

Development of a Psychological-Behavioral Model of Behavioral Change

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Abstract—Behavior is influenced by context and personality. To change habitual behavior, we need to clarify its underlying mechanism and the factors affecting it. To achieve behavioral change, the factors affecting it must be changed. We classified anxiety, developed a psychological-behavioral model, and performed an experiment to verify this model. In this paper, we present a specific example of the psychological-behavioral model and the results of the experiment. We also present the approaches that could be considered to achieve behavioral change.

Keywords—behavioral change, experience economy, context, personality psychology, anxiety

I. INTRODUCTION

The awareness of the change from “objects” to “things,” known as “shift towards service industry,” has been recently increasing in the manufacturing industry [1]. Added to that, the business practice that prompts users to create value through a new experience by word-of-mouth, such as SNS and movie contents, is increasing [2]. According to experience economy [3], the former refers to a paradigm shift from industrial economy to service economy, whereas the latter refers to a paradigm shift from service economy to experience economy. The next stage after experience economy is innovation economics. Innovation economics is a business approach that influences individual users who aspire for innovation, which means that it is considered to be a business of behavioral change. We took notice of innovation economics and behavioral change. Based on this perspective, we studied the psychological-behavioral model as the fundamental mechanism of behavioral change via manufacturing or obtaining information. In previous studies, we classified anxiety, developed a psychological-behavioral model, and performed an experiment to verify this model [4]. In this paper, we present a specific psychological-behavioral model and an experiment based on it. We also introduce the approaches to behavioral change based on this model.

II. PSYCHOLOGICAL-BEHAVIORAL MODEL

To examine behavioral change, we modeled the structure of behavior in view of personality psychology and clinical psychology to understand the state of mind and behavior.

A. Personality Psychology

According to personality psychology, two factors, “human traits” and “situation,” influence the occurrence of a behavior [5]. In the early stages of the history of psychology, there was a major dispute regarding two conflicting opinions. The first was that almost all human behavior is governed by the internal traits of humans (known as “trait theory”) [6]. The second notion was that the environment is more influential than internal factors, such as personality, in affecting behavior (known as “situational theory”) [6].

Based on these arguments, Levin [7] explained human behavior using the equation below, which posits that human behavior is a result of the interaction between personality (individual factor) and context (situational factor). This is referred to as the “transactional theory.”

$$B=f(P, E)$$

(B: behavior, f: function, P: personality, E: environment)

B. Clinical Psychology

We have been studying anxiety from the perspective of clinical psychology. Fig.1 shows the mechanism of the occurrence of anxiety [4].

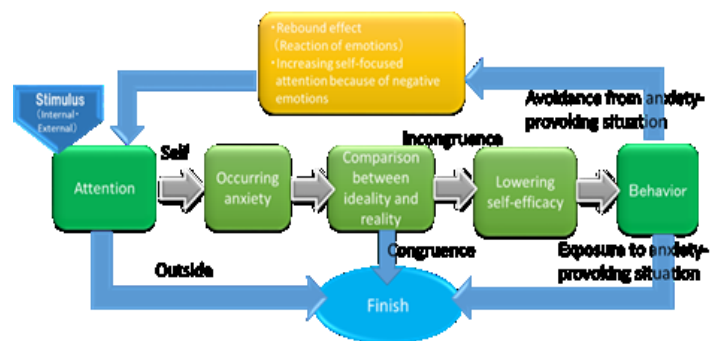


Fig. 1. Mechanism of Anxiety

Fig. 1 is a flowchart, which illustrates the process by which anxiety occurs. First, when an individual is exposed to an internal or external stimulus, anxiety ensues, followed by judgment induced by self-focused attention. Moreover, a comparison of ideality and reality and a decrease in self-efficacy are reflected in the judgment to implement or avoid a behavior. When we avoid anxiety, anxiety contrarily increases.

C. Psychological-Behavioral Model

We developed the psychological-behavioral model based on the personality and clinical psychological theories. We aimed to elucidate the psychological-behavioral process and its influential factors, such as context or personality. However, context is not substantiated in this model because several contexts might influence each target behavior.

