zhang et al., 2020). Other research suggests that despite people having environmentally conscious attitudes, this does not lead to environmentally conscious behavior (Moser, 2015; Prati, Albanesi and Pietrantoni 2017), also known as *the attitude-behavior gap* (Peattie, 2010). Diekmann and Preisendörfer (2003) provide an explanation for this gap by arguing that costs are an often forgotten factor in attitude behavior research and can help to reduce the variation in correlations between attitude and behavior. Diekmann and Preisendörfer (2003) refer to costs more broadly: both costs in a financial sense and the cost of behavior. Behavioral costs refer to how much effort something takes to do (Hunecke et al., 2001). Examples of high behavior costs are the considerable time-taking and high cognitive load in processing complex information related to energy savings (Huang ,Wen and Gao 2020; Stern, 2011). Individuals are less likely to save energy when behavior costs are high (Steg, 2008). Following Diekmann and Preisendörfer's (2003) low-cost hypothesis, behavior is only explained by attitudes when acting upon these attitudes causes little cost and inconvenience to the individual. The effect of attitudes on behavior would therefore depend on the cost intensity of the situation: the higher the cost in behavior or money, the less people act on the attitude they have. According to the low-cost hypothesis of Diekmann and Preisendörfer (2003), individuals should save energy if behavior costs are reduced, as individuals with environmentally conscious attitudes are then more likely to

act according to their values. Assuming that many individuals undergoing the effort of signing up to get help with making their home more sustainable and energy efficient have high pro-environmental attitudes, the information, tips and tools provided by an energy coach should lead to lower energy consumption.

Energy coaches analyzed in this study are trained by the housing cooperation !WOON, that provides their energy coaches with an application on a tablet to register all characteristics relevant for energy consumption of the home they are visiting, to provide detailed technical energy efficiency advice. The energy coach is also allowed to give away products worth up to 20 euros that help saving energy like LED lamps and radiator foil. An energy coach could therefore be expected to be effective in reducing energy consumption by lowering behavioral costs, through providing residents with energy saving information. Specifically, we expect the associated decrease in time and effort needed to figure out how to make their house more sustainable as well as the associated aid in overcoming barriers, such as how feedback from tools like a smart meter can be applied to their specific home situation, to lead to more action to reduce energy consumption (Geelen et al., 2019; Huang et al., 2020).

Another crucial contributor towards behavior change and decision making is the interaction with other people in one's surrounding. Social norm theory explains this phenomenon where people are influenced by others (Parece et al., 2013). People look to other people to determine which behavior is acceptable and not acceptable and which behavior is most frequently displayed, to align their own behavior with it (Parece et al., 2013). Cialdini and Trost (1998, p. 152) define social norms as 'rules and standards that are understood by a group and that guide and/or limit social behavior without the power of laws'. Compelling standards are about what most people find suitable or unsuitable and affect people because they often involve social rewards or punishments (e.g. social exclusion; Voss, 2001). If someone is the only one in a neighborhood without solar panels on the roof, they can be socially excluded (Voss, 2001), and therefore try to avoid this by purchasing solar panels like the others. Normative social influence has been shown to cause substantial behavior changes in energy conservation when compared to other information to conserve energy, even though individuals themselves indicate that normative information is *not* an important driver of their own behavior (Nolan et al., 2008).

Given that energy coaches lower behavioral costs for people to lower their energy consumption as explained above and can provide a social comparison indicating that similar residents are consuming less energy, we hypothesize that a visit by an energy coach is associated with residents reducing their energy consumption:

H1a: A visit by an energy coach is associated with residents reducing their gas consumption.

H1b: A visit by an energy coach is associated with residents reducing their electricity consumption.

As part of the social influence dynamic we also need to consider the so-called boomerang effect. This effect is an unintended consequence of a descriptive standard, in which individuals who are below the norm adapt to the standard of comparable individuals and thereby consume *more* energy (Rasul and Hollywood, 2012). This boomerang effect has been found in several studies. For example, Schultz and colleagues (2007) found that it matters to whom information is given about descriptive standards. Giving descriptive standards to individuals with high energy consumption compared to average energy consumption led to a decrease in energy consumption. The opposite was found for individuals with lower energy consumption compared to the average. These individuals started to consume more energy (Schultz et al., 2007). Similar results have been found by Buchanan and colleagues (2015), where individuals started to consume more energy feeling free to meet the social norm, after seeing feedback on a display in the home that they consumed less energy compared to others.

The !WOON energy coaches we investigate provide the residents they visit with such a descriptive social standard, giving the resident a so called frame of reference of what is 'normal' (Handgraaf, De Jeude and Appelt 2013). More specifically, the energy coach fills in all characteristics of the house and the consumption data of the resident and then the tablet indicates whether the occupant consumes more or less than similar other households. The residents are therefore made aware whether they consume more or less energy compared to the norm, by the information of the tablet analysis and the assessment of the coach. Following this reasoning, we compare the group of residents that received the positive social comparison with those residents that received the negative social comparison. We predict the following:

H2a: Households that are told they are consuming more gas than a comparable household by an energy coach reduce their gas consumption, but households that are told they are consuming less gas than a comparable household will increase their gas consumption.

H2b: Households that are told they are consuming more electricity than a comparable household by an energy coach reduce their electricity consumption, but households that are told they are consuming less electricity than a comparable household will increase their electricity consumption.

3.3 Methods

3.3.1 Procedure

In order to test our hypotheses, we collected data about the energy coach project from the independent non-profit housing-foundation !WOON, which had organized 3888 energy coach home visits between 2017 and 2019. Trained energy coaches had been visiting interested households, until the corona crisis in 2020 made home visits less desirable and led to a decline in energy coach visits and prohibited further data collection with a fitting control group. The housing foundation !WOON promoted free visits from an energy coach, through flyers with a response rate of 6-8%, and Facebook and advertisements through the municipalities Amsterdam and Haarlem. After a resident had signed up for an energy coach a visit was scheduled. The housing foundation !WOON is independent and they provide information, advice and services like the energy coach program to all interested residents. The client base therefore is very diverse ranging from homeowners, renters up to people looking for housing. However, the households that participated in the energy coach program might be particular in the sense that they were interested in saving energy. As a result, they do not necessarily form a representative sample of Dutch household along dimensions such as energy consumption, income, or any other relevant parameter. Households were selected to get help by an energy coach on a first-come-first-serve policy, without any further selection criteria. During such a visit by an energy coach the resident would share information about the state of their house and the resident's consumption behavior. The energy coach entered this information into a tablet that is provided by !WOON. Besides combining all possible savings options together into a savings report in possible m^3 saved for gas and kWh for electricity consumption, the energy coach would also provide a comparison of the current household's consumption to that of similar comparable households in terms of number of inhabitants (electricity) and housing type (gas). This comparative score was calculated by taking into account the average gas consumption score of the applicable housing type, the average gas consumption of the city of the household and the national average gas consumption (details in Appendix B). For electricity consumption the comparative score was calculated by using the household size of a household, the average electricity consumption of the city of the household and the national average electricity consumption (details in Appendix B). Note that an actual questionnaire was not part of the energy coach visit and such a questionnaire would probably have made the participation more selective. Therefore, we do not have detailed additional data on the visited households on other types of behaviors, attitudes, etc.

After the home visit, the energy coach sent the savings report to the household, and when given permission, the tablet data was sent to the foundation !WOON. The new consumption data can be used to make a comparison with the old consumption data. Gas

and electricity consumption was measured in the months of January, February, and March of the years 2018 and 2019. As a benchmark, we consider the change in energy consumption that occurred between 2017 and 2018 in overall Dutch energy consumption. According to the CBS (2022) differences in energy consumption between 2017 and 2018 were relatively small. The average gas consumption increased from 1240 m^3 to 1270m^3 in these two years, which is an increase of 2.4%, while the electricity use decreased from 2860 kWh to 2790 kWh, which is a decrease of 2.5% (CBS, 2022). In comparison to the other 26 European member states in the year 2019, the Netherlands is one of the larger energy consumers of the EU with the highest percentage of gas used for space heating at 84.9% and electricity, with renewables and waste only accounting for 2.5% and 8.5% (Eurostat, 2021).

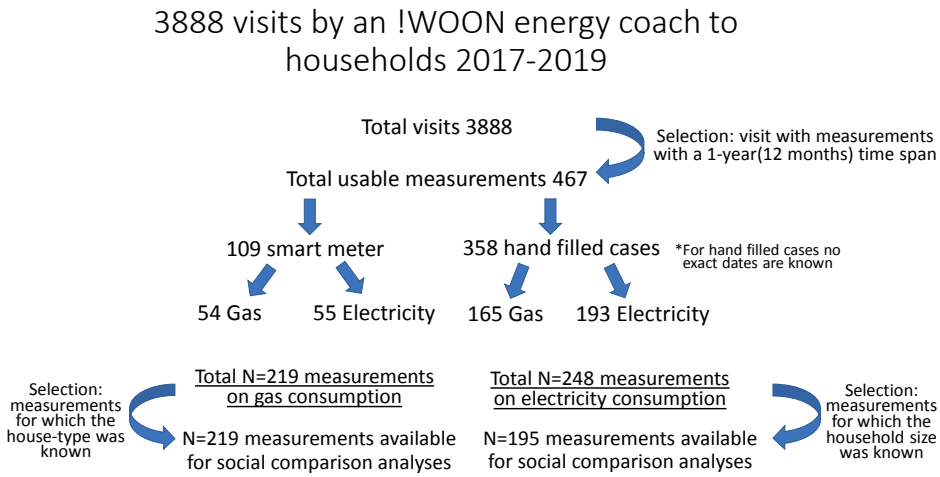
3.3.2 Participants

From the total of 3888 visits the housing cooperation !WOON had organized, we were able to construct a sample of 467 cases. Each case is a household for which either gas or electricity is measured. If we have both gas and electricity measurements, the respective household is included in the sample twice. Figure 3.1 shows how we arrive at our ultimate sample of 467. For 109 cases (54 gas and 55 electricity), energy consumption in both years was directly derived from smart meters. The reason this number is so low is twofold: many households did not give permission to use smart meter data, and for some that did give permission, the energy company had technical problems reading out the smart meter. For the remaining 358 measurements (165 gas and 193 electricity), old consumption scores were filled in by hand by the energy coach and self-reported by the household to !WOON. Our sample of 467 cases combines these 358 cases with the 109 smart meter cases. The 467 cases consist of 219 gas comparisons and 248 electricity comparisons.

A weather-corrected analyses is not possible as it is only known that there was 1 year between the old and new consumption measurements, yet the specific dates of measurements were missing for the hand-filled data. Gas consumption varies depending on the severity of the winter, and ideally, if the comparison months would have been known for more than 54 cases, weather degree days could have been accounted for. We do not have demographic information about the home owners and therefore cannot analyze how representative our sample households are of Dutch households in general. We thus do not know how sample selection limits representation of the wider population of Dutch households. For the social comparison hypotheses, we need to consider the household size for the electricity measurements and the type of house for the gas measurements, so that we are able to check what sort of social comparison they received. The Appendix shows the formulas provided by !WOON that show how the comparison scores were calculated by the energy coach app to tell a resident if their gas or electricity

consumption was higher or lower than that of comparable consumers. We miss this information for 53 households to do the social comparison on electricity consumption. So, for these analyses, we only have 248 − 53 = 195 cases. We know that of these 195 cases, most are apartments 161 (82.6%), followed by 18 (9.2%) corner houses, 10 (5.1%) terraced houses, and 1 (0.5%) detached house. Of these 195 cases, 104 (53.3%) households consisted of single person, followed by 58 (29.7%) two-person households, 24 (12.3%) three-person households, 6 (3.1%) four-person households, and 3 (1.5%) households with five inhabitants. For the gas measurements, we do not know household size, but only the type of house. Of the 219 cases, 153 (69.9%) are apartments, followed by 40 (18.3%) terraced houses, 24 (11%) corner houses, and 2 (0.9%) detached houses.

Figure 3.1 Overview of what data was collected and when.



The results section contains both the smart meter and hand-filled cases. An overview of the descriptive statistics can be seen in Table 3.1. Table 3.1 shows that the reduction in gas is 8.4%, while the reduction in electricity consumption is 6.3%. This decrease in gas consumption is realized although the average household gas consumption in the Netherlands increased by 2.4 percent between 2017 and 2018 mentioned above (CBS, 2022). The 6.3% decrease in electricity consumption that we observe is substantially larger than the 2.5% decrease in electricity consumption that occurred in the Netherlands between 2017 and 2018. The data also show that the participating households used less energy than average Dutch households in those years, which indicates some selectivity in the sample from the average Dutch household. The minimum value of − 14329.2 kWh for new electricity consumption indicates that there are households with solar panels who ended up with negative net consumption as they gave back more to the electricity grid than they consumed.

Table 3.1 Descriptive statistics on energy consumption before and 12 months after the visit of the energy coach

	Mean	Median	SD	Min.	Max.	25%	75%
Gas (m^3) (n = 219)							
Old consumption	1014.0	858.0	638.9	18.0	3762.0	549.0	1329.5
New consumption	928.2	799.9	570.5	2.8	3146.4	545.2	1199.7
Difference old and new consumption	-85.8	-55.7	393.3	-1820.3	2626.4		
Electricity (kWh) (n = 248)							
Old consumption	1991.6	1723.8	1178.5	3.0	7853.0	1183.3	2568.2
New consumption	1865.9	1682.3	1516.7	-14329.2	8207.1	1146.6	2457.0
Difference old and new consumption	-125.8	-39.1	1243.8	-17116.2	2966.5		

3.3.3 Analytical approach

The energy consumption data is not normally distributed: the old and new gas consumption scores show right-skewed distributions with some outliers having high gas consumption scores. The old and new electricity consumption scores also show right-skewed distributions with some outliers with high electricity consumption scores before and after the visit of an energy coach. There are also some cases of negative electricity consumption, presumably due to solar panels feeding electricity to the grid. After log transformation—where we deal with negative values using f(x)=sign(x)*ln(abs(x))—our distributions of energy readings still exhibit significant deviations from normality. We therefore conducted non-parametric Wilcoxon signed-rank tests in addition to t-tests. We report both in order to show that our results mostly do not depend on the choice of test. Specifically, for testing the first and second hypothesis, we perform non-parametric Wilcoxon signed-rank tests and show the one-sided paired sample t-tests comparing gas and electricity consumption before and after the energy coach visit. We provided the 90% confidence intervals in line with the $\alpha=0.05$ one-sided tests. All results of the tests can be found in Table 2. For both the first and second hypotheses, we conduct one-sided tests following our theory that provides one-sided predictions. This implies that we treat small non-significance in the expected direction as well as large differences in the unexpected direction similarly as lack of evidence for our theoretical predictions. For testing the second hypothesis on the boomerang effect, we also perform non-parametric Wilcoxon signed-rank tests and show the one-sided paired sample t-tests comparing gas and electricity consumption for these two different groups before and after the energy coach visit, which can be found in Table 3.2.

We do not have data on installations of solar panels, improved energy efficiency, nor on other socio-technical changes such as changes in work or household size that may

have occurred within the 12 months after the visit of the energy coach that could have affected the energy usage. We are therefore not able to consider such aspects and have to base our analyses on comparing the imported energy consumption data we have. We focus on straightforward comparison of the energy use before and after the energy coach visit, but only distinguish above- and below-average users. We do not use the type of house nor household size as covariates in our analysis because there are too few cases for drawing type- or size-specific conclusions. Given that we do not have a control group of similar residents and can only refer to the national average consumption scores, we are limited in our causal interpretation of effects based on a comparison of pre- and post-measurement of energy consumption. In the discussion, we go into more depth as to how our analyses may be extended to arrive at firmer conclusions.

3.4 Results

Table 3.2 provides an overview of the results that will be discussed below.

Table 3.2 Comparisons of gas and electricity consumption before and after the visit of an energy coach

	Mean old	Mean new	Mean diff. *CI* 90% (*t*)	SD old	SD new	*t*	Non-parametric(*Z*)
Gas (m^3) (n = 219)							
General difference old and new consumption (*n* = 219)	1014.0	928.2	-85.8 [-129.7, -41.9]	638.9	570.5	-3.23***	-3.99***
Difference in consumption for above-average consumers (*n* = 113)	1421.4	1195.5	-225.9 [-288.4, -163.4]	610.4	562.5	-5.99***	-6.21***
Difference in consumption for below-average consumers (*n* = 106)	579.7	643.2	63.5 [11.0, 116.0]	284.7	423.5	2.01*	1.70*
Electricity (kWh) (n = 248)							
General difference old and new consumption (*n* = 248)	1991.6	1865.9	-125.8 [-256.2, 4.6]	1178.5	1516.7	-1.59#	-2.43**
Difference in consumption for above-average consumers (*n* = 77)	2933.9	2462.6	-471.3 [-865.3, -77.3]	1071.9	2277.5	-1.99*	-3.76*
Difference in consumption for below-average consumers (*n* = 118)	1255.7	1250.4	-5.3 [-54.5, 43.9]	447.6	436.2	-0.18	-0.82

#*p* <0.10, **p* < 0.05, ***p* < 0.01, ****p* < 0.001 (one-sided)

3.4.1 Difference between old and new energy consumption after an energy coach visit

New gas consumption (n=219) 1 year after the visit of an energy coach was on average lower than old gas consumption prior to the visit (ΔM = −85.8, CI 90% [−129.7, −41.9], t(218) = −3.23, p < 0.001, Z = −3.99, p < 0.001), so gas consumption significantly declined. This decline of 8.4% corresponds to a Cohen's d of −0.218 suggesting a small effect size. This supports H1a.

New electricity (n=248) consumption is lower than old electricity consumption (ΔM = −125.8, CI 90% [−256.2, 4.6], t(247) = −1.59, p=0.056, Z = −2.43, p=0.008) so electricity consumption did not significantly decline according to the t test but did significantly decline according to the Wilcoxon test. This provides mixed support for H1b. The decline of 6.5% corresponds to a Cohen's d of −0.101 suggesting a small effect size.

3.4.2 Social comparison related changes in gas consumption

For households with above-average gas consumption, there was a significant decline in the scores between their old gas consumption and new consumption (ΔM = −225.9, CI 90% [−288.4, −163.4], t(112) = −5.99, p < 0.001, Z = −6.21, p < 0.001). This indicates that this group of residents whom were told that they were doing worse than comparable other households with regard to gas consumption reduced their gas consumption. This decline of 15.9% corresponds to a Cohen's d of −0.56, which indicates a medium-sized effect. For households with a below-average gas consumption, there was a marginally significant increase in consumption from their old gas consumption to their new consumption (ΔM=63.5, CI 90% [11.0, 116.0], t(105)=2.01, p=0.027, Z=1.70, p=0.046). This increase of 11.0% corresponds to a Cohen's d of 0.20 indicating a small effect size. This shows that this group of residents whom were told that they were doing better than the rest with regard to gas consumption increased their gas consumption. Figure 2 illustrates these differences in gas consumption changes between the two types of households. Figure 3.2 below illustrates the difference of the gas consumption before (blue) and after (red) the energy coach visit, between the two types of households.

3.4.3 Social comparison related changes in electricity consumption

For above-average consuming households in terms of electricity, there was a significant decrease in consumption between their old electricity consumption and new consumption (ΔM = −471.3, CI 90% [−865.3, −77.3], t(76) = −1.99, p=0.025, Z = −3.76, p < 0.001) which also can be seen in Fig. 3.3. This indicates that the above-average consuming households reduced their electricity consumption. This decline of 16.0% corresponds to a Cohen's d of −0.23, which indicates a small-sized effect. For below-average consuming households, there was no significant difference between their old electricity consumption and new consumption (ΔM = −5.3, CI 90% [−54.5, 43.9], t(117) = −0.18, p=0.429, Z = −0.82, p=0.207).

Figure 3.2. Gas consumption comparison of residents below average (left panel, n = 106) and above average (right panel, n = 113) gas consumption, and before (blue) and after (red) the energy coach visit.

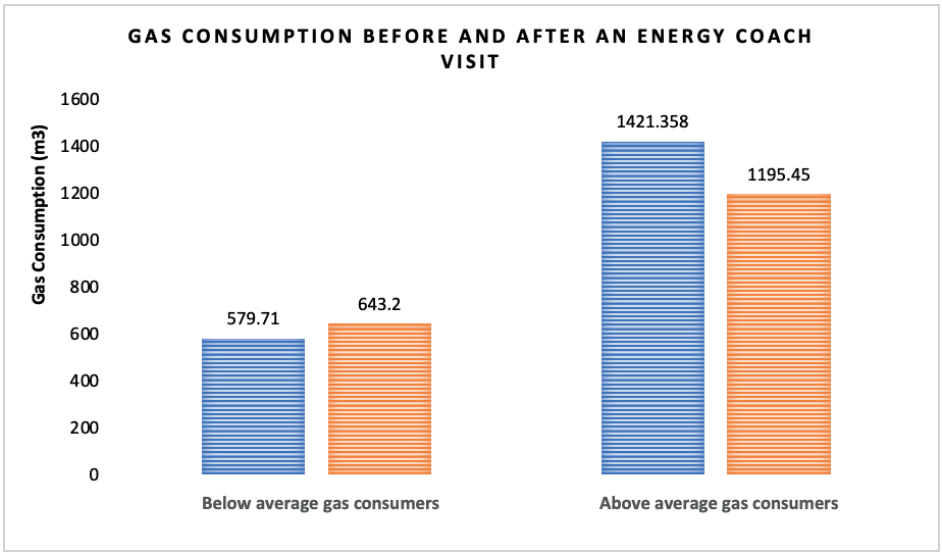
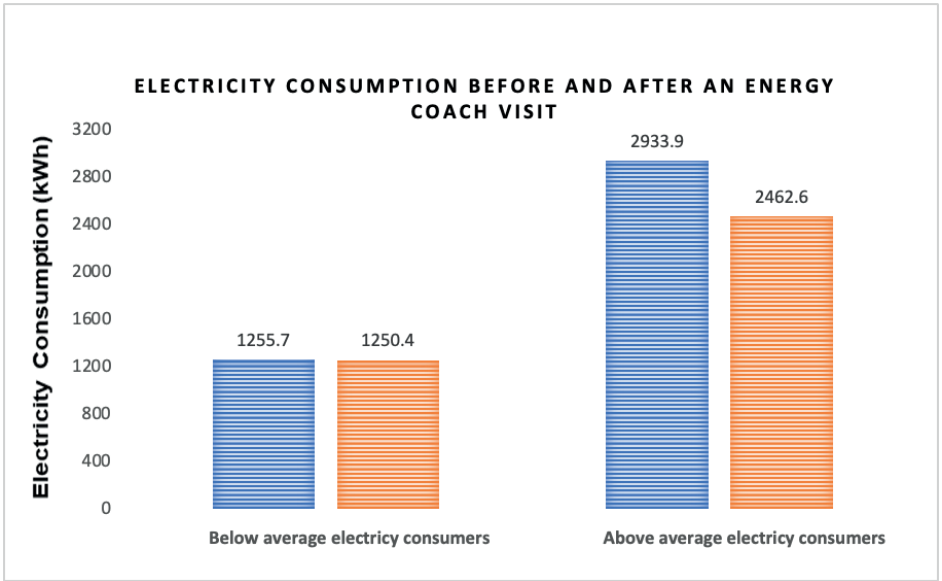


Figure 3.3. Electricity consumption comparison of residents consuming below average (left panel, n = 77) and above average (right panel, n = 118) electricity, before (blue) and after (red) the energy coach visit.



3.4.4 Accounting for regression to the mean

The differences in consumption change between above-average and below-average consumers provide tentative support for our social comparison hypotheses 2a and 2b. However, an alternative interpretation of Figures 3.2 and 3.3 is regression-to-the-mean: consumption deviations from the mean in any year may be for reasons specific to a household in that particular year, e.g., living half a year abroad, or due to measurement error. In these cases, above-average consumption households would be expected to see consumption reduced in 2018 also without an energy coach visit. Vice versa, below-average households would then be expected to increase consumption also without an energy coach. To disentangle regression-to-the-mean from a social influence effect, we tested whether the variance in consumption differed before and after the visit of the energy coach. If we assume that adaptations in gas and electricity consumption are occurring just due to a regression to the mean, we would expect the variance both for gas and for electricity to be similar at both time points.

We measured changing variance in energy use using the interquartile range, the distance between the 25th and 75th percentile. The interquartile range, which can be seen in Table 1, decreased for both gas (−126 m3) and electricity (−148 kWh). We then conducted Levene's tests for equality of variances. The first Levene's test failed to reject the hypothesis that the variances of the 219 gas consumption measurements before the visit of an energy coach and the 219 gas consumption measurements after the visit are equal ($F(1,436)=2.42$, $p=0.121$). For the Levene's test for electricity, we leave out the two outliers with negative values for the new consumption. Including these values further increases variance in new consumption. Again, the Levene's test fails to reject the null hypothesis that the variances of the 246 electricity consumption measurements before the visit of an energy coach and the 246 electricity consumption measurements after the visit are equal ($F(1,490)=1.08$, $p=0.299$).

