

PSPB (Persuasive Service Design Strategies Based on the Theory of Planned Behavior) Methodology for User Behavior Modification

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Abstract

Background Researchers have recently pointed out the necessity of linking human-computer interaction (HCI) with Behavioral Theory, since Persuasive Technology (PT) has focused mainly on technology implementation.

Methods In order to verify the behavioral predictive variables discussed in the Theory of Planned Behavior (TPB), this study focuses on three strategies defined as the “Persuasive Service design strategies based on TPB” (collectively referred to as PSPB): emotional support, social learning support, and ability support. The efficacy of these strategies on 400 participants in four groups, including three app services, was evaluated using each strategy and 1 control group.

Results All three strategies mitigated the negative reactions of the users compared to the control group and strengthened behavioral predictive variables, perceived behavior control (PBC), and subjective norm (SN), according to social learning support and ability support purposes.

Conclusions This study proposes the PSPB methodology, diagnoses the problem with behavior using TPB, presents PSPB Design Strategies as a design solution, and evaluates the utility of the service using TPB.

Keywords Design with Intent, Persuasive Technology, Behavior Change, Sustainable Behavior, UX Design, Persuasive Service Design Process

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1. Introduction

As mobile technology evolved, the human-computer interaction (HCI) field was actively researched to provide information and change people's behaviors and thoughts in the right direction. In 2002, Fogg published "Persuasive technology: using computers to change what we think and do." In this book, Persuasive Technology (PT) is defined as the use of computers to change people's behavior and attitudes. As data technology evolves and more information is provided to users, users are more likely to avoid extraneous information. Therefore, designers should know what psychological changes will occur when users access information in the process of using a persuasion service. In addition, it should be possible to know what psychological factors are acting when the target behavior is achieved and when it is not achieved. Therefore, in this study, we identify psychological variables that can induce users' behavior based on persuasive psychological theory and identify ways to provide persuasive information as a means to strengthen each psychological variable. Additionally, verify that the persuasive information provided could lead to the intended psychological changes. We propose a reconciliation strategy for persuasion so that the existing persuasion strategies reinforce Attitude toward Behavior (AB), Subjective Norm (SN), and Perceived Behavioral Control (PBC), which are components of Planned Behavioral Theory (PBT). This strategy was successful in reinforcing SN and PBC and succeeded in maintaining a positive AB compared to the control group.

2. Related Works

2.1. Uses of Behavioral Theories to Predict Behavior

The Theory of Planned Behavior (TPB) allows the user to precisely predict which actions to take. TPB consists of AB, SN, PBC, and Intention. To explain TPB, one must understand Fishbein and Ajzen's Theory of Reasoned Action (TRA). TRA describes AB and Intention separately and reveals that the factor that directly determines behavior is the behavioral intention rather than AB. Behavioral intention indicates the strength of the intent to act, which is determined by the individual AB and SN of the behavior. TRA presupposes that individuals can control their own actions, but in reality, they often face situations that are not the case; everyone has had the experience of not carrying out a plan. For example, people say they are willing to stop a behavior, but they quickly resume the behavior; for example, someone may quit smoking today but end up smoking again in three days. In order to illustrate these cases, Ajzen revealed TPB, which extended TRA with PBC. According to Ajzen, AB, SN, and TPB influence each other, and they mediate intention and influence behavior. TPB is an important variable that can directly affect behavior with intention, so it is also used as a substitute for measuring actual behavior. It can be used as a psychological factor to describe the process by which an individual can control his/her own behavior as well as the situation in which he/she can control his/her own behavior.

