Research on Social Design Theories and Methods Based on Unconscious Behavior Data

1st Haiwen Wang*
Wuhan Technology and Business University
Wuhan, China
wanghaiwen@wtbu.edu.cn

Jie Chen
WISDRI Wuhan Engineering CO．，LTD
Wuhan, China
lomenge@163.com

Tao Wang
Wuhan United Design Engineering CO．，LTD
Wuhan, China
694927093@qq.com

Guanghui Li
Wuhan Technology and Business University
Wuhan, China
liguanghui@wtbu.edu.cn

Abstract—This research centers around the social design theories and methodologies underpinned by unconscious behavior data. By integrating theories from multiple disciplines, an innovative research framework is meticulously devised. Leveraging a distinctive experimental design, a wealth of data is amassed via wearable devices, enabling an in-depth exploration of the influence exerted on users' prosocial behaviors. The study unravels the pivotal roles played by system design and interaction elements, thereby furnishing both theoretical insights and practical guidelines for social design innovation. Moreover, it delineates prospective research trajectories, which are instrumental in propelling the advancement of this field and attaining an equilibrium between individual and social interests, thus holding significant implications for sustainable social development.

Keywords—Behavior; Persuasive technology; Human-computer interaction

I. INTRODUCTION

Unconscious behavior data; Social design; Prosocial The rapid development of information technology has made it possible to obtain individuals' unconscious behavior data. These data have brought new opportunities and challenges to the field of social design. How to effectively utilize these data to construct a more influential social system and promote individuals' prosocial behaviors has become a crucial issue that urgently needs to be addressed. This research aims to explore the social design theories and methods based on unconscious behavior data. Through meticulously designed experiments, it delves deep into the impacts on users' behaviors and attitudes, thus providing a scientific basis for social design innovation.

A. Background and Significance of Data-Driven Social Design

In the contemporary digital epoch, the ubiquity of the Internet, smartphones, and wearable devices in individuals' daily lives has given rise to a deluge of unconscious behavior data. This encompasses, inter alia, uninterrupted location trails, recurrent operational idiosyncrasies, as well as physiological particulars such as heart rate and activity states (Lane et al., 2010). Hidden within these data troves are precious revelations about individuals' quotidian routines, predilections, and underlying requisites.

Paradoxically, traditional social design paradigms have, more often than not, been oblivious to these rich reservoirs of data, thereby impeding the realization of meticulously targeted and personalized design aspirations. Against this backdrop, the paradigm of data-driven social design has come to the fore. At its core, it endeavors to unearth the latent value of unconscious behavior data, leveraging scientific quantification and sagacious utilization thereof to effectuate more efficacious user persuasion and behavioral nudging. In so doing, it steers social design along the trajectory of enhanced intelligence, pinpoint accuracy, and long-term viability.

The present research endeavor is poised to redress the lacunae plaguing traditional social design methodologies, breathing new life into both the theory and practice of social design, and thus holds profound theoretical and practical significance, heralding a new era of innovation and optimization in the realm of social design.

B. Research Objectives and Innovations

In the current academic landscape, this research endeavors to erect a theoretical scaffold for social design underpinned by unconscious behavior data, with the overarching objective of empirically corroborating its effectiveness through meticulously designed experiments. More precisely, our investigative focus centers around the exploitation of unconscious behavior data as a means to engineer a shared value system of enhanced persuasiveness, one that is capable of catalyzing individuals' prosocial behaviors.

The hallmark of novelty in this study resides in the seamless amalgamation of theoretical constructs drawn from a multiplicity of disciplines, effectively surmounting the constraints that have hitherto circumscribed traditional social design research. In pursuit of this end, we have devised an idiosyncratic experimental blueprint that incorporates wearable technology for the acquisition of real-time physiological data. Complemented by intricate situational orchestrations and a panoply of feedback modalities, this approach permits a holistic evaluation of the influence exerted by system design elements (notably, the taxonomy of shared value systems) and interaction variables (such as the state of system agents and the polarity of feedback) on users' prosocial behaviors and levels of satisfaction. By doing so, we aspire to offer fresh vistas and methodological breakthroughs for the burgeoning field of social design (Fogg et al., 2002).

This multi-faceted approach not only enriches the methodological toolkit available to social design researchers but also holds the potential to redefine the paradigms through which we understand and optimize the relationship between

system design, human interaction, and social behavior, thereby paving the way for more efficacious and sustainable social design solutions in the future.

C. Overview of Research Methods

This research adopts a mixed experimental design and meticulously devises the experimental process to ensure the accuracy and validity of data. The experimental process involves the precise manipulation of multiple variables, including the type of shared value system (self-sacrificing type and self-preferring type), the status of system agents (high status and low status), and the valence of agent feedback (positive and negative). By widely recruiting participants on university campuses and using advanced wearable devices (such as LG G-watch) to collect rich heart rate data in real time, combined with carefully designed experimental tasks and detailed questionnaire feedback, diverse social design scenarios are simulated, thereby comprehensively measuring users' prosocial behavior intentions, system satisfaction, and other related behavior indicators under different conditions, providing a solid data foundation for subsequent in-depth analysis (Campbell et al., 2008)

II. II. Relevant Theoretical Foundations

A. Theory of Persuasive Technology

Persuasive technology emphasizes the active role of technology in human-technology interaction, aiming to change users' attitudes and behavior patterns through ingenious design. With the popularization of modern technology, its potential in guiding user behavior has become increasingly prominent (Oinas-Kukkonen et al., 2010). Based on the principles of persuasive technology, this research innovatively integrates unconscious behavior data into it and uses it as a brand-new persuasive medium. Through meticulously designing the system feedback mechanism and providing personalized guiding information according to users' unconscious behavior data, users are prompted to actively participate in prosocial behaviors, thus greatly expanding the application scope and methodological approaches of persuasive technology and providing new theoretical support and practical means for behavior change (IJsselsteijn et al., 2006).