3.5 Conclusion and discussion

3.5.1 Discussion

Our results summarized in Table 3.2 indicate that energy coaches are associated with lower energy consumption. By comparing the general electricity and gas consumption of households before the visit of a local energy coach and their consumption 1 year later, we find that both gas and electricity consumption decreased substantially and significantly, with the exception of electricity consumption when evaluated using a t test. One year after the visit of an energy coach gas consumption declined by −8.4% and electricity consumption by −6.3%. These findings support hypotheses 1a and 1b.

These changes for this select group of people who signed up for an energy coach session are considerably larger than the changes in the average Dutch population (CBS, 2022). The somewhat clearer decreases in gas consumption vis-à-vis electricity consumption might be attributed to financial incentives leading households to be more focused in changing their gas consumption, as this can help save hundreds of euros annually in the Netherlands, compared to rather low electricity bills.

Table 3.2 further shows that residents that were told that they were doing worse and consuming more energy than comparable other households, reduced their gas and electricity consumption. On the contrary, residents that were told that they were doing better than similar others with regard to gas and electricity consumption did not show a decrease in energy consumption. For gas consumption, we even found a small increase of consumption after households heard they used less than comparable other households. These findings support hypotheses 2a and 2b and the theory that social comparisons with worse-performing others lead to boomerang effects. The support is very tentative, however, as we could not rule out that increases in consumption by households who were initially below-average were not simply an artifact stemming from the statistical tendency for observations to revert back to the mean. Our analysis comparing variance in consumption among households before and after the visit by an energy coach failed to clearly identify social comparison effects above and beyond regression-to-the-mean.

3.5.2 Conclusion

Our study indicates that the visits of energy coaches are associated with a decrease in energy use. As expected, we do find different changes in energy consumption dependent on the social comparison information that residents received. However, our evidence is tentative, and further study is required for assessing their effectiveness at aiding households to decrease their energy consumption. Several limitations in particular should be considered and taken up as challenges to be addressed in future research. These limitations include the small amount of usable data. Due to the corona crisis, a second wave of data collection could not take place, as the energy coach project relies on home visits to provide the personal energy consumption advice.

A second limitation is the lack of a good control group. Our use of national averages provides a poor benchmark. We cannot rule out that comparable households that were not visited by an energy coach did not also see declines in energy. A control group in the form of households that do not receive guidance from an energy coach would be a major improvement for future research, because self-selection into participation might lead to an overestimation of the effects. For example, people might have signed up for a visit by

an energy coach in anticipation of changing their energy consumption. Such individuals may have used less energy for heating even if the energy coach would not have provided them with guidance. However, this would not explain consumption changes that depend on social comparison information provided by the energy coach: those interested in learning how to save more energy through the visit of an energy coach did not achieve the intended improvements if the coach told them they were already doing better than average.

Third, we drew heavily on self-reported energy consumption data which raises reliability concerns. Using only smart meter data would be another improvement as they provide reliable information on energy use over time and ensure that one can correct for weighted heating degree days.

A fourth limitation is our inability to correct for weighted heating degree days between the years of measuring. Nonetheless, as mentioned previously, the difference in gas and electricity consumption between 2017 and 2018 were relatively small (CBS, 2022), and since natural gas consumption in the Netherlands has been fairly stable for the years 2017, 2018, and 2019 (CEIC, 2021), we expect that the weather differences did not affect our results substantially.

One avenue for future research is the possibility of changing the reference point in social comparisons, that is, to change what peer or what standard a household is compared with. Possibly, comparing households to the most sustainable rather than the average neighbor or to those that have reached municipal sustainability goals could incentivize more energy savings and might also motivate below-average energy consumers to save even more.

Another possible direction for future research is to explore household-type and size-specific effects. This will require more comprehensive data, but would allow researchers to include covariates and investigate whether effects of an energy coach visit differ depending on household size or type of house. Similarly, future studies could conduct comparisons with energy programs in other EU states.

Future research testing social comparison hypotheses will likely need a larger sample of participants to allow differentiation from "regression to the mean" effect. Assessing the effect of being told one is above instead of below-average in consumption requires excluding the possibility that changes in energy consumption consistent with social comparison theory are actually just due to random variations leading scores that are initially above average to naturally decline and scores below average to go up. One approach that requires sufficient numbers of cases near the threshold of average consumption is a regression-discontinuity design, in which the discontinuous effect of

a social comparison treatment is separated from the continuous effect of pre-treatment consumption on post-treatment consumption (Allcott, 2011).

Given the current energy crisis, it seems important to also look into the problem of energy poverty. We do not have any data on the financial situations of the households that participated in the energy coach program; however, future research may be able to investigate if normative comparisons could also lead to wanted increases in energy consumption. Households who are currently under heating their homes could be prompted through social comparisons into increasing their heating. By highlighting that such residents are consuming less energy than the norm they might be inclined to increase their energy consumption. Being able to find a way to stimulate more heating among residents that are currently underheating their homes could help to avoiding health risks associated to underheating.

Chapter 4

HOW DO SOCIAL COMPARISON ORIENTATION AND SOCIAL CONNECTEDNESS RELATE TO SOCIAL NORMS ON ELECTRICITY CONSUMPTION AND ENVIRONMENTAL CONCERN [1]

[1] This chapter is based on a paper written by P.T. Schneider and V. Buskens. It has been submitted to an international peer-reviewed journal. Schneider wrote the manuscript and did the data analysis. Buskens contributed towards the methodology, review and editing of the writing. For this study, we used existing data by Bruderer Enzler, Diekmann and Liebe (2019). Our code is available at https://osf.io/kx85d.

Abstract

This study delves into the relationships between social norms, social connectedness, and social comparison in influencing individuals' pro-environmental attitudes and electricity consumption. The two types of social norms that function as unspoken rules shaping societal conduct regard what one ought to do (injunctive) and the behaviour that certain amount of people are displaying (descriptive). Recognizing the significance of individual variations in social comparison orientation and social connectedness within communities, we inspect their roles in adherence to injunctive and descriptive norms relating to pro-environmental attitudes and electricity consumption. We analyse data from a comprehensive survey encompassing 1050 participants in the German-speaking region of Switzerland, coupled with electricity consumption records. The survey contains questions exploring social connectedness, social comparison orientation, and environmental concern. Noteworthy findings emerge illustrating that heightened social comparison orientation correlates positively with an increased sense of environmental concern. Furthermore, individuals exhibiting higher social comparison orientation demonstrate environmental concern levels akin to those with comparable household and house sizes. Similarly, enhanced feelings of local social connectedness are linked to higher levels of environmental concern. No significant association was recognized between descriptive norms of environmental concern and heightened levels of social connectedness. Unexpectedly, we did not observe the anticipated correlations between social comparison orientation, social connectedness, and electricity consumption. These results suggest that while social norms exert substantial influence in shaping attitudes, their impact may be more nuanced in driving costlier behavioural changes. Consequently, relying solely on social norms may prove insufficient in catalysing substantive alterations in actual environmental behaviour.

Keywords: Social norms, social connectedness, social comparison orientation, pro-environmental attitudes and electricity consumption.

4.1 Introduction

Social norms, important for organizing social behavior and understanding different kinds of cooperative behavior, are one of the most interdisciplinary researched concepts in the social sciences (Bicchieri, 2006; Cialdini & Jacobson, 2021; Elster, 1989; Przepiorka et al., 2022). People's attitudes and behaviors are influenced by two distinct forms of social norms, namely injunctive norms, which refer to what most other people approve or disapprove and descriptive norms, which refer to what most other people do (Cialdini et al., 1990). Injunctive norms can be used to stimulate attitudes and behaviors that reflect what ought to be done, whereas descriptive norms stimulate the adoption of average attitudes and behaviors (Cialdini et al., 1991).

Personal and social factors can have a direct influence on pro-environmental concern and behavior, such as education, political views, age, gender, religion, social class. etc. (Gifford & Nilsson, 2014). In addition, the strength of the effects of injunctive and descriptive social norms on pro-environmental attitudes and behavior depends on personal and context-related aspects (Saracevic & Schlegelmilch, 2021). A large body of research has examined the relationship between social norms and sustainable behavior, yet research on how social factors might moderate this so-called "norm-sustainability" relationship remains scarce (Saracevic & Schlegelmilch, 2021). Such moderators can help explain unaccounted-for empirical variability as to why some people favor doing altruistic pro-environmental actions while others chose more self-interested behaviors (Chuang et al., 2016). For example, individuals with a interdependent self-construal, who view their close relationships and group membership as central to their self might be more effected by the norms in their social context than individuals with an independent self-construal (cf. Chuang et al. 2016). Researching moderating social factors is important from a theoretical perspective as it can offer a better understanding of how and why certain social norms affect sustainable consumer behavior (Saracevic & Schlegelmilch, 2021).

Saracevic and Schlegelmilch (2021) investigated the moderators' culture and self-construal, which refer to how individuals define themselves, and showed that the influence of injunctive and descriptive social norms on pro-environmental attitudes and behaviors depends on whether the individual or collective self is activated. We aim to examine moderators related to the social network of people. We investigate if the strength of social norms specifically depends on how strongly people are influenced by others around them. We argue that the extent to which people are influenced depends on two factors, first to what extent are people *connected* to others who can induce their norms upon them and, second, the more personal property of social *comparison* orientation: to

what extent do people let themselves be influenced? Are those who are more connected to their social network and those who compare themselves more with others more susceptible to descriptive or injunctive norms?

We not only examine attitudes but investigate both real-world objective behavior in combination with attitudes. We analyze data by Bruderer Enzler, Diekmann and Liebe (2019) that include self-reported environmental concern scores derived from a survey on energy usage conducted in 2016 in the German speaking part of Switzerland, as well as the actual metered electricity consumption of these participants. A clear majority of 82% of Swiss people have been found to view the mediatization of environmental issues as justified or something that should be done more given the dangers of climate change (Statista, 2019). Therefore, it seems fair to assume that there is a majority of Swiss that support the notion that more ought to be done with regards to pro-environmental behavior. This results in the following research question: Do people who feel more connected to their social network and those who compare themselves more with others, have higher levels of environmental concern and pro-environmental behaviors and to what extent do their attitudes and behaviors become more like the average of the people around them?

In the next section we elaborate on our theoretical reasoning and predictions for the associations between social comparison orientation and social connectedness with environmental concern and electricity consumption. Before we show the results of these analyses we elaborate more on our dependent and independent variables. After presenting our findings we conclude with policy advice and acknowledge the limitations of our study and give recommendations for future research.

4.2 Theory

4.2.1 Social comparison orientation and social connectedness

Social comparison is the process of comparing one's own opinions, capabilities and behaviors with those of others (Festinger, 1954). The perspective of individual differences in social comparison processes argues that people do not only compare themselves with others but vary in amount and frequency in which they compare themselves with others (S. M. Schneider & Schupp, 2014). People who compare themselves more with others are said to have higher levels of social comparison orientation (SCO) which is related to higher levels of empathy and lower self-esteem (A. P. Buunk & Gibbons, 2007). Students for example with higher levels of SCO saw drinking and driving as less risky and drank and drove more themselves the more common they thought it was amongst other students, whereas for students with lower levels of SCO there was no relationship between others' perceived behavior and their own risks and behaviors (Gibbons et al., 2002).

People who care more about social comparison information tend to comply more with behaviors when there is more normative pressure (Bearden & Rose, 1990). Research that follows Festinger's social comparison theory (1954) has shown that older adults report lower levels of social comparison tendencies (Callan et al., 2015). More autonomous people often behave more in accordance with their own interests and values, whereas less autonomous people tend to act more according to perceived outside expectations (Neighbors & Knee, 2003). Furthermore, higher levels of SCO have been shown to be associated with higher levels of association with role models resulting in more prosocial behavior (Lockwood & Kunda, 1997). Yet until now there seems to be no comprehensive investigation of the moderating effects of SCO on the relationship between norms and pro-environmental behavior. People with higher levels of SCO could be more motivated to act more prosocial as they are said to have higher levels of empathy, interest in others' needs and feelings (A. Buunk & Gibbons, 2005). However, people who compare themselves more with others can also be more susceptible to descriptive norms, adopting perceived majority opinions as well as behaviors (A. Buunk & Gibbons, 2005). To the authors' knowledge it remains unknown if those with higher levels of SCO are more susceptible to injunctive or descriptive norms?

People who compare themselves more than others should also compare themselves more on the important topic of environmental issues (Petkov et al., 2011), and as a result have more knowledge about the subject (Gibbons & Buunk, 1999). Given the increasing importance of environmental issues and the extensive literature that shows that people compare their pro-environmental behaviors (Abrahamse and Steg 2013; Allcott 2011; Steg 2008), we also argue that people compare themselves on pro-environmental attitudes and behaviors. It is expected that increased levels of SCO are positively associated with the extent to which norms are followed, however it remains unknown which social norms are followed more.

It is important to distinguish between injunctive norms and descriptive norms, when examining what kind of comparisons people make, as the impact of these norms can otherwise be unrecognized (Cialdini et al., 1990). The injunctive norms reasoning suggests that hearing and knowing more about environmental issues leads to more environmental concern and pro-environmental behavior. As those are the attitudes and behavior one is supposed to have and do against the climate change related problems. The descriptive norms reasoning suggest that it is not important what concerns or behaviors a person ought to have or do. Rather the actual behaviors and concerns of others are influential and predicative of peoples own environmental concern and pro-environmental behavior. It is therefore vital to differentiate between these two forms of norms as they predict different effects of SCO.

Another socio-psychological factor that might be associated with environmental concern and pro-environmental behavior are levels of social connectedness. Community attachment can encourage environmental behaviors (Pradhananga et al., 2021). Studies that have drawn on social identity theory, argue that individuals' identification with a community or nation can strengthen their solidarity and empathy to act in favor of the environment (Brieger, 2019). A need for membership of a community can result in pro-environmental attitudes and engagement with sustainable community projects (Broska, 2021). It is therefore important to not only examine if levels of SCO are associated with environmental concern and pro-environmental behavior, but also investigate how levels of social connectedness influence this relationship, as a social network can play a crucial role in subordinating ones individual benefits to a public good (Flache, 1996).

When reducing electricity consumption is mostly done to aid the environment and not because of financial reasons, this action becomes a social dilemma. One wants to help preserve the environment, which can be seen as a public good, yet this comes at the expense of personal comfort. Flache (1996) explained that within a social network social cohesion increases the willingness of individuals to think about the others and the public good, resulting in more pro-social behavior when people feel higher levels of connectedness. Reversely, the drawback of close social networks is that they can become self-sufficient when the appreciation from the members for each other undermines the drive to do something for the public good resulting in tight social networks doing even less for the public good (Flache, 1996). Social connectedness can therefore encourage pro-environmental behavior, yet higher levels of social connectedness can also lead to a tight social network that prioritizes its own members desires, above those of others.

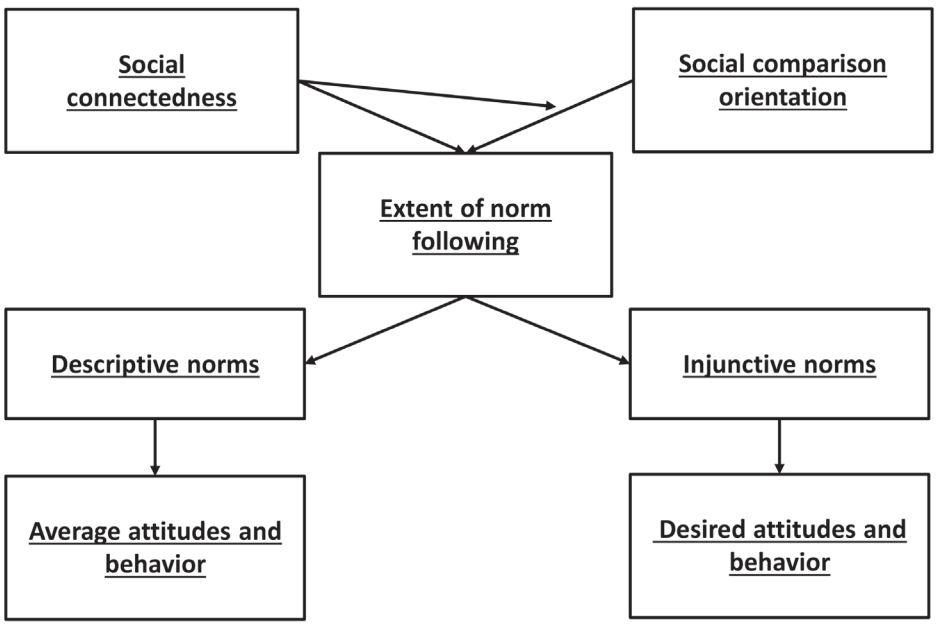
To be able to decipher how levels of social connectedness are related to environmental concern and pro-environmental behavior, we again distinguish between the influence of injunctive norms and descriptive norms. Do people with higher levels of social connectedness have a higher desire to have similar environmental attitudes and behavior such as electricity consumption? Or do their attitudes and behavior reflect what they and the community they identify with should be doing?

Recent research suggests that people are more likely influenced by descriptive norms when deciding whether to take a risk themselves, yet rely on injunctive norms when making recommendations to others (Zou & Savani, 2019). When asked what one should do, people answer according to what they think is viewed as the most appropriate by their peers, however, descriptive norms tend to play a bigger role in influencing peoples own decisions (Zou & Savani, 2019). The available research does therefore not provide a clear indication if higher levels of SCO or higher levels of social connectedness among

individuals would follow an injunctive or descriptive norms reasoning. This makes it important to investigate these predictions separately. We do not formulate competing hypothesis as both types of norms can also affect attitudes and behavior simultaneously. A push towards higher levels of environmental concern and lower electricity consumption can be strengthened or weakened by a tendency of becoming more like the average. This can occur for both people that compare themselves more with others as well for those that have higher level of social connectedness. For example, the difference in environmental concern from those people that have little SCO to those with a lot of SCO could be such that there is an increase in environmental concern from those who have below average environmental concern and little change from those who have above average concern. Resulting in those with higher level of SCO having both higher as well as more average scores overall than those with lower levels of SCO. The same principle can occur for social connectedness and in reverse for electricity consumption.

Figure 4.1 below summarizes our reasoning for our following 6 hypotheses. It illustrates the conceptual model in which we argue that both social connectedness and SCO are positively associated with the extent of norm following. We investigate to what extent higher levels of social connectedness and SCO are associated with an increased norm following of descriptive or injunctive norms.

Figure 4.2. **Moderators effects on the norm following of injunctive or descriptive norms.**



Following this conceptual model we get two strands of hypotheses. The injunctive norms reasoning hypotheses and descriptive norms reasoning hypotheses. The injunctive norms hypotheses are based on the argument that having higher levels of SCO or social connectedness lead to higher levels of environmental concern and pro-environmental behavior. We focus the hypotheses on environmental concern and lower electricity consumption specifically as those are directly related to the concrete measurement we have from our data.

Our first set of hypotheses focuses on the associations related to injunctive norms.

H1a: Higher levels of SCO are associated with more environmental concern.

H1b: Higher levels of SCO are associated with less electricity consumption.

H2a: Higher levels of social connectedness are associated with more environmental concern.

H2b: Higher levels of social connectedness are associated with less electricity consumption.

The descriptive norms hypotheses are based on the argument that people who are more socially connected to their neighborhood and/or those that compare themselves more with others should be inclined to have attitudes and behavior more like the average of the people around them. As indicated above, both injunctive and descriptive norms can be influencing the attitudes and behaviors simultaneously.

In the methods section we explain in more detail how we calculate the absolute average scores of environmental concern and electricity consumption to examine to what extent increases in social connectedness and SCO are related to more average attitudes and behaviors. Our second set of hypotheses focuses on the associations related to descriptive norms.

H3a: Higher levels of SCO are negatively associated with the difference between environmental concern and **average** environmental concern.

H3b: Higher levels of SCO are negatively associated with the difference between electricity consumption and **average** electricity consumption.

H4a: Higher levels of social connectedness are negatively associated with the difference between environmental concern and **average** environmental concern

H4b: Higher levels of social connectedness are negatively associated with the difference between electricity consumption and **average** electricity consumption.

Lastly, we formulate interaction hypotheses based on the argument that higher levels of social connectedness are positively related to the extent to which people compare themselves to others. More and stronger social connections should positively affect the chance of people to be influenced by their SCO. People base much of their opinions and actions on information they receive from their social networks (Vriens & Corten, 2018), but if you do not have many connections you have not much comparison opportunities. The amount of social connectivity a person has, should therefore influence the extent to which the SCO of a person affects the resulting attitudes and behaviors. Our third set of hypotheses therefore focuses on these interactions.

H5a: The positive association of SCO with environmental concern increases with social connectedness (injunctive)

H5b: The negative association of SCO with electricity consumption increases with social connectedness (injunctive)

H6a: The negative association of SCO with the absolute difference between environmental concern and **average** environmental concern increases with social connectedness (descriptive)

H6b: The negative association of SCO with the absolute difference between electricity consumption and **average** electricity consumption increases with social connectedness (descriptive)

4.3 Methods

4.3.1 Data collection

We draw on a dataset from Bruderer Enzler et al. (2019) that combines survey data on psychometric variables with household energy use data provided by an energy company. We agree with Bruderer Enzler et al. (2019) that it is important to not only examine attitudes but investigate both real-world objective behavior in combination with attitudes. We therefore analyze both the self-reported environmental concern scores derived from a survey conducted in 2016 in the German-speaking part of Switzerland, as well as the actual metered electricity consumption of these participants. Our paper responds to the call for future research to examine more naturally occurring decision contexts (Cialdini & Jacobson, 2021).We examine the naturally occurring disbalance between what should

be done with regards to pro-environmental attitudes and behaviors, compared to the populations' average levels of concerns and behaviors.

Bruderer Enzler et al. (2019) cooperated with EWB (a local energy company), to connect the questionnaire data to the customers' household energy usage. The questionnaire was sent to 10,000 customers of EWB, of which 1,392 participated, with a response rate of 14% (Bruderer Enzler et al., 2019). Bruderer Enzler et al. (2019) ensured that the survey was introduced as a questionnaire on energy usage by the ETH Zurich and the University of Bern on the topic of energy use in Swiss households, rather than saving energy, for a smaller chance of self-selection bias. The questionnaire was carried out anonymously. The participant group that we investigate reduces in size due to two reasons. First, when we select all cases that provided answers to our outcome variables: local and national social connectedness, social comparison orientation, environmental concern and electricity consumption, we are left with 1201 cases. Second, the participant number further reduces from 1201 to 1050 when we select the cases that also provided answers to our control variables: age, gender, income, high education, electric devices, electric heating, being a homeowner, household size and house size. We will elaborate on how each of these variables was constructed below. The majority of the missing cases are due to income, yet we chose to include income in our analysis as we find it an important control variable and the results of our analyses do not change substantially if we would drop income as a control variable. For this study, we therefore include 1050 participants who have provided answers to all variables we consider in this study, which is a larger group than the 723 participants that were investigated by Bruderer Enzler et al. (2019). Our sample of participants is larger than in their study as we omit variables with relatively many missings important to answer questions in their study.

4.3.2 Dependent variables

Our first dependent variable is environmental concern. The survey included the environmental concern scale by Diekmann and Preisendörfer (2003), which can be seen in Table 4.1 below. The reliability for the environmental concern scale is Cronbach's $\alpha = .86$. This indicates that there is a large internal consistency reliability for this scale allowing us to merge the items into one variable which we use to measure environmental concern. All items are related to how much a person is concerned about the environment. Item 6 was reverse coded to match the direction of the other items. All items in this scale and other scales discussed below have a five-point response scale with verbal labels ranging from "does not apply at all" to "applies fully". Scores range from 1 to 5 and higher scores indicate higher values for the relevant variable. The scales contain the sum of the response scores divided by the number of items.

Table 4.1. Items used for the variable environmental concern.

Variable	Item text
Environmental concern	1. It bothers me when I think about the environmental conditions in which our children and grandchildren probably have to live. 2. If we continue down the same path, we are heading toward an environmental catastrophe. 3. If I read news or watch TV news reports about environmental problems, I often become outraged and angry. 4. There are limits on growth that our industrialized world has already exceeded or will soon reach. 5. Most people in this country still do not act in an environmentally conscious way. 6. In my opinion, many environmentalists exaggerate claims about environmental threats.* 7. Politicians still do not do enough to protect the environment. 8. In order to protect the environment, we should all be willing to reduce our current standard of living. 9. Actions to protect the environment should be implemented even if they cause job losses.

Our second dependent variable is electricity consumption. We use the electricity consumption variable (see Bruderer Enzler et al. 2019: page 6) as the natural logarithm of the average electricity consumption per month in kWh. Note that the number of months for which measurements were available vary over households.

For our descriptive norms hypotheses we want to investigate if the participants environmental concern and electricity consumption are more similar to the average with increasing levels of SCO and social connectedness. To test this we create a variable consisting of the absolute difference between the actual and the average environmental concern and electricity consumption scores. From previous research (P. T. Schneider, van de Rijt, et al., 2023), we know that people's energy consumption is related to average energy use information they receive about other households with comparable household size or house size. Related to this, we construct comparison variables for the analysis using household size and house size. To check the robustness of our results we consider two versions: one only considering participants with the same household size as a comparison group and the other with the combination of household size and house size as a comparison group. The household size variable was categorized into 1-person households, 2-person households and 3-or-more-people households. The house size variable consisted also of three groups: small (1 or 2 rooms), medium (3 or 4 rooms) and large (5 or more rooms) homes. So we determined average environmental concern and average (logged) electricity consumption by taking the average over three different household sizes as well as over the nine groups combining household size and house size. As the dependent variables, we then constructed the absolute difference between a

participant's environmental concern and the average over this participant's comparison group. Similarly, we constructed the dependent variables for differences in electricity consumption between the participant's use and the average of the comparison groups. Alternatively, one might consider studying the tendency of participants to conform to mean environmental concern and energy consumption by analyzing whether the variance in concern and consumption decreases with more SCO and social connectedness. As we assume that participants only conform to the mean of their own subgroup, the overall variance-decreasing effect is less obvious. To facilitate also control for other covariates, we chose to analyze descriptive norm effects via the dependent variable explained above.