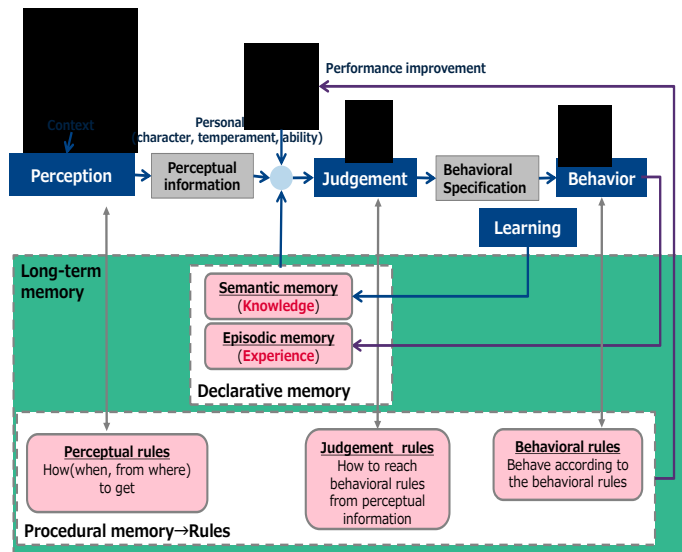


Fig. 2. Psychological-Behavioral Model

1) Process

In the behavioral process, we apply the standard concepts of perception (or cognition), judgment, and behavior. The process starts when we perceive our context. Next, mindset and behavior are decided through a judgment process in consideration of one's personality. Finally, the mindset and behavior are put into action according to the consequence of the judgment process.

2) Personality

We considered personality as a factor that influences which behavior will be performed after receiving information from the perception.

Judgment processing is influenced by declarative memory such as knowledge or experience. Each process of perception, judgment, and behavior also become subconscious or habitual by procedural memory, which refers to memorized skills or know-how by means of repetition. From this perspective, behavioral change refers to the change of this habit. This way, the regulations of the mind and behavior are strongly affected by memory.

In general, the word "personality" is also used to refer to similar concepts such as "character" or "temperament" [6]. However, we believe that memory is also endogenous to personality.

III. VERIFICATION OF THE PSYCHOLOGICAL-BEHAVIORAL MODEL

Based on the above discussion, we present the results of the experiment performed to verify the psychological-behavioral model. We used a driving situation in this study. The car industries have recently emphasized "peaceful mind and safety" as a slogan of car development. However, the way to acquire a "peaceful mind" is not as clearly known as the way to gain "safety" [4]. Therefore, we thought it was necessary to develop a technique to reduce anxiety, which is the opposite of a "peaceful mind." This effort might contribute to safe driving and actualizing driving pleasure for all drivers.

Using descriptions and images, participants were presented with different scenarios, wherein a driving assistance technology could help them overcome difficult circumstances due to lack of experience. This approach intends to reduce anxiety by helping drivers oversee their situation and by increasing their coping capability, i.e., "self-efficacy" [8], in a difficult situation. The research design is detailed below.

This research design was approved by the ethics committee of the second author's affiliated institution.

A. Research Participants (Table I)

This study was conducted by WEB survey company (NEO MARKETING INC.). Prior to the main study, we conducted a preliminary investigation ($n=8197$). In the preliminary study, we measured "Neuroticism"—a personality trait, which is characterized by a tendency to easily become anxious—using the Japanese Version of the Ten Item Personality Inventory (TIPI-J) [9]. The items of the questionnaire are rated on a 7-point Likert scale. "Neuroticism" is measured by two items: "Anxious, easily upset" and "Calm, emotional stable" (Reverse-scored). Further, we asked the participants about their experiences in various crises. Specifically, "An experience when you were laughed at when you presented something in front of many people and failed," "An encounter with a natural disaster," "Long-term absenteeism because of physical health deterioration," "Strong fear of a specific subject." For these items, we included the following two items: "the experience of a car collision while parking" (hereinafter referred to as "Parking") and "the experience of two cars scratching against each other in a narrow street" (hereinafter referred to as "Passing each other").