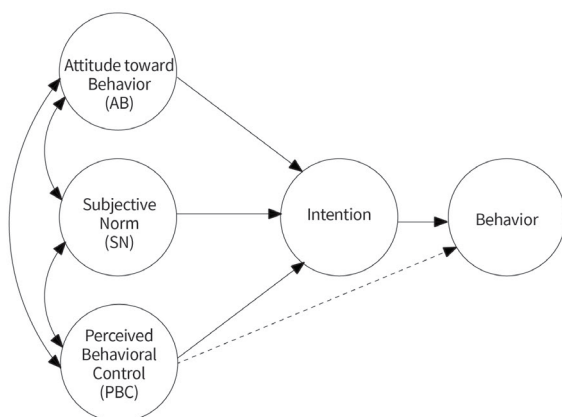


Figure 1 Theory of planned behavior

2. 2. Persuasive Service Design Methodologies: Related Research

Fogg, Oinas-Kukkonen, and Lockton suggest different ways to design persuasive services. Fogg defines the type of target behavior and then gives design guidelines. A resource guide is provided that suggests a persuasive service design method suitable for the target behavior. The strategy proposed in the resource guide is based on triggers, abilities, and motivation, which are the three behavior-inducing conditions of the FBM model. According to the Fogg's Behavior Model (FBM), in order to achieve the target behavior, the actor must first have the ability to execute the target behavior and have sufficient motivation, and triggers can be used to ensure such ability and motivation (see Fig 2). According to Fogg, persuasion services can influence behavior more effectively by simplifying target behavior and using appropriate triggers rather than motivation. Fogg does not recommend a strategy of providing information as a method of motivation because it can cause user avoidance.

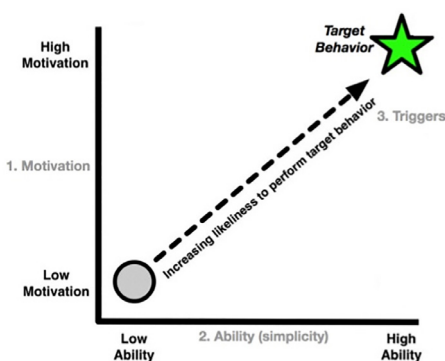


Figure 2 Fogg's Behavior Model(FBM)

Oinas-Kukkonen proposes persuasive service design principles used in the 2006-2008 Persuasive Conferences, assigning them to four criteria: Primary task, Social, Dialogue, and System credibility. These criteria are attributes that influence the behavior and thinking of the user in the execution phase of behavior change support systems.

Lockton's team announced Design with Intent (DwI) at the 2008 Persuasive Technology Conference. PT is part of the six strategies proposed by DwI, and DwI is a broader concept

than PT. DWI also considers enforcement and coercion as strategies to change behavior. The PT strategy is mostly derived from Fogg, but it suggests ways to accommodate a wide range of users by structuring and presenting information according to the characteristics of the media.

It is important to identify the advantages and disadvantages of each researcher's method. Fogg's method has the advantage of instantly confirming the effect, but it has a disadvantage in that it is difficult to apply to areas where motivation is important. Oinas-Kukkonen offers the most diverse design strategies, providing easy-to-apply guidance for development situations, while focusing on technology rather than target behavior. Design guidelines are so specific that they can be applied directly to development. Lockton's method provides an idea for structuring the information.

3. Suggestion For Persuasive Service Design Strategies Based on Behavioral Theories

We aim to provide designers with guidance on designing persuasive services based on behavioral theories. We first collected persuasive service design strategies from related studies. We then assigned collected strategies to the three components of TPB. The components are AB, SN, and PBC. We then used these distinctions to enable persuasive strategies to selectively influence the psychology associated with user behavior and gave each distinction a name that could represent the purpose of the strategy.

3. 1. Assigning Collected Strategies to TPB

We reconstructed persuasive service design strategies proposed by the three researchers based on three TPB behavioral predictors - AB, SN, and PBC. On the left side of the table, the three persuasive strategies proposed by Fogg's FBM model are classified, and the behavioral psychology is mapped on the right side of the table (see Table 1).

Table 1 PT assigned to TPB components

FBM Model	Persuasive Technology			TPB
	Fogg	Oinas-Kukkonen	Lockton	
Trigger	Prompt: Call to action	Reminder	Kairos	PBC
	Offer: Request	-	-	
	Cue	-	-	
Ability	Reduction	Reduction	Reduction	PBC
	Suggestion	Suggestion	-	
	Self-monitoring	Self-Monitoring; Personalization	Self-monitoring; Feedback through form	PBC
	Tunneling (process)	Tunneling; Simulation; Rehearsal	Tunneling; Simulation & feedforward	

Motivation	Tailoring	Tailoring; Praise; Liking; Reward; Similarity	Tailoring	AB
	Tunneling (info)	Surface Credibility; Trustworthiness; Real-world feel; 3rdParty endorsements; Verifiability	-	AB SN
	Surveillance	Social Role; Social Comparison; Normative Influence; Authority; Expertise; Social learning; Recognition; Cooperation; Social facilitation; Competition	Computers as social actors	SN
	Conditioning	-	Operant conditioning; Respondent conditioning	PBC

3. 2. Proposing PSPB Design Strategies

Through this process, we could propose PSPB design strategies consisting of three persuasive service design strategies based on planned behavior theory.