4.3.3 Independent variables

Social comparison orientation (SCO) was measured by using the scale that can be seen below in Table 4.2. The 6 items of this scale had a reliability Cronbach's $\alpha = .76$. This indicates that there is a reasonable internal consistency within this scale allowing us to merge the items into one variable which we use as an indication for the level of SCO a participant indicates to have. All items are related to how much a person compares themselves with others.

Table 4.2. Items for the variable SCO.

Variable	Item text
SCO	1. 'I am always paying attention to how I do things compared to others.' 2. 'I often compare my social skills and popularity to that of other people.' 3. 'I am not the type of person that often compares myself to others.' 4. 'I often try to find out what others think, who are faced with similar problems as me.' 5. 'I always like to know how others would behave in a similar situation.' 6. 'When I want to learn more about something, I try to find out what others think or know about it. '

For the questions that were asked about the feelings of social connectedness that can be seen in Table 4.3 below, a factor analysis indicated that there are two factors with an eigenvalue larger than 1 for social connectedness. First, the local surroundings that people feel connected to: family, friends, close neighbors and people in their neighborhood form the local connectedness variable. The local social connectedness scale had a reliability Cronbach's $\alpha = .68$. Taber (2018) argues that it is more important to explain the reasoning as to why one creates a construct, than a combination of items adhering to the arbitrary rule of thumb that a reliability score has to be larger than 0.70. We argue that this combination of items represents the local level of social connectedness that are most

influential for a person's pro-environmental attitudes and behaviors, and that the score of .68 is close enough to the standard .70 reliability threshold. Second, there are items related to national connectedness with the capital Bern, people in German-speaking Switzerland and all of Switzerland forming the national connectedness variable. The national social connectedness scale had a reliability Cronbach's $\alpha = .88$, which indicates that there is a high internal consistency reliability when combining these three items into the measure of national social connectedness.

Table 4.3. Item for the variable social connectedness

Variable:	Items:
Social Connectedness	Q: To what degree do you feel connected to the following people: My family. My friends. My close neighbors. The people in my neighborhood. The people who are living in Bern. The people who are living in the German-speaking part of Switzerland. The people who are living in Switzerland.

The scales for environmental concern, SCO and social connectedness were translated from German into English.

4.3.3 Control variables

The survey also included socio-demographic variables such as age used as control variables. We include the following control variables that can affect environmental concern and electricity consumptions. Participants indicated their birthyear which was used to determine their age at that time. Another variable that is included in our analyses is Female that was coded 0 for men and 1 for women. Subsequently, we included variable Higher Education in our analyses, which is 0 if a participant did not go to higher education, or 1 if they did go to higher education including finishing a degree at a university of applied sciences or a normal university. Another variable that is included is the household income which was categorized in 7 categories increasing with CHF 2,000 each, starting with earning less than CHF 2,000 up to more than CHF 12,000. Other variables included the house size, which was categorized into small, medium and large as indicated above. Households size was categorized into either 1, 2, 3, 4 or 5 and more people living in a household. For this variable scores of 11-52 people living in a household were categorized as being missing, due to them being very extreme values.

Another control variable that is included concerns if a participant either did have an electric heating that was coded 0 for no electric heating and 1 for electric heating present. Then, we include a variable for electric devices. This variable reflects a score that was calculated by taking the sum of a scale of five binary items indicating whether each of the following devices is available to the household: television set, dishwasher, washing machine and tumble drier (both exclusively accessed by the household), electric stove (with or without oven). In the limitations we address the risk of overcontrol in our analyses of electricity consumption, as we cannot rule out that the social influence processes we investigate is related to the purchase of electric devices and heating systems or that these devices affect electricity consumptions unrelated to the influence processes.

Because the observations are one-time measurements of a random sample of Swiss households and the dependent variables approximate well enough continuous variables, the hypotheses were analyzed by means of ordinary least squares regression. All analyses were carried out using SPSS version 28.

4.4 Results

4.4.1 Descriptive results

Table 4.4 gives a descriptive overview of our data. The participants' average age of 50 is slightly higher than the average Swiss age of 49 in 2016, and 60% males correspond to an overrepresentation of males as the adult Swiss population was 49% males in 2016 (Bruderer Enzler et al. 2019). Participants indicated a relatively high degree of environmental concern of 3.88 out of 5. There is an upward bias in education with 62% of participants having earned a college (university of applied sciences) or university degree. The average household income of CHF 6,000 up to CHF 8,000 is also higher than the national average Swiss household income of around CHF 5000 per household in 2016 (CEIC, 2021).

Table 4.5 below shows the analysis for investigating the association between levels of SCO and local and national connectedness with environmental concern. The assumptions for the regression model between SCO, social connectedness and environmental concern, as well as the control variables, were checked. The tolerance (.89) and variance inflation factor (1.13) values did not indicate high multicollinearity. The Durbin-Watson statistic (2.05) indicated that the residuals are independent. The scatterplot indicated that there are no substantial deviations from homoscedasticity and the P-P plot showed that the residuals are normally distributed. Support for our descriptive norm hypotheses would suggest a reduction in variance across the residuals of our outcome variable environmental concern, yet we do not observe a significant

decrease in spread and no heteroscedasticity. This makes it less likely that we find support for descriptive norms hypotheses but it is not impossible as we see in our results below. Finally, the Cook's Distance values were below 1, indicating that there were no influential cases biasing the model.

Table 4.4. Descriptive statistics

	Mean	Median	SD	Min.	Max.	25%	75%
All participants N= 1050							
Social comparison orientation (SCO)	2.87	2.83	.67	1.00	5.00	2.33	3.33
Local connectedness	3.49	3.50	5.41	1.75	5.00	3	3.75
National connectedness	2.44	2.33	.70	1.00	5.00	2	3
Environmental concern	3.88	4.00	.72	1.22	5.00	3.4	4.44
Electricity consumption	236.13	195.46	187.19	.50	2003.00	111.9	304.5
Logged electricity consumption	5.20	5.28	.78	-.69	7.6	4.71	5.72
Number of persons in household	2.20	2	1.10	1	5	1	3
House size	2.10	2	.68	1	3	2	3
Electric devices	.62	.60	.27	0	1	.40	.80
Electric heating system(0 = no, 1 = yes)	.14	0	.34	0	1	0	0
Home owner (0 = no, 1 = yes)	.42	0	.49	0	1	0	1
Female (0 = no, 1 = yes)	.40	0	.48	0	1	0	1
Age (in years)	50.37	51	15.76	20	92	37	62.25
Higher Education (0 = no, 1 = yes)	.62	1	.48	0	1	0	1
Household income	3.71	4	1.67	0	6	2	5

People with higher SCO (B = .093, p = .005) and those who with higher local connectedness (B = .171, p < .001) have higher levels of environmental concern, all else equal. This provides support for H1a and H2a. In accordance with the descriptive norms hypothesis H3a, we find that those with higher SCO have closer to average levels of environmental concern attitudes. This remains true when we consider the household size as comparison groups (B = -.064, p = .003), as well as when we consider the household size in combination with the house size for the comparison groups (B = -.063, p = .003). Higher levels of SCO are therefore associated with both higher and more average levels of environmental concern. We do not find such a convergence of environmental concern attitudes for higher levels of social connectedness. We do not find such associations for local (B = .001, p = .975) nor for national social connectedness (B = .002, p = .913). We therefore do not find support for H4a. Social connectedness is not associated with a

tendency of environmental concern to be closer to average environmental concern. The control variables household size, electric devices and gender are associated with levels of environmental concern. Women have more environmental concern than men and those with more electric devices and people living together in bigger household sizes have less environmental concern.

We do not find any support for our interaction hypotheses H5 and H6 for environmental concern. The positive effect of SCO on environmental concern does not increase (H5a) (B = .004, p = .938) with higher levels of social connectedness. Nor do higher levels of social connectedness strengthen the association between SCO and the tendency of environmental concern to be closer to average environmental concern levels (H6a), not when we only consider the household size as comparison groups (B = .011, p = .771), nor when we consider the household size together with the house size for the comparison groups (B = .007, p = .841).

Table 4.6 below shows the analysis for investigating the association between levels of SCO and local and national connectedness with electricity consumption. The assumptions for the regression model between SCO, social connectedness and the logged electricity consumption, as well as the control variables, were checked. The tolerance (.75) and variance inflation factor (1.33) values did not indicate multicollinearity. The Durbin-Watson statistic (1.97) indicated that the residuals are independent. The scatterplot indicated that there is no problem with homoscedasticity as the P-P plot showed that the residuals of our outcome variable electricity consumption are normally distributed. There is a similar concern related to the descriptive norm hypotheses as for environmental concern. Finally, the Cook's Distance values were below 1, indicating that there were no influential cases biasing the model.

As it can be seen below we do not find the expected associations between people with higher levels of SCO (B = -.012, p = .701) and those with higher levels of local connectedness (B = .136, p = .002), or national connectedness (B = -.026, p = .423) having lower electricity consumption. We therefore neither find support for H1b nor for H2b on social connectedness. Surprisingly, we find the opposite effect than expected for H2b with higher levels of local social connectedness being positively associated (B = .136, p = .002) with an increase in energy consumption. We interpret and provide further possible explanations for this in the discussion section.

Table 4.5 OLS regression for the analyses of environmental concern

	Environmental concern				Abs. diff. environmental concern (comparison groups: household size)				Abs. diff. environmental concern (comparison groups: household size combined with house size)			
	Main effects		Interactions		Main effect		Interactions		Main effect		Interactions	
SCO	.093**	(.033)	.093**	(.033)	-.064**	(.021)	-.064**	(.021)	-.063**	(.021)	-.063**	(.021)
Local social connectedness	.171***	(.045)	.171***	(.045)	-.004	(.029)	-.005	(.029)	.001	(.028)	.001	(.028)
SCO * local connectedness			.004	(.056)			.011	(.036)			.007	(.036)
National social connectedness	.028	(.033)	.028	(.033)	.001	(.021)	.001	(.021)	.002	(.021)	.002	(.021)
Household size (ref: >2)												
Household size = 1	-.155*	(.075)	-.155*	(.075)	.051	(.048)	.051	(.048)	.068	(.047)	.068	(.047)
Household size = 2	-.067	(.057)	-.066	(.057)	.092*	(.036)	.093*	(.036)	.096**	(.036)	.096**	(.036)
House size (ref: large)												
House size small	-.132	(.091)	-.133	(.091)	.136**	(.058)	.135**	(.058)	.112#	(.058)	.112#	(.058)
House size medium	-.067	(.058)	-.067	(.058)	.017	(.037)	.017	(.037)	.004	(.037)	.004	(.037)
Electric devices	-.509***	(.097)	-.509***	(.097)	.048	(.062)	.048	(.062)	.067	(.061)	.067	(.061)
Electric heating system	-.004	(.063)	-.004	(.063)	-.031	(.041)	-.031	(.041)	.033	(.040)	-.033	(.040)
Home owner	-.012	(.054)	-.012	(.054)	-.007	(.034)	-.006	(.034)	-.012	(.034)	-.012	(.034)
Female	.276***	(.047)	.276***	(.047)	-.075*	(.030)	-.075*	(.030)	-.075*	(.029)	-.075*	(.029)
Age (in years)	.001	(.002)	-.001	(.002)	-.002#	(.001)	.002#	(.001)	-.002#	(.001)	.002#	(.001)
Higher Education	.079#	(.046)	.079#	(.046)	.016	(.029)	.016	(.029)	.014	(.029)	.014	(.029)
Household income	-.027#	(.016)	-.027#	(.016)	.006	(.011)	.006	(.011)	.007	(.010)	.007	(.010)
Constant	3.310***	(.238)	3.371***	(.215)	.777***	(.152)	.556***	(.138)	.752***	(.151)	.520***	(.136)
Observations	1050		1050		1050		1050		1050		1050	
adj.R^2	.118		.117		.034		.033		.035		.035	

Notes: standard errors in brackets; # $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Neither do we find any support for our convergence hypotheses H3b nor for H4b as neither high levels of SCO (B = -.016, p = .456), nor of local (B = -.019, p = .522) or national (B = -.006, p = .768) social connectedness are associated with a tendency towards average environmental concern. We do not find any support for our interaction hypotheses H5 and H6 related to electricity consumption. The effect of SCO on electricity consumption does not increase (H5a) (B = .039, p = .479) with higher levels of social connectedness. In addition, higher levels of social connectedness do not strengthen the relation between SCO and a tendency of electricity consumption to be closer to the average electricity consumption (H6a), not when we only consider the household size as comparison groups (B = -.001, p = .968), nor when we consider the household size combined with the house size for the comparison groups (B = .023, p = .537).

The control variables household size, house size, electric devices, electric heating and gender are associated with levels of electricity consumption. Women consume less electricity than men and those living together in bigger household sizes, in bigger houses, with more electric devices and electric heating consume more electricity. We do not control for environmental concern in our electricity consumption analyses as we are interested in the total effect of social embeddedness, which might be partially mediated by environmental concern. Appendix C shows a correlation table of our independent and dependent variables, indicating that environmental concern is correlated to our other variables expect of electricity consumption.

4.5 Conclusion and discussion

In this paper, we have addressed the recent debate in the social norms literature that has called for research on moderators that explain more of the norm-sustainability relationship (Saracevic & Schlegelmilch, 2021). Researching such moderating factors has been deemed theoretically important as it aids a better understanding of when injunctive or descriptive norms affect sustainable consumer attitudes and behaviors (Saracevic & Schlegelmilch, 2021). We investigated if the strength of social norms depends on how strong people are influenced by others around them. More specifically, we examined if the extent to which people are connected to others and to which degree they compare themselves with others influence their pro-environmental attitudes and behaviors. In this study, we differentiated the effects of injunctive and descriptive norms, by examining if injunctive norms result in increasing effects compared with descriptive norms that imply people's attitudes and behavior become more similar to the average scores of comparable others.

Table 4.6 OLS regression analyses of electricity consumption

	Logged Electricity consumption				Abs. diff. logged electricity consumption (comparisons groups: household size)				Abs. diff. logged electricity consumption (comparison groups: household size combined with house size)			
	Main effects		Interactions		Main effect		Interactions		Main effect		Interactions	
SCO	-.012	(.032)	-.012	(.032)	-.032	(.022)	-.032	(.022)	-.016	(.022)	-.016	(.022)
Local social connectedness	.136**	(.043)	.136**	(.043)	-.004	(.030)	-.004	(.030)	-.019	(.029)	-.019	(.029)
SCO * local connectedness			.039	(.055)			-.001	(.030)			.023	(.037)
National social connectedness	-.026	(.032)	-.025	(.032)	-.017	(.022)	-.017	(.022)	-.006	(.022)	-.006	(.022)
Household size (ref: >2)												
Household size = 1	-.539***	(.072)	-.537***	(.072)	.104*	(.050)	.104*	(.050)	.055	(.049)	.057	(.049)
Household size = 2	-.167**	(.055)	-.165**	(.055)	.079*	(.038)	.079*	(.038)	.047	(.037)	.047	(.037)
House size (ref: large)												
House size small	-.437***	(.088)	-.441***	(.088)	.009	(.060)	.009	(.061)	.046	(.059)	.044	(.059)
House size medium	-.211***	(.056)	-.210***	(.056)	-.155***	(.039)	-.155***	(.039)	-.086*	(.038)	-.085*	(.038)
Electric devices	.575***	(.093)	.576***	(.093)	-.143*	(.064)	-.143*	(.064)	-.142*	(.063)	-.141*	(.063)
Electric heating system	.195***	(.061)	.195***	(.061)	.012	(.042)	.012	(.042)	.027	(.041)	.027	(.041)
Home owner	-.025	(.052)	-.022	(.052)	.056	(.036)	.056	(.036)	.031	(.035)	.032	(.035)
Female	-.104*	(.045)	-.104*	(.045)	.004	(.031)	.004	(.031)	-.003	(.030)	-.003	(.030)
Age (in years)	-.002	(.002)	.002	(.002)	.003*	(.001)	-.003*	(.001)	.002	(.001)	-.002	(.001)
Higher Education	-.002	(.044)	-.003	(.044)	-.035	(.030)	-.035	(.030)	-.029	(.030)	-.030	(.030)
Household income	.003	(.016)	.003	(.016)	.012	(.011)	.012	(.011)	.011	(.011)	.011	(.011)
Constant	5.035***	(.230)	4.789***	(.208)	.545***	(.158)	.890***	(.143)	.566***	(.155)	.776***	(.140)
Observations	1050		1050		1050		1050		1050		1050	
adj. R^2	.302		.302		.038		.037		.019		.019	

Notes: standard errors in brackets $^{\#}p < .10$, $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

To our knowledge we are the first to directly investigate using both survey data as well as actual electricity consumption if those people who compare themselves more with others and if those who feel more local or national social connectedness have different levels of environmental concern and electricity consumption. More specifically, we see that increases in the amount people compare themselves with others are positively associated with higher levels of environmental concern. Their environmental concern levels are also more similar to people with comparable household sizes and house sizes. These findings indicate that people who compare themselves more with others are influenced both by injunctive and descriptive norms as they have higher environmental concern levels as they ought to, as well as increasingly more average levels of environmental concern. For electricity consumption, we do not find such effects and have to conclude that people who compare themselves more with others do not use less electricity nor do they consume electricity more like the average.

National connectedness, was neither related to environmental concern nor to electricity consumption. We do however find a positive association between higher levels of local social connectedness and environmental concern. This follows an injunctive norms reasoning as one ought to have higher environmental concern given the climate crisis. We do not find any support for the descriptive norms reasoning with regards to local social connectedness as there is no such association with environmental concern nor electricity consumption. However, we do find an unexpected positive association between higher local social connectedness and increased electricity scores. This association is in the opposite direction as we expected. We expected people to follow an injunctive norms reasoning such that people that feel more connected to their local network consume less energy and not more. We can only speculate about this unexpected relationship and future research will have to investigate it further. One possible explanation could be that people with higher levels of social connectedness are more likely to have larger and more intense social networks which might be related to a life style that correlates with a higher consumption of electricity.

There are many different possibilities how people can make social comparisons. They can compare themselves with the people that they see in the media, by comparing themselves with the available information about similar others on the internet or by comparing themselves with their social network. The increasing media coverage of climate change related problems and the interventions and actions of others against climate change shown on television, newspapers and social media, surely influence people's attitudes and behaviors. Similarly, it is likely that people make social comparisons of their energy consumption compared to similar others via information on the internet or information supplied by their energy supplies or local authorities. Besides these public

forms of social comparisons we expected that peoples connectivity with their own personal social network influences to what degree they make social comparison and to what degree that influences their norm following behavior. However, in our study the level of social connectedness does not strengthen the effect of SCO on environmental concern nor electricity consumption.

Overall we observe that SCO and social connectedness both affect attitudes, we do not observe a distinction in relative importance of the two, finding evidence for injunctive as well as descriptive norm following. Moreover, SCO and social connectedness do not seem to effect electricity consumption, implying no evidence for behavior being influenced through injunctive or descriptive norms. Our theoretical framework displayed in Figure 1 has therefore found only limited support. Social connectedness and social comparison orientation's effect on norm following is not different for injunctive or descriptive norms. Both types of moderators of effects on norm following of injunctive and descriptive norms seem only effective for attitudes. This suggest that influence through social norms is more apparent for "cheap" attitudes than for "expensive" behaviors. For actual behavior change, norms alone do not seem to provide enough motivation as far as we can infer from our analyses. There are several theories that aim at explaining such an intention-behavior inconsistency. The attitude behavior gap claims that it depends on the product types and the risk associated with acting and purchasing sustainably (Park & Lin, 2020). The low-cost hypothesis argues that the strength of effects of environmental concern on environmental behavior diminish when the behavior costs increase (Diekmann & Preisendörfer, 2003). Other reasons why we find social embeddedness effect for attitudes but not for behaviors could be that people answer questionnaires with a social desirability.

4.5.1 Future research and limitations

When studying social comparison orientation, it is important to know what the actual comparison groups of people are. We make strong assumptions on this by basing it on household size and house size. We check for the robustness on this assumption by using two variants based on only household size and on the combination of household size and house size. Our comparison groups are assumptions, yet reflect comparison groups that are also used by housing corporations and energy suppliers (P. T. Schneider, van de Rijt, et al., 2023). Future research should try to know better to whom individual households are comparing themselves or create conditions of social comparison in the design of the study, in order to make more founded claims. Additionally, future research should try to take into account what sort of social comparison information residents receive. Residents

that compare themselves a lot with others that live in a neighborhood with low electricity consumption might have more of an incentive to consume little energy compared to residents that compare themselves a lot with others that live in a neighborhood of people with high levels of electricity consumption (P. T. Schneider, van de Rijt, et al., 2023). Another limitation of this study is that we controlled for electric heating systems and the ownership of certain electric devices without knowing whether these were bought also as a result of a social comparison effect. Therefore, there is a risk of overcontrol in our analyses of electricity consumption as we cannot rule out that the social influence processes we investigate led to the purchase of electric devices and heating systems. Future research should therefore aim at taking into account understanding also other environment-related investments, for example, by collecting longitudinal data on which investments were made when and based on which mechanisms.

As mentioned above our results indicate that higher levels of social connectedness and social comparison are associated with higher levels of environmental concern but not with lower levels of electricity consumption. Next steps of encouraging actual behavior change have to be investigated further. Economic incentives should be considered to encourage actual pro environmental behavior, while keeping in mind that too small economic incentive can have adverse effects on intrinsic motivation (Rode et al., 2015).

In terms of policy advice, social comparison and social connectedness have to be investigated further to examine if they are related to environmental concern and electricity consumption. Finding the optimal set of individuals to first receive information in a social network is also called seeding, and can help in the spread of information (Akbarpour et al., 2020). For policy makers, it would be interesting if future research would investigate whether those who feel more connected or compare themselves more with others are optimal seeds for optimizing the information provision and educational campaigns. Our findings suggest that people who compare themselves a lot with others and those who feel especially connected to the people in their surroundings, follow injunctive and descriptive norms with regards to attitudes, yet in order to predict and influence actual behavior combinations with other incentives are required.

Chapter 5

SOCIAL PROOF IS INEFFECTIVE AT SPURRING COSTLY PRO-ENVIRONMENTAL HOUSEHOLD INVESTMENTS[1]

[1] A slightly different version of this chapter has been published as Schneider, P. T., Buskens, V., & van de Rijt, A. (2023). Social proof is ineffective at spurring costly pro-environmental household investments. *Online Journal of Communication and Media Technologies*, 13(4), e202351. Schneider carried out the investigation, wrote the original draft, and conceptualized the research and conducted the formal analysis. All authors were responsible for the methodology and review & editing of the writing. We provide the code at https://osf.io/ebav8.

Abstract

One of the most popular techniques of persuasion in online marketing is social proof, also referred to as social validation. It takes advantage of the fact that when other individuals have decided in favor of a particular behavior people are more likely to follow that behavior as it is perceived as more valid. Yet there is a theoretical reason to be skeptical about the effectiveness of this persuasion technique for the encouragement of more costly investment decisions taken under high uncertainty. This study investigated the effectiveness of social proof in influencing consumer responses to calls for action on a bank's sustainable home improvement website. A first field experiment investigated whether participants engaged more with a webpage that provided a personalized testimonial or informed users that thousands of other clients had used the bank's sustainable home improvement services. A second field experiment encouraged clients to use the bank's services to obtain solar panels and we again investigated whether clients engaged more with a webpage that provided a personalized testimonial rather than without such a testimonial. Clients were directed to these webpages through a newsletter that is distributed to half a million clients of the bank. Overall, our evidence suggests that messages of social proof are ineffective at urging customers to consider larger pro-environmental household investments, let alone making those investments.

Keywords: Social proof, complex contagion, pro-environmental investments, online marketing

5.1 Introduction

In the context of the energy transition, forms of social influence are used as a policy instrument for mobilizing collective behavior to fight climate change and allow countries to meet their climate goals (Ministry of Economic Affairs and Climate Policy, 2020). Social influence is often defined as a change in a person's attitudes or behavior due to interactions with other people. It can be distinguished from conformity and coercion, the latter referring to behavioral changes that occur more reluctantly and forcefully (Rashotte, 2007). There are many forms of social influence techniques and marketing practitioners are said to have "nearly limitless arrays of motivational strings to pull" to stimulate consumers to participate and purchase environmentally friendly products (Goldstein et al., 2007). Within the field of psychology and social influence, the universal principles of persuasion have been identified by Robert Cialdini as liking, authority, social proof, scarcity, and reciprocation, which can be utilized off- and online to aid in persuading consumers (Cialdini, 2001). Thaler and Sunstein's book "Nudge", where persuasion principles are used to encourage desirable behavior, identified a form of social influence called choice architecture, which gained much popularity in the behavioral sciences (Thaler & Sunstein, 2009). However, despite their popularity and encouraging findings regarding low-threshold decisions, it remains uncertain if such persuasion techniques are also effective in the context of more costly pro-environmental investments whose returns are uncertain. Households encounter several types of decision situations, from adapting straightforward behavior and habits like adjusting one's room temperature to decreasing energy usage up to complex investment decisions such as insolating one's home or installing a new heating system with thousands of euros and permanent changes in living quality at stake.