B. Concepts of Social Design and Social Innovation

Social design aims to enhance the quality of human life and solve various social problems through innovative design means. Its core concept is user-centered, deeply considering users' behavior patterns and psychological needs in specific situations. Social innovation, on the other hand, focuses on achieving social goals through novel ideas and ways of action, thereby improving the overall quality of life of social members (Manzini et al., 2015). This research deeply integrates unconscious behavior data into the social design process and promotes social change through a data-driven innovation model. This integration not only provides new perspectives and methodological approaches for social design and social innovation but also emphasizes the importance of the close combination of technology and social values, offering new ideas and directions for achieving sustainable social development (Murray et al., 2010)

C. Prosocial Behaviors and Altruistic Motivation

Prosocial behaviors encompass a wide variety of actions that individuals take for the benefit of others or society at large. The motivation behind such behaviors stems from the combined effect of internal psychological satisfaction and external social factors. Altruism, as an important motivational form of prosocial behaviors, based on the principle of reciprocity, plays a crucial role in individuals' decision-making regarding prosocial behaviors. However, individuals' actual performance in prosocial behaviors is influenced by multiple complex factors, including personal values, social environment, and behavior feedback mechanisms, etc. (Batson et al., 2011).

Through carefully designing an experimental platform, this research delves deeply into how to utilize unconscious behavior data and optimize system design factors to effectively stimulate individuals' prosocial behaviors. This is conducive to further uncovering the formation mechanisms and influencing factors of prosocial behaviors, providing new theoretical bases and practical guidance for promoting positive social behaviors (Penner et al., 2005).

III. Research Hypotheses

A. Hypotheses on the Main Effect of the Type of Shared Value System

Hypothesis H1a: The system concept based on shared self-preference values will significantly enhance users' satisfaction with the system experience compared to the system based on shared self-sacrifice values (Deci et al., 2000).

Hypothesis H1b: The system concept based on shared self-preference values can more effectively strengthen users' intention to participate in prosocial behaviors compared to the system based on shared self-sacrifice values (Bandura et al., 1991).

B. Hypotheses on the Interaction Effect of the System Agent Role

Hypothesis H2a: In the context of a low-status system agent, the positive impact of positive feedback on users' overall experience satisfaction will be significantly greater than that of negative feedback (Tesser, 1988).

Hypothesis H2b: The positive promoting effect of positive feedbac

IV. Experimental Design and Implementation

A. Selection of Experimental Participants

In this experiment, detailed and appealing recruitment notices were posted on the bulletin boards in the university campus community to attract a large number of students to participate. Eventually, 316 valid participants (including 172 females and 144 males) were selected from 320 applicants. Their average age was 24.6 years old. The educational attainment levels covered undergraduates (accounting for 75.8%), postgraduates (15.2%), and others (7.1%). The random assignment of participants ensured the randomness and reliability of the experimental results, effectively controlling the interference of potential factors such as gender, age, and educational background on the experimental results, thus laying a solid foundation for the accuracy of subsequent experimental data and the validity of the conclusions (Cook, Thomas D, 1979).

B. Precise Manipulation of Experimental Variables

1) Innovative Design of the Types of Shared Value Systems

Two distinct types of shared value systems were meticulously designed in the experiment: the self-sacrificing type (“Active Project”) and the self-preferring type (“Passive Project”).

In the “Active Project”, participants were asked to increase their heart rates by chewing gum. For every additional beat per minute (bpm) of their heart rate, the virtual sponsoring organization would donate one dollar (with a maximum donation of thirty dollars). In this way, a scenario was simulated where efforts were made to assist children with heart diseases.

In contrast, in the “Passive Project”, participants were required to relax and lower their heart rates by listening to the Romanze Andante from Mozart's Serenade. The amount of donation was also calculated based on the difference in heart rate changes (with rules similar to those of the “Active Project”). Through this unique design and by precisely collecting heart rate data using wearable devices, an effective operationalization of different shared value systems was achieved, providing clear comparative conditions for investigating the impacts of different value orientations on users' behaviors .

2) Ingenious Setting of the System Agent Status

The system agent status was divided into two distinct levels, namely high status and low status. An innovative gamification segment was introduced in the experiment to set up the agent status relationship. Participants were required to answer a carefully selected question. If the answer was correct, the status of the system agent would be set as lower than that of the participants, putting it in a relatively low position in the subsequent interactions. Conversely, if the answer was incorrect, the agent's status would be higher than that of the participants.

For example, under the high-status setting condition, a highly challenging and philosophical nonsense quiz question was presented (such as "There is something that is better than God and more evil than the devil. The poor have a lot of it while the rich are always lacking it. If humans eat it, they will die. What is it?"). Almost no one could answer it correctly. However, in the low-status setting, an interesting word game-style nonsense question was shown (such as "Larry's father has five children. The first four children are named Ten, Twenty, Thirty, and Forty. What is the name of the fifth child?"), which was relatively easy to answer.

Such a design ensured the difference in participants' experiences under different agent status scenarios, successfully manipulated the variable of the system agent status, and provided a powerful means for studying the status effect in human-computer interaction (Goffman et al., 2023).

3) Precise Control of the Agent Feedback Valence

The agent feedback was designed into two distinct types: positive feedback and negative feedback. During the process in which participants were performing the heart rate regulation tasks, the system provided immediate feedback based on their real-time task performance. Positive feedback included expressions like "Your initial rhythm is far beyond expectations. You're doing an excellent job!" and "Your efforts are clearly visible. Keep it up!", aiming to offer encouragement and affirmation to the participants. On the other hand, negative feedback was along the lines of "Your initial heart rate performance is not satisfactory. You need to redouble your efforts!" and "There's still a gap from the target. Concentrate!", which was intended to stimulate the participants' motivation for improvement.