First, the emotional support strategy aims to change the AB. The definition of AB in TPB is whether the evaluation of a particular object is favorable. Therefore, it consists of persuasive strategies that can lead to a positive emotional response to the behavior. Second, the social learning support strategy aims to strengthen the SN. Therefore, we presented a strategy to help users predict social norms and moods. Third, ability support strategy aims to strengthen PBC. Thus, information is provided that can simplify the target behavior or improve the user's ability. As a result of theoretical considerations, it can be argued that PT should be able to strengthen the three psychological components in order to successfully induce action. Therefore, the three persuasion service design strategies based on TPB are summarized in Table 2.

Table 2 Principles of the three types of strategies of PSPB

	emotional support	social learning support	ability support
Persuasive Technology	Tailoring Liking Reward Similarity Surface Credibility Praise	Social Role Authority Expertise Real-world feel 3rdParty endorsements Verifiability Social Comparison Normative Influence Social learning Recognition Cooperation Social facilitation Competition Surveillance	Tunneling Reduction Self-Monitoring Simulation Personalization Rehearsal Conditioning Suggestion Prompt Call to action Reminder Cue Request Offer feedforward feedback Kairos
	▼	▼	▼
TPB components	AB ; Attitude toward Behavior	SN ; Subjective Norm	PBC ; Perceived Behavioral Control

The persuasion strategies that are bundled with emotional support can affect AB and the behavioral predictors of TPB. The persuasive strategies that are tied to social learning support affect SN and the ability support may influence PBC and consequently change behavioral intent and trigger behavior (see Fig 3 and Table 2).

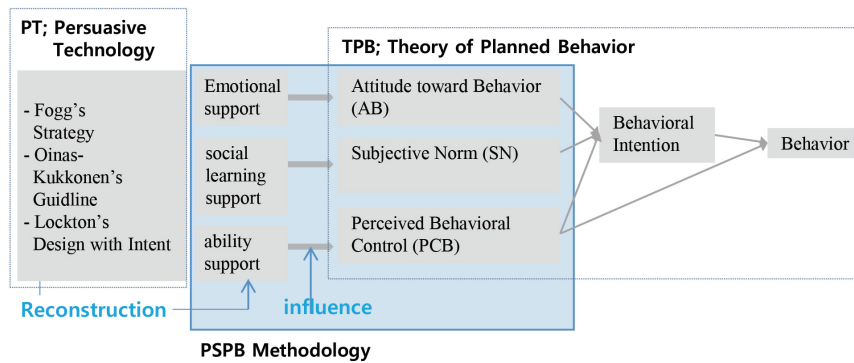


Figure 3 Relationship among PT, TPB and PSPB methodology

4. Hypothesis and Survey

As described above, persuasive service aims to change the user's behavior and thinking as desired. Therefore, we proposed PSPB design strategy that can support each component of TPB. We anticipate that we will be able to predict users' behaviors relatively accurately based on TPB components and to persuade users by strengthening the psychological elements in TPB. We set hypotheses and planned surveys to verify the effectiveness of our proposed strategy.

4. 1. Setting a Hypothesis

We have constructed three persuasive service design strategies based on TPB to strengthen AB, SN, and PBC, respectively. Therefore, we could set two hypotheses as follows.

H1: Based on TPB, it is possible to diagnose factors that are unlikely to cause target behavior.

H2: Using the PSPB design strategy, we can improve psychological factors that induce behavior.

4. 2. Choosing Research Domains and Targeted Behavior

The research domain was selected as use of electrical energy among sustainable action areas. Recently, efforts are being made to solve energy and environmental problems through international smart grid business.

Hamari, J., et al. (2014)'s research on sustainable behavior using IT technology has been actively conducted in the HCI field by directly confirming behavior through experiments. However, studies applying the theory of behavior in the psychology field are very scarce. 36% of energy consumption is due to behavioral factors such as lifestyle or user activity, so research that drives users' energy saving behavior is valuable.