The social network literature distinguishes two kinds of social contagion. The first is simple contagion: an adoption process for which only a single contact is required for transmission between a source and a destination (Centola & Macy, 2007). Examples are viruses, basic information, and risk-free behavioral changes with obvious benefits. In these cases, exposure is sufficient for propagation. The second kind is complex contagion, an adoption process for which adoption requires prior adoption by multiple network contacts (Centola & Macy, 2007). Examples are actions that violate an established norm or uncertain investment decisions that are only attractive if others confirm they are sensible. In complex contagions, an individual's threshold indicates the number or proportion of network neighbors who need to adopt a behavior before a focal individual will adopt it as well (Granovetter, 1978).

We argue that making costly pro-environmental investments with uncertain returns is a behavior that might not always spread through mere exposure or light forms of

persuasion. It could be that such investment decisions are not able to spread unless reinforced through the prior adoption of many friends, colleagues, and neighbors in local networks. Therefore, it seems vital to examine if the often-used social proof persuasion techniques based on research that has focused on easier-to-adopt behavior are also applicable to larger pro-environmental investment behavior. We use social proof as it is described by Cialdini (2001, p.78), "One fundamental way that we decide what to do in a situation is to look to what others are doing or have done there. If many individuals have decided in favor of a particular idea, we are more likely to follow, because we perceive the idea to be more correct, more valid." Investigating if social proof, one of the most popular principles of persuasion in the online realm (Fenko et al., 2017), is also effective for the proliferation of costly behavior, such as the making of pro-environmental investments, is the aim of this paper. More specifically we focus on the very first phase of making a larger investment, namely the orientation phase, by examining if the positive effect of social influence messages found for simple behavior remains relevant for the first step of information seeking before making more costly investment decisions.

5.2 Theory

We consider whether light persuasion techniques like social proof apply to high-cost/high-risk behavior by first examining the existing literature on the effectiveness of forms of social proof for encouraging more straightforward adoptions. Then we argue why a difference in effectiveness can be expected between the use of techniques for stimulating such straightforward behavior and convincing people to adopt larger, more complex behavior. We raise the question until when social proof techniques remain effective.

Due to the increasing importance of online orientation and purchasing this domain seems the most applicable to investigate the effects of social proof especially since corporations have spent millions on designing their corporate websites, yet many websites have failed to reach their organizations' goals resulting in the higher importance of online persuasion, and the research related to it (Hausman & Siekpe, 2009). Research investigating the effectiveness of persuasion techniques that focus on product popularity using claims such as "94% of consumers bought this product after viewing this site" indicate that such claims increase the quality perception of products and work particularly well among risk-averse consumers (Jeong & Kwon, 2012). With much of this research being based on Festinger's (1954) famous social comparison theory that explained that individuals compare themselves with others to determine their abilities and opinions. Among online shops, testimonials are attributed great importance in the success of marketing campaigns as getting customer feedback has become a priority

with companies' focus shifting towards the quality of service (Meyers, 2021). In the healthcare sector, the use of regular personal testimonials in marketing has been shown to increase perceptions of trust (E. Kemp et al., 2015).

Testimonials are fundamentally different from reviews as they are normally given to a company themselves and are solicited and used by those companies in marketing to provide a more specific description of what went well with regards to the experience with a product or service, whereas reviews tend to be shorter and are given to third-party websites having more influence through their quantity and independence (Donnell et al., 2022). Experimental research in the healthcare sector has shown that the effect of persuasive messages in the form of personal testimonials can be more effective in increasing risk perception and intention to get vaccinated compared to presenting objective statistics (de Wit et al., 2008). Testimonials have been shown to trigger pro-environmental behavior such as purchasing non-overpackaged goods, even when this is not the behavior of the majority (Elgaaied-Gambier et al., 2018). Furthermore, identification with a non-famous and normal endorser is shown to increase the credibility of advertisements (Elgaaied-Gambier et al., 2018).

For this study we focus on examples and research related to the pro-environmental behavior contexts, however, variations of social proof heuristics apply to a large variety of contexts, such as influencing the purchase of tickets for culture or entertainment events (Fenko et al., 2017). Meta-analysis has indicated that there are various ways of successfully utilizing social influence in the field of pro-environmental behavior (Abrahamse & Steg, 2013). Studies utilizing social proof as a social influence technique have done this successfully by presenting descriptive norms as a form of percentage or number of people following a certain norm (Goldstein et al., 2007; Han & Hyun, 2018). Recent findings even show that descriptive norms can encourage the adoption of pro-environmental behavior when it does not reflect the behavior of the majority, as long as the advertisement is seen as credible (Elgaaied-Gambier et al., 2018). Goldstein, Griskevicius, and Cialdini (2007) show how social norms can motivate simple environmental conservation in hotels. In their experiments, they tested and compared social influence techniques by placing different signs urging guests to reuse their towels. They compared standard environmental messages that focus guests' attention on environmental protection, injunctive norms through a request to help the hotel save energy, and a descriptive norm message informing guests that a majority of other guests had participated in reusing their towels to help the environment, demonstrating that the latter was the most effective. Goldstein, Griskevicius, and Cialdini (2007) argue that as part of a constant learning process people adapt behavior toward decisions that have led

to the best outcome in the past. To simplify decision-making, especially in uncertain circumstances, individuals often generalize their own and others' previous experiences. Other studies that have focused on encouraging simple pro-environmental behavior utilizing a form of social proof to invoke social norms have demonstrated that this form of social influence can be effective in lowering electricity consumption (Schultz et al., 2018) as well as water conservation (Han & Hyun, 2018).

We aim at expanding this line of research and investigating to what degree these findings are translatable towards more costly investment decisions. As mentioned above, the social network literature indicates that there are two kinds of adoption processes through networks: simple contagion requiring only a single contact between a source and a destination for transmission (Centola & Macy, 2007), and complex contagion requiring adoption by multiple network contacts before it can be adopted by a target (Centola & Macy, 2007). An example from epidemiology that serves as an apt illustration of the difference between these two adoption processes is the ease with which HIV spreads contrasted with the great difficulty to get people to adopt preventative measures (Lehmann & Ahn, 2018). Infectious diseases are considered a simple contagion requiring only one activated source for transmission, while preventative measures that can be costly, difficult, or unfamiliar are complex contagion processes of behavior, attitudes, or beliefs requiring more extensive exposure and convincing. Following the theory of complex contagion, it seems that the effectiveness of social proof decreases with the cost and uncertainty associated with a focal decision. Complex contagions seem to undergo a process of stages ranging from the first time one hears about a pro-environmental investment opportunity up to the actual purchase decision, with several social influence stages in between.

We focus on one of the first stages, namely the beginning stage of orientation and information seeking. We argue that it is essential to examine if the often commercially used social influence technique of social proof is still effective in advocating behavior when it is more uncertain and costly. We, therefore, investigate if individuals contemplating making a larger pro-environmental investment are still susceptible to social proof at the orientation phase where social proof techniques are simply used to influence consumers to request more information. Given we are investigating this first and simple orientation step we base our hypotheses on the success of social proof studies so far.

More specifically we collaborate with one of the largest banks in the Netherlands to investigate if the mentioned findings of the social influence literature are also applicable to the orientation process for the more costly decisions of improving the sustainability of one's home or acquiring solar panels. We test if two variations of social proof, a more qualitative and personalized testimonial approach or a quantitative information

and descriptive norms approach, are effective in encouraging clients to act and inform themselves about potential multi-thousand euro home investments. An additional explorative analysis is done to investigate whether one of the two approaches is more effective than the other.

The websites that include social influence information are therefore expected to result in more engagement with the website. Clients are expected to click more on the links that provide further information on how to finance sustainable home improvements, governmental subsidies, a tool to calculate how to increase the sustainability of their home, or a link to request a personal advice talk.

H1: The social influence technique of showing a testimonial leads to more website engagement than a control website without such a testimonial.

H2: The social influence technique of showing descriptive norms, in the form of the number of bank clients that have used a sustainable home improvement scan of the bank, leads to more website engagement than the control website without this information.

5.3 Methods

We advised on the design and implementation of two field experiments conducted by one of the biggest banks in the Netherlands. The bank aims to make their sustainability websites as engaging as possible by providing information and stimulating their clients to use the bank's services and take up loans to invest in sustainable home improvements. For the first field experiment, three identical websites A, B, and C were built with the only difference being the kind of additional social influence information that was provided on each of these websites. For the second field experiment, two identical websites A and B were built with the only difference being the kind of additional social influence information that was provided on each of these websites. The bank's clients received a newsletter with a link that randomly allocated participants among the three websites. The engagement with the websites is measured by comparing the number of views that were generated for each website with the number of clicks that occurred on each of these websites. By comparing the proportion of clicks made given the number of views that were made on each website, we can observe which website results in more website engagement.

5.3.1 Experiment 1

Nearly half a million homeowners (N = 492,148) received a newsletter in February 2021 that included a link. When clients clicked this link (N = 9117), they were randomly

forwarded to one of three websites, namely a control website (A), a website with a qualitative form of social proof in the form of a testimonial text (B), and a website with a quantitative form of social proof in the form of numerical facts about previous other clients' actions (C). Clients could also reach the websites through the banks client portal leading to a total of 9285 clients viewing one of the websites. Clients could visit one of the three pages as often as they wanted and click every link on the websites. However, every unique Internet Protocol (IP) address was only assigned to one of the three websites, in order to avoid that clients saw different versions of the websites when they visited the website again. If clients visited the website from different devices and different IP addresses, they end up as multiple clients in the data, which might distort our data a bit, but we assume that this is a small portion of the observations we have. Because we find similar results if we analyze effects only for people who access the website through their own newsletter, we can be quite sure that this is indeed the case.

Each website contained an identical setup, explaining the benefits of insulating one's home and informing the client that governmental changes might result in additional subsidy possibilities, followed by a link for further information by the Dutch government. On websites B and C, the manipulation for each condition was placed in the center of the website. The manipulation was a picture of a middle-aged man standing on a roof showing his solar panels and the title "Many clients are on their way towards a better energy label". On website B, the manipulation, which can be seen in Figure 5.1 below, had the following layout and text (translated from Dutch to English):

Figure 5.1. Manipulation website B experiment 1

Many clients are on their way towards a better energy label

Choosing what sustainable investments you make can be challenging. Financing these sustainable investments plays an important role in these decisions. Your personal advisor can help in finding the best option for your specific situation.

H.B. (44) "*The Bank really customized their services for me as a single man without children, mortgages or a lease car I am not a normal client. Without the bank's flexibility, I could have never realized this dream*".

The above illustration replicates the actual manipulation as accurately as possible. The only differences are that the picture of the customer is not shown, that the initials

of the customer are represented by H.B. instead of displaying the actual name of the customer that gave the testimonial text and that the banks name is not shown. This is done for privacy reasons of the customer and to guarantee the banks anonymity. Website C displays the same picture and title followed by numerical facts about previous other clients using the bank's services. The manipulation of website C was translated from Dutch to English and had the following layout as it can be seen in Figure 5.2 below.

Figure 5.2. Manipulation website B experiment 1

Many clients are on their way towards a better energy label

Choosing what sustainable investments you make can be challenging. Financing these sustainable investments plays an important role in these decisions.

Already **42,815** clients have used the house-scan to discover what sustainable investments they could take to improve the sustainability of their homes. Furthermore, **18,6%** of clients who have a mortgage with us have additionally financed sustainability related renovations to make their homes more sustainable.

The above illustration replicates the actual manipulation as accurately as possible. The only difference that the picture of the customer is not shown and that the banks name is not shown. This is done for privacy reasons of the customer and to guarantee the banks anonymity.

On the websites, four main links serve as outcome variables for experiment:

- a link for personal advice from a bank specialist
- a link for conducting a sustainability and insulation scan of the home called "House-scan" highlighted with an orange button
- a link for information about the bank's financing options
- a link for information regarding government subsidies.

We did not influence the bank's website design or texts for these links and outcome variables as they are ongoing services the bank provides in collaboration with other businesses and the Dutch government. Hypotheses 1 and 2 predict that these links will all be clicked more on websites that provide social proof (B and C) than the control website (A).

Additionally, we carry out explorative analyses to see whether either the testimonial treatment or the descriptive norm treatment in the form of client statistics are more effective and whether these social influence techniques are more or less effective for a specific action on the website.

5.3.2 Experiment 2

Experiment 2 was similar to the first. This time the aim of the websites was to encourage the clients (N = 8835) that were again recruited through a link in the banks newsletter to take a loan to finance getting solar panels. Clients could visit one of the two pages as often as they wanted and click every link on the websites. However, every unique Internet Protocol (IP) address was only assigned to one of the two websites, in order to avoid that clients saw different versions of the websites when they visited the website again. For experiment 2, there were only two websites A and B. We compare a control website (A) with a website that additionally has a social proof element in the form of a testimonial text (B). Website A and B both included the text: "Optimally use the sun this summer and install solar panels on your roof. You save money through lowering your energy bill, help the environment and increase the worth of your property. Interested in the possibilities? Do the solar panel scan and within a few clicks you will get personal advice about how to place solar panels on your roof" (translated from Dutch to English).

Website B additionally included a social proof element in the form of a quote from a past client that recommends using the bank's service and help to get solar panels, next to an icon of a house that has solar panels and a five-star rating below it. The manipulation of website B for the second experiment is illustrated by Figure 5.3 with the following layout and text (translated from Dutch to English):

Figure 5.3. Manipulation website B experiment 2

Save money with Solar panels

Optimally use the sun this summer and install solar panels on your roof. You save money through lowering your energy bill, help the environment and increase the worth of your property. Interested in the possibilities? Do the solar panel scan and within a few clicks you will get personal advice about how to place solar panels on your roof.

Client experience

"It all worked so smoothly and quickly. The service of the installations was also good"

R. R. from Gouda

Websites A and B were otherwise identical. The above illustration replicates the actual manipulation as accurately as possible. The only differences are that the initials of the customer are represented by R.R. instead of displaying the actual name of the customer that gave the testimonial text and that the banks name is not shown. This is done for privacy reasons of the customer and to guarantee the banks anonymity. Both provided a link to a solar panel scan in the middle of the website allowing clients to scan their roof to calculate how many solar panels they could install, how much money that would cost and how much money a client could potentially earn back. We again did not influence the bank's website design or texts for these links and outcome variables. Hypothesis 1 now predicts that the link to the solar panel scan will be clicked more often on the website that provides an additional testimonial text compared to the control website.

5.3.3 Data

We received the bank's aggregated Google Analytics data of the websites for experiments 1 and 2. The first dataset consists of the aggregated page views per website for the websites A, B, and C of experiment 1 and the number of clicks made on each of the four links highlighted on websites A, B, and C. We had agreed with the bank that they would not send us any demographic or other personal information of the clients following the GDPR and our ethics protocol. Therefore, we did not receive any individual-level data. We were only able to see on which website people clicked more. By using the page views and comparing the proportion of clicks made per pageviews for each website were able to make comparisons for the websites.

Similarly, we received data showing the aggregated page views for experiment 2 for websites A and B as well as the number of clicks made on each of the three links that were present on websites A and B. Again, we did not receive any demographic or other personal information of the clients nor any individual-level data. We were only able to see on which website people clicked more. By using the page views and comparing the proportion of clicks made per pageviews for each website were able to make comparisons for the websites.

For both experiments, we are therefore able to compute straightforward cross-table Fisher exact tests comparing the websites, using the aggregated page views per website and the clicks made on each website. For experiment 1 an additional analysis was conducted. We investigated if there was a different website engagement of the clients that came to the website through the link that was shared in the newsletter. There were no differences in the results compared to analyzing all people who viewed the websites. The results of this extra analysis can be found in Appendix D.

5.3.4 Variables experiment 1

The dependent variable is *proportion of clicks made:* It's the number of clicks made on a specific link on the website divided by the total amount of page views for that website. Independent variables: type of social influence message on separate websites, control (A), testimonial (B), or client statistics (C).

5.3.5 Variables experiment 2

The dependent variable is *proportion of clicks made:* It's the number of clicks made on a specific link on the website divided by the total amount of page views for that website.

Independent variables: type of social influence message on separate websites, control (A), testimonial (B).

5.4 Results

5.4.1 Results experiment 1

For experiment 1, we first conduct one-sided Fischer exact tests for our hypotheses 1 and 2. We conduct these one-sided Fischer exact tests in STATA Version 14 using as measures of engagement the page views of websites A, B, and C as well as the clicks on each of those websites on hyperlinks to the House-scan, Subsidy information by the Dutch government, information about financing opportunities, and a personal advice talk with a bank specialist. Table 5.1 below shows results for the four different hyperlinks that serve as outcome variables.

The testimonial website B does not receive a higher proportion of clicks than the control website A for the House-scan (0.161) vs (0.179), $p = .967$. Similarly, the client statistics website C does not receive a higher proportion of clicks than the control website A for the House-scan (.158) vs (.179), $p = .970$. Neither is there a difference in the proportion of clicks made between the testimonial website B and the client statistics website C for the House-scan (.161) vs (.158), $p = .754$. The testimonial website B does not receive a higher proportion of clicks than the control website A for information regarding financing opportunities by the bank (.012) vs (.014), $p = .614$. Similarly, the client statistics website C does not receive a higher proportion of clicks than the control website A for information regarding financing opportunities by the bank (.010) vs (.014), $p = .614$. Neither is there a difference in the proportion of clicks made between the testimonial website B and the client statistics website C for information regarding financing opportunities by the bank (.012) vs (.010), $p = .468$. The testimonial website B does not receive a higher proportion of clicks than the control website A for planning a

personal advice talk with a bank specialist (.006) vs (.004), $p = .227$. Similarly, the client statistics website C does not receive a higher proportion of clicks than the control website A for planning a personal advice talk with a bank specialist (.003) vs (.004), $p = .649$. Neither is there a difference in the proportion of clicks made between the testimonial website B and the client statistics website C for planning a personal advice talk with a bank specialist (.006) vs (.003), $p = .184$. In summary Table 5.1 and Figure 5.4 show that we do not find significantly more engagement and clicks for the two treatment websites B and C compared to the control website for the House-scan, information regarding financing opportunities by the bank, and personal advice talk.

Table 5.1. Comparison of the number of clicks that were made on each website compared to the number of views for each of the three websites A, B, and C of experiment 1 (proportion followed by the number of clicks in brackets)

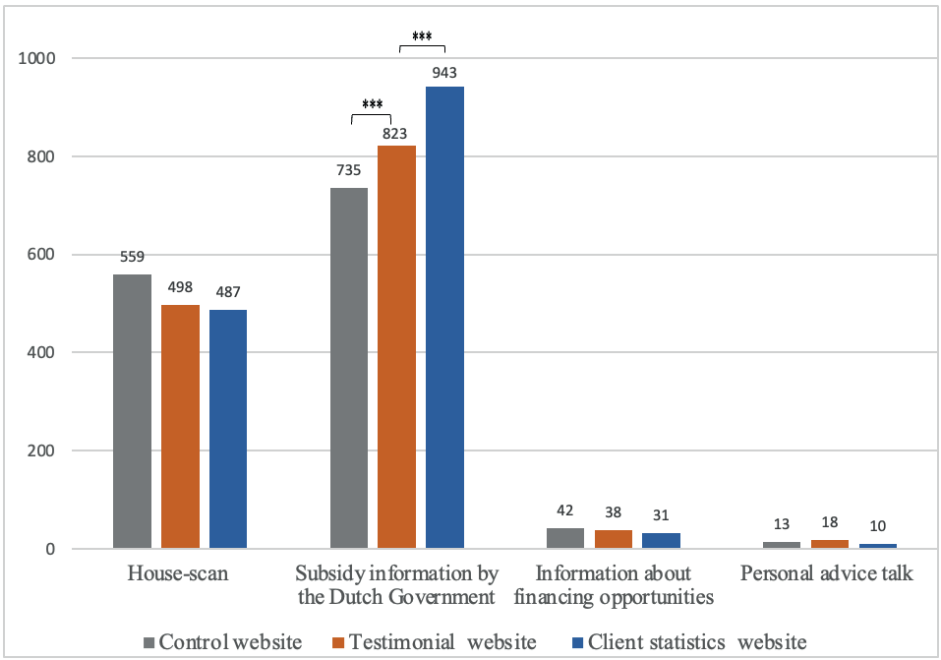
	Control (A)	**Testimonial (B)**	**Client statistics (C)**	**Test Diff A vs B and Test A vs C: one-sided; Test Diff B vs C: two-sided**
Page views	3120	3088	3077	*N* of observations 9285
House-scan	.179 (559)	.161 (498)	.158 (487)	Diff A vs B: $p = .967$ Diff A vs C: $p = .970$ Diff B vs C: $p = .754$
Subsidy information by the Dutch government	.236 (735)	.267 (823)	.307 (943)	Diff A vs B: $p = .003$ Diff A vs C: $p < .001$ Diff B vs C: $p = .001$
Information about financing opportunities	.014 (42)	.012 (38)	.010 (31)	Diff A vs B: $p = .614$ Diff A vs C: $p = .868$ Diff B vs C: $p = .468$
Personal advice talk	.004 (13)	.006 (18)	.003 (10)	Diff A vs B: $p = .227$ Diff A vs C: $p = .649$ Diff B vs C: $p = .184$

For the information regarding subsidies of the government link, we do find that the proportion of clicks made by clients in the testimonial condition (.267) viewing website B, is significantly higher than the proportion of clicks made on the control website A (.236), $p = .003$. Similarly, we observe that the information regarding subsidies of the government link was also clicked more on the website C (.307) with client statistics, than the control website A (.236), $p < .001$. When comparing the proportions of clicks made for conditions B (.267) and C (.307), we find that the websites engaged clients differently for this link and that the numbers of clicks and website engagement were higher for website C, $p = .003$.

5.4.2 Results experiment 2

For experiment 2, we also conduct one-sided Fisher exact tests to examine if providing social proof in the form of a testimonial leads to more engagement with a website that is advocating the purchasing of solar panels. However, our hypothesis is not supported as we do not observe significant differences for either of the three different links between the control website and the testimonial website. The testimonial website B does not receive a significantly higher proportion of clicks than the control website A for the solar panel scan (.962) vs (.958), p = .160. Similarly, the testimonial website B does not receive a higher proportion of clicks than the control website A for a link for information about financial support by the bank (.126) vs (.129), p = .638. The testimonial website B also does not receive a higher proportion of clicks than the control website A for the House-scan (.031) vs (.039), p = .160. These results are summarized in Table 5.2 and illustrated in Figure 5.5.

Figure 5.4. Comparison of the number of unique clicks made by clients on each website for experiment 1.



Difference between clicks *p<0.05, **p<0.01, ***p<0.001 (one-sided)

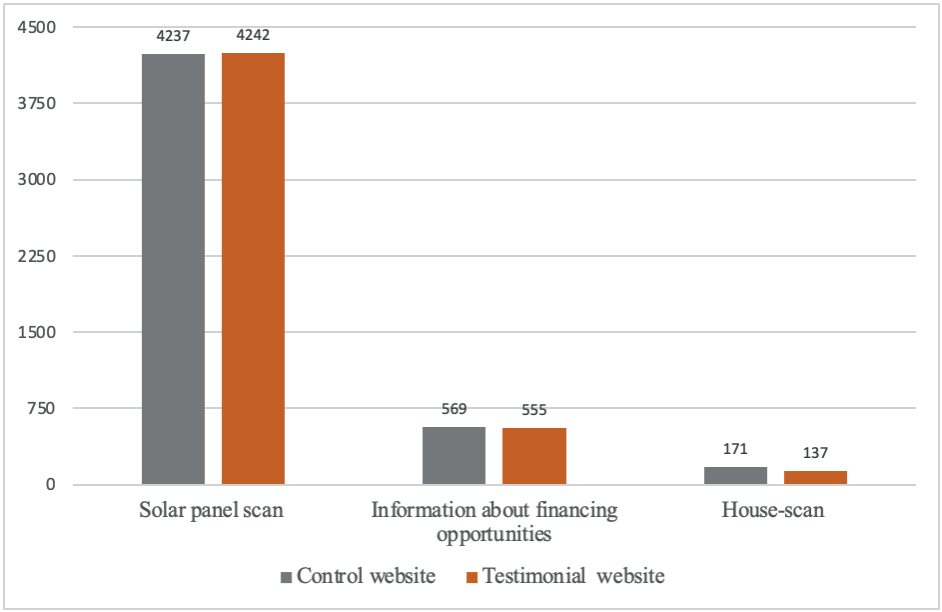
The engagement in experiment 2 is much higher than in experiment 1. This could be due to many factors, ranging from the subject of solar panels being more popular to the website being clearer. Both the control website (N = 4425) and the testimonial website (N = 4410) were viewed nearly equally often.

