Motivating Sustainable Behavior through Social Comparison on Online Social Visualization

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ABSTRACT
Individuals could drastically reduce their carbon footprint by changing daily behaviors to more sustainable practices. In order for this change to occur, individuals must be made aware of their impact and must be provided with an incentive to change their consumption patterns. In this paper we provide a literature review of the current research in the areas of energy feedback, social psychology, and social visualization to determine functionality that is important in a computer-based feedback system to motivate users. Future work would include creating a visualization based on these findings.

Author Keywords
Social visualization, social comparison, sustainability

INTRODUCTION
In the United States, residents have complete control over a large portion of their energy consumption [12, 16]. By changing daily habits to more sustainable practices, individuals could greatly reduce their carbon impact [12, 13]. However there exists a general ignorance on the part of individuals to the fact that their actions directly impact the environment [7, 12]. In order to change behavior patterns, individuals must be made aware of their carbon footprint.

Many studies have shown that individual feedback on energy usage is essential in increasing personal awareness on the ecological impact of daily actions [3, 7, 9, 15, 16]. Darby, in a thorough literature review of energy feedback systems, found that direct feedback, in the form of an interactive computer display, could contribute to reducing household energy consumption by twenty per cent [3]. Furthermore, individuals report being interested in receiving information about other households [4]. In fact, comparisons to other individuals could be a motivational stimulant [7]. Moreover, social comparison visually emphasizes the position of the individual within the collective by making individuals "gain understanding that [their] contribution is part of a larger picture: personal practices accumulate into collective practices" [7]. To create a carbon footprint awareness system that would show an individual's performance compared to others, we must understand the different parameters of social comparison and study existing visualizations to see how social comparison has already been applied in other domains.

There are different types of social comparison such as implicit and explicit comparisons, which result in different emotions [18]. This paper will present a preliminary map of the social comparison design space, and then the space will be completed with existing social visualizations. Finally, based on the exploration of these applications, we will describe the specific characteristics of our data that must be taken into consideration for the implementation of a carbon footprint comparative visualization on the Stepgreen.org website.

SOCIAL COMPARISON DESIGN SPACE
Social comparison is defined as "a phenomenon wherein people match their rate of performance to the rate of people working around them" [17]. Depending on different parameters of comparison such as group membership, relative performance, scale, explicitness, and anonymity, this phenomenon can make individuals motivated to adjust their behavior. In this section we present a preliminary map of the social comparison design space to understand how different parameters interact with one another.

Group membership
Many environmental social networks encourage users to form groups and to compete with other groups [24, 25]. In these situations, individuals could compare personal performance to other individuals in their group or to other individuals in other groups [19]. For the purpose of this paper, we assume that all the users of the visualization are members of a global group and we will focus on in-group comparisons.