"Power off after using lights and appliances" which is a waste of energy if the power users are not conscious of the easy actions they do on a daily basis, is set as the target behavior for power-saving. This is one of Fogg's behavioral matrices where mobile involvement is an effective area of action.

4. 3. Outline of Experiments for Hypothesis Verification

To test the hypothesis, we planned two surveys:

Survey 1 allowed us to openly question whether users were interested in the use of electricity and fees and how to pay attention to electricity bill statements. The purpose of this was to find out how much interest users have in the research domain of energy conservation.

Survey2 conducts surveys that compare pre and post exposure to experimental stimuli to identify and confirm behavioral psychology related to the user's target behavior. First, we conducted a survey asking about AB, SN, and TPB in target behavior to predict behavior change. In the second stage, each group of the three types of PSPB design strategies and the control group are exposed to each design sample at an appropriate time. Five seconds after respondents started viewing the sample image, The NEXT button is activated to answer questions. Finally, we examined the design sample in the three steps and participants were asked to respond to the same questionnaire on predicting behavioral change as in step 1.

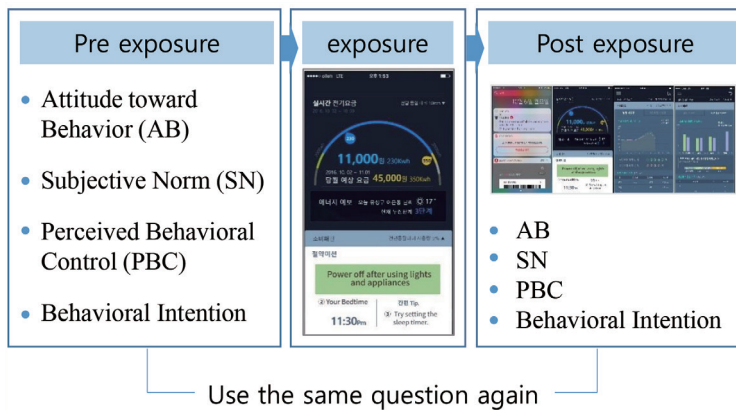


Figure 4 Survey 2 Preliminary follow-up to identify the user's behavioral changes in target behavior after exposure stimuli exposure

4. 4. Experimental Stimulus Design Using PSPB Strategy

We have designed four types of app services to drive power-saving behavior by providing energy usage information to verify the PSPB design strategy. The basic design that provides monitoring of energy usage was used as a control group, and three app service designs were made by applying emotional support, social learning support, and ability support strategies. The application service for energy conservation, which is an experiment stimulus, was categorized into three pages according to the information provided: the notification center, the home, and the consumption pattern (see Figure 5).



Figure 5 Baseline version of experiment stimuli (the notification center/ the home/the consumption pattern 1/2).

Table 3 Explanation of experimental stimuli with three types of PSPB strategies

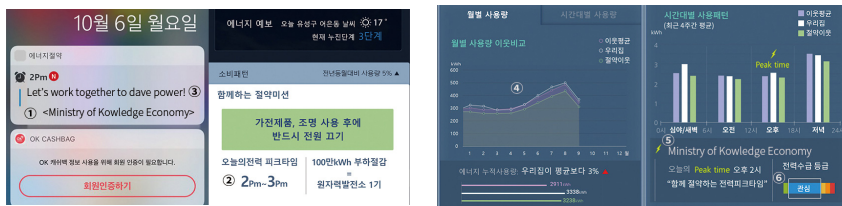
Ability support	
<p>The Notification Center / The home</p>	<p>The consumption pattern 1, 2</p>
<p>① Tunneling : Turn off the light before bedtime Guidance message ② Personalization :Utilizing the preset life patterns of individuals ③ Suggestion :Sleep timer setting suggestion</p>	<p>④ Self-Monitoring : Graph of comparison between my last year's usage and this year's usage ⑤ Personalization : Diagnose waste point based on personal data</p>

Emotional support



- ① Reward : Offer virtual rewards (★)
- ② Praise: Message to praise electricity saving
- ③ Liking : Use special characters (★) in positive images, use positive words
- ④ Praise: Emphasize the time to save electricity and praise it.