Figure 5.5 below illustrates that there are no differences between the two conditions and that the additional testimonial text did not help in increasing the engagement of clients. The control website was already extremely effective in engaging clients. Therefore, a huge improvement is not possible, yet due to our large sample size, we believe that we would have had enough power to notice even if there was just a small difference.

Table 5.2. Comparison of the number of clicks that were made on each website compared to the number of views for each of the two websites of experiment 2 (proportion followed by the number of clicks in brackets)

	Control (A)	Testimonial (B)	Test Diff A vs B: one-sided
Page views	4425	4410	*N* of observations 8835
Solar panel scan	.958 (4237)	.962 (4242)	$p = .160$
Information about financial support by the bank	.129 (569)	.126 (555)	$p = .638$
House-scan	.039 (171)	.031 (137)	$p = .970$

Figure 5.5. Comparison of the number of clicks made on each website for experiment 2



5.5 Conclusion and discussion

5.5.1 Conclusion

We collaborated on two field experiments with a large bank in the Netherlands to investigate if the social influence technique of social proof is also effective in increasing client engagement at the very beginning of a more complex decision process, namely orientating oneself to make multi-thousand euro sustainable home improvement investments. The social norms literature has revealed that invoking social norms can be effective in lowering electricity consumption (Schultz et al., 2018), encouraging the reuse of towels (Goldstein et al., 2007), or water conservation (Han & Hyun, 2018). We extend this research towards the very beginning phase of making more costly pro-environmental home improvement investments.

Experiment 1 gave us inconsistent results with the websites that included additional messages of social proof in the form of a testimonial text or client statistics not univocally leading to more website engagement. For three out of the four links that were highlighted on each of the websites, we did not notice an increase in clicks. For the information regarding subsidies of the government link, we do find that the clients that viewed the website that included a picture and a testimonial text clicked on that link significantly more than the clients that viewed the control website that did not include any social proof information. Similarly, we observe that the information regarding subsidies of the government link was also clicked more by those who viewed the website with the social proof in the form of client statistics. Given the multiple comparisons and the fact that the tests that are significant are not independent, it seems that social proof treatment did not elicit more engagement overall. The differences we do find, regarding the client statistics leading to more clicks on the subsidies of the government link than the website that showed the testimonial text, are more accidental findings.

In experiment 2, the additional testimonial did not lead to more clicks on either the highlighted solar panel scan feature, or the other House-scan, or financial information links. The social influence technique of displaying testimonials might increase engagement in certain contexts that are more emotional and rely on trust like the healthcare sector (de Wit et al., 2008). Within the larger pro-environmental investment context, we do not find such support. Experiment 2 was more efficient and specifically targeted desired website engagement. Namely, more than 95% of clients clicked on the solar scan that was highlighted on each of the two websites of experiment 2. Noticing a significant difference between the websites, therefore, becomes much more difficult. For experiment 1, we see that less than half of the clients who viewed one of the three websites clicked on one of the links that were highlighted on the website, whereas for experiment 2 more than 95% of clients clicked the highlighted solar panel scan for both websites.

We have to conclude that the much-applied social influence technique of social proof is not univocally effective for encouraging action towards making a more complex decision. These are important results, especially considering the popularity of this persuasion technique and that we deliberately examined whether social proof messages are effective in influencing and encouraging the very beginning and simple orientation processes before making multi-thousand-euro sustainable home improvement investments. It seems that the effect of social proof as a persuasion technique is scope conditioned by the cheapness of the decision.

5.5.2 Discussion

We argue that our results indicate that prior to using social proof messages to influence and encourage costly pro-environmental purchasing behavior more research is required. Marketing practitioners should be careful in transferring the findings of the effectiveness of rather simple purchasing decisions towards more complex investment decisions. Furthermore, more recent meta-analyses have indicated that similar social influence techniques such as nudging might have been attributed effects more due to a publishing bias for significant results than the treatments' actual effectiveness (Maier et al., 2022). Businesses and governments might be tempted to extend the use of these inexpensive and easily applicable persuasion techniques for societal problems such as encouraging pro-environmental behavior, yet we argue that it is vital to research when persuasion techniques like social proof can be effective and when other measures such as hard incentives, strong group pressure and the activation of local networks are needed. Our findings are an important addition to the literature as we demonstrate that the principle of simple vs complex behavior or trivial vs non trivial decisions is similarly important outside the context of diffusion, namely for social proof from anonymous others.

We are aware that we suggest that we are investigating behavior related too rather large investments, but are actually comparing the number of clicks made during the orientation process before making such a big investment. We argue that this is the first step of orientation before a complex and costly decision is made. Informing oneself before investing tens of thousands of euros is part of a larger decision process, especially when compared to previous research having mostly investigated whether participants reuse towels or use less electricity, which is rather straightforward behavior. Given our results, we also feel this assumption is supported.

A limitation that affected which of the four links would be clicked in experiment 1 was that the newsletter that was sent to the clients of the bank to get them to visit the websites included a heading about a new governmental subsidy. This makes it difficult to do additional analyses as to which social proof technique is more effective. As it is likely that a self-selection process took place, with those clients interested in

governmental subsidies being more likely to visit the website than, for example, those interested in the bank's house-scan. The treatment information is targeted at increasing the usage of the House-scan and how helpful the bank's services are. The increase in clicks on the governmental subsidies website is therefore a desired by-product, but not the initial target of the social influence text. Yet, given that the newsletter text was the same for all clients, the differences between the websites should only be caused by our manipulations. For future research on effects of website manipulations, it is important that the newsletter also focuses on emphasizing the topic related to the manipulation to avoid that the manipulation has additional unwanted or uninformative effects.

The layout for the website of experiment 1 changed for the treatment conditions as the manipulation texts were added in the middle of the websites changing the position of the links on the websites slightly, compared to the control website, which did not have any text or picture added. It could be that website design influences the early orientation part of the purchasing processes (Hausman & Siekpe, 2009) and future studies should be aware of this risk. For experiment 2, the figure and text added did not change the layout of the website nor did it influence the placement of the links on the website. The websites for experiment 2 are therefore as similar as possible. Given that the website design for experiment 2 did not differ between treatments and we still did not find support for an effect of social proof in the orientation phase, we do not expect that we would have received different results for experiment 1 if the websites would have been identical.

Given the data we had, we could only focus on clicks as a measure of engagement, which does not provide a full picture of participants' website engagement. Future research could add analyzes of other measures of engagement such as time spent on the page, bounce rate or the number of pages visited to study whether the effect of stronger engagement is larger than for less extensive forms of engagement. In comparison to other studies that conduct experiments in an abstract context, our study reaches external validity as we are studying real behavior of actual people. However, the bank's clients are selective as they are homeowners interested in making their home more sustainable. For further generalizations a more representative sample of people is advisable for future research. Furthermore, our results are impacted by the Dutch cultural and contextual factors in which our experiments took place. Comparisons of individualistic and collectivistic cultures have shown that higher collectivism scores are associated with an increased desire to make social comparisons (Chung & Mallery, 1999). It is speculated that cultures with higher levels of collectivism lead to more upward self-improvement comparisons for the sake of the group (Chung & Mallery, 1999). The Netherlands is a more individualistic country, future research could take cultural aspects into account and test if social proof information is more influential in a more collectivistic context.

Future research should expand on our findings and examine when social proof is effective in stimulating behaviors and when it is not. More fundamentally, we would like to suggest that future research ought to examine when principles of persuasion are only effective in encouraging low-threshold decisions, and when they are also effective persuasion techniques in the context of more costly investments with uncertain return.

Appendix A

SUPPLEMENTARY MATERIAL FOR CHAPTER 2

Appendix A Supplementary material for Chapter 2

A.1 Experiment instructions

Experimental Laboratory for Sociology and Economics  **Universiteit Utrecht**

A.1.1. Instructions

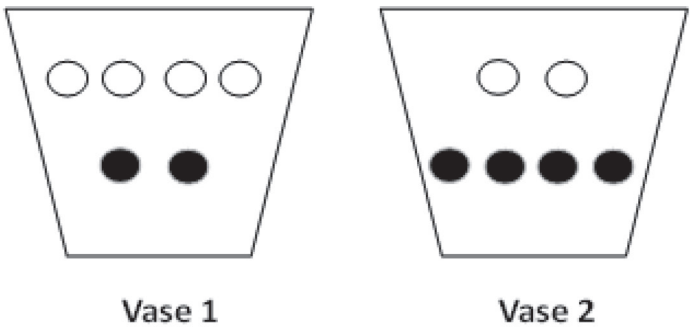
Welcome! These instructions are the same for all participants. Please read them carefully. If you have any questions, please raise your hand. One of the experimenters will approach you and answer your question. You can earn money by means of earning points during the experiment. The number of points that you earn depends on your own choices. At the end of the experiment, the total number of points that you earn during the experiment will be exchanged at an exchange rate of: **20 points = 1** €. The money you earn will be rounded up to the next 50 euro cents and paid out in cash at the end of the experiment. There is a minimum payment of 5 euros. Other participants will not see how much you have earned. During the experiment you are not allowed to communicate with other participants. Please turn off your mobile phone and put it in your pocket or bag. You may only use the functions on the computer screen that are necessary to carry out the experiment.

A.1.2. Overview of the experiment

In this experiment, you will play investment games that involve you and 5 other participants. You play in networks that have been programmed to connect groups of 6 computers in the lab. There are 4 different ways the computers will be connected to each other, which are the 4 networks of this experiment. All participants will be randomly assigned to a position in the network. You will only be able to see the decisions of 2 or 3 other participants in your network. You will therefore at no point during this experiment see the investment decisions of all 6 participants of your network. You have to make your investment decisions based on the information that you receive at the beginning and the investment decisions of the 2 or 3 other participants that you will see. The aim of each game is to find out which of the two vases represented by Figure A.1. is the vase your group of 6 participants has been assigned to. You earn points by choosing the correct vase.

As you can see, the vases show distributions of black and white balls and they are the information available to your group. You do not know which of the two vases has been selected for your network. Each participant in your network receives one of the balls randomly drawn from the selected vase, without replacement. Your task is to make investment decisions based on what vase you think was selected for your group. The color of your ball as well as the investment decisions of the 2 or 3 other participants in your network may lead you to think a particular vase was selected. In total you will play 8 games with each vase having a 50% chance to be drawn and every game consisting of 4 rounds of investment decisions each worth 10 points.

Figure A.1. The vases of the game



Each game is therefore worth 40 points which are divided equally over the 4 rounds of the game. In the first round of each game you will receive a ball from the selected vase, either white or black, after which you have to make a decision whether to invest points in Vase 1 or in Vase 2. After this first round you will see the first round decisions of the 2 or 3 other participants that you can see in your network, and they will see your decision. You then make your second investment decision, deciding to invest in Vase 1 or in Vase 2. The same procedure is repeated in the third and then in the fourth the final round of each game. Every point you invested in the correct vase you get to keep and will earn you real money, every point invested in the wrong vase will be gone.

A.1.3. Earnings

For every correct investment decision you make you will get to keep the invested points, since you will play 8 games with 4 investment rounds each you can earn up to 320 points in total. You can therefore earn up to 16,00 Euros in this experiment, and at least you will always get 5 Euros for participating.

A.1.4. End of experiment

You must fill out a questionnaire at the end of the experiment. You will then be asked to collect your payment one participant after each other at the front of the lab. If you have any questions, please raise your hand and the experimenter will come to you. Thank you very much for participating in this experiment.

A.1.4. Overview of the session

The experiment lasts about **1 hour**. The 8 games are played in 2 stages, each stage consisting of 4 games all in different networks. Before you play the first 4 games, we will first ask you to answer some quiz questions about the game.

The investment decision questions will appear multiple times throughout the experiment, to be precise for every of the 8 games you will be asked to make 4 investment decisions. You do not have to be consistent with your answers to these questions, as each of the four games is played in a different network.

After this 1st stage of 4 games, you will receive new instructions on your computer screen for the 2nd stage of the experiment. The 2nd stage of the experiment is very similar to the 1st stage, both in length and in what is required of you as a participant.

Because you play together with other persons, you will sometimes have to wait until the other persons have made their decision. These waiting times are incorporated in the total expected duration of 1 hour for the experiment.

Please go back to the computer screen if you have finished reading these instructions and click Continue.

A.2 Simulations adapted with decision noise

Figure A.2 below shows the simulations of the proportion of correct final investments in the correct final vase when we include noise.

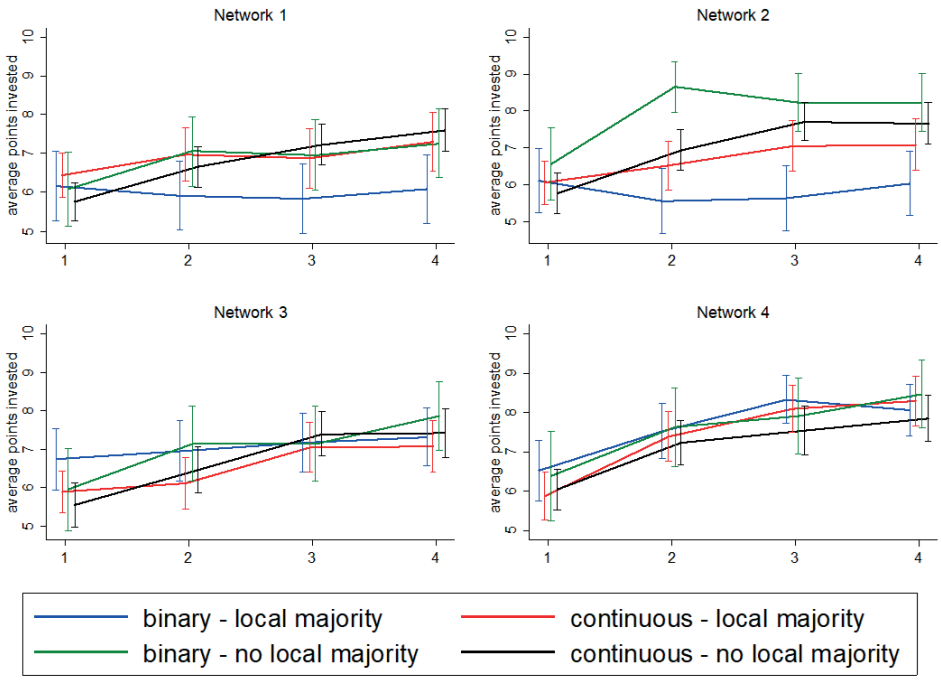
Table A.2 Simulations - Proportion correct final investment in the network in the correct vase including noise.

Network	Binary		Continuous	
	Local majority	No local majority	Local majority	No local majority
1	.62	.69	.63	.65
2	.59	.70	.61	.66
3	.61	.72	.64	.67
4	.63	.7	.67	.67

A.3 Comparison of correctly invested points for all networks

Figure A.3 below shows an overview of how many points were invested on average in the correct vase, for each round. The blue and red line show how the local majority conditions generally lead to less correct points invested. With the blue line representing the binary local majority condition which clearly obstructed the spread of the correct investment decision in Networks 1 and 2.

Figure A.3 Comparing the average points correctly invested for all four networks for binary and continuous investments and with and without a local majority.



A.3

Appendix B

SUPPLEMENTARY MATERIAL FOR CHAPTER 3

Appendix B. Supplementary material for Chapter 3

Table B.1. Electricity consumption comparison calculations table from !WOON

Dutch original text of Electricity consumption calculations

Naam	gemKWHverbruik		
Omschrijving	Deze variabele rekent uit wat het gemiddelde stroomverbruik is van de grootte van het huishouden en vergelijkt deze met de ingevoerde waarde in de app. De tip laat vervolgens zien of het verbruik hoger of lager is dan gemiddeld.		
Gekoppeld aan	2. B. 7. Hoeveel stroom en gas verbruikt u?		
Veld ID	huishouden.energieverbruik.totaal.kWh.		
formule	gemiddeldVerbruik		
Argumenten	A. gemiddeldElektraVerbruik =>huishouden.grootte	Constante =>invoer	2420 2920 3420 3920 4420 1 2 3 4 5
	B.gemiddeldElektraVerbruikNL	Constante	2980
	C.gemiddeldElekraVerbruikSTAD	Constante	2230
Berekening	(A/B)*C		
Voorbeeld	Huishouden van 2 personen	(2920/2980)*2230=2185 kWh	

Translation of Electricity consumption calculations

Name	Average electricity consumption kWh(kilowatt per hour)		
Description	This variables calculates the average electricity consumption given the size of the household and compares it to the actual electricity consumption that has been filled into the app. Hereafter it is shown if the consumption is higher or lower than the average.		
Connected to	2. B. 7. How much electricity and gas do you consume?		
Field ID	Household.energyconsumption.total.kWh.		
Formula	averageConsumption		
Arguments	A. averageElectricityConsumption =>size of household	Constant =>enter	2420 2920 3420 3920 4420 1 2 3 4 5
	B.averageElectricityConsumptionNL	Constant	2980
	C.averageElectricityConsumptionCity	Constant	2230
Calculations	(A/B)*C		
Example	Household with 2 residents	(2920/2980)*2230=2185 kWh	

Table B.2. Gas consumption comparison calculations table from !WOON

Dutch original text of Gas consumption calculations

Naam	gemM3verbruik		
Omschrijving	Deze variabele rekent uit wat het gemiddelde gasverbruik is van het woningtype en vergelijkt deze met de ingevoerde waarde in de app. De tip laat vervolgens zien of het verbruik hoger of lager is dan gemiddeld.		
Gekoppeld aan	2. B. 7. Hoeveel stroom en gas verbruikt u?		
Veld ID	huishouden.energieverbruik.totaal.m3gasGj.		
formule	gemiddeldVerbruik		
Argumenten	A. gemiddeldGasVerbruik =>woning.type	Constante =>invoer	1060 App; 1630 Rij tussen; 2040 Hoek en 2/1 kap; 2440 Vrijstaand
	B.gemiddeldGasVerbruikNL	Constante	1250
	C.gemiddeldGasVerbruikSTAD	Constante	870
Berekening	(A/B)*C		
Voorbeeld	Appartement	(1060/1250)*870=738 m³	

Translation of Gas consumption calculations

Name	Average gas(m3) consumption		
Description	This variables calculates the average gas consumption given the type of the home and compares it to the actual gas consumption that has been filled into the app. Hereafter it is shown if the consumption is higher or lower than the average.		
Connected to	2. B. 7. How much electricity and gas do you consume?		
Field ID	Household.energyconsumption.total.m3gasGJ		
Formula	averageConsumption		
Arguments	A. averageGasConsumption =>type of housing	Constant =>enter	1060 Apartment; 1630 Terraced house; 2040 Corner house; 2440 Detached house
	B.averageGasConsumptionNL	Constant	1250
	C.averageGasConsumptionCity	Constant	870
Calculations	(A/B)*C		
Example	Apartment	(1060/1250)*870=738 m³	

Appendix C

SUPPLEMENTARY MATERIAL FOR CHAPTER 4

Appendix C. Supplementary material for Chapter 4

Table C.1. Correlations table (N = 1050) Pearson correlations with each variable

Variable	M	SD	Environ mental concern	SCO	Social connected ness local	Social connectedness national	Logged electricity consumption	ABS. Diff. Environ mental concern	ABS. Diff. (LN)electricity consumption
Environ mental concern	3.88	.722	1	.125***	.162***	.100***	-.144***	-.421***	.006***
SCO	2.88	.670	.125***	1	.002	.109***	-.086***	-.119***	-.020
Social connectedness local	3.48	.54	.162***	.002	1	.395***	.153***	-.022	-.040
Social connectedness national	2.49	.70	.100***	.109***	.395***	1	.008	-.015	-.008
Logged electricity consump tion	5.20	.78	-.144***	-.86***	.153***	.008	1	.041	-.280***
ABS. Diff. Environ mental concern	.569	.44	-.421***	-.119***	-.022	-.015	.041	1	0
ABS. Diff. logged electricity consump tion	.60	.50	.006	-.020	-.040	-.008	-.280***	0	1

Notes:; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

C

Appendix D

SUPPLEMENTARY MATERIAL FOR CHAPTER 5

Appendix D. Supplementary material for Chapter 5

Table D.1 shows additional control analysis for experiment 1. We check if it made a difference whether people arrived at the website only through the newsletter (N = 9117) or if we could use the total amount of clients that viewed the websites (N = 9285) and include the clients who landed on one of the websites through the bank's general interphase. As can be seen below, the results did not change when we control for the way people landed on the website.

Table D.1. Comparison of the number of clicks that were made on each website compared to the number of views for each of the 3 websites A, B, and C of experiment 1 for clients that were directed to the websites through the newsletter (N = 9117) (proportion followed by the number of clicks in brackets)

	Control (A)	**Testimonial (B)**	**Client statistics (C)**	**Test Diff A vs B and Test A vs C: one-sided; Test Diff B vs C: two-sided**
Page views	3067	3022	3028	Total: 9117
House-scan	.174 (535)	.157 (475)	.161 (454)	Diff A vs B: p =.962 Diff A vs C: p =.995 Diff A vs C: p =.454
Subsidy information by the Dutch government	.231 (707)	.264 (798)	.305 (922)	Diff A vs B: p = .001 Diff A vs C: p = <.001 Diff B vs C: p = .001
Information about financing opportunities	.012 (38)	.013 (38)	.009 (27)	Diff A vs B: p = .520 Diff A vs C: p = .116 Diff B vs C: p =.173
Personal advice talk	.004 (11)	.003 (8)	.003 (10)	Diff A vs B: p = .335 Diff A vs C: p = .512 Diff B vs C: p = .814

D

NEDERLANDSE SAMENVATTING

Achtergrond

Om het doel van de Nederlandse overheid te halen om in 2050 over te stappen van fossiele brandstoffen naar hernieuwbare energiebronnen, moeten Nederlandse huishoudens hun energieconsumptiegedrag veranderen en duurzame woninginvesteringen doen (Ministerie van Economische Zaken en Klimaat, 2020). Variaties van sociale beïnvloedingsstrategieën worden gebruikt door lokale gemeenten, energiebedrijven en woningbouwcoöperaties als beleidsinstrument om huishoudens te mobiliseren om duurzame woninginvesteringen te doen en minder energie te verbruiken. (Beauchampet & Walsh, 2021; P. T. Schneider, van de Rijt, et al., 2023).

Sociale invloed verwijst naar de verandering in de houding of het gedrag van mensen na het observeren van de overwegingen of het gedrag van andere mensen (Rashotte, 2007). Meta-analyses hebben aangetoond dat interventies gericht op het aanmoedigen van duurzaam gedrag die gebaseerd zijn op inzichten uit sociale beïnvloedingstheorieën effectief kunnen zijn, met verschillen in effectiviteit afhankelijk van de doelgroep en het type sociale beïnvloedingsbenadering (Abrahamse & Steg, 2013). Toch blijven de langetermijneffecten van sociale beïnvloedingsprikkels in andere contexten dan energie- en afvalverwijdering en waterefficiëntie onderbelicht (Grilli & Curtis, 2021). Bovendien hebben sociale beïnvloedingsinterventies zoals sociale feedback gemengde resultaten opgeleverd, waarbij sommige studies effectieve verandering rapporteren en andere kleine effecten (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019). Ook blijft het door een publicatiebias, waarbij niet-significante bevindingen te weinig gepubliceerd worden en onvoldoende vertegenwoordigd zijn in de literatuur, onzeker wanneer en hoe effectief sociale beïnvloedingsprikkels zijn (Abrahamse & Steg, 2013).

Dit proefschrift beoogt meer antwoorden te geven op de vraag: op welke manier hangt het energiebesparingsgedrag en het doen van duurzaamheidsinvesteringen van huishoudens af van de milieuvriendelijke houding en het gedrag van andere huishoudens? We doen dit terwijl we rekening houden met de effecten van individuele verschillen en van sociale normen en netwerkstructuren. We beargumenteren specifiek dat sociologische netwerk- en diffusietheorieën onvoldoende worden toegepast op de sociale kant van de energietransitie.

Voordat we ingaan op onze meer specifieke onderzoeksvragen, geven we in deze samenvatting achtergrondinformatie over de psychologische mechanismen van sociale beïnvloeding en het belang van sociale netwerken en sociale normen bij het bestuderen van deze sociale processen.

Psychologische mechanismen horend bij sociale beïnvloeding

In de psychologie zijn de mechanismen van cognitie in onze hersenen onderverdeeld in twee systemen. *Systeem 1* verwijst naar ons snelle en moeiteloze denken dat vaak gebaseerd is op praktische mentale shortcuts: heuristieken en biases genaamd. *Systeem 2* verwijst naar het langzame, weloverwogen rationele denken (Kahneman, 2011). Aangezien we de voorkeur geven aan consistente gedachten om mentale capaciteit te besparen en systeem 1 ons altijd als eerste een eenvoudige manier biedt om met een probleem om te gaan, is het aan systeem 2 om de moeite te nemen om rationeel te beslissen of het goed is om een snelle beslissing te bevestigen of om nieuwe en ontbrekende informatie te zoeken (Kahneman, 2011). Wanneer beslissingen worden genomen in een context van intuïtief en automatisch gedrag, worden mensen meer geleid door stereotypen en vooroordelen dan wanneer beslissingen worden genomen in een meer reflectieve context. (Tutic et al., 2023). De verwerking van informatie over sociale beïnvloeding wordt op vergelijkbare wijze onderverdeeld in *systematische* en *perifere* verwerking, waarbij het eerste verwijst naar doordachte en weloverwogen informatieverwerking en het tweede naar meer automatische en heuristische informatieverwerking (Gass, 2015). Het maken van onderscheid tussen intuïtief en reflectief gedrag wordt ook wel duale verwerking genoemd en heeft substantiële bijdragen geleverd aan ons begrip van ons sociale gedrag (Miles et al., 2023). In de empirische hoofdstukken van dit proefschrift hebben wij zowel de systematische als de perifere verwerking van sociale beïnvloedingsprocessen onderzocht.

