

# User Characteristic-Based Information-Providing Service for Museum with Optical See-Through Head-Mounted Display: Does It Evoke Enthusiasm?

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**Abstract.** In psychology, users' enthusiasm for products or services is categorized as a kind of intrinsic motivation. One theory states that enthusiasm is evoked when users perceive an adequate gap between their own characteristics and those of an object from the viewpoints of emotion, cognition, and ability. This study develops a method for computing an adequate psychological gap based on the characteristics of each user. We experimentally produce a service that makes each user feel the effect of the gap, and conduct a scientific evaluation. In particular, by focusing on the case of a museum, this study constructs an application to provide different sets of information to enable each user experience an adequate psychological gap with an optical see-through head-mounted display (OSD), and effectively evaluates whether this evokes user enthusiasm.

**Keywords:** Enthusiasm, Optical See-Through Head-Mounted Display, Museum, Information Providing Service.

## 1 Introduction

Different types of user interfaces are being presently developed and are expected to be applied to next-generation services. For these new types of services to be accepted in our society, practically utilized, and sustainably enjoyed, it is necessary that they make a positive impact on users' minds. That is, users should want to use the services, want to re-use them in other situations, tell others about them, and not forget them.

In psychology, users' enthusiasm for products or services is categorized as a kind of intrinsic motivation [1]-[10]. One theory states that enthusiasm is evoked when users perceive an adequate gap between their own characteristics and those of an object from the viewpoints of emotion, cognition, and ability [11] [12].

However, different users have different characteristics. Accordingly, to create products or services that evoke enthusiasm, it is necessary to provide an effect that corresponds to each user. Thus, this study develops a method for computing an adequate psychological gap based on the characteristics of each user. We experimentally produce a service that makes each user feel the effect of the gap, and conduct a scientific evaluation. In particular, by focusing on the case of a museum, this study constructs an

application to provide different sets of information to enable each user experience an adequate psychological gap with an optical see-through head-mounted display (OSD), and effectively evaluates whether this evokes user enthusiasm.

## 2 Experiment

The gap between a user’s own characteristics and those of an object from the viewpoints of emotion, cognition, and ability cannot be observed directly, and creating a method to measure it will require much examination. Thus, in this study, for the present step, we regard users’ characteristics in the multiple aspects of emotion, cognition, and ability as simply a kind of inner characteristic. With this in mind, we designed the following experiment.

### 2.1 Experimental Environment

We built a mock museum booth with seven kinds of paintings. Fig. 1 shows the layout of the museum booth. The basic information on the seven kinds of paintings exhibited in the booth is summarized in Table 1. Each painting was framed and had a caption board next to it that provided basic information such as titles and artist names. Moreover, a preparatory room was prepared adjoining the museum booth where participants were given the informed consent form before the experiment and wrote down their reflections afterward.

### 2.2 Experimental Procedure

First, participants entered the preparatory room. Next, after agreeing to participate in the experiment, they were given fourteen items that are of interest to young people (selected based on [13]; see Table 2), and asked to classify them into five levels. The participants then selected the item that they were most interested in as the first level, the next two items as the second level, the next three items as the third level, the next four items as the fourth level, and the next four items as the fifth level, according to their own intuition. Here, the item in the first level was regarded as the one that had no gap from a participant’s inner characteristics, while the items in the fourth and fifth

levels were regarded as those with a large gap. Items in the second and the third levels were regarded as the ones with an adequate gap.

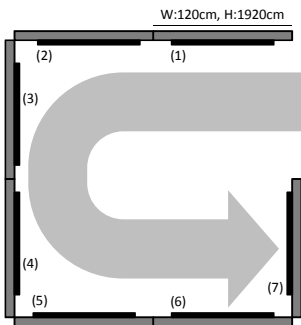


Fig. 1. Layout of the museum booth

Table 1. Paintings exhibited in the museum booth

No.	Title:	Artist:	Year:
(1)	Self portrait	Henri de Toulouse-Lauterec	1880
(2)	Die Gesandten	Hans Holbein der Jüngere	1533
(3)	Vulcan's Forge	Luca Giordano	1660
(4)	The Tower of Babel	Pieter Bruegel de Oude	1563
(5)	The School of Athens	Raffaello Santi	1511
(6)	Waterfall	Maurits Cornelis Escher	1961
(7)	Ultima Cena	Leonardo da Vinci	1498

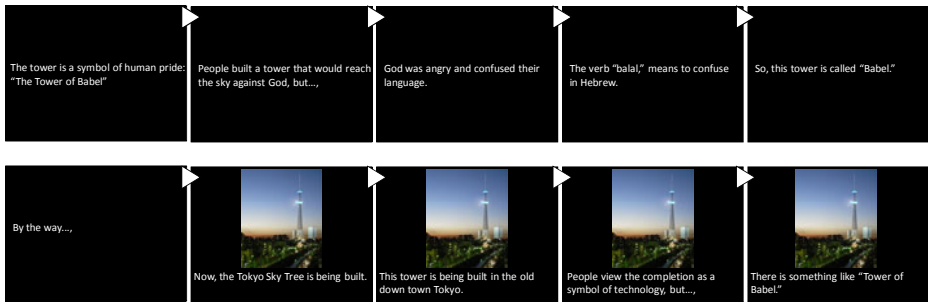
**Table 2.** Items of interest given to the participants

Sports	Travel
Music	Art
Game	Learning
Outdoor	Manga
Photo	Eating/Drinking
Reading	Internet
Movie	Gamble

After that, participants were asked to relax while sitting on the seat for three minutes. Next, they were explained about their upcoming experience in the museum booth. The main points of the instruction were the following: (a) After participants entered the museum booth, they could appreciate each painting by walking along the regular route (see Fig. 1); (b) After completing a circuit of the museum booth, participants were free to walk inside and appreciate any painting

they liked; and (c) Participants could exit the museum booth any time they wanted to after appreciating the paintings. Finally, they were told to relax and enjoy the experience.