Social learning support



- ① Authority : Message citing Energy Management Corporation
- ② Expertise : peak time information
- ③ Cooperation : Cooperative Savings Information, Messages encouraging cooperation
- ④ Social Comparison : Provide comparison data and graph with neighbor
- ⑤ Authority : Message citing Energy Management Corporation
- ⑥ Expertise : Peak time / Power supply information

* Experimental stimuli proceeded in Korean, but some of them were modified in English to explain the stimuli

- The Notification Center provides updated power-saving information in the app service and preset alert.

- Baseline (Basic function): Updated information alert
- Emotional support: Basic function + Praise + Liking
- Ability Support: Basic function + Tunneling + Personalization + Suggestion
- Social learning support: Basic function + Authority + Expertise + Cooperation

- At the top of the home screen, real-time power usage, rate status, forecasted rates for the current month, and weather and progressive phase information are provided. Saving missions mean targeted actions to be achieved through app services. The same saving mission is presented in four experimental stimuli.

- Baseline (Basic function): real-time power usage, cost of electricity, Saving Mission
- Emotional support: Basic function + Praise + Liking
- Ability Support: Basic function + Tunneling + Suggestion
- Social learning support: Basic function + Authority + Expertise / Cooperation
- The Consumption Pattern page provides a table and graph of the user's power usage
- Baseline (Basic function): table and graph of the user's power usage
- Emotional support: Basic function + Liking, Praise
- Ability support: Basic function + Self-Monitoring, Personalization
- Social learning support: Basic function + Social Comparison, Competition, Authority

4. 5. Survey 1: Preliminary Investigation – Awareness of Power-Saving Behavior

Survey 1: Methods

From February 13-16, 2016, we received responses via Google Drive from a total of 57 participants. Among the respondents, there were 37 males and 20 females. We asked open-ended questions about the method of payment of electric bills, household composition, housing type, and the use of electric energy.

Survey 1: Results

Qualitative classification of open-ended questions using the affinity method showed that out of 59 respondents, 30 did not check the bills at all or viewed them in a cursory manner. 13 respondents said they read the bill with interest. 14 respondents said they would look at the bill in detail when they had a specific issue. 8 of them look closely at the bill when they spend a lot in electricity for heating and cooling in winter and summer.

The other 6 people check the bill to find out why the charge is suddenly high. Participants did not judge the consumption of electric power based on electricity usage that could be related to behavior, but rather the fee charged at the time of billing. With regard to TPB, the users have a positive attitude toward energy conservation behavior. Also, in terms of subjective norm, energy conservation behavior is accepted as a positive action that is in the public interest. Since more than 80% of respondents showed their willingness to economize, behavioral intentions for saving behavior are also sufficient. Participants, however, said that they did not know how to save energy and how their actions affected power use. PBCs for power use behaviors were found to be very insufficient because they were aware of their own power usage status through the bill. It has also been found that individuals doubt whether saving energy is helpful.

Table 4 survey1; electricity bills and electricity use

		total		age			Electric billing method		
				20s	30s	40s	Included in management fee	Charge separately	Unawareness
Total		57	100%	13	34	10	31	24	2
Gender	Male	37	64.9	7	23	7	20	15	2
	Female	20	35.1	6	11	3	11	9	0
Perceived electric charges	low	22	38.6	5	13	4	10	12	-
	heavy	20	35.1	5	10	5	14	6	-
	Unawareness	15	26.3	3	11	1	7	6	2
How to check charges	bill	39	68.4	8	23	40	24	14	1
	compare neighborhood	6	10.5	3	2	1	2	4	-
	Unawareness	12	21.1	2	9	1	5	6	1
Thinking about energy saving	Required for economic reasons.	27	47.4	8	14	5	14	12	1
	Required for public interest	19	33.3	1	14	1	12	6	1
	unnecessary	11	19.3	4	6	1	5	6	-

4. 6. Survey 2: Predictive Behavioral Change Before and After Exposure to Experimental Stimulants

We examined the effect of app services designed on four types of behavioral psychology including baseline, ability support, social learning support, and emotional support. We conducted an online survey for five days, from March 24-28, 2017. Participants first responded to the AB, SN, and PBC for the target action, “Turn off the power after using appliances and lights.” Then, they checked the stimulus sample of the app service and responded to the same question once more.