Er wordt gezegd dat veel sociale beïnvloeding plaatsvindt via perifere verwerking en binnen het vakgebied van de psychologie is Robert Cialdini de pionier geweest in het onderzoeken van beïnvloedingsprincipes (Gass, 2015). Deze overtuigingstactieken maken gebruik van de overvloed aan informatie in het dagelijks leven door in te spelen op de heuristieken die mensen gebruiken bij het maken van keuzes. Het leveren van sociaal bewijs kan mensen bijvoorbeeld helpen om snel een beslissing te nemen. Dit komt doordat ze zich veiliger kunnen voelen om een keuze te maken, omdat anderen al eerder dezelfde beslissing hebben genomen (Cialdini, 2001). Mensen vertrouwen op sociale invloed, vooral in situaties met onzekerheid, waarin men keuzes baseert op eerder gedrag van anderen (Bikhchandandi et al., 1992). De energietransitie is een context waarin mensen veel onzekere beslissingen moeten nemen. Wij geven concrete voorbeelden van hoe sociale invloed een belangrijke rol speelt bij onzekere investeringsbeslissingen. Voordat we dit doen, zullen we eerst het belang van sociale netwerken in dit proces belichten.

Het belang van netwerken voor sociale invloed

Sociale invloed komt voor in alle aspecten van het dagelijks leven en gebeurt vaak onbedoeld (Gass, 2015). Sociale contacten van mensen, zoals buren in een buurt, kunnen elkaar onbedoeld beïnvloeden met betrekking tot hun duurzame gedrag en investeringen. Sociale netwerken kunnen echter ook worden gebruikt door beleidsmakers om bewust gedrag te initiëren en te katalyseren (Abrahamse & Steg, 2013). Een sociaal netwerk bestaat uit mensen die met elkaar omgaan, en men kan twee vormen van connecties onderscheiden binnen zo'n sociaal netwerk: zwakke en sterke banden (Granovetter, 1973). Sterke banden verwijzen naar mensen die elkaar goed kennen en elkaars meningen als geloofwaardig beschouwen, terwijl zwakke banden worden gekenmerkt door mensen die elkaar nauwelijks kennen. Granovetter (1973) toonde aan dat het belangrijk is om alle vormen van sociale banden tussen gemeenschappen te onderzoeken. Niet alleen sterke banden hebben namelijk invloed op de verspreiding van informatie en gedrag in een sociaal netwerk, maar ook zwakke banden zijn cruciaal voor een bredere verspreiding van gedrag en informatie buiten hechte gemeenschappen van mensen. (Granovetter, 1973). Verder spelen sociale netwerken binnen buurten een centrale rol voor de verspreiding van informatie op mondiaal niveau, omdat lokale clusters van bepaalde beslissingen juist kunnen leiden tot mondiale polarisatie zoals Axelrod (1997) illustreerde in zijn beroemde model van de verspreiding van cultuur.

De vorm van sociale netwerken kan ook van invloed zijn op de verspreiding van informatie, aangezien meer gecentraliseerde netwerkstructuren of netwerken met meer verbindingen tussen leden kunnen leiden tot een snellere verspreiding en een hogere adoptiegraad van innovaties, informatie en gedrag. (Buskens, 2002; Buskens & Yamaguchi, 1999; Flache et al., 2017; Friedkin, 2001; Granovetter, 1978; Uzzi et al., 1993). Granovetter (1973) illustreerde dat er een verschil is in wie informatie verspreidt binnen een sociaal netwerk door het onderscheid te maken tussen zwakke en sterke banden die informatie verspreiden binnen sociale netwerken. Een soortgelijke differentiatie wordt gemaakt voor welke informatie of welk gedrag wordt verspreid in een sociaal netwerk. Centola en Macy (2007) maken onderscheid tussen informatie of gedrag dat slechts één willekeurig contact nodig heeft om informatie over te dragen om geloofwaardig te zijn, een *eenvoudige beïnvloeding* genoemd, en informatie of gedrag dat meerdere geloofwaardige contacten nodig heeft om de informatie te ondersteunen voordat het wordt overgenomen, een *complexe beïnvloeding* genoemd. Dit verschil tussen eenvoudige en complexe beïnvloeding kan worden vergeleken met het idee van zwakke en sterke banden, aangezien zwakke banden voldoende lijken te zijn voor eenvoudige beïnvloeding en sterke banden essentieel lijken te zijn voor complexe beïnvloeding.

Sociale netwerken spelen een cruciale rol binnen de context van de energietransitie omdat er eenvoudige stappen en investeringen zijn die bewoners kunnen nemen, maar ook complexe en kostbare investeringen die sociale verificatie vereisen. Het is belangrijk om te onderzoeken welke sociale beïnvloedingsprocessen effectief zijn voor elk type investeringsbeslissing en hoe sociale netwerken de verspreiding van dergelijke investeringsbeslissingen faciliteren. De overgang van het gebruik van gas voor koken en verwarming naar groene elektriciteit kan alleen succesvol zijn als we een manier vinden om iedereen te mobiliseren om mee te doen.

Soorten sociale normen en hun belang voor sociale beïnvloeding

Samenwerking is essentieel om ambitieuze doelen te bereiken waarbij veel mensen moeten bijdragen, zoals in de energietransitie. Om samenwerking te begrijpen, zijn sociale normen een van de meest interdisciplinair onderzochte onderwerpen (Bicchieri, 2006; Cialdini & Jacobson, 2021; Elster, 1989; Przepiorka et al., 2022). Sociale normen zijn de ongeschreven regels van het sociale leven; het zijn de regels die onze verwachtingen en ons gedrag in sociale situaties sturen (Przepiorka et al. 2022). Wanneer mensen moeten kiezen tussen hun eigen belang en het algemeen belang, ook wel een sociaal dilemma genoemd, worden sociale normen vaak gezien als een van de weinige oplossingen om mensen te stimuleren zich coöperatief te gedragen (Przepiorka et al. 2022).

Als men de houding en het gedrag van mensen wil beïnvloeden, dan zijn er twee specifieke soorten normen die van belang zijn, die *injunctieve* en *descriptieve* normen worden genoemd. Injunctieve normen kunnen worden beschreven als wat de meeste mensen binnen een groep vinden wat wel en niet gedaan moet worden in een bepaalde situatie (Cialdini et al., 1990. Descriptieve normen verwijzen naar wat de meeste mensen daadwerkelijk doen. (Cialdini et al., 1990). Door het verschil tussen deze twee normen, zijn hun effecten op het gedrag ook verschillend. Het is aangetoond dat injunctieve normen onder de juiste omstandigheden de toename van gedrag dat gewenst is door de groep stimuleren en dat descriptieve normen ertoe leiden dat mensen de gemiddelde houding en het gemiddelde gedrag van een groep overnemen (Cialdini et al., 1990). Afhankelijk van de situatie is het dus effectief om injunctieve of descriptieve normen te communiceren.

Daarnaast zijn er individuele verschillen in de mate waarin mensen zichzelf met anderen vergelijken en hoe ontvankelijk ze zijn voor sociale beïnvloeding wanneer ze horen over de sociale normen van hun groep (Bearden & Rose, 1990). Deze karaktertrek wordt ook wel sociale vergelijkingsgevoeligheid genoemd (Buunk & Gibbons, 2007). Voor de energietransitie is het belangrijk om de mensen te identificeren die gevoelig zijn voor beïnvloeding.

Centrale onderzoeksvragen

Onze studies zijn relevant voor de energietransitie en zijn toegepast op de specifieke context ervan, die de dringende samenwerking en zo snel mogelijke adoptie van duurzaam gedrag vereist. Met de vierde en laatste vraag lichten we toe hoe elk van onze fundamentele onderzoeksvragen zich verhoudt tot deze context. We beginnen met het presenteren van de drie fundamentele onderzoeksvragen die onderzoeken wanneer sociale beïnvloedingsprocessen attitudes en gedrag binnen een sociaal netwerk beïnvloeden.

1. In welke mate hangt de effectiviteit van sociale beïnvloedingsprocessen voor het verspreiden van informatie af van de gevoeligheid voor sociale vergelijking en het type gedrag of houding dat wordt verspreid?

2. Hoe beïnvloeden contacten binnen een sociaal netwerk elkaars houding en duurzaam gedrag?

3. Wanneer kunnen sociale beïnvloedingsprocessen minder effectief zijn en wanneer zijn ongewenste neveneffecten van sociale beïnvloeding te verwachten?

4. Wat betekenen de antwoorden op de eerste drie vragen voor sociale beïnvloedingsprocessen met betrekking tot de energietransitie?

In dit proefschrift worden meerdere methoden gecombineerd: laboratoriumexperimenten, analyses van enquêtes en veldexperimenten. Elk van deze methoden heeft zijn voor- en nadelen. Hieronder volgt een samenvatting van de voor- en nadelen van elk van de methoden en hoe het combineren van meerdere van deze methoden voordelig kan zijn.

Methoden

Laboratoriumexperimenten

Onze eerste centrale vraag van dit proefschrift, die de effectiviteit van sociale beïnvloedingsprocessen voor verschillende soorten houdingen en gedragingen wil ontleden, vereist een strikte onderzoeksmethode die een causale test mogelijk maakt. Met een laboratoriumexperiment kunnen we irrelevante contextuele factoren weglaten die de besluitvorming van mensen kunnen beïnvloeden. In het algemeen heeft ons onderzoek veel baat bij de toepasbaarheid en focus op de energietransitie. Echter, wanneer we ons richten op het ontcijferen van zeer specifiek beslisgedrag, moeten we er zeker van zijn dat geen andere contextgerelateerde elementen onze bevindingen beïnvloeden. We zouden bijvoorbeeld niet willen dat milieuvriendelijke attitudes bepaalde investeringsbeslissingen beïnvloeden wanneer we systematisch de effectiviteit van een discrete modelbenadering (Granovetter, 1978) vergelijken met een meer continue modelbenadering (Friedkin, 2001). Alle andere contextuele factoren zou ons vermogen om een causale claim te maken over het belang van het type beslissing dat wordt genomen in het bereiken van een uniforme adoptie van een geschikte investeringsbeslissing in een sociaal netwerk beperken. Door deelnemers willekeurig toe te wijzen aan verschillende experimentele groepen kunnen we er bovendien voor zorgen dat individuele verschillen de besluitvorming niet beïnvloeden. Alleen in een laboratoriumexperiment kunnen we variaties van sociale netwerken creëren door computers op zo'n manier met elkaar te verbinden dat onze deelnemers alleen het gedrag zien van anderen dat wij willen dat ze zien.

Een fictieve samenwerking binnen een kunstmatige setting kan echter slechts een gedeeltelijke kopie zijn van grote sociale netwerken in de wereld en de diverse sociale connecties. Laboratoriumexperimenten hebben daarom ook nadelen. Mensen die deelnemen aan een laboratoriumexperiment weten dat ze worden geobserveerd, waardoor ze zich mogelijk op een meer coöperatieve en sociaal geaccepteerde manier gaan gedragen (Zizzo, 2010). Een andere vaak besproken beperking is dat laboratoriumexperimenten beperkt zijn in tijd en slechts een paar uur duren (Otten, 2023). Deze scepsis ten opzichte van de echtheid en het vermogen van zulke snelle gedragsbeslissingen om de werkelijke afweging van complexere en tijdrovende beslissingen en investeringen te representeren, is behoorlijk. Maar alleen een laboratoriumexperiment stelt onderzoekers in staat om een bepaald deel van een beslissingsproces dat normaal weken, maanden of zelfs jaren duurt, na te bootsen en vervolgens een groep echte mensen op dat moment moeilijke beslissingen te laten nemen.

Enquêtes en gegevens over energieverbruik

Laboratoriumexperimenten hebben het voordeel dat het tijdstip en de volgorde van gebeurtenissen duidelijk is en dat door de willekeurige toewijzing van deelnemers storende factoren en alternatieve causale volgordes kunnen worden uitgesloten. Enquêteonderzoek heeft echter ook veel voordelen. Ten eerste is enquêteonderzoek in staat om toegang te krijgen tot grote aantallen deelnemers, omdat het niet vereist dat deelnemers fysiek of tegelijkertijd actief zijn. Ook hoeven onderzoekers het gedrag van de deelnemers niet te observeren. Vooral online enquêtes hebben veel voordelen, zoals lage kosten, snellere verspreiding dan traditionele post en wereldwijde en permanente toegankelijkheid (Tuten et al., 2002).

Reviews van methoden om milieuvriendelijk gedrag aan te moedigen hebben terecht kritiek geuit op het feit dat er niet genoeg onderzoek is gedaan om te kijken of gedragsveranderingsbenaderingen succesvol zijn over langere perioden (Grilli & Curtis, 2021). Enquêtes zoals de European Social Survey bieden uitgebreide ervaringen in het bestuderen van langetermijntrends van klimaatopvattingen, houdingen ten opzichte van hernieuwbare energie en gedragsintenties (Marquart-Pyatt et al., 2019). Longitudinale enquêtes zouden daarom zeer toepasbaar kunnen zijn om te bestuderen of milieuvriendelijke gedragsveranderingsbenaderingen succesvol zijn over langere perioden.

Enquêtes kunnen als anoniemer worden ervaren omdat mensen niet direct worden geobserveerd. Ze kunnen namelijk worden ingevuld wanneer mensen dat willen en als ze op hun gemak zijn. Er bestaat toch ook een kans dat mensen sociaal wenselijke antwoorden geven (Tuten et al., 2002). Er kan namelijk sprake zijn van een "observer bias" zoals bijvoorbeeld het zogenaamde Hawthorne effect, waarbij mensen sociaal wenselijk handelen als ze zich ervan bewust zijn dat hun antwoorden of gedrag worden geobserveerd (Adair, 1984). Toch lijkt het logisch dat een van de beste manieren is om de attitudes van mensen te onderzoeken, om mensen naar hun werkelijke gedachten te vragen en hun werkelijke gedrag te bekijken in een echte context waarin het gedrag niet in de context van een onderzoek plaatsvond.

Veldexperimenten

Veel van het onderzoek dat sociale beïnvloedingsprocessen bestudeert binnen de context van milieuvriendelijk gedrag is gebaseerd op veldexperimenten, wat duidelijke voordelen heeft met betrekking tot de toepasbaarheid en hoe realistisch en interpreteerbaar de resultaten van dit onderzoek zijn voor beleidsmakers (Abrahamse & Steg, 2013). Aangezien we willen onderzoeken of sociale beïnvloedingsmechanismen

zoals sociaal bewijs effectief zijn in een complexer en kostbaarder beslissingsscenario, winnen we aan geloofwaardigheid door daadwerkelijk gedrag in de echte wereld te testen. Wanneer onderzoek realistisch moet zijn, wordt het echter erg moeilijk om zeer dure investeringsbeslissingen te bestuderen met behulp van veldexperimenten. Je kunt je bijvoorbeeld voorstellen dat het moeilijker is om te testen of sociale beïnvloedingsmechanismen in staat zijn om investeringen van duizenden euro's in duurzame huizen aan te moedigen dan om te testen wat voor soort milieuvriendelijke of normatieve informatie hotelgasten overtuigt om hun handdoek te hergebruiken. (Goldstein et al., 2007). Bepaalde individuele investeringsbeslissingen zijn kostbaarder dan andere en de grote bedrijven zoals banken die zulke kostbare investeringen faciliteren, zijn erg voorzichtig om onafhankelijke anderen toe te staan onderzoek te doen naar de sociale beïnvloedingsprocessen die zij gebruiken. Bovendien zijn bepaalde milieuvriendelijke investeringsbeslissingen, zoals de investering in een nieuw elektrisch verwarmingssysteem, op dit moment nog te zeldzaam om op grote schaal bestudeerd te worden. Laboratoriumexperimenten en enquêtes stellen ons in staat om specifieke attitudes en investeringsgedrag te bestuderen voordat ze plaatsvinden in de specifieke contexten.

Om de individuele problemen van elke onderzoeksmethode aan te pakken, geven we de voorkeur aan een combinatie van methoden voor het uitvoeren van onderzoek naar milieuvriendelijk gedrag. Het testen van gerelateerde hypotheses met behulp van verschillende onderzoeksmethoden biedt mogelijk meer overtuigende ondersteuning voor de bevindingen, omdat de verschillende methoden andere zwakke en sterke punten hebben. Hoewel we in dit proefschrift tot op zekere hoogte rekening houden met de context van beslissingssituaties, is het belangrijk om te onderzoeken of onze bevindingen zich vertalen naar andere contexten. Goedkope en dure milieuvriendelijke investeringen zouden bijvoorbeeld verschillende benaderingen van sociale beïnvloeding nodig kunnen hebben.

Bevindingen en conclusies

In dit proefschrift hebben we bijgedragen aan de kennis over mechanismen achter sociale beïnvloedingsprocessen en hebben we concrete inzichten verkregen in enkele toepassingen voor de energietransitie. Binnen de energietransitie zijn sociale beïnvloedingsmechanismen steeds populairder geworden onder beleidsmakers, omdat overheden het belang inzien van de menselijke dimensies binnen energiebesparend gedrag (Spandagos et al., 2021). Het uitgangspunt van ons onderzoek was dat er geen consensus is over de effectiviteit van interventies op basis van sociale beïnvloeding,

omdat sommige interventies in bepaalde omgevingen wel effectief zijn bevonden en in andere niet (Spandagos et al., 2021). Dit gebrek aan consensus wordt toegeschreven aan studies uit het verleden die zich richtten op de vraag of de interventies op basis van sociale beïnvloeding succesvol waren in het bereiken van hun doel, in plaats van ook de onderliggende omstandigheden en de contexten te onderzoeken die de bevindingen vormden (Spandagos et al., 2021). Andere problemen naast de gemengde resultaten binnen de sociale beïnvloedingsliteratuur zijn een publicatiebias en het ontbreken van onderzoek naar langetermijneffecten (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019).

Onze bijdrage richt zich op sociale beïnvloedingsmechanismen in verschillende contexten en houdt rekening met de effecten van zowel individuele verschillen als sociale normen en netwerkstructuren. We breiden de huidige literatuur uit door psychologische mechanismen die betrokken zijn bij sociale beïnvloeding te relateren aan sociologische aspecten. Verder onderzoeken we of de verschillen in de mate waarin mensen zichzelf vergelijken en hoe verbonden ze zich voelen met hun omgeving gerelateerd zijn aan normvolging. We gebruiken Centola en Macy's (2007) onderscheid tussen eenvoudige en complexe beslissingen en passen dit toe op sociale beïnvloedingsmechanismen. Net zoals Centola en Macy (2007) hebben beschreven dat er verschillen zijn tussen gedrag en attitudes die slechts een klein beetje aanmoediging vereisen en gedrag dat steun van meerdere geloofwaardige anderen nodig heeft, suggereren wij dat de effectiviteit van sociale beïnvloedingsmechanismen afhangt van de complexiteit van de context waarin ze worden toegepast. We hebben getest of sociale beïnvloedingsmechanismen zoals sociaal bewijs, die effectief zijn gebleken in scenario's met lage kosten, ook toepasbaar zijn in gedragssituaties met hoge kosten. Daarnaast hebben we onderzocht of de onderliggende factor van beslissingen die continu of binair zijn, van invloed zijn op een sociaal beïnvloedingsproces in de richting van uniforme adoptie of dat ze polarisatie binnen sociale netwerken bevorderen.

Conclusies voor onze eerste centrale onderzoeksvraag

Onze eerste centrale onderzoeksvraag - in hoeverre de effectiviteit van sociale beïnvloedingsprocessen die informatie verspreiden afhankelijk is van de gevoeligheid op sociale vergelijking en het type gedrag of houding dat wordt verspreid - kan worden onderverdeeld in twee deelvragen. Ten eerste gaat het om individuele verschillen tussen mensen in hun gevoeligheid om zich aan te passen aan sociale normen en ten tweede om het fundamentele verschil of informatie en gedrag continu of binair zijn. Mensen verschillen in de mate waarin ze zich verbonden voelen met de mensen om hen heen en in de mate

waarin ze zichzelf vergelijken, de zogenaamde sociale vergelijkingsgevoeligheid (Buunk & Gibbons, 2007). We hebben onderzocht of deze individuele verschillen geassocieerd zijn met injunctieve of descriptieve normvolging, waarbij het respectievelijk verwijst naar wat mensen vinden dat een groep zou moeten doen en naar wat anderen daadwerkelijk doen. Door zowel enquêtegegevens als werkelijke gegevens over energieverbruik van 1050 Zwitserse huishoudens te analyseren, ontdekten we dat natuurlijk voorkomende sociale normen binnen een samenleving een impact hebben op het vormen van attitudes, maar niet direct geassocieerd lijken te zijn met veranderingen in gedrag. De mensen die zichzelf meer met anderen vergeleken en degenen die hogere niveaus van lokale sociale verbondenheid rapporteerden, hadden hogere niveaus van milieubewustheid en leken meer op elkaar in hun houding ten opzichte van de mensen met een vergelijkbare huishoudgrootte en huisgrootte. Toch was geen van deze individuele kenmerken geassocieerd met een verschil in elektriciteitsverbruik. Dit kan in verband worden gebracht met de gedragskloof tussen houding en gedrag, die benadrukt dat mensen een positieve houding ten opzichte van het milieu kunnen hebben, maar er soms niet naar handelen om verschillende redenen, zoals een gebrek aan effectiviteit of waargenomen risico's van duurzaam kopen (Park & Lin, 2020).

Naast individuele verschillen kunnen ook sociale netwerkstructuren zelf de effectiviteit van sociale beïnvloedingsprocessen beïnvloeden. Het tweede deel van onze eerste centrale vraag richt zich op de verspreiding van informatie in een sociaal netwerk. Sociale beïnvloedingsprocessen kunnen zowel gedrag als attitudes beïnvloeden. Onze resultaten tonen aan dat het vermogen van geleidelijke processen om genuanceerde vormen van informatieverspreiding mogelijk te maken er niet toe leidt dat geleidelijke gedragingen superieur zijn voor het gebruik van sociale beïnvloedingsmechanismen om iedereen binnen een verbonden netwerk te bereiken. Ons laboratoriumexperiment hield alle andere factoren gelijk om specifiek te testen of continue beslissingen inderdaad beter zijn in het bereiken van iedereen binnen een netwerk dan binaire beslissingen. Onze resultaten falsifiëren echter onze voorspellingen en een sociaal beïnvloedingsproces van continu gedrag is niet significant beter in het bereiken van iedereen binnen een sociaal netwerk. Binnen de context van de energietransitie suggereert dit dat beleidsmakers zich zullen moeten richten op andere benaderingen om de verspreiding van investeringen in duurzame woningverbetering te optimaliseren. De continuïteit van investeringsbeslissingen leidt niet tot verbeteringen in adoptiepercentages vergeleken met binaire beslissingen.

Conclusies voor onze tweede centrale onderzoeksvraag

Onze tweede centrale onderzoeksvraag - hoe beïnvloeden contacten binnen een sociaal netwerk elkaars houding en gedrag - kan opnieuw worden opgesplitst in twee deelvragen. Ten eerste keken we naar het specifieke geval van minderheden die zichzelf als een meerderheid beschouwen en prioriteit geven aan de mening van lokale anderen. Ten tweede observeerden we de impact van energievergelijkingen en besparingsadviezen van vrijwilligers op het energieverbruik van de bewoners.

Gebaseerd op het model van de verspreiding van cultuur van Axelrod (1997) waarbij lokale convergentie kan leiden tot wereldwijde polarisatie, laten de resultaten van ons laboratoriumexperiment zien dat wanneer mensen samengeklonterd zijn en slechts toegang hebben tot de beslissingen van een paar mensen om hen heen, ze een lokale meerderheid van afwijkende informatie kunnen vormen. Omdat ze verbonden zijn met mensen met dezelfde mening als zijzelf, kunnen mensen hun eigen mening als een meerderheid gaan beschouwen, zelfs als ze in het hele sociale netwerk in de minderheid zijn. Dit kan een zeer uitdagend probleem worden voor een adoptieproces wanneer deze clusters van mensen vasthouden aan hun afwijkende informatie omdat ze zichzelf niet als een minderheid beschouwen. Door dit specifieke probleem te illustreren, zetten we de eerste stap om het aan te pakken. Het vergroten van de sociale cohesie en het aantal sociale connecties van anderszins intern geclusterde groepen zou een manier kunnen zijn om het probleem van de lokale meerderheden aan te pakken, aangezien onze bevinding dat er geen verschil is tussen het vermogen van continu en binair gedrag om zich naar iedereen binnen een netwerk te verspreiden, geen praktischer alternatief opleverde.