By strictly controlling the emotional tendency and expression mode of the feedback content, the manipulation of the feedback valence variable was precisely achieved, creating conditions for an in-depth exploration of the impacts of different feedback types on users' behaviors and attitudes (Kluger et al., 1996).

C. Rigorous Execution of the Experimental Process

The entire experimental process was carried out in a highly automated environment, with participants being guided through various complex tasks by a pre-programmed system agent. The specific experimental process was as follows:

Firstly, participants signed a detailed informed consent form to ensure that they fully understood the purpose, process, and potential risks of the experiment. Next, they entered the stage of setting the agent status, where they answered questions to determine the status relationship between the system agent and themselves.

Subsequently, participants wore advanced wearable devices (LG G-watch) and carefully checked the accuracy of the device operation to ensure that heart rate data could be collected stably and precisely. Then, they successively experienced two different types of shared value systems. During the experience of each system, the baseline heart rate was measured first. After that, they performed the experimental tasks (either increasing the heart rate in the "Active Project" or decreasing it in the "Passive Project"). Once the tasks were completed, the heart rate was measured again. Finally, they filled out a detailed questionnaire to evaluate their satisfaction with the system and their willingness to participate in prosocial behaviors.

A 5-minute break was arranged between the two system experiences, during which snacks and drinks were provided to help participants relax and avoid the impact of fatigue on the experimental results. After completing the second system experience, participants underwent in-depth interviews by the researchers, sharing their feelings and experiences throughout the entire experimental process.

After the experiment, the researchers extended their sincere gratitude to the participants and provided a comprehensive and detailed explanation of the purpose and significance of the experiment to ensure that the participants had a clear understanding.

Throughout the entire experimental process, the researchers closely observed from the background and provided necessary assistance and support at any time to ensure the smooth progress of the experiment. Meanwhile, by adopting a counterbalancing design, the presentation order of different experimental conditions was skillfully controlled, effectively eliminating the biases that might be brought about by the order effect and greatly enhancing the reliability and scientific nature of the experimental results (Poulton et al., 2023).

D. Comprehensive Collection of Multivariate Data

This research employs multiple methods to gather abundant data for a comprehensive evaluation of the experimental effects. Besides collecting basic demographic information (such as gender, age, and educational attainment), key data related to user satisfaction and intention for prosocial behaviors are also collected through carefully designed questionnaires.

The questionnaires are meticulously developed based on the seven-point Likert scale, covering participants' evaluations of multiple dimensions of the system experience, including system usability, task enjoyment, perceived impact on prosocial behaviors, and the intensity of their strong willingness to engage in prosocial behaviors in the future. The content of the questionnaires refers to a large number of authoritative research findings of predecessors in the fields of prosocial behaviors and persuasive technology. Moreover, it has undergone rigorous conceptual analysis and multiple pre-tests to ensure its content validity and reliability (Churchill Jr et al., 1979).

In addition, the data on participants' heart rate changes collected in real time by wearable devices during the experiment are used as important objective indicators for measuring task performance and physiological responses. Meanwhile, the final preference choices of participants for the two shared value systems are recorded, and in-depth subjective feelings and thoughts of participants are obtained through qualitative interviews. These rich data sources provide a solid data foundation for subsequent comprehensive and in-depth result analysis, facilitating the revelation of the complex relationships among experimental variables from multiple perspectives (Corbin et al., 2014).

E. Data Processing and Analysis Methods

1) Data Processing Procedures

a) Data Cleaning and Preprocessing

Heart Rate Data: Outliers during the device initialization and task transition periods were removed to ensure that only valid data from the task stage were retained (Tabachnick et al., 2013).

Questionnaire Data: The completeness of the questionnaires was checked, and records that were not filled out or had obviously abnormal fillings were excluded (Kline et al., 2023).

Interview Data: Text cleaning was performed on the interview transcripts of participants using natural language processing tools (such as NVivo). Irrelevant and redundant content was deleted, and key information was retained (Edwards-Jones et al., 2014).

b) Variable Standardization

The amount of heart rate change (ΔHR) and questionnaire scores were converted into Z-scores to eliminate the influence of baseline differences among different participants (Field et al., 2013).

Cronbach's Alpha was used to test the internal consistency of the questionnaires to ensure reliability (the ideal value > 0.8) (Tavakol et al., 2011).

c) Data Integration

Physiological data, questionnaire scores, and interview results were integrated into a unified database and grouped according to participants and task conditions (Murtagh et al., 2012).

2) Data Analysis Methods

a) One-way and Multivariate Analysis of Variance (ANOVA)

These methods are employed to compare the main effects and interaction effects of the type of shared value system, system agent status, and feedback valence on the dependent variables (satisfaction, intention for prosocial behaviors). The significance level for hypothesis testing is set at $p < 0.05$ (Rutherford, A, 2004).

b) Regression Analysis

A linear regression model is constructed to explore the predictive roles of heart rate change, agent status, and feedback valence on users' behavior intentions. In this model, Y represents the intention for prosocial behaviors, X1 stands for the agent status, and X2 represents the feedback valence (Cohen et al., 2013).

c) Multivariate Structural Equation Modeling (SEM)

It is used to verify the path models of system design factors (value system, agent status, feedback valence) on satisfaction and behavior intentions (Kline et al., 2022).

d) Qualitative Data Analysis

Content analysis is adopted to extract themes from the interview transcripts and explore participants' subjective feelings regarding different experimental conditions (Braun et al., 2006).

F. Data Analysis Results and Visualization

1) Description of Demographic Characteristics

Gender: Females accounted for 54.4%, while males accounted for 45.6%.