Next, we calculated the mean neuroticism score ($M=7.96$, $SD=2.24$). We classified participants who scored more than 11 points, which is 1 standard deviation higher than the mean score, into the "high neuroticism" group ($n=930$) and participants who scored between 6 and 10, which is within 1 standard deviation from the mean score, into the "normal neuroticism" group ($n=6,192$). We randomly selected participants with an experience of "Parking" ($n=100$; 50 men and 50 women) or "Passing each other" ($n=100$, 50 men and 50 women) from each neuroticism group.

Finally, a total number of 200 participants were included in the main study (see Table I for details).

TABLE I. STUDY PARTICIPANTS

Context	Parking				Passing each other			
	Sex	Male		Female		Male		Female
Degree of neuroticism	High	Middle	High	Middle	High	Middle	High	Middle
<i>n</i>	25	25	25	25	25	25	25	25

Note: All participants had an experience of an accident caused by parking or witnessed car scratches

B. Research Design (Table II)

Participants had to imagine the presented scenarios from their point of view. Referring to our past research [4], we established two scenarios, “Parking” and “Passing each other,” which were the situations people reported easily causing anxiety during driving. In the “Parking” condition, they had to halt their new car in a crowded parking lot, with several other cars queuing behind their car. In the “Passing each other” condition, they must go to the train station to pick up their friend. However, they need to pass through narrow roads to get to the station (This is referred to as Scenario 1). After that, we let them read another two scenarios (Scenario 2 and Scenario 3). Finally, a video clip showing the details of the driving support system presented in Scenario 3 was shown to the participants (Scenario 4). Table II shows the contents of each scenario. The webpage links provided in the Scenario 4 box (TABLE II) are the links to the video clip of the driving support system described in Scenario 3.

The participants were requested to rate their current level of state anxiety [10] after they read out each scenario. The scale consists of 20 items such as “I am tense,” “I feel upset.” The items were rated on a 4-point Likert scale.

As an explorative survey, all participants were asked the following question: “Which approach is better to reduce anxiety, using technological help or by own skills?” with four responses choices (A: technology B: yourself C: both D: neither) as well as free responses.

TABLE II. RESEARCH DESIGN

	Context 1: Parking	Context 2: Passing each other
Scenario 1 Basic context	You have just arrived in front of a newly-opened shopping mall in the new car which your family purchased recently. The parking lot is crowded, and many cars are queuing behind your car. You, therefore, need to park your car as quickly as possible.	You have just gone out to meet your friend who arrived at the station which is close to your house. You need to pass through narrow streets to get to the station from your house.
Measurement: State Anxiety (Time 1)		
Scenario 2 Past experience	Before replacing your family car, you were used to bumping your car into another car while parking at a different shopping mall.	You have seen many incidents of cars scratching against each other while passing by each other or a driver alerting another driver when the cars were about to collide.
Measurement: State Anxiety (Time 2)		
Scenario 3 Content of support (presented in text)	When you start parking, the situations around your car is projected on the monitor of the car very clearly. Therefore, you can confirm the distance between your car and the adjacent car with your eye. Further, the device alerts you by a warning sound when your car is likely to collide with another car.	While driving through a residential area a car is approaching your car. When you are about to pass each other, your car clearly projects the approaching car, wall, or curbstone on the opposite side of the approaching car, as well as the peripheral situation of your car. Furthermore, the device alerts you by a warning sound when your car is likely to collide with another car or go around the curbstone.
Measurement: State Anxiety (Time 3)		
Scenario 4 Content of support (presented in the movie)	https://www.youtube.com/watch?v=zqqnjCSruo	https://www.youtube.com/watch?v=DRYv-z11Jdc
Measurement: State Anxiety (Time 4)		
Asking participants' viewpoints: The expected way to reduce anxiety while using a car. A) Advanced Driver Assistance System B) By improving your own driving skills C) Both D) Neither		

Note: State anxiety was measured using the Japanese version of the State-Trait Anxiety Inventory State-form [7]

C. Analysis

A 2 (between-subject factors: high and normal neuroticism) \times 4 (within-subject factors: Measurement of state anxiety at time-points 1, 2, 3, and 4) mixed ANOVA was performed for each of the two conditions (“Parking” and “Passing each other”). Anticipated support score was obtained by summing the frequency distributions.