Hoewel de effectiviteit van sociale beïnvloedingsbenaderingen op energiebesparing een van de meest bestudeerde contexten is binnen de sociale energiewetenschappen (Abrahamse & Steg, 2013), zijn wij de eersten die het specifieke instrument van de energiecoaches hebben onderzocht. In tegenstelling tot meer gebruikelijke benaderingen van energiebesparing zoals informatieverstrekking via communicatie van de lokale autoriteiten of energieleveranciers, combineren deze lokale vrijwilligers verschillende voordelen. Vergelijkbaar met de succesvolle blokleidersaanpak (Abrahamse & Steg, 2013) is er een grotere kans dat mensen een band krijgen met deze lokale vrijwilligers. Onze resultaten geven aan dat een bezoek van zo'n lokale vrijwilliger die intrinsiek gemotiveerd is om mensen te helpen energie te besparen en duurzamer te worden, geassocieerd is met een vermindering van het energieverbruik. Energiecoaches hebben een scala aan mogelijkheden om bewoners tot actie aan te zetten. Dit maakt het moeilijk om precies te weten waarom een bezoek van een energiecoach geassocieerd wordt met een vermindering in energieverbruik. Het is belangrijk om te testen of zo'n veel toegepaste

aanpak effectief is, maar het lijkt essentieel om de onderliggende aspecten te ontdekken waarom het effectief is. Een van deze aspecten is de sociale vergelijkingsinformatie die energiecoaches geven aan de bewoners die ze bezoeken. Door onderscheid te maken tussen degenen die te horen kregen dat ze meer energie verbruikten dan vergelijkbare anderen en degenen die te horen kregen dat ze minder energie verbruikten dan gemiddeld, illustreren we het belang van de sociale beïnvloedingsinformatie die wordt gegeven. Onze resultaten suggereren dat het bezoek van een energiecoach geassocieerd was met een vermindering van het energieverbruik, maar alleen voor degenen die van de energiecoach te horen kregen dat ze meer energie verbruikten dan vergelijkbare anderen.

Conclusies voor onze derde centrale onderzoeksvraag

Contacten binnen een sociaal netwerk beïnvloeden elkaars houding en gedrag op zowel gewenste als ongewenste manieren. Dit brengt ons bij onze derde centrale vraag - wanneer kunnen sociale beïnvloedingsprocessen minder effectief zijn en wanneer kunnen ongewenste neveneffecten van sociale beïnvloeding worden verwacht? We hebben deze vraag opnieuw opgedeeld in twee deelvragen, ten eerste willen we weten wanneer informatie over sociale beïnvloeding contraproductief is en ten tweede zijn sociale beïnvloedingstechnieken zoals sociaal bewijs nog steeds effectief als de beslissingssituatie duurder wordt?

Zoals hierboven vermeld was de sociale vergelijkingsinformatie van de energiecoaches geassocieerd met een vermindering van het energieverbruik, maar alleen voor diegenen die van de energiecoach te horen kregen dat ze meer energie verbruikten dan vergelijkbare anderen. Degenen die te horen kregen dat ze minder verbruikten dan gemiddeld en zich dus al beter gedroegen dan anderen wat betreft geld besparen en zich milieuvriendelijk gedragen, verminderden hun energieverbruik niet, maar verhoogden het zelfs: een boemerangeffect (Rasul en Hollywood, 2012; Schultz et al. 2007, 2018). We kunnen alleen maar speculeren waarom mensen hun gedrag precies op deze manier aanpassen. Toch geven onze bevindingen zeker aan dat beleidsmakers er rekening mee moeten houden dat het verstrekken van informatie over sociale invloed aan bewoners gewenste effecten maar ook ongewenste neveneffecten kan hebben.

Om te onderzoeken of sociale beïnvloedingstechnieken zoals sociaal bewijs effectief blijven als de beslissingssituatie duurder wordt, hebben we samengewerkt met een van de grootste banken van Nederland. We hebben verschillende websites gemaakt die respectievelijk duurzame woningverbeteringsdiensten en diensten van de bank om zonnepanelen te krijgen promoten. Na de bank te hebben geholpen bij het ontwikkelen van twee soorten sociaal bewijs manipulaties, en het vergelijken van de aantallen views

en het aantal kliks op de oproepen tot actie op de websites van de banken, moeten we concluderen dat sociaal bewijs het gedrag van klanten niet effectief verhoogt. Het aantal klanten dat de diensten van de bank overwoog was niet significant verschillend, ongeacht of de sociaalbewijsmanipulatie aanwezig was of niet. Onze resultaten hebben een bredere implicatie dan het specifieke geval van sociaal bewijs en de effectiviteit ervan op het stimuleren van gedrag op de website van een bank. Onze resultaten benadrukken dat sociale beïnvloedingstechnieken zoals sociale bewijskracht in verschillende contexten moeten worden onderzocht, voordat ze worden geïmplementeerd om aan te zetten tot actie om een complexere beslissing te nemen.

We concluderen dat ons onderzoek heeft aangetoond dat zowel individuele verschillen als sociale normen en netwerkstructuren belangrijke contextuele factoren zijn waarmee rekening moet worden gehouden bij het bestuderen van de effectiviteit van sociale beïnvloedingsmechanismen. Wat betreft de onderliggende condities die de effectiviteit van sociale beïnvloeding bepalen, vertrouwen we erop dat eerder onderzoek heeft aangetoond dat de zichtbaarheid van gedrag voor anderen belangrijker is dan de inspanning die nodig is om het effectief te laten zijn (Abrahamse & Steg, 2013). Onze resultaten dragen bij aan deze redenering door het belang te benadrukken van de complexiteit van de context waarin sociale beïnvloedingsmechanismen worden toegepast. Gevestigde onderzoeksresultaten in eenvoudige omstandigheden met een laag risico moeten worden gerepliceerd in complexere beslissingssituaties voordat ze worden aanbevolen voor toepassing in het veld. Net zoals Centola en Macy (2007) hebben aangetoond dat voor complex gedrag en attitudes het overtuigen van meerdere geloofwaardige anderen nodig is, suggereren wij dat een combinatie van sociale beïnvloedingsmechanismen en andere interventies zoals economische prikkels nodig kan zijn voor complexere gedragscondities.

Conclusies voor onze vierde centrale onderzoeksvraag

Onze bevindingen en onderzoeksinspanningen voor de eerste drie centrale onderzoeksvragen laten zien dat sociale beïnvloedingsprocessen een belangrijke rol kunnen spelen binnen de energietransitie. Ze kunnen helpen bij het stimuleren en activeren van bewoners om duurzaam te handelen, maar de context waarin ze worden toegepast lijkt cruciaal voor hun succes. De energietransitie is een context waarin van mensen wordt gevraagd om niet alleen beslissingen te nemen uit eigenbelang, maar ook om bij te dragen aan een meer algemene zaak. Door te focussen op één context, kunnen de resultaten van de meer toegepaste hoofdstukken in dit proefschrift in het bijzonder gelden voor de energietransitiecontext. We merken op dat er geen eenvoudige manier is om

sociale beïnvloedingsprocessen te verbeteren om iedereen binnen een sociaal netwerk te bereiken om duurzame investeringen in woningverbetering te doen. Ook moeten sociale vergelijkingen van energieverbruik niet onzorgvuldig worden gemaakt, omdat ze kunnen leiden tot ongewenste overloopeffecten. Mensen verschillen in hun gevoeligheid op sociale vergelijking en de mate waarin ze zich verbonden voelen met anderen. Toch zijn degenen die zichzelf meer vergelijken met anderen en degenen die zich meer verbonden voelen met anderen alleen maar vatbaarder voor sociale normen met betrekking tot milieuvriendelijke houding en niet gedrag. Tot slot vereist de energietransitie kleine gedragsveranderingen en grotere investeringen van huiseigenaren. Ons onderzoek benadrukt dat sociale beïnvloedingsmechanismen die effectief zijn bevonden voor kleine gedragsveranderingen moeten worden getest in duurdere contexten voordat ze worden toegepast.

DEUTSCHE ZUSAMMENFASSUNG

Hintergrund

Um das Ziel der niederländischen Regierung zu erreichen, bis 2050 von fossilen Brennstoffen auf erneuerbare Energiequellen umzusteigen, müssen die niederländischen Haushalte ihr Energieverbrauchsverhalten ändern und nachhaltige Investitionen in Wohngebäude tätigen (Ministerium für Wirtschaft und Klimawandel, 2020). Verschiedene Strategien der sozialen Beeinflussung werden von lokalen Gemeinden, Energieunternehmen und Wohnungsbaugenossenschaften als politische Instrumente eingesetzt, um Haushalte dazu zu bewegen, in nachhaltigen Wohnraum zu investieren und weniger Energie zu verbrauchen. (Beauchampet & Walsh, 2021; P. T. Schneider, van de Rijt, et al., 2023).

Sozialer Einfluss bezieht sich auf die Veränderung der Einstellung oder des Verhaltens von Menschen, nachdem sie die Überlegungen oder das Verhalten anderer Menschen beobachtet haben (Rashotte, 2007). Meta-Analysen haben gezeigt, dass Interventionen zur Förderung nachhaltigen Verhaltens, die auf Erkenntnissen aus Theorien des sozialen Einflusses beruhen, wirksam sein können, wobei die Wirksamkeit je nach Zielgruppe und Art des Ansatzes des sozialen Einflusses unterschiedlich ist (Abrahamse & Steg, 2013). Die langfristigen Auswirkungen von Anreizen durch sozialen Einfluss in anderen Bereichen als der Energie- und Abfallentsorgung und der Wassereffizienz sind jedoch noch nicht ausreichend erforscht (Grilli & Curtis, 2021). Darüber hinaus haben Interventionen zur sozialen Beeinflussung, wie z. B. soziales Feedback, zu gemischten Ergebnissen geführt, wobei einige Studien über wirksame Veränderungen und andere über geringe Auswirkungen berichten (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019). Auch aufgrund von Publikationsverzerrungen, bei denen nicht signifikante Ergebnisse zu wenig veröffentlicht und in der Literatur unzureichend dargestellt werden, bleibt es ungewiss, wann und wie wirksam Anreize zur sozialen Beeinflussung tatsächlich sind (Abrahamse & Steg, 2013).

Ziel dieser Arbeit ist es, mehr Antworten auf die Frage zu geben, inwieweit das Energiesparverhalten und die Nachhaltigkeitsinvestitionen der Haushalte von den umweltfreundlichen Einstellungen und Verhaltensweisen anderer Haushalte abhängen. Wir tun dies unter Berücksichtigung der Auswirkungen individueller Unterschiede sowie sozialer Normen und Netzwerkstrukturen. Insbesondere argumentieren wir, dass soziologische Netzwerk- und Diffusionstheorien unzureichend auf die soziale Seite der Energiewende angewandt werden.

Bevor wir auf unsere spezifischeren Forschungsfragen eingehen, geben wir in dieser Zusammenfassung Hintergrundinformationen über die psychologischen Mechanismen des sozialen Einflusses und die Bedeutung sozialer Netzwerke und sozialer Normen bei der Untersuchung dieser sozialen Prozesse.

Psychologische Mechanismen, die zum sozialen Einfluss gehören

In der Psychologie werden die Mechanismen der Wahrnehmung in unserem Gehirn in zwei Systeme unterteilt. *System 1* bezieht sich auf unser schnelles und müheloses Denken, das oft auf praktischen mentalen Abkürzungen beruht: den so genannten Heuristiken und Vorurteilen. *System 2 bezieht sich auf das* langsame, bewusste, rationale Denken (Kahneman, 2011). Da wir konsistente Gedanken bevorzugen, um mentale Kapazität zu sparen, und System 1 uns immer als Erstes einen einfachen Weg zur Lösung eines Problems anbietet, ist es Aufgabe von System 2, sich die Mühe zu machen, rational zu entscheiden, ob es richtig ist, eine schnelle Entscheidung zu bestätigen oder neue und fehlende Informationen zu suchen (Kahneman, 2011). Wenn Entscheidungen in einem Kontext von intuitivem und automatischem Verhalten getroffen werden, lassen sich Menschen stärker von Stereotypen und Vorurteilen leiten, als wenn Entscheidungen in einem stärker reflektierten Kontext getroffen werden. (Tutic et al., 2023). Die Verarbeitung von Informationen über soziale Einflüsse wird in ähnlicher Weise in *systematische* und *periphere* Verarbeitung unterteilt, wobei sich erstere auf eine durchdachte und bewusste Informationsverarbeitung bezieht und letztere auf eine eher automatische und heuristische Informationsverarbeitung (Gass, 2015). Die Unterscheidung zwischen intuitivem und reflexivem Verhalten wird auch als duale Verarbeitung bezeichnet und hat wesentlich zu unserem Verständnis des Sozialverhaltens beigetragen (Miles et al., 2023). In den empirischen Kapiteln dieser Arbeit haben wir sowohl die systematische als auch die periphere Verarbeitung von sozialen Einflussprozessen untersucht.

Es heißt, dass ein Großteil der sozialen Beeinflussung durch periphere Verarbeitung erfolgt, und im Bereich der Psychologie war Robert Cialdini der Pionier bei der Erforschung von Beeinflussungsprinzipien (Gass, 2015). Diese Überzeugungstaktiken nutzen die Fülle an Informationen im Alltag, indem sie sich die Heuristiken zunutze machen, die Menschen bei ihren Entscheidungen anwenden. So kann zum Beispiel die Bereitstellung sozialer Beweise dazu beitragen, dass Menschen schnell eine Entscheidung treffen. Der Grund dafür ist, dass sie sich sicherer fühlen, wenn sie eine Entscheidung treffen, weil andere dieselbe Entscheidung schon einmal getroffen haben (Cialdini, 2001). Menschen verlassen sich auf sozialen Einfluss, insbesondere in Situationen der Unsicherheit, in denen sie ihre Entscheidungen auf das frühere Verhalten anderer stützen (Bikhchandandi et al., 1992). Die Energiewende ist ein Kontext, in dem die Menschen viele unsichere Entscheidungen treffen müssen. Wir geben konkrete Beispiele dafür, wie der soziale Einfluss bei unsicheren Investitionsentscheidungen eine wichtige Rolle spielt. Zuvor werden wir die Bedeutung sozialer Netzwerke in diesem Prozess hervorheben.

Die Bedeutung der Vernetzung für den sozialen Einfluss

Soziale Beeinflussung findet in allen Aspekten des täglichen Lebens statt und geschieht oft ungewollt (Gass, 2015). Soziale Kontakte von Menschen, z. B. in der Nachbarschaft, können sich gegenseitig ungewollt in Bezug auf ihr nachhaltiges Verhalten und ihre Investitionen beeinflussen. Soziale Netzwerke können jedoch auch von politischen Entscheidungsträgern genutzt werden, um bewusstes Verhalten zu initiieren und zu katalysieren (Abrahamse & Steg, 2013). Ein soziales Netzwerk besteht aus Menschen, die miteinander interagieren, und man kann zwei Formen von Verbindungen innerhalb eines solchen sozialen Netzwerks unterscheiden: schwache und starke Bindungen (Granovetter, 1973). Starke Bindungen beziehen sich auf Menschen, die sich gut kennen und die Meinung des anderen als glaubwürdig ansehen, während schwache Bindungen durch Menschen gekennzeichnet sind, die sich kaum kennen. Granovetter (1973) zeigte, dass es wichtig ist, alle Formen sozialer Bindungen zwischen Gemeinschaften zu untersuchen. Denn nicht nur starke Bindungen wirken sich auf die Verbreitung von Informationen und Verhaltensweisen in einem sozialen Netzwerk aus, sondern auch schwache Bindungen sind für die weitere Verbreitung von Verhaltensweisen und Informationen außerhalb enger Gemeinschaften von Menschen entscheidend. (Granovetter, 1973). Darüber hinaus spielen soziale Netzwerke innerhalb von Stadtvierteln eine zentrale Rolle für die Verbreitung von Informationen auf globaler Ebene, da lokale Häufungen bestimmter Entscheidungen tatsächlich zu einer globalen Polarisierung führen können, wie z. B. Axelrod (1997) in seinem berühmten Modell der Kulturverbreitung veranschaulicht.

Auch die Form sozialer Netzwerke kann die Informationsverbreitung beeinflussen, da zentralisiertere Netzwerkstrukturen oder Netzwerke mit mehr Verbindungen zwischen den Mitgliedern zu einer schnelleren Verbreitung und höheren Adoptionsraten von Innovationen, Informationen und Verhalten führen können. (Buskens, 2002; Buskens & Yamaguchi, 1999; Flache et al., 2017; Friedkin, 2001; Granovetter, 1978; Uzzi et al., 1993). Granovetter (1973) veranschaulichte, dass es einen Unterschied darin gibt, wer Informationen innerhalb eines sozialen Netzwerks verbreitet, indem er zwischen schwachen und starken Bindungen unterschied, die Informationen innerhalb sozialer Netzwerke verbreiten. Eine ähnliche Unterscheidung wird für die Informationen oder Verhaltensweisen getroffen, die in einem sozialen Netzwerk verbreitet werden. Centola und Macy (2007) unterscheiden zwischen Informationen oder Verhaltensweisen, die nur einen zufälligen Kontakt zur Übermittlung von Informationen benötigen, um glaubwürdig zu sein, was als *einfacher Einfluss* bezeichnet wird, und Informationen oder Verhaltensweisen, die mehrere glaubwürdige Kontakte zur Unterstützung der Informationen benötigen, bevor sie angenommen werden, was als *komplexer Einfluss*

bezeichnet wird. Dieser Unterschied zwischen einfacher und komplexer Beeinflussung kann mit dem Konzept der schwachen und starken Bindungen verglichen werden, da schwache Bindungen für eine einfache Beeinflussung ausreichend und starke Bindungen für eine komplexe Beeinflussung wesentlich zu sein scheinen.

Soziale Netzwerke spielen im Rahmen der Energiewende eine entscheidende Rolle, denn es gibt einfache Schritte und Investitionen, die die Bürger tätigen können, aber auch komplexe und kostspielige Investitionen, die eine soziale Überprüfung erfordern. Es ist wichtig zu untersuchen, welche sozialen Einflussprozesse für jede Art von Investitionsentscheidung wirksam sind und wie soziale Netzwerke die Verbreitung solcher Investitionsentscheidungen erleichtern. Der Übergang von der Verwendung von Gas zum Kochen und Heizen zu grünem Strom kann nur dann erfolgreich sein, wenn wir einen Weg finden, alle zur Teilnahme zu mobilisieren.

Arten von sozialen Normen und ihre Bedeutung für den sozialen Einfluss

Zusammenarbeit ist unerlässlich, um ehrgeizige Ziele zu erreichen, zu denen viele Menschen beitragen müssen, wie bei der Energiewende. Um Kooperation zu verstehen, sind soziale Normen eines der am meisten untersuchten interdisziplinären Themen (Bicchieri, 2006; Cialdini & Jacobson, 2021; Elster, 1989; Przepiorka et al., 2022). Soziale Normen sind die ungeschriebenen Regeln des sozialen Lebens; sie sind die Regeln, die unsere Erwartungen und unser Verhalten in sozialen Situationen leiten (Przepiorka et al. 2022). Wenn Menschen zwischen ihren eigenen Interessen und dem Gemeinwohl wählen müssen, was auch als soziales Dilemma bezeichnet wird, gelten soziale Normen oft als eine der wenigen Lösungen, um Menschen zu kooperativem Verhalten zu bewegen (Przepiorka et al. 2022).

Wenn man die Einstellungen und das Verhalten von Menschen beeinflussen will, sind zwei spezifische Arten von Normen von Bedeutung, die sogenannten *injunktiven* und *deskriptiven* Normen. Injunktive Normen können als das beschrieben werden, was die meisten Menschen innerhalb einer Gruppe denken, was in einer bestimmten Situation getan und nicht getan werden sollte (Cialdini et al., 1990. Deskriptive Normen beziehen sich auf das, was die meisten Menschen tatsächlich tun. (Cialdini et al., 1990). Aufgrund des Unterschieds zwischen diesen beiden Normen sind auch ihre Auswirkungen auf das Verhalten unterschiedlich. Es hat sich gezeigt, dass unter den richtigen Umständen injunktive Normen das von der Gruppe gewünschte Verhalten fördern und dass deskriptive Normen dazu führen, dass die Menschen die durchschnittliche Einstellung und das Verhalten einer Gruppe übernehmen (Cialdini et al., 1990). Je nach Situation ist es also wirksam, injunktive oder deskriptive Normen zu vermitteln.

Darüber hinaus gibt es individuelle Unterschiede darin, inwieweit Menschen sich mit anderen vergleichen und wie empfänglich sie für sozialen Einfluss sind, wenn sie von den sozialen Normen ihrer Gruppe erfahren (Bearden & Rose, 1990). Diese Eigenschaft wird auch als Sensibilität für soziale Vergleiche bezeichnet (Buunk & Gibbons, 2007). Für die Energiewende ist es wichtig, die Menschen zu identifizieren, die für eine Beeinflussung anfällig sind.

Zentrale Forschungsfragen

Unsere Studien sind für die Energiewende relevant und werden auf ihren spezifischen Kontext angewandt, der die dringende Zusammenarbeit und die Annahme nachhaltiger Verhaltensweisen so bald wie möglich erfordert. In der letzten von vier Fragen erläutern wir, wie jede unserer grundlegenden Forschungsfragen mit diesem Kontext zusammenhängt. Wir beginnen mit der Vorstellung der drei grundlegenden Forschungsfragen, die untersuchen, wann soziale Einflussprozesse Einstellungen und Verhalten innerhalb eines sozialen Netzwerks beeinflussen.

1. Inwieweit hängt die Wirksamkeit sozialer Beeinflussungsprozesse zur Verbreitung von Informationen von der Sensibilität für soziale Vergleiche und der Art des zu verbreitenden Verhaltens oder der Einstellung ab?

2. Wie beeinflussen die Kontakte innerhalb eines sozialen Netzwerks die Einstellungen und das nachhaltige Verhalten der anderen?

3. Wann können soziale Beeinflussungsprozesse weniger effektiv sein und wann sind unerwünschte Nebeneffekte sozialer Beeinflussung zu erwarten?

4. Was bedeuten die Antworten auf die ersten drei Fragen für die gesellschaftlichen Einflussprozesse im Zusammenhang mit der Energiewende?

In dieser Arbeit werden mehrere Methoden kombiniert: Laborexperimente, Umfrageanalysen und Feldversuche. Jede dieser Methoden hat ihre Vor- und Nachteile. Im Folgenden werden die Vor- und Nachteile der einzelnen Methoden zusammengefasst und erläutert, wie die Kombination mehrerer Methoden von Vorteil sein kann.

Methoden

Laborversuche

Die erste zentrale Frage dieser Arbeit, die darauf abzielt, die Wirksamkeit sozialer Beeinflussungsprozesse für verschiedene Arten von Einstellungen und Verhaltensweisen zu untersuchen, erfordert eine strenge Forschungsmethode, die einen Kausaltest ermöglicht. Ein Laborexperiment ermöglicht es uns, irrelevante Kontextfaktoren, die die Entscheidungsfindung der Menschen beeinflussen könnten, auszuschließen. Insgesamt profitiert unsere Forschung stark von ihrer Anwendbarkeit und ihrem Fokus auf die Energiewende. Wenn wir uns jedoch darauf konzentrieren, ein ganz bestimmtes Entscheidungsverhalten zu entschlüsseln, müssen wir sicherstellen, dass keine anderen kontextbezogenen Elemente unsere Ergebnisse beeinflussen. Wir würden zum Beispiel nicht wollen, dass umweltfreundliche Einstellungen bestimmte Investitionsentscheidungen beeinflussen, wenn wir systematisch die Wirksamkeit eines diskreten Modellansatzes (Granovetter, 1978) mit einem eher kontinuierlichen Modellansatz (Friedkin, 2001) vergleichen. Alle anderen kontextuellen Faktoren würden unsere Fähigkeit einschränken, eine kausale Aussage über die Bedeutung des Entscheidungstyps für die einheitliche Annahme einer angemessenen Investitionsentscheidung in einem sozialen Netzwerk zu treffen. Außerdem können wir durch die zufällige Zuweisung der Teilnehmer zu verschiedenen Versuchsgruppen sicherstellen, dass individuelle Unterschiede die Entscheidungsfindung nicht beeinflussen. Nur in einem Laborexperiment können wir Variationen sozialer Netzwerke schaffen, indem wir Computer so miteinander verbinden, dass unsere Teilnehmer nur das Verhalten der anderen sehen, das wir ihnen zeigen wollen.

Eine fiktive Zusammenarbeit in einem künstlichen Umfeld kann jedoch nur teilweise die großen sozialen Netzwerke der Welt und die vielfältigen sozialen Verbindungen nachbilden. Laborexperimente haben daher auch Nachteile. Menschen, die an einem Laborexperiment teilnehmen, wissen, dass sie beobachtet werden, was dazu führen kann, dass sie sich kooperativer und sozial akzeptabler verhalten (Zizzo, 2010). Eine weitere häufig diskutierte Einschränkung ist, dass Laborexperimente zeitlich begrenzt sind und nur wenige Stunden dauern (Otten, 2023). Die Skepsis gegenüber der Authentizität und der Fähigkeit solcher schnellen Verhaltensentscheidungen, den wahren Kompromiss komplexerer und zeitaufwändigerer Entscheidungen und Investitionen darzustellen, ist groß. Aber nur ein Laborexperiment ermöglicht es den Forschern, einen Teil eines Entscheidungsprozesses zu imitieren, der normalerweise Wochen, Monate oder sogar Jahre dauert, und dann eine Gruppe echter Menschen zu diesem Zeitpunkt schwierige Entscheidungen treffen zu lassen.