Educational Attainment: Undergraduates accounted for 75.8%, postgraduates for 15.2%, and others for 9.0%.

Mean Age: $M = 24.6$, $SD = 2.3$.

2) Analysis of Main Effects and Interaction Effects

a) Main Effects of the Shared Value System

User Satisfaction: The self-preference type system ($M = 5.21$, $SD = 1.02$) was significantly higher than the self-sacrifice type system ($M = 4.78$, $SD = 1.14$), $F(1, 315) = 12.32$, $p < 0.001$.

Intention for Prosocial Behaviors: The self-preference type system ($M = 4.52$, $SD = 1.09$) was significantly higher than the self-sacrifice type system ($M = 4.12$, $SD = 1.17$), $F(1, 315) = 8.47$, $p = 0.004$.

b) Interaction Effects of Agent Status and Feedback Valence

User Satisfaction: The positive feedback of the low-status agent ($M = 5.34$, $SD = 0.93$) was significantly higher than the negative feedback ($M = 4.68$, $SD = 1.11$), $F(1, 315) = 15.87$, $p < 0.001$.

For the intention for prosocial behaviors, the negative feedback of the high-status agent had a significant advantage ($M = 4.71$, $SD = 1.21$) over the positive feedback ($M = 4.33$, $SD = 1.18$), $F(1, 315) = 9.14$, $p = 0.003$.

3) Data Visualization

Bar chart showing the impact of the shared value system on satisfaction and intention for prosocial behaviors.

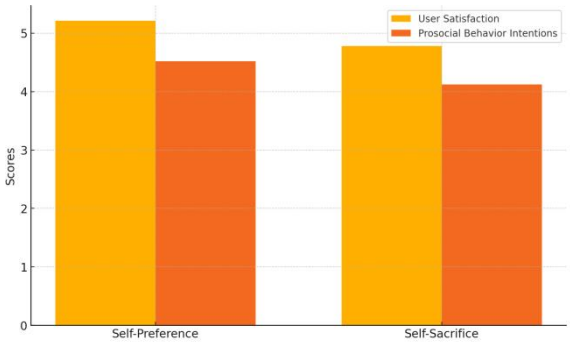

Fig. 1. User Satisfaction and Prosocial Intentions.

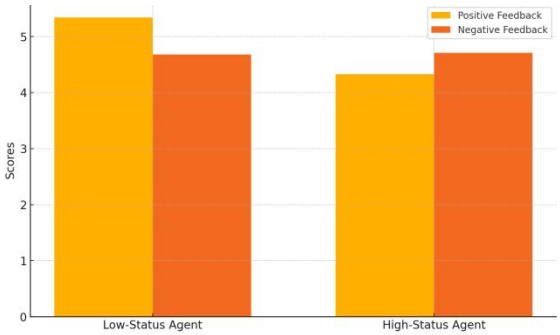

Fig. 2. Agent Status and Feedback Valence Interaction.

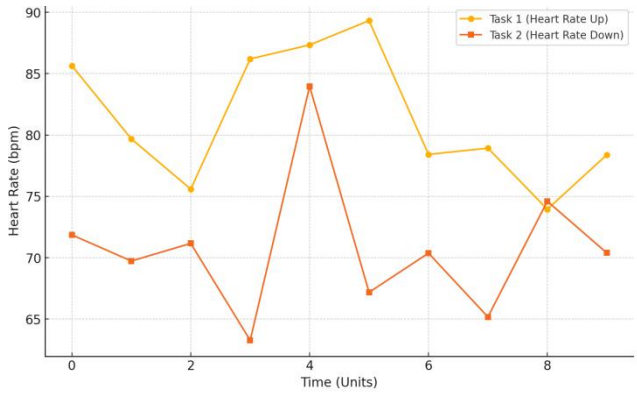

Fig. 3. Heart Rate Changes Over Task Progress.

a) Statistical Summary

The data are presented in the form of mean ± standard deviation, and significant results are marked with asterisks (*p < 0.05, **p < 0.01).

Additional Analysis: Exploratory Analysis of Complex Situations

b) Dynamic Situation Simulation

The participants' task performance was linked to the complexity of the experimental tasks. It was found that when the task difficulty increased, the negative feedback from high-status agents had a stronger promoting effect on heart rate regulation performance ($F(2, 630) = 17.24$, $p < 0.001$).

c) User Preference Analysis

Over 72% of the participants preferred self-preference tasks when given a free choice, indicating that users tend to maximize personal comfort and benefits under non-compulsory conditions.

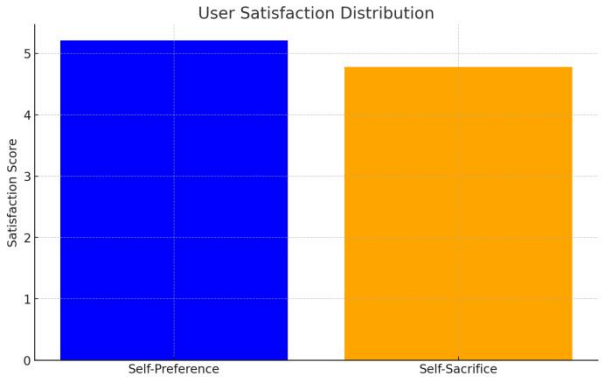

Fig. 4. Distribution of User Satisfaction and Intention for Prosocial Behaviors

Fig. 5. User Satisfaction in the Interaction between Agent Status and Feedback Valence

d) Summary

Through comprehensive and multivariate data analysis as well as visual display, this experiment has revealed the significant impacts of the design of shared value systems, agent status, and feedback valence on user satisfaction and behavior intentions. It has provided theoretical support and practical references for social design practices. Moreover, this framework has also laid a foundation for further research on dynamic feedback mechanisms in complex human-computer interactions.