Survey 2: Method

In the questionnaire, age and gender were adjusted so that the adults in their 20s and 60s could be distributed evenly, and 100 persons could be assigned to each experimental group. A total of 400 panel members participated in four groups. We used a panel of online research companies to maintain the objectivity of the questionnaire population. The target behavior we want to drive through app services is “Turn off power after using home appliances and lighting for the next two months.” Behavioral prediction survey items were constructed to measure how the psychological variables AB, SN, and PBC changed before and after the exposure to the app services.

Survey 2: Results

The reliability of the questionnaire items for AB, SN, and PBC was found to be higher than 0.8 for Cronbach's alpha. SPSS 18 was used to verify the change of the dependent variable between the two time points. The four groups had different effects on AB, SN and PBC (see Figure 4).

The group with a statistically significant effect on AB was baseline ($t = 2.333$, $df = 99$, $p < 0.05$). However, in the case of the baseline group, we could see that AB had turned negative. This suggests that the characteristics of the users who try to avoid the motivation, those which Fogg was concerned with, seem to be revealed in the baseline group, however, the results of AB were all positive in the other group except for the baseline group. This suggests the possibility of using PSPB design strategies to reduce the negative effects of persuasion services.

The groups that showed statistically significant results in SN were social learning support ($t = -2.387$, $df = 99$, $p < 0.05$) and ability support ($t = -2.387$, $df = 99$, $p < 0.05$).

The group that showed statistically significant results in PBC was ability support ($t = -2.561$, $df = 99$, $p < 0.05$).

These results have shown the potential to improve target psychological factors to diagnose target behavior based on TPB and to use PSPB design strategies to drive targeted behavior.

Table 5 TPB component change before and after exposure to app service (Statistical significance, $p < 0.05$)

	TPB Component	N	Average		sd	t	df	p	
			pre	post					Difference
Emotional support	AB	100	5.595	5.463	.132	.761	1.174	99	.085
	PBC	100	5.342	5.438	-.095	.809	-1.174	99	.243
	SN	100	5.113	5.113	-.002	.824	.030	99	.976
	Intention	100	5.417	5.383	-.033	.819	.407	99	.685

Ability support	AB	100	5.468	5.590	-.122	.911	-1.344	99	.182
	PBC	100	5.258	5.478	-.220	.859	-2.561	99	.012
	SN	100	5.003	5.243	-.240	1.005	-2.387	99	.019
	Intention	100	5.310	5.630	-.320	1.020	-3.136	99	.002
Social learning support	AB	100	5.608	5.575	.032	.708	.459	99	.647
	PBC	100	5.403	5.463	-.060	.642	-.935	99	.352
	SN	100	5.037	5.218	-.180	.727	-2.474	99	.015
	Intention	100	5.550	5.550	-.050	.664	.753	99	.453
Baseline	AB	100	5.720	5.555	.165	.707	2.333	99	.022
	PBC	100	5.403	5.445	-.043	.807	-.527	99	.600
	SN	100	5.183	5.265	-.083	.738	-1.118	99	.266
	Intention	100	5.503	5.480	-.023	.839	.278	99	.781

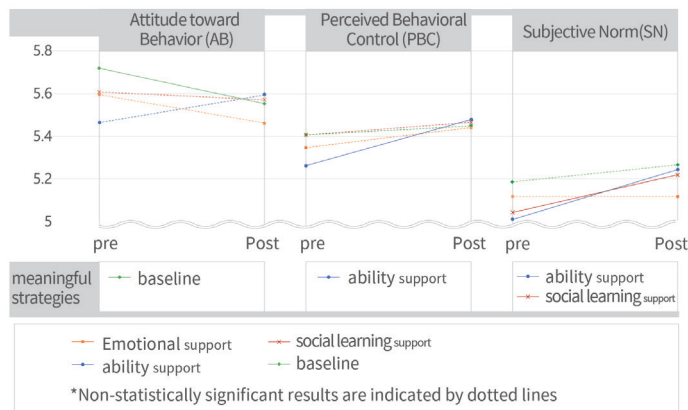


Figure 6 How PSPB Design Strategies Affect TPB Components, pre–posttest comparison results

5. Discussion and Suggestion

In Survey 2, SN was the lowest in the survey on the target behavior, “Turn off the power after using household appliances and lighting for the next two months.” However, the perception of power-saving behavior in Survey 1 was confirmed to have high AB, SN, and behavioral intention, and a lack of PBC. These results show that there is a recognition gap between power-saving behavior, which is the purpose of the behavior, and the target behavior to be performed. As for energy conservation, it is a socially acceptable action wherein both the intention to practice and the AB are high, but users do not know how to implement this behavior.