Erhebungen und Daten zum Energieverbrauch

Laborexperimente haben den Vorteil, dass der Zeitpunkt und die Abfolge der Ereignisse klar sind und die zufällige Zuweisung der Teilnehmer den Ausschluss von Störfaktoren und alternativen Kausalverläufen ermöglicht. Die Umfrageforschung hat jedoch auch viele Vorteile. Erstens ist die Umfrageforschung in der Lage, auf eine große Anzahl von Teilnehmern zuzugreifen, da sie nicht voraussetzt, dass die Teilnehmer physisch oder gleichzeitig aktiv sind. Außerdem brauchen die Forscher das Verhalten der Teilnehmer nicht zu beobachten. Insbesondere Online-Umfragen haben viele Vorteile, darunter niedrige Kosten, eine schnellere Verbreitung als der traditionelle Postversand und eine weltweite und ständige Erreichbarkeit (Tuten et al., 2002).

In Übersichten über Methoden zur Förderung umweltfreundlicher Verhaltensweisen wird zu Recht kritisiert, dass nicht genügend Untersuchungen durchgeführt wurden, um festzustellen, ob Ansätze zur Verhaltensänderung über längere Zeiträume hinweg erfolgreich sind (Grilli & Curtis, 2021). Erhebungen, wie die Europäische Sozialerhebung, bieten umfangreiche Erfahrungen bei der Untersuchung langfristiger Trends in Bezug auf Klimaüberzeugungen, Einstellungen zu erneuerbaren Energien und Verhaltensabsichten (Marquart-Pyatt et al., 2019). Längsschnitt-Erhebungen könnten daher sehr gut geeignet sein, um zu untersuchen, ob umweltfreundliche Ansätze zur Verhaltensänderung über längere Zeiträume erfolgreich sind.

Umfragen können als anonymer empfunden werden, da die Personen nicht direkt beobachtet werden. Sie können in der Tat ausgefüllt werden, wenn die Befragten es wollen und wenn sie sich wohlfühlen. Dennoch besteht auch die Möglichkeit, dass die Befragten sozial erwünschte Antworten geben (Tuten et al., 2002). In der Tat kann es eine „Beobachterverzerrung" geben, wie z. B. den so genannten Hawthorne-Effekt, bei dem Menschen sozial erwünscht handeln, wenn sie wissen, dass ihre Antworten oder ihr Verhalten beobachtet werden (Adair, 1984). Nichtsdestotrotz scheint es logisch, dass eine der besten Möglichkeiten, die Einstellungen der Menschen zu untersuchen, darin besteht, die Menschen nach ihren tatsächlichen Gedanken zu fragen und ihr tatsächliches Verhalten in einem realen Kontext zu beobachten, in dem das Verhalten nicht im Rahmen einer Umfrage stattgefunden hat.

Feldversuche

Ein Großteil der Forschung, die soziale Einflussprozesse im Zusammenhang mit umweltfreundlichem Verhalten untersucht, basiert auf Feldexperimenten, was eindeutige Vorteile in Bezug auf die Anwendbarkeit und die Realitätsnähe und Interpretierbarkeit der Ergebnisse dieser Forschung für politische Entscheidungsträger hat (Abrahamse & Steg,

2013). Da wir untersuchen wollen, ob soziale Einflussmechanismen wie social proof in einem komplexeren und kostspieligen Entscheidungsszenario wirksam sind, gewinnen wir an Glaubwürdigkeit, indem wir tatsächliches Verhalten in der realen Welt testen. Wenn die Forschung jedoch realistisch sein muss, wird es sehr schwierig, sehr teure Investitionsentscheidungen mithilfe von Feldexperimenten zu untersuchen. Man kann sich zum Beispiel vorstellen, dass es schwieriger ist, zu testen, ob soziale Einflussmechanismen in der Lage sind, Investitionen von Tausenden von Euro in nachhaltige Häuser zu fördern, als zu testen, welche Art von umweltfreundlichen oder normativen Informationen Hotelgäste davon überzeugen, ihr Handtuch wiederzuverwenden. (Goldstein et al., 2007). Bestimmte individuelle Investitionsentscheidungen sind kostspieliger als andere, und die großen Unternehmen wie Banken, die solche kostspieligen Investitionen ermöglichen, sind sehr zurückhaltend, wenn es darum geht, unabhängigen Dritten die Erforschung der von ihnen angewandten Verfahren der sozialen Einflussnahme zu gestatten. Darüber hinaus sind einige umweltfreundliche Investitionsentscheidungen, wie z. B. die Investition in eine neue elektrische Heizungsanlage, derzeit zu selten, um umfassend untersucht zu werden. Mit Hilfe von Laborexperimenten und Umfragen können wir bestimmte Einstellungen und das Investitionsverhalten untersuchen, bevor sie in den jeweiligen Kontexten stattfinden.

Um die individuellen Probleme der einzelnen Forschungsmethoden anzugehen, bevorzugen wir eine Kombination von Methoden zur Erforschung umweltfreundlichen Verhaltens. Die Prüfung verwandter Hypothesen mit verschiedenen Forschungsmethoden kann die Ergebnisse überzeugender untermauern, da die verschiedenen Methoden unterschiedliche Schwächen und Stärken haben. Obwohl wir in dieser Arbeit den Kontext von Entscheidungssituationen bis zu einem gewissen Grad berücksichtigen, ist es wichtig zu untersuchen, ob sich unsere Ergebnisse auf andere Kontexte übertragen lassen. So könnten beispielsweise kostengünstige und kostspielige Umweltinvestitionen unterschiedliche Ansätze zur sozialen Beeinflussung erfordern.

Feststellungen und Schlussfolgerungen

In dieser Arbeit haben wir zum Wissen über die Mechanismen sozialer Einflussnahme beigetragen und konkrete Einblicke in einige Anwendungen für die Energiewende gewonnen. Im Rahmen der Energiewende erfreuen sich Mechanismen der sozialen Beeinflussung zunehmender Beliebtheit bei politischen Entscheidungsträgern, da die Regierungen die Bedeutung der menschlichen Dimensionen bei energiesparendem Verhalten anerkennen (Spandagos et al., 2021). Ausgangspunkt unserer Studie war die Tatsache, dass es keinen Konsens über die Wirksamkeit von auf sozialer Beeinflussung

basierenden Interventionen gibt, da sich einige Interventionen in einigen Bereichen als wirksam erwiesen haben, in anderen hingegen nicht (Spandagos et al., 2021). Dieser Mangel an Konsens wird auf frühere Studien zurückgeführt, die sich darauf konzentrierten, ob auf sozialem Einfluss basierende Interventionen ihre Ziele erreichen, anstatt auch die zugrunde liegenden Bedingungen und Kontexte zu untersuchen, die die Ergebnisse beeinflussten (Spandagos et al., 2021). Zu den weiteren Problemen neben den gemischten Ergebnissen in der Literatur über sozialen Einfluss gehören die Verzerrung der Veröffentlichungen und der Mangel an Untersuchungen über langfristige Auswirkungen (Abrahamse & Steg, 2013; Grilli & Curtis, 2021; Tiefenbeck et al., 2019).

Unser Beitrag konzentriert sich auf Mechanismen der sozialen Beeinflussung in verschiedenen Kontexten und berücksichtigt die Auswirkungen individueller Unterschiede sowie sozialer Normen und Netzwerkstrukturen. Wir erweitern die aktuelle Literatur, indem wir psychologische Mechanismen, die an sozialem Einfluss beteiligt sind, mit soziologischen Aspekten in Verbindung bringen. Darüber hinaus untersuchen wir, ob Unterschiede im Ausmaß des Selbstvergleichs und der Verbundenheit mit der Umwelt mit der Befolgung von Normen zusammenhängen. Wir verwenden die von Centola und Macy (2007) getroffene Unterscheidung zwischen einfachen und komplexen Entscheidungen und wenden sie auf die Mechanismen der sozialen Beeinflussung an. So wie Centola und Macy (2007) beschrieben, dass es Unterschiede zwischen Verhaltensweisen und Einstellungen gibt, die nur ein wenig Ermutigung benötigen, und solchen, die die Unterstützung mehrerer glaubwürdiger Personen erfordern, gehen wir davon aus, dass die Wirksamkeit sozialer Einflussmechanismen von der Komplexität des Kontexts abhängt, in dem sie angewendet werden. Wir haben getestet, ob soziale Beeinflussungsmechanismen wie social proof, die sich in Szenarien mit geringen Kosten als wirksam erwiesen haben, auch in Situationen mit hohen Kosten für das Verhalten anwendbar sind. Darüber hinaus untersuchten wir, ob der zugrundeliegende Faktor von Entscheidungen, die kontinuierlich oder binär sind, einen sozialen Beeinflussungsprozess in Richtung einer einheitlichen Annahme bewegen oder ob sie eine Polarisierung innerhalb sozialer Netzwerke fördern.

Schlussfolgerungen zu unserer ersten zentralen Forschungsfrage

Unsere erste zentrale Forschungsfrage - inwieweit die Wirksamkeit sozialer Beeinflussungsprozesse, die Informationen verbreiten, von der Sensibilität für soziale Vergleiche und der Art des verbreiteten Verhaltens oder der Einstellung abhängt - lässt sich in zwei Unterfragen unterteilen. Die erste bezieht sich auf die individuellen Unterschiede zwischen Menschen in ihrer Sensibilität für die Anpassung an soziale Normen und die zweite auf den grundlegenden Unterschied, ob Informationen und

Verhalten kontinuierlich oder binär sind. Menschen unterscheiden sich darin, inwieweit sie sich mit den Menschen um sie herum verbunden fühlen und inwieweit sie sich selbst vergleichen, die so genannte soziale Vergleichssensitivität (Buunk & Gibbons, 2007). Wir haben untersucht, ob diese individuellen Unterschiede mit einer injunktiven oder deskriptiven Normbefolgung zusammenhängen, d. h. mit dem, was Menschen glauben, dass eine Gruppe tun sollte, bzw. mit dem, was andere tatsächlich tun. Durch die Analyse von Umfragedaten und tatsächlichen Energieverbrauchsdaten von 1050 Schweizer Haushalten fanden wir heraus, dass natürlich vorkommende soziale Normen innerhalb einer Gesellschaft einen Einfluss auf die Bildung von Einstellungen haben, aber nicht direkt mit Verhaltensänderungen verbunden zu sein scheinen. Diejenigen, die sich mehr mit anderen verglichen und die über ein höheres Maß an lokaler sozialer Verbundenheit berichteten, hatten ein höheres Umweltbewusstsein und waren sich in ihren Einstellungen gegenüber Personen mit ähnlicher Haushaltsgröße und Hausgröße ähnlicher. Keines dieser individuellen Merkmale wurde jedoch mit einem Unterschied im Stromverbrauch in Verbindung gebracht. Dies könnte mit der Kluft zwischen Einstellung und Verhalten zusammenhängen, die darauf hinweist, dass Menschen zwar eine positive Einstellung zur Umwelt haben, diese aber aus verschiedenen Gründen nicht in die Tat umsetzen, z. B. wegen mangelnder Wirksamkeit oder wahrgenommener Risiken einer nachhaltigen Beschaffung (Park & Lin, 2020).

Neben individuellen Unterschieden können auch die Strukturen sozialer Netzwerke selbst die Wirksamkeit sozialer Einflussnahme steuern. Der zweite Teil unserer ersten zentralen Frage konzentriert sich auf die Verbreitung von Informationen in einem sozialen Netzwerk. Soziale Beeinflussungsprozesse können sowohl Verhalten als auch Einstellungen prägen. Unsere Ergebnisse zeigen, dass die Fähigkeit gradueller Prozesse, nuancierte Formen der Informationsverbreitung zu ermöglichen, graduelle Verhaltensweisen nicht dazu führt, dass sie besser geeignet sind, soziale Einflussmechanismen zu nutzen, um jeden in einem verbundenen Netzwerk zu erreichen. In unserem Laborexperiment blieben alle anderen Faktoren gleich, um speziell zu testen, ob kontinuierliche Entscheidungen tatsächlich besser geeignet sind, alle Menschen innerhalb eines Netzwerks zu erreichen als binäre Entscheidungen. Unsere Ergebnisse haben jedoch unsere Vorhersagen widerlegt, und ein sozialer Beeinflussungsprozess mit kontinuierlichem Verhalten ist nicht signifikant besser darin, alle Menschen innerhalb eines sozialen Netzwerks zu erreichen. Im Kontext der Energiewende deutet dies darauf hin, dass sich die politischen Entscheidungsträger auf andere Ansätze konzentrieren müssen, um die Verbreitung von Investitionen in nachhaltige Haushaltsverbesserungen zu optimieren. Die Kontinuität von Investitionsentscheidungen führt im Vergleich zu binären Entscheidungen nicht zu einer Verbesserung der Adoptionsraten.

Schlussfolgerungen zu unserer zweiten zentralen Forschungsfrage

Unsere zweite zentrale Forschungsfrage - wie beeinflussen sich Kontakte innerhalb eines sozialen Netzwerks gegenseitig in ihren Einstellungen und ihrem Verhalten - lässt sich wiederum in zwei Unterfragen aufteilen. Erstens untersuchten wir den spezifischen Fall, dass Minderheiten sich als Mehrheit betrachten und die Meinung der anderen Anwohner bevorzugen. Zweitens haben wir die Auswirkungen von Energievergleichen und Energiesparberatung durch Freiwillige auf den Energieverbrauch der Bewohner beobachtet.

Auf der Grundlage des Modells der Kulturverbreitung von Axelrod (1997), wonach lokale Konvergenz zu globaler Polarisierung führen kann, zeigen die Ergebnisse unseres Laborexperiments, dass Menschen, die in einer Gruppe leben und nur Zugang zu den Entscheidungen einiger weniger Personen in ihrer Umgebung haben, eine lokale Mehrheit von abweichenden Informationen bilden können. Da sie mit Personen verbunden sind, die dieselbe Meinung vertreten wie sie selbst, kann es passieren, dass sie ihre eigene Meinung als Mehrheit ansehen, auch wenn sie im gesamten sozialen Netzwerk in der Minderheit sind. Dies kann zu einem sehr schwierigen Problem für einen Adoptionsprozess werden, wenn diese Gruppen von Menschen an ihren abweichenden Informationen festhalten, weil sie sich nicht als Minderheit betrachten. Indem wir dieses spezielle Problem veranschaulichen, machen wir den ersten Schritt, um es zu lösen. Die Erhöhung des sozialen Zusammenhalts und der Anzahl der sozialen Verbindungen von ansonsten intern geclusterten Gruppen könnte eine Möglichkeit sein, das Problem lokaler Mehrheiten anzugehen, da unsere Feststellung, dass es keinen Unterschied zwischen der Fähigkeit von kontinuierlichem und binärem Verhalten gibt, sich auf jeden innerhalb eines Netzwerks zu verbreiten, keine praktischere Alternative bot.

Obwohl die Wirksamkeit von Ansätzen der sozialen Einflussnahme auf die Energieeinsparung einer der am meisten untersuchten Zusammenhänge innerhalb der sozialen Energiewissenschaft ist (Abrahamse & Steg, 2013), sind wir die ersten, die das spezifische Instrument der Energy Coaches untersuchen. Im Gegensatz zu herkömmlichen Ansätzen zum Energiesparen, wie z. B. der Bereitstellung von Informationen durch Mitteilungen von lokalen Behörden oder Energieversorgern, kombinieren diese lokalen Freiwilligen mehrere Vorteile. Ähnlich wie bei dem erfolgreichen Block-Leader-Ansatz (Abrahamse & Steg, 2013) ist es wahrscheinlicher, dass die Menschen eine Bindung zu diesen lokalen Freiwilligen aufbauen. Unsere Ergebnisse zeigen, dass der Besuch eines solchen lokalen Freiwilligen, der intrinsisch motiviert ist, den Menschen beim Energiesparen zu helfen und nachhaltiger zu werden, mit einer Verringerung des Energieverbrauchs einhergeht. Energy Coaches haben eine Reihe von Möglichkeiten, die Bewohner zum Handeln zu bewegen. Daher ist es schwierig, genau zu wissen, warum der Besuch eines

Energy Coaches mit einer Verringerung des Energieverbrauchs verbunden ist. Es ist zwar wichtig zu prüfen, ob ein derartig weit verbreiteter Ansatz wirksam ist, doch scheint es unerlässlich zu sein, die zugrundeliegenden Aspekte zu ermitteln, warum er wirksam ist. Ein solcher Aspekt sind die Informationen zum sozialen Vergleich, die die Energy Coaches den Bewohnern geben, die sie besuchen. Indem wir zwischen denjenigen, denen gesagt wurde, dass sie mehr Energie verbrauchen als vergleichbare andere, und denjenigen, denen gesagt wurde, dass sie weniger Energie verbrauchen als der Durchschnitt, unterscheiden, veranschaulichen wir die Bedeutung der gegebenen Informationen über den sozialen Einfluss. Unsere Ergebnisse deuten darauf hin, dass der Besuch eines Energy Coaches mit einer Verringerung des Energieverbrauchs verbunden war, allerdings nur bei denjenigen, denen der Energy Coach sagte, dass sie mehr Energie verbrauchten als ähnliche andere.

Schlussfolgerungen zu unserer dritten zentralen Forschungsfrage

Kontakte innerhalb eines sozialen Netzwerks beeinflussen die Einstellungen und das Verhalten der anderen sowohl in erwünschter als auch in unerwünschter Weise. Dies bringt uns zu unserer dritten zentralen Frage - wann können soziale Beeinflussungsprozesse weniger effektiv sein und wann sind unerwünschte Nebeneffekte sozialer Beeinflussung zu erwarten? Wir haben diese Frage wiederum in zwei Unterfragen unterteilt: Erstens wollen wir wissen, wann Informationen über soziale Beeinflussung kontraproduktiv sind, und zweitens, ob soziale Beeinflussungstechniken wie social proof noch wirksam sind, wenn die Entscheidungssituation kostspieliger wird.

Wie bereits erwähnt, wurde die Information über den sozialen Vergleich durch den Energy Coach mit einer Verringerung des Energieverbrauchs in Verbindung gebracht, allerdings nur bei denjenigen, denen der Energy Coach mitteilte, dass sie mehr Energie verbrauchten als ähnliche andere. Diejenigen, denen gesagt wurde, dass sie weniger als der Durchschnitt verbrauchen und sich daher bereits besser als andere verhalten, was das Sparen von Geld und umweltfreundliches Verhalten angeht, reduzierten ihren Energieverbrauch nicht, sondern erhöhten ihn sogar: ein Bumerangeffekt (Rasul und Hollywood, 2012; Schultz et al. 2007, 2018). Wir können nur spekulieren, warum genau Menschen ihr Verhalten auf diese Weise anpassen. Nichtsdestotrotz weisen unsere Ergebnisse darauf hin, dass politische Entscheidungsträger im Hinterkopf behalten sollten, dass die Bereitstellung von Informationen über den sozialen Einfluss von Bewohnern erwünschte Effekte, aber auch unerwünschte Nebenwirkungen haben kann.

Um zu untersuchen, ob soziale Beeinflussungstechniken wie social proof auch dann noch wirksam sind, wenn die Entscheidungssituation teurer wird, haben wir mit einer der größten Banken in den Niederlanden zusammengearbeitet. Wir erstellten mehrere

Websites, auf denen für nachhaltige Heimwerkerdienste bzw. für die Dienste der Bank zum Erwerb von Solarzellen geworben wurde. Nachdem wir der Bank geholfen hatten, zwei Arten von social-proof-Manipulationen zu entwickeln, und die Anzahl der Aufrufe und Klicks auf die Handlungsaufforderungen auf den Websites der Banken verglichen hatten, mussten wir feststellen, dass social proof das Kundenverhalten nicht effektiv erhöht. Die Anzahl der Kunden, die die Dienstleistungen der Bank in Betracht zogen, unterschied sich nicht signifikant, unabhängig davon, ob die social-proof-Manipulation vorhanden war oder nicht. Unsere Ergebnisse haben weitreichendere Auswirkungen als der spezielle Fall von social proof und seiner Wirksamkeit bei der Steuerung des Verhaltens auf der Website einer Bank. Unsere Ergebnisse machen deutlich, dass Techniken der sozialen Beeinflussung wie *social proof* in verschiedenen Kontexten untersucht werden sollten, bevor sie eingesetzt werden, um eine komplexere Entscheidung herbeizuführen.

Wir kommen zu dem Schluss, dass unsere Forschung gezeigt hat, dass individuelle Unterschiede sowie soziale Normen und Netzwerkstrukturen wichtige Kontextfaktoren sind, die bei der Untersuchung der Wirksamkeit sozialer Einflussmechanismen zu berücksichtigen sind. In Bezug auf die Rahmenbedingungen, die die Wirksamkeit sozialer Einflussnahme bestimmen, vertrauen wir darauf, dass frühere Forschungen gezeigt haben, dass die Sichtbarkeit des Verhaltens für andere wichtiger ist als der Aufwand, den es erfordert, um wirksam zu sein (Abrahamse & Steg, 2013). Unsere Ergebnisse tragen zu dieser Argumentation bei, indem sie die Bedeutung der Komplexität des Kontexts hervorheben, in dem soziale Einflussmechanismen angewendet werden. Etablierte Forschungsergebnisse unter einfachen, risikoarmen Bedingungen müssen in komplexeren Entscheidungssituationen repliziert werden, bevor sie für die Anwendung in der Praxis empfohlen werden. So wie Centola und Macy (2007) gezeigt haben, dass komplexe Verhaltensweisen und Einstellungen die Überzeugung mehrerer glaubwürdiger Personen erfordern, schlagen wir vor, dass für komplexere Verhaltensbedingungen eine Kombination aus Mechanismen der sozialen Beeinflussung und anderen Interventionen, wie z. B. wirtschaftliche Anreize, erforderlich sein könnte.

Schlussfolgerungen zu unserer vierten zentralen Forschungsfrage

Unsere Ergebnisse und Forschungsanstrengungen zu den ersten drei zentralen Forschungsfragen zeigen, dass soziale Einflussprozesse eine wichtige Rolle bei der Energiewende spielen können. Sie können dazu beitragen, die Bewohner zu nachhaltigem Handeln anzuregen und zu aktivieren, aber der Kontext, in dem sie angewendet werden, scheint entscheidend für ihren Erfolg zu sein. Die Energiewende ist ein Kontext, in dem die Menschen aufgefordert werden, nicht nur aus Eigeninteresse

Entscheidungen zu treffen, sondern auch einen Beitrag zu einer allgemeineren Sache zu leisten. Durch die Fokussierung auf einen Kontext können die Ergebnisse der eher anwendungsbezogenen Kapitel in dieser Arbeit insbesondere auf den Kontext der Energiewende angewendet werden. Wir stellen fest, dass es keine einfache Möglichkeit gibt, soziale Einflussprozesse zu verbessern, um alle Menschen innerhalb eines sozialen Netzwerks zu erreichen, damit sie nachhaltige Investitionen in die Verbesserung ihrer Wohnsituation tätigen. Auch sollten soziale Vergleiche des Energieverbrauchs nicht unbedacht vorgenommen werden, da sie zu unerwünschten Nebeneffekten führen können. Menschen sind unterschiedlich empfänglich für soziale Vergleiche und fühlen sich in unterschiedlichem Maße mit anderen verbunden. Diejenigen, die sich mehr mit anderen vergleichen, und diejenigen, die sich mehr mit anderen verbunden fühlen, sind jedoch nur anfälliger für soziale Normen in Bezug auf umweltfreundliche Einstellungen, nicht aber für umweltfreundliches Verhalten. Schließlich erfordert die Energiewende kleine Verhaltensänderungen und größere Investitionen von Hausbesitzern. Unsere Forschung zeigt, dass Mechanismen der sozialen Beeinflussung, die sich bei kleinen Verhaltensänderungen als wirksam erwiesen haben, vor ihrer Umsetzung in teureren Kontexten getestet werden sollten.

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ABOUT THE AUTHOR

Philipp Tobias Schneider was born in Fulda, Germany, on 25th of July, 1993. In 2017, he obtained his bachelor's degree in Psychology at Leiden University. In 2018, he completed the Economic and Consumer Psychology master cum laude. During his master he was awarded the Leiden International Student Fund (LISF) Internship Grant for his internship at the United Nations Environment Program (UNEP) in Geneva Switzerland. In 2018, he started working as a Ph.D. candidate at the Interuniversity Centre for Social Science Theory and Methodology (ICS), the Department of Sociology, and the research group Cooperative Relations at Utrecht University. He wrote his dissertation under the supervision of prof. dr. ir. Vincent Buskens (Department of Sociology, Utrecht University) and prof. dr. Arnout van de Rijt (Department of Political and Social Sciences, European University Institute). His research revolves around the social side of the energy transition, with a focus on social influence, networks and norms. Since December 2023 he works as sustainability policy advisor and project manager for the municipality of Haarlem.

Peer-reviewed publications

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Working paper

Schneider, P. T. and Buskens, V. (2024). How do social comparison orientation and social connectedness relate to social norms on electricity consumption and environmental concern.

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