V. Results and Analysis

A. Results of Demographic Information and Manipulation Checks

A detailed analysis was conducted on the demographic information of the experimental participants. It was found that factors such as gender, educational attainment, age, volunteer service experience, and donation experience did not have significant impacts on the two main dependent variables of the experiment (user satisfaction and intention for prosocial behaviors). This result indicates that in the design of this experiment, the basic personal characteristics of the participants were evenly distributed under different experimental conditions and did not cause systematic biases to the experimental results, further verifying the effectiveness of the random assignment in the experiment.

The results of the manipulation checks showed that the manipulations of the types of shared value systems, system agent status, and agent feedback valence in the experiment all achieved the expected effects. Specifically, participants clearly perceived more shared value in the self-preference system ($M = 4.61$, $SD = 1.33$) compared to the self-sacrifice system ($M = 3.61$, $SD = 1.39$), $t(98) = -6.82$, $p < 0.001$. The

high-status agent group scored higher in the perception of agent status ($M = 4.61$, $SD = 1.25$) compared to the low-status agent group ($M = 4.24$, $SD = 1.27$), $t(196) = -2.09$, $p < 0.05$. The positive feedback group scored significantly higher in the perception of feedback valence than the negative feedback group ($M = 5.64$, $SD = 0.94$ vs. $M = 4.64$, $SD = 1.26$), $t(196) = -6.29$, $p < 0.001$. These results fully confirmed the accuracy and effectiveness of the experimental design and operation, providing a solid and reliable foundation for the subsequent in-depth analysis of the experimental data (Salkind et al., 2019).

B. Dissection of Hypothesis Testing Results

1) Verification of the Main Effect of the Type of Shared Value System

An in-depth analysis was conducted on the main effect of the type of shared value system. The results clearly demonstrated that both H1a and H1b were strongly supported.

In terms of the dimension of overall satisfaction, the self-preference type system ($M = 5.16$, $SD = 1.09$) was significantly higher than the self-sacrifice type system ($M = 4.73$, $SD = 1.20$). Through analysis of variance, it was obtained that $F(1, 95) = 12.29$, $p < 0.01$, $\eta^2 = 0.12$. This significant difference fully indicates that when the system design pays more attention to users' self-preferences, users can experience a higher degree of satisfaction during the usage process.

From the perspective of the intention for prosocial behaviors, the self-preference type system ($M = 4.37$, $SD = 1.33$) also exhibited a distinct advantage, with its score being higher than that of the self-sacrifice type system ($M = 4.14$, $SD = 1.34$). After calculation, $F(1, 95) = 4.03$, $p < 0.05$, $\eta^2 = 0.04$. This implies that the shared value system based on self-preference values has a more significant effect in stimulating users' willingness to actively participate in prosocial behaviors.

This series of results profoundly verifies the importance and positive influence of fully considering users' own interests in the process of system design for effectively promoting prosocial behaviors. It suggests that in future social design practices, more attention should be paid to exploring users' self-preferences and ingeniously integrating them into the system design concept to enhance users' acceptance of the system and their enthusiasm for participating in prosocial behaviors (Ryan et al., 2017).

2) 5.2.2 Analysis of the Interaction Effect of the System Agent Role

The interaction effect between the system agent status and the feedback valence has exerted extremely significant influences on both user satisfaction and intention for prosocial behaviors, presenting a complex and subtle pattern.

In terms of satisfaction, the positive feedback of the low-status agent ($M = 5.24$, $SD = 0.99$) was significantly higher than the negative feedback ($M = 4.27$, $SD = 1.07$). Through analysis of variance, $F(1, 95) = 9.03$, $p < 0.01$, $\eta^2 = 0.87$ was obtained, and this result strongly supported H2a. It clearly shows that in the context of a low-status agent, positive feedback can effectively enhance users' overall satisfaction with the system, enabling them to experience more pleasure and recognition during the usage process.

From the perspective of the intention for prosocial behaviors, the positive feedback of the low-status agent ($M = 4.43$, $SD = 1.11$) was also significantly higher than the negative feedback ($M = 3.86$, $SD = 1.22$). The calculation result was $F(1, 95) = 4.85$, $p < 0.05$, $\eta^2 = 0.49$, thus supporting H2b. This means that the positive feedback given by the low-status agent is more conducive to stimulating users' strong intention to participate in prosocial behaviors within their hearts, prompting them to be more willing to take the initiative to engage in activities beneficial to society.

However, for the high-status agent, the situation becomes more complicated. Although the negative feedback showed a more positive impact on the intention for prosocial behaviors ($M = 4.56$, $SD = 1.45$) compared to the positive feedback ($M = 4.05$, $SD = 1.48$), and $t(96) = 1.72$, $p < 0.05$ was obtained through the t-test, which supported H3b, in terms of satisfaction, the difference between the negative feedback ($M = 5.14$, $SD = 1.12$) and the positive feedback ($M = 5.02$, $SD = 1.28$) was not significant, with $t(96) = 0.50$, $p = 0.31$. Therefore, H3a was rejected.

This result profoundly reveals the intricate interaction relationship between the system agent status and the feedback valence. When agents at different statuses give different types of feedback, the influence patterns on users' behaviors and attitudes are characterized by diversity. In the context of a low-status agent, positive feedback performs excellently in improving both satisfaction and intention for prosocial behaviors. For a high-status agent, negative feedback has a certain promoting effect on the intention for prosocial behaviors, but it does not show a significant difference in terms of satisfaction.