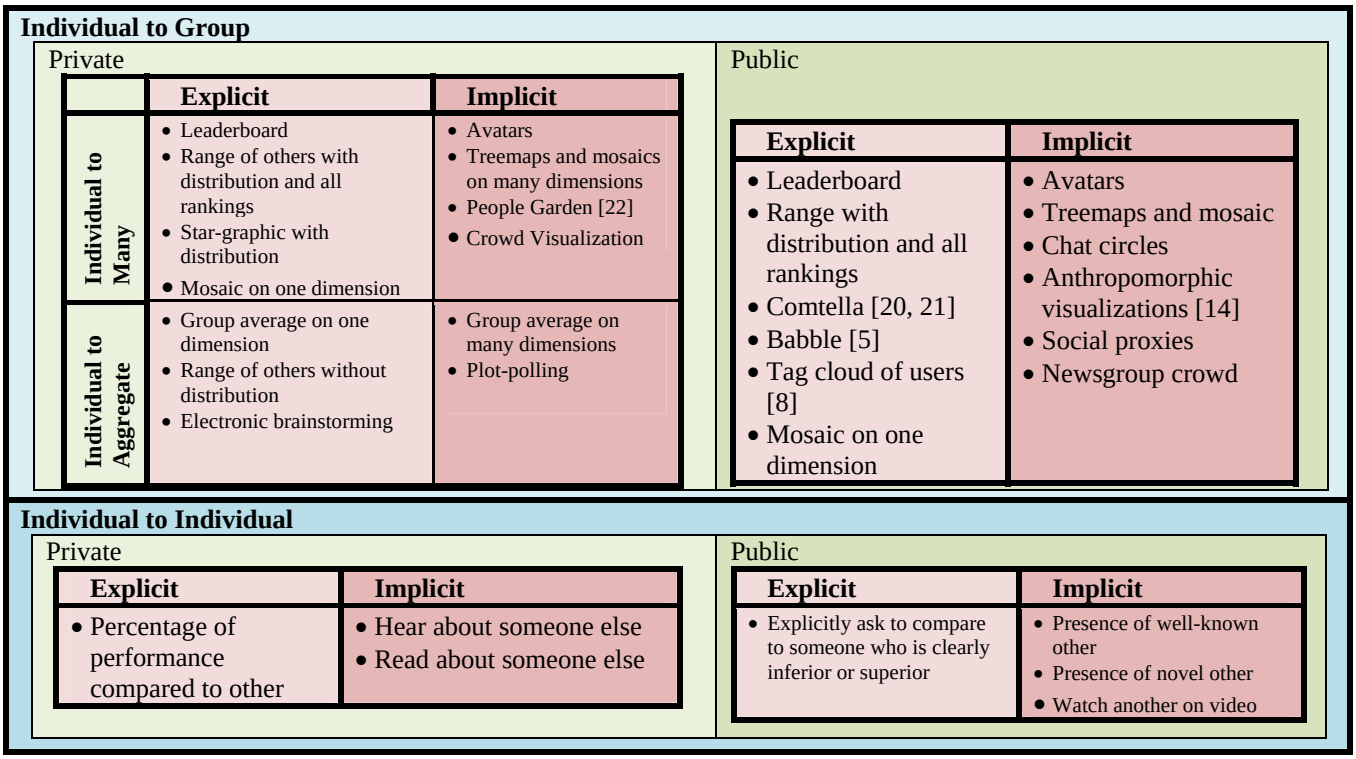

Figure 1. Design Space of Social Comparison

Relative performance

Comparing oneself to a higher performer or to a lower performer lead to different outcomes [19]. Engaging in upward comparison with someone similar and slightly better could have a positive motivating effect on the lower performer [19]. In fact it is best to always have someone better; being the overall highest performer could be a source of apathy [20]. In contrast, comparing oneself to a lower performer is downward comparison [19]. Extreme downward comparison can make an individual feel very good while extreme upward comparison can lead to discouraging feelings. This type of impact is true unless the other person is very dissimilar in which case the comparison has no effect [19].

Scale

The number of comparison others is an important aspect as well. Festinger, the first psychologist to introduce the concept of social comparison, found that interpersonal comparison, or individual-to-individual comparison, led to personal identity definition [19]. Turner et al. found that at the group level, or individual-to-group comparison, social identity is emphasized [1]. Individuals evaluate their performance based on the performance of the group [1]. Thus the intimacy of individual-to-individual comparison will bear different outcomes on self-definition than individual-to-group comparison.

Explicitness

Comparing people on a single performance, or one-dimensional comparison, is an explicit comparison. This type of comparison results in assimilation with others [18]. In contrast, implicit comparison involves a multi-dimensional comparison [18]. With implicit comparison, it is difficult to tell whether someone is better or worse than someone else; they may be better on some dimensions and worse on others but overall the concluding sentiment is a feeling of contrast [18].

Anonymity

When an individual is characterized by personal identification, such as by name or by photograph, the individual's reputation is at stake. However, if users are anonymously identified, by an avatar for example, the results of a good or poor performance are much less significant. Shepherd studied an online brainstorming application where anonymous users were shown to be more productive than explicitly identified participants [17]. Shepherd also acknowledged that anonymity allows more social loafing and public identification may lead to more responsible behaviors. However, it is possible that public recognition would dissuade low performers from participating.