Table 6 Comparison of perception differences between target behavior and action goal in survey1 and survey2

	Survey 1	Survey 2
category	behavioral goal	target Behavior
Content of action	'power-saving behavior'	'Turn off the power after using household appliances and lighting for the next two months'
PBC	High: Positive attitude	1
SN	High: Public and eco-friendly behavior	4 (lowest)
AB	Low: they do not know how to save energy	3
Behavioral Intention	High: they think they should save energy	2

However, after deciding on specific tasks such as “turning off the power after using household appliances and lighting,” the PBC increased, but SN seemed to be undervalued because the target behavior was regarded as a minor action. This difference in evaluation can be a barrier preventing actual power-saving actions (see Table 5). Therefore, TPB can be used to identify a large category of behavior and to recognize the target behavior.

6. PSPB Methodology

Step 1: Problem definition through TPB questionnaires

We propose a problem definition method through two stages of behavioral evaluation to enhance the effectiveness of the persuasive service. (see Figure 5). First, evaluate the purpose of the action with the TPB questionnaire, and evaluate and compare the target behavior in the same way. In Table 4, we can see exactly which part of the behavioral predictor of the target behavior should be supported to induce the behavior. The questionnaire for predicting behavior change utilizes the structured questionnaire method suggested by Ajzen.

Step 2: Troubleshoot with PSPB design strategy

When the cause of the non-target behavior is identified through the first step problem definition, the service can be constructed by selecting a persuasion strategy as the main strategy to support the insufficient elements of the PSPB design strategy. In the case of the app service, the user will be informed sequentially of the information center, the home screen, the detailed screen, etc., and it is the user's choice to check or ignore the information provided at this time.

Therefore, when the user's PBC is the shortest, the service can be configured with an ability support priority.

Step 3: Assess the effectiveness of the PSPB design strategy

The process of utilizing the PSPB design strategy can evaluate the effectiveness of the service using the diagnostic items in the problem definition. It is possible to control the method and level of service by evaluating the target behavior during the problem diagnosis and evaluating the efficacy evaluation afterwards to see how the psychology of the behavior has changed.

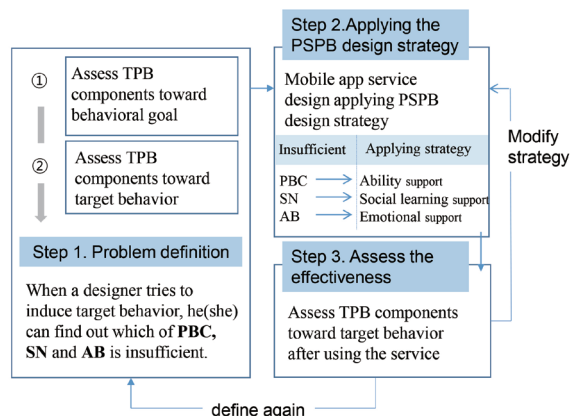


Figure 7 Three-step process utilizing PSPB design strategy

7. Conclusions and Future Work

The user's psychological response to target behavior is not fixed, but varies with persuasion. Therefore, it can provide accurate problem diagnosis, provide design solutions, and periodically evaluate the effectiveness of design strategy to provide customized strategies for the user's situation. We confirmed that the three types of PSPB design strategies proposed by our preliminary post-test on 400 participants are suitable for persuading each other by supporting AB, SN, and PBC. We were able to propose a three-step process to design and continually improve the persuasion service based on the actor's psychology. However, this study was conducted by asking psychological questions related to behavior rather than to observe the user's actual behavior after using the service. So, in the future, we will be able to clarify our design strategy by comparing it with actual behavioral data. We expect to continue to expand and refine research by changing the user orientation and service domain.

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