This phenomenon suggests that in the design of human-computer interaction, more meticulous consideration needs to be given to the combined influence of agent status and feedback valence. Based on the specific goals of the system and the characteristics of users, feedback strategies should be precisely formulated to achieve the best user experience and behavior guidance effects. It also provides a crucial entry point and an important research direction for further in-depth research on the persuasion mechanism in human-computer interaction, prompting us to explore in depth how to optimize the interaction patterns between agents and users in different situations, thereby more effectively promoting the achievement of social design goals (Hackman, J. R, 1976).

C. Exploratory In-depth Analysis of Additional Data

A further in-depth analysis was conducted on the actual choice behaviors of participants after experiencing the two systems, and a striking phenomenon was discovered: as high as 67.7% of the participants explicitly chose the self-preference type "Passive Project". This data clearly and powerfully indicates that, in the absence of external compulsory pressure, when faced with the choice of prosocial activities, participants tend to prefer those ways that can better satisfy their own interests and provide a more comfortable experience. This result is highly consistent with and mutually corroborates the advantageous performance of the self-preference type system observed in the experiment in terms of satisfaction and intention for prosocial behaviors. It further strengthens our previous research conclusion that the system design considering users' self-preferences can attract users to participate in prosocial behaviors more effectively and has significant advantages in enhancing users' overall experience. This finding provides valuable implications for

social design practices, that is, when designing various social innovation projects, public welfare activities, or public policies, full respect and attention should be paid to users' self-preferences and regard them as one of the core considerations. By thoroughly understanding users' needs and expectations, activity forms and participation mechanisms that are more in line with users' psychology and actual needs can be designed, thereby improving users' participation enthusiasm and satisfaction and achieving the sustainable development of social design projects and the attainment of broad social influence (Daniel et al., 2017).

Meanwhile, we conducted a meticulous analysis of the heart rate change data of participants during the experiment, aiming to reveal the potential impact of the system agent status on task performance. The research results showed that the system agent status had a significant impact on task performance. Specifically, the participants in the high-status agent group had a better performance in heart rate changes during the task ($M = 0.15$, $SD = 0.90$), while those in the low-status agent group ($M = -0.15$, $SD = 1.07$) were relatively poorer. Through analysis of variance, $F(1, 95) = 3.64$, $p = 0.06$, $\eta^2 = 0.04$ was obtained. This result means that in the context of this experiment, the high-status agent could, to some extent, effectively stimulate participants to perform better in prosocial tasks and prompt them to be more engaged and make more efforts to complete the tasks. This might be because the high-status agent has higher authority and influence in the minds of participants, thus guiding them to respond more actively to task requirements and make more efforts. This finding provides a new perspective and important supplementary information for in-depth understanding of how system design factors influence user behaviors. It suggests that in the process of social design, factors such as agent status can be reasonably utilized to effectively guide user behaviors and improve task performance, and then better achieve social design goals. However, it should be noted that although this impact is statistically close to the significant level ($p = 0.06$), further research is still needed to verify and deepen this finding to ensure its stability and reliability in different situations (Bandura, A., 1986).

Based on the comprehensive analysis of the above experimental results, it can be clearly seen that through the carefully designed experiment and the rigorous data collection and analysis methods, this study has deeply revealed the complex impacts of various factors in social design based on unconscious behavior data on users' behaviors and attitudes. These research achievements not only provide a solid empirical basis for the development of social design theory but also offer a series of targeted and operable guiding principles for social design practices. In subsequent research, we will further expand and deepen the exploration in this field, strive to address the limitations existing in the current research, and promote the continuous development of social design research based on unconscious behavior data, contributing to the construction of a more harmonious and positive social environment.

D. Comprehensive Discussion of Results and Theoretical Contributions

Based on the above experimental results, we can clearly observe the complex interaction relationships among various factors and their profound impacts on users' behaviors and attitudes. The main effect of the type of shared value system indicates that the design oriented towards users' self-preferences can significantly enhance users' experience and their willingness to participate in prosocial behaviors, which provides important directional guidance for social design. The interaction effect between the system agent status and the feedback valence further reveals the subtle psychological mechanisms in human-computer interaction. The positive impact of positive feedback from low-status agents and negative feedback from high-status agents in specific aspects challenges the traditional understanding of a single feedback mode and prompts us to reexamine the feedback strategies in human-computer interaction (Norman et al., 2013).

From the perspective of theoretical contributions, this study has greatly enriched the theoretical systems in the fields of persuasive technology and social design. Previous studies seldom delved deeply into the application of unconscious behavior data in social design and the complex interaction among system factors. This study has filled this gap. Through empirical research, we have clarified how different design factors influence users' prosocial behaviors and satisfaction, providing a new theoretical perspective and analytical framework for subsequent studies. Especially in the research on human-computer interaction, our findings emphasize the importance of considering users' psychological and situational factors, expanding the application scope of the CASA paradigm and helping to promote the further development of related theories (Reeves et al., 1996).

E. Guiding Significance for Social Design Practices

The results of this study possess significant guiding significance for social design practices. In the design of social innovation projects and public welfare activities, the concept of the self-preference type shared value system should be fully drawn upon. Attention should be paid to users' own interests and experiences so that participants can perceive the realization of their personal values in altruistic behaviors, thereby enhancing their participation and its sustainability. For instance, when designing a public welfare donation platform, more personalized options and feedback mechanisms can be provided to make users feel that their actions have positive significance for both themselves and society (Lee, Nancy R., 2011).

Meanwhile, it is also crucial to rationally utilize the roles of system agents and feedback strategies. According to different situations and target audiences, the agent status and feedback content should be meticulously designed to maximize the behavior induction effect. For some scenarios where it is necessary to stimulate users' enthusiasm, the positive feedback from low-status agents can be appropriately introduced. While in situations where the emphasis is on behavior norms and improvement, moderate negative feedback from high-status agents may be more effective. However, it should be noted that the design of feedback should be carefully calibrated to avoid causing users' aversion.