The design space represented in Figure 1 organizes these parameters of social comparison. First of all the space is divided by the number of others being compared to: an individual to another individual or an individual to a group of others (the number of others can range from two to infinitely many). This is based on our assumption that the intimacy in individual-to-individual comparison yields different results than comparisons to many others. Then the

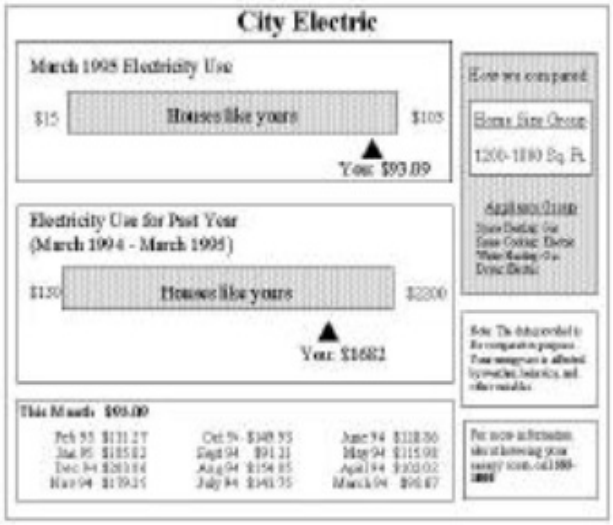

Figure 2. non-bell curve graph [4]

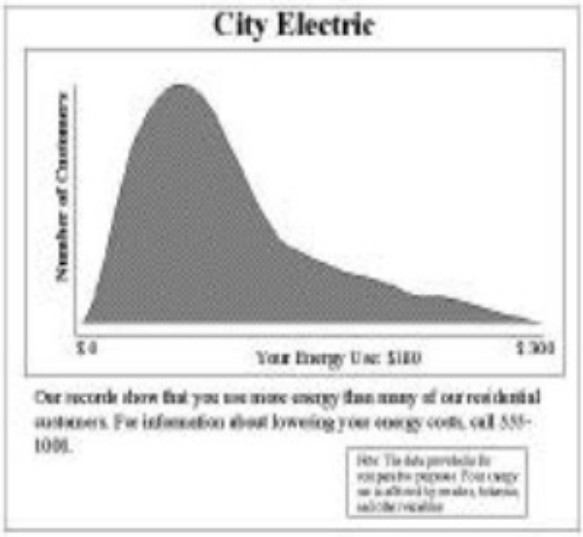

Figure 3. bell-curve distributional graph [4]

spaces are divided by public recognition and private recognition, and finally the space is separated by explicit and implicit comparison.

Having created the design space of social comparison, we will next organize existing visualizations in the social comparison space and determine what types of comparison are already used in the context of environmental data.

EXISTING SOCIAL VISUALIZATIONS

In this section, we will discuss visualizations supporting social comparison, focusing on comparisons between an individual and many others.

Donath, a pioneer in the area of social visualization, defines social visualization as: "the visualization of social data for social purposes" [11]. Karahalios and Viégas explain that the "social data" are "traces that one leaves" and "social purposes" are to "increase in understanding of one's social environment and highlight cues and patterns implicit in communication" [11]. Here we modify this definition of social data to mean data pertaining to a social impact, where each individual is an actor such as environmental conservation, and the social purpose is to motivate individuals towards a common goal. Next we study two visualizations that follow this definition.

Comtella

By definition, social visualizations support social comparison since they display social information. However, only few studies of social visualization focus on the comparative aspect of these applications. In the example of Comtella, a social motivational visualization to encourage users to contribute publications, individuals are represented by a star [21]. The size of the star is based on the user's amount of contributions [21]. This study concluded that such visualizations, with visual ratings, are best for people who are competitive but are not an effective motivator for non-competitive people.

Online Brainstorming

Another study of social comparisons on social visualizations is for an online brainstorming application. The study revealed that social comparison limits the effects of social loafing in anonymous-based electronic brainstorming [17]. Both of these studies focus on a single parameter of comparison, explicitness for Comtella and anonymity for online brainstorming.

The design space in Figure 1 has been completed with Comtella, Online Brainstorming and other visualizations that do not explicitly study social comparison but display social data and thus social comparison occur. These are examples of social visualizations in other domains than environmental data, however there exist many applications to display comparative environmental data that are not social visualizations.