The hypothesis was based on the psychological-behavioral model and the mechanism described above wherein the anxiety level in Scenario 2 was higher than that in Scenario 1 in both groups, because the memory of the past accident was activated by the description of Scenario 2. On the other hand, after presenting Scenario 3, wherein they became aware of the driving assistance technology, the level of state anxiety significantly decreased compared to that in Scenario 2. Moreover, the level of state anxiety in Scenario 4 also significantly decreased compared to that in Scenario 3, because they were able to get a concrete image of the driving assistance technology through the movie clip.

D. Results (Table III, Table IV)

The interaction was not significant for both groups (Parking $F(2.29, 223.89) = 1.83, n.s.$; Passing each other $F(2.46, 241.28) = 1.10, n.s.$). Only the main effect of the state anxiety as a within-subject factor was significant. (Parking $F(2.29, 223.89) = 73.84, p < .001, \eta_p^2 = .43$; Passing each other $F(2.46, 241.28) = 43.84, p < .001, \eta_p^2 = .31$). Bonferroni post hoc test showed that the anxiety level in Scenario 2 was significantly higher than that in Scenario 1 in both groups ($ps < .001$). In Scenario 3 and Scenario 4 wherein the support technique was presented, the anxiety level had significantly decreased compared to the anxiety level in Scenario 2 in the “Parking” condition ($p < .001$). The anxiety level in Scenario 4 was significantly lower than that in Scenario 3 in both groups ($ps < .001$).

The main effect of neuroticism as a between-subject factor was significant (Parking $F(1, 98) = 8.15, p < .01, \eta_p^2 = .08$; Passing each other $F(1, 98) = 7.72, p < .01, \eta_p^2 = .07$). The result showed that the level of anxiety of the high neuroticism group was significantly higher than that of the normal neuroticism group.

For both groups, the highest number of responses to the approach to reduce anxiety was “C: both” (Table IV). Participants stated the following in their free responses: “I want to overcome my weakness by improving my driving skills while being supported by the machine,” “If I become completely dependent on the machine, I might get into trouble when the machine becomes faulty.”

TABLE III. RESULTS OF THE TWO-WAY MIXED ANOVA

Context	Parking			Passing each other			
	High ($n=50$)	Middle ($n=50$)	Total ($n=100$)	High ($n=50$)	Middle ($n=50$)	Total ($n=100$)	
	<i>M(SD)</i>			<i>M(SD)</i>			
State Anxiety	T1	59.5(13.3)	52.8(11.5)	56.1(12.8)	47.6(13.2)	43.8(9.3)	45.7(11.5)
	T2	66.6(11.8)	60.2(11.5)	63.4(12.0)	59.7(12.1)	54.0(10.4)	56.8(11.6)
	T3	52.3(9.9)	48.7(9.7)	50.4(9.9)	58.8(11.7)	52.6(9.5)	55.7(11.0)
	T4	47.3(10.8)	45.5(9.9)	46.4(10.4)	50.0(10.3)	47.5(8.8)	48.8(9.6)
Main Effect/Multiple comparison	73.8*** / 1<2>3>4			43.8*** / 1<2, 1<3, 2<3>4			
η_p^2	.43			.31			
Interaction	1.8			1.1			

*** $p < .001$

TABLE IV. RESULTS OF THE EXPECTED WAY TO REDUCE ANXIETY WHILE USING A CAR

Context	Parking		Passing each other	
	High ($n=50$)	Middle ($n=50$)	High ($n=50$)	Middle ($n=50$)
	Frequency		Frequency	
Technology	7	9	5	7
By myself	5	11	8	4
Both	32	24	31	29
Neither	6	6	6	10

E. Discussion

This study showed that anxiety tends to become aggravated by a past negative memory; in other words, the memory about a past negative situation might affect subsequent judgment to avoid or approach a situation. If the level of neuroticism is high, the degree of aggravation is higher than when the level of neuroticism is normal. However, providing information that gives a perspective of the future might help to decrease the anxiety level of both normal and high neuroticism groups. The extent of anxiety reduction was notable in the high neuroticism group. From a psychological perspective, people tend to avoid social anxiety-inducing situations that they have experienced before and thus, hesitate to re-experience the anxiety-inducing situation. Therefore, it is important to provide adequate information to increase their sense of coping ability and motivation to face such situations.