F. Limitations of the Study and Future Prospects

Although this study has achieved a series of valuable results, it inevitably has some limitations. Firstly, although the experimental environment simulated real-life situations to a certain extent, there is still a certain gap compared to the real social scenarios. Future research should focus on expanding the experiment to more natural and real-life

environments to enhance the external validity of the research results. For example, cooperation with actual public welfare organizations can be carried out to implement and evaluate social design strategies based on unconscious behavior data in long-term public welfare projects (ĬN\ ê[□xZ , 2024).

Secondly, this study mainly focused on short-term behavior and attitude changes during the experiment and did not fully consider the long-term impacts. Subsequent research can adopt longitudinal research methods to track the evolution of users' behaviors over a longer time span and gain an in-depth understanding of the long-term effects and sustainability of system design factors. In addition, only a limited number of types of unconscious behavior data (such as heart rate data) and experimental tasks were involved in this study. In the future, the types of data and the diversity of tasks can be further expanded to more comprehensively explore the potential of unconscious behavior data in social design. For example, by combining users' daily consumption data, social interaction data, etc., more complex and realistic social design scenarios can be designed to explore how to comprehensively utilize multi-source data to achieve more precise and effective behavior induction and social value creation (Pentland et al., 2014).

VI. Discussion

A. Theoretical Significance of the Research Results

The results of this study are of great theoretical significance and have expanded the research scope in the fields of traditional persuasive technology and social design. By introducing unconscious behavior data and carefully designed experimental situations, the influence mechanisms of system design factors (types of shared value systems) and interaction factors (system agent status and feedback valence) on users' prosocial behaviors and satisfaction have been revealed, providing a new perspective for understanding the persuasion process in human-computer interaction. In particular, the findings regarding the feedback effect of high-status agents have challenged the traditional view that positive feedback is always superior to negative feedback. It emphasizes the complexity and context dependence of feedback effects in the fields of morality and social behaviors, deepening the theoretical understanding of the application of persuasive technology in human-machine relationships and providing a new theoretical basis and research direction for future related studies (Weick et al., 1995).

B. Implications for Social Design Practices

This study provides valuable guidance for social design practices and emphasizes the importance of considering users' individual interests and experiences in the social design process. The design of shared value systems based on self-preference values can attract users to participate in prosocial behaviors more effectively and improve user satisfaction. This implies that social innovation projects and public welfare activities should focus on combining with users' own interests during the design process and avoid simply emphasizing sacrifice and dedication.

Meanwhile, the interaction effect between the system agent status and the feedback valence observed in the experiment indicates that when designing human-computer interaction systems, the agent roles and feedback mechanisms should be reasonably set according to the system goals and user situations to maximize the behavior induction effect. For example, in some cases, appropriate negative feedback may be more helpful for high-status agents to stimulate users' prosocial behaviors. However, it needs to be handled carefully to avoid causing users' aversion, so as to achieve the effectiveness and sustainability of social design in practice (Simon et al., 2019).

C. Limitations of the Study and Future Research Directions

Although this study has achieved certain results, it still has some limitations. In terms of the experimental situation, although efforts were made to simulate real-life situations, there is still a gap compared to actual life scenarios. Future research needs to further apply and evaluate the shared value system in real life more realistically to verify its effectiveness under different cultural and social backgrounds.

Meanwhile, this study mainly focused on the basic situations during the user experience process and did not fully consider the influencing factors before and after use. Future research can further explore how to continuously influence user behaviors over a longer time span and enhance the long-term persuasiveness of the system.

In addition, the complexity of the feedback effect of high-status agents found in the research results also presents a new topic for future research. It is necessary to explore more deeply the psychological and behavioral response mechanisms of humans to mechanical feedback and how to optimize the feedback design in human-computer interaction to better achieve social design goals (Suchman et al., 2007).

VII. Conclusion

This study has successfully constructed and verified the social design theories and methods based on unconscious behavior data. Through rigorous experimental design and in-depth data analysis, the significant impacts of factors such as the types of shared value systems, system agent status, and feedback valence on users' prosocial behaviors and satisfaction have been revealed. The research results have not only provided important theoretical support and practical guidance for the field of social design but also offered a beneficial example for interdisciplinary research. Although there are certain limitations, this study has pointed out the direction for the future development of related fields. It is expected that subsequent research can further deepen our understanding of this field, promote the continuous innovation and improvement of social design based on unconscious behavior data, and ultimately achieve a high degree of harmony and common development between individual and social interests.

References

[1] Lane, Nicholas D., Emiliano Miluzzo, Hong Lu, Daniel Peebles, Tanzeem Choudhury, and Andrew T. Campbell. "A survey of mobile phone sensing." IEEE Communications magazine 48, no. 9 (2010): 140-150.

[2] Fogg, Brian J. "Persuasive technology: using computers to change what we think and do." Ubiquity 2002, no. December (2002): 2.

[3] Campbell, Andrew T., Shane B. Eisenman, Nicholas D. Lane, Emiliano Miluzzo, Ronald A. Peterson, Hong Lu, **ao Zheng, Mirco Musolesi, Kristóf Fodor, and Gahng-Seop Ahn. "The rise of people-centric sensing." IEEE Internet Computing 12, no. 4 (2008): 12-21.

[4] Oinas-Kukkonen, Harri. "Behavior change support systems: A research model and agenda." In Persuasive Technology: 5th International Conference, PERSUASIVE 2010, Copenhagen, Denmark, June 7-10, 2010. Proceedings 5, pp. 4-14. Springer Berlin Heidelberg, 2010.

[5] IJsselsteijn, Wijnand, Yvonne De Kort, Cees Midden, Berry Eggen, and Elise Van Den Hoven. "Persuasive technology for human well-being: setting the scene." In Persuasive Technology: First International Conference on Persuasive Technology for Human Well-Being, PERSUASIVE 2006, Eindhoven, The Netherlands, May 18-19, 2006. Proceedings 1, pp. 1-5. Springer Berlin Heidelberg, 2006.