Paper-based environmental social comparison

Results from paper-based (e.g. energy bills) feedback studies can be valuable for computer-based visualizations because they focus on the graphical display of social comparison. Egan explored comparative feedback on energy bills to determine the most effective graphical representation of comparisons [4]. This study revealed users have difficulties interpreting graphs in general but non bell-curve graphs, see Figure 2, were more preferable than bell-curved distributional graphs, see Figure 3, for comparing one's household energy usage to others [10]. Another study considered the differences between individual feedback and comparative feedback of energy consumption in the workplace [16]. The data was displayed on bulletins and

through announcements in the company's magazine. The graphs displayed weekly savings over all energy saving behaviors and were expressed as percentages of the total potential [16]. The results indicated that individuals who received comparative information saved more energy than those who did not [16]. As opposed to paper-based feedback where information is given intermittently, public displays of a building's energy usage give residents an immediate response to their actions.

Public displays of energy usage

Eco-visualization combines public art, computer science, architectural design and environmental engineering to publicly display a building's or a community's energy usage [10]. Such displays have also been used in college dormitory buildings for energy saving competitions at Oberlin College [10] and Indiana University [25]. Studies evaluating the effectiveness of these displays indicate an overall decrease in energy use in the targeted building [10]. While public visualizations are useful for sparking environmental interest and for showing a building's carbon impact, they fail to make the residents understand their personal conservation contributions within the global savings. In online social networks, users can have access to their personal profile and contrast their results with other participants.

Online environmental social networks

Over the past few years, online social networking websites have been flourishing. Many have focused on connecting people through a conservation objective such as www.carbonrally.com [24] and www.carbondiet.com [23]. Most of these environmental social networks foster competitions between individuals or groups of individuals, and publically recognize the highest performers. Even though these websites are relatively successful, meaning they have substantial amounts of users, the comparative visualization is often limited to leader boards or to general geographical summaries [24].

Most environmental social feedback systems posit that social comparisons of environmental data are valuable in encouraging personal conservation behavior. However the paper-based feedback methods lack important technical qualities, eco-visualizations omit individual performance and existing online personal displays don't focus on the format of the comparative visualization.

CHARACTERISTICS OF ENVIRONMENTAL DATA ON STEPGREEN.ORG

Stepgreen.org is a website developed by the Footprints team at Carnegie Mellon University to encourage users to save energy and money. To track their progress, users commit to taking green actions and can see their personal progress.

Figure 4. Current Stepgreen.org visualization

Network-based virtual community

Users will generally be strangers to each other. They have a purpose or motive for joining the website (for environmental activism) and thus share a common identity through their concern for the environment. The website may lead to new relationships but does not specifically be a support for existing real-life relationships.

Inequality in amount of data

Some users may make large contributions while others make smaller ones and some users may have been participants for a long time while others are newcomers. Therefore the visualization should not proportionally calibrate an individual's representation in the space based on amount of contribution. In the Comtella study, Sun and Vassileva assigned a fixed set of different avatar sizes rather than displaying users proportionally to their participation [21]. However another possibility could be to give everyone the same size in the space and numerically assign rankings. Moreover users who have been members of the system for longer will have accumulated more data than new users. This could be discouraging to new users, and may reduce motivation for high performers. To avoid this, we could base all comparisons on daily or weekly savings.

Data source

The data collected can come from self-reports and sensors in the environment. Part of the data could record real-life activity, such as energy saving habits, and another part could record online activity data, such as the last login time. In other words, the data can potentially have different levels of accuracy. Thus, we believe showing trends rather than details is preferable.

Indefinite number of users

In the individual-to-group visualization, the visual representation would be different when there are many users as when there are few users. Moreover the data of one individual could be negligible among that of a large crowd. To avoid this we could compare an individual to a small group (chosen on similarity with the individual or randomly), and minimize the rest of the space.

Public recognition

For environmentalism, public recognition is an incentive for saving energy [2]. Thus public recognition on Stepgreen.org could have positive benefits for high performers.

CONCLUSION

This survey of background work in social feedback of environmental data, social comparison, and social visualization, has helped organize the parameters of social comparison in a design space. Moreover it enabled a review of existing visualizations and highlighted areas lacking innovation. These areas include individual-to-individual comparisons and an individual to possibly infinitely many others comparisons.

Future work in this area might be to study one of these particular comparisons and produce innovative designs to support these comparisons, followed by detailed usability studies to measure their effectiveness. It appears that individual-to-individual comparisons have not been explored much. Moreover, the scale of individual-to-group comparison primarily stays within a range of around five to about two hundred individuals at maximum. Thus it would be interesting to develop new design techniques for a visualization that could accommodate possibly thousands of comparisons or more (e.g. a whole city).

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