On the other hand, participants' responses indicate that although they are open to receiving technological support, they hope to overcome the anxiety-inducing situation by developing their own coping skills. From this standpoint, it is suggested

that people cannot obtain technological support unless they are confident in the technology itself, although this might not be related to the credibility and stability of the technology. Thus, it is especially important to have various experiences as well as have confidence in the provided information to change one's behavior.

IV. THE PLOTTING APPROACH FOR BEHAVIORAL CHANGE

Behavioral change means the change from behavior A to behavior B. According to the transactional theory and the psychological-behavioral model, this is achieved by controlling the context and personality. To stimulate a behavioral change, we must analyze and specify the influential context and personality to target behavior A and B.

A. Behavioral Change by Controlling the Context

Behavioral change is achieved by restraining the context that influences behavior A and reinforcing the context that leads to the choice of behavior B. For example, we control the context which strongly impacts the behavioral choice. It is said that a value is decided when there is a balance between utility and load. Therefore, behavioral change may be accomplished when we provide the context that decreases utility and increases the load for behavior A and increase the utility and decrease the load for behavior B.

B. Behavioral Change by Controlling the Personality

Behavioral change does not refer to a one-time change, which is seen in experiential economy, but a change of habitual behavior, which is seen in innovative economy. In this case, it is more effective to control personality than to control the context. That is, we provide information which subsequently becomes a procedural memory. After that, behavior B can be performed habitually.

More specifically, if a more flexible attitude is applied to let go of the existing obsessive and rigid thinking, it is possible to achieve behavioral change. This refers to a cognitive-emotional shift from avoidant behavior to acceptance of the behavior.

V. IMPLICATIONS AND FUTURE DIRECTIONS OF THIS STUDY

Based on the present study results, information about future driving circumstances must be presented constantly for drivers to actualize driving with a sense of security. We must also provide opportunities for experiencing operation of safety devices for car users who own cars equipped with the newest security devices. These approaches heighten driver confidence.

We must examine whether or not we can obtain the same results using other driving situations. The research results might be influenced by repeated answers. Therefore, another research design that could eliminate habituation due to repeated answers must be used in future study. Finally, we must also compare our results to those of other related studies to confirm the validity of this research.

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REFERENCES

- [1] W. Richard and B. Peter, "Go Downstream: The New Profit Improvement in Manufacturing", *Harvard Business Review*, Vol.77 No.5, pp.133-141, 1999.
- [2] W.K.Eric See-To and K.W. Kevin Ho, "Value co-creation and purchase intention in social network sites: The role of electronic Word-of-Mouth and trust-A theoretical analysis", *Computers in Human Behavior*, Vol. 31, pp. 182-189, 2014.
- [3] Pine. J. Gilmore. J, "The Experience Economy", Harvard Business School Press, Boston, 1999.
- [4] T. Matsuura and K. Sato, "Clinical psychological classification and measurement of anxieties related to driving", *Transactions of Society of Automotive Engineers of Japan*, vol. 48, no. 1, pp. 141-146, January 2017.
- [5] W. Mischel and Y. Shoda, "A cognitive-affective system theory of personality: Reconceptualizing situations, dispositions, dynamics, and invariance in personality structure", *Psychological Review*, Vol.102,no.2, pp.246-268, 1995.
- [6] T. Suzuki (Ed), "Personality Psychology," (Personality Shinrigaku Gairon Seikaku Rikai eno tobira), Kyoto, Japan, Nakanishiya Shuppan, 2012.
- [7] K. Lewin and C. Dorwin (Eds), "Field theory in social science", Harper, New York, 1951.
- [8] A. Bandura. "Self-efficacy: Toward a Unifying Theory of Behavioral Change", *Psychological Review*, vol. 84, no. 2, pp. 191-215, 1977.
- [9] A. Oshio, S. Abe, and P. Cutrone, "Development, Reliability, and Validity of the Japanese Version of Ten Item Personality Inventory (TIPI-J)" *The Japanese Journal of Personality*, vol. 21, no. 1, pp. 40-52, July 2012.
- [10] C. Spielberger, K. Mizuguchi, J. Simonaka, and K. Nakazato, "Japanese version of State-Trait Anxiety Inventory Manual", Kyoto, Japan, Sankyobo, 1991.