[6] Manzini, Ezio. Design, when everybody designs: An introduction to design for social innovation. The MIT Press, 2015.

[7] Murray, R. "The open book of social innovation." National endowment for science, technology and the art (2010).

[8] Batson, Charles Daniel. Altruism in humans. Oxford University Press, 2011.

[9] Penner, Louis A., John F. Dovidio, Jane A. Piliavin, and David A. Schroeder. "Prosocial behavior: Multilevel perspectives." Annu. Rev. Psychol. 56 (2005): 365-392.

[10] Deci, Edward L., and Richard M. Ryan. "The" what" and" why" of goal pursuits: Human needs and the self-determination of behavior." Psychological inquiry 11, no. 4 (2000): 227-268.

[11] Bandura, Albert. "Social cognitive theory of self-regulation." Organizational behavior and human decision processes 50, no. 2 (1991): 248-287.

[12] Tesser, A. "Toward a self-evaluation maintenance model of social behavior." Advances in experimental social psychology/Academic Press (1988).

[13] Cialdini, Robert B., and Noah J. Goldstein. "Social influence: Compliance and conformity." Annu. Rev. Psychol. 55, no. 1 (2004): 591-621.

[14] Festinger, L. "A theory of cognitive dissonance: Stanford university press.[Google Scholar]." (1957).

[15] Aronson, Elliot, and Judson Mills. "The effect of severity of initiation on liking for a group." The Journal of Abnormal and Social Psychology 59, no. 2 (1959): 177.

[16] Cook, Thomas D. "Quasi-experimentation: Design and analysis issues for field settings." Rand McNaly College Publishing (1979).

[17] Goffman, Erving. "The presentation of self in everyday life." In Social theory re-wired, pp. 450-459. Routledge, 2023.

[18] Kluger, Avraham N., and Angelo DeNisi. "The effects of feedback interventions on performance: a historical review, a meta-analysis, and a preliminary feedback intervention theory." Psychological bulletin 119, no. 2 (1996): 254.

[19] Poulton, Eustace Christopher. Bias in quantifying judgments. Routledge, 2023.

[20] Churchill Jr, Gilbert A. "A paradigm for develo** better measures of marketing constructs." Journal

[21] of marketing research 16, no. 1 (1979): 64-73.

[22] Corbin, Juliet, and Anselm Strauss. Basics of qualitative research: Techniques and procedures for develo** grounded theory. Sage publications, 2014.

[23] Tabachnick, Barbara G., Linda S. Fidell, and Jodie B. Ullman. Using multivariate statistics. Vol. 6. Boston, MA: pearson, 2013.

[24] Kline, Rex B. Principles and practice of structural equation modeling. Guilford publications, 2023.

[25] Edwards-Jones, Andrew. "Qualitative data analysis with NVIVO." (2014): 193-195.

[26] Field, Andy. "Discovering statistics using IBM SPSS statistics." (2013).

[27] Tavakol, Mohsen, and Reg Dennick. "Making sense of Cronbach's alpha." International journal of medical education 2 (2011): 53.

[28] Murtagh, Fionn, and André Heck. Multivariate data analysis. Vol. 131. Springer Science & Business Media, 2012.

[29] Rutherford, A. "Designing experiments and analyzing data: A model comparison perspective." British Journal of Mathematical & Statistical Psychology 57 (2004): 185.

[30] Cohen, Jacob, Patricia Cohen, Stephen G. West, and Leona S. Aiken. Applied multiple regression/correlation analysis for the behavioral sciences. Routledge, 2013.

[31] Kline, Rex B. Principles and practice of structural equation modeling. Guilford publications, 2023.

[32] Braun, Virginia, and Victoria Clarke. "Using thematic analysis in psychology." Qualitative research in psychology 3, no. 2 (2006): 77-101.

[33] Salkind, Neil J., and Bruce B. Frey. Statistics for people who (think they) hate statistics. Sage Publications, 2019.

[34] Ryan, Richard M. Self-determination theory: Basic psychological needs in motivation, development, and wellness. Guilford Press, 2017.

[35] Hackman, J. R. "Motivation through the design work: Test of the theory." Organizational Behavior and Human Performance (1976).

[36] Daniel, Kahneman. Thinking, fast and slow. 2017.

[37] Bandura, A. "Social foundation of thought and action: A social cognitive theory." Prentice-Hall google schola 2 (1986): 165-172.

[38] Norman, Don. The design of everyday things: Revised and expanded edition. Basic books, 2013.

[39] Reeves, Byron, and Clifford Nass. "The media equation: How people treat computers, television, and new media like real people." Cambridge, UK 10, no. 10 (1996): 19-36.

[40] Lee, Nancy R., and Philip Kotler. Social marketing: Influencing behaviors for good. SAGE publications, 2011.

[41] ĬN\ ẽ[□xZ . "Case study research and applications: Design and methods." `k\ck\ \kZ-xd@ ÈS =Li .:bk akcṅ (Zlb[akcṅ x^i .@=ZakcṅṄ) 5, no. 1 (2024): 101-103.

[42] Pentland, Alex. Social physics: How good ideas spread-the lessons from a new science. Penguin, 2014.

[43] Weick, Karl E., and Karl E. Weick. Sensemaking in organizations. Vol. 3. Thousand Oaks, CA: Sage publications, 1995.

[44] Simon, Herbert A. The Sciences of the Artificial, reissue of the third edition with a new introduction by John Laird. MIT press, 2019.

[45] Suchman, Lucille Alice. Human-machine reconfigurations: Plans and situated actions. Cambridge university press, 2007.