While the participants were given this explanation, a set of additional information for each one was edited as follows. Eight to twelve kinds of explanatory movies belonging to different genres were produced for each exhibit as elements of a set of information provided to each participant. These genres mostly corresponded to the interest items used for identifying participants’ inner characteristics. One movie belonging to the genre corresponding to the interest items with an adequate gap from the participant’s inner characteristics was chosen for each of the exhibits and summarized as a set of information provided to the participant. In case there were two or more movies belonging to the genre corresponding to the interest items with an adequate gap, one was chosen randomly. In this way, the movies were compiled into a program and installed on the mobile PC used for outputting the image to the OSD. An outline of one of the additional information sets prepared for “The Tower of Babel” (Pieter Bruegel de Oude, 1563) is shown in Fig. 2 as an example.



**Fig. 2.** Example of additional information (for “The Tower of Babel”)

Participant put on the OSD before entering the museum booth. After checking visibility using a test pattern, they switched the image on the OSD to a standby image and entered the museum booth. After entering, the participants viewed each painting, referring to the additional information presented on the OSD. The additional information corresponding to one painting was a movie, which lasted around fifty to seventy seconds, some of which comprised multiple chapters. When



Fig. 3. A participant appreciating a painting

the participant wanted to advance to the next chapter, return to the beginning of the chapter, or skip the chapter, they could do so using a handheld mobile controller. During each participant's experience, no other person entered the museum booth. Fig. 3 shows a participant appreciating a painting.

The participants exited the museum booth and then returned to the preparatory room to write their reflections on a self-evaluation form.

### 2.3 Data

Before the museum booth experience, the face of each participant who relaxed for three minutes in the preparatory room was captured by a digital video camera (Cyber-shot DSC-TX7, made by SONY). Moreover, the results of the classification of the fourteen interest items were recorded as data.

During the experience, a participant's movement within the museum booth was captured by a digital video camera (Cyber-shot DSC-WX1, made by SONY) positioned at the center of the 266-cm-high ceiling. Moreover, the participant's face was captured by an ultra small video camera (AGENT CAM, made by Agent Camera) positioned above the frame of "The Tower of Babel."

After the experiment, participants filled out a self-evaluation form that asked for their reflection on the experience. The self-evaluation form was structured based on our previous study, in which we categorized the causal factors that induce enthusiasm by referring to the relevant theories [14]-[17] in psychology (see [18]), which included eight questions to be answered by free description (Table 3).

Table 3. Self-evaluation form

Self Evaluation Form	
Please answer the following questions by free description.	
(1)Please describe how you felt before entering the museum.	<input type="text"/>
(2)Please describe how you felt when you appreciated the first painting.	<input type="text"/>
(3)Please describe how you feel now (after the museum experience).	<input type="text"/>
(4)Please describe as much as you can remember about what impressed you in the paintings you appreciated.	<input type="text"/>
(5)Please describe what you thought of during the museum experience as much as you can remember (daily life, past memory, knowledge, etc.)	<input type="text"/>
(6)How would you describe today's experience to your friends and family? Please describe it freely.	<input type="text"/>
(7)Is there something more you want to know about the paintings you appreciated, please describe it freely.	<input type="text"/>
(8)How much can you pay for the museum you visited today?	<input type="text"/>
That's all. Thank you.	

## 2.4 Experimental System

The retinal scanning display (prototype, made by Brother Industries, Ltd.) was adopted as the OSD used for providing information to the participant in the museum booth. This see-through type OSD provides the user with a full-color image with a size of around  $800 \times 600$  pixels. Moreover, a laptop (VAIO VGN-T70B, made by SONY) was used to send the image to the OSD, and a mobile controller (Sa-Shi-41, made by KOKUYO S&T) was used to operate the image on the OSD.

## 2.5 Experimental Conditions

To examine whether providing information that had an adequate gap from the participants' inner characteristics enhanced participant enthusiasm in the museum booth experience, we set the following three cases as the experimental conditions.

- (i) No additional information is provided to the participant: In a real museum, it is not rare to find exhibits with only basic information displayed on caption boards. As in this case, the participant experiences the museum booth without wearing the OSD.
- (ii) Additional information that is chosen randomly (without considering the gap from the participant's inner characteristics) is provided: Regardless of the participant's inner characteristics, the set of information provided is composed by choosing movies one by one for each painting. The participant experiences the museum booth referring to this through the OSD.
- (iii) Additional information that has an adequate gap from the participant's inner characteristics is provided: A set of information is composed in accordance with the processes described in Section 2.1. The participant experiences the museum booth referring to this information through the OSD.

## 2.6 Participants

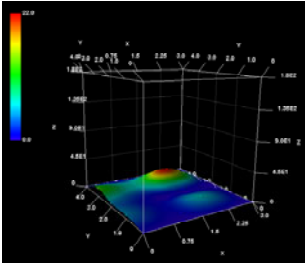
The participants comprised 27 adults aged 20 to 36. Thirteen participants experienced the museum booth under the conditions of case (i), 7 under those of case (ii), and 7 under those of case (iii).

# 3 Results

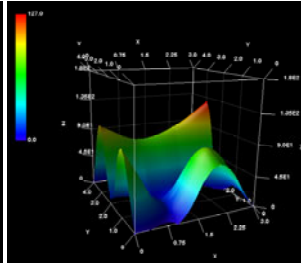
Our analysis of the behavioral, physiological, and psychological data yielded the following results.

## 3.1 Time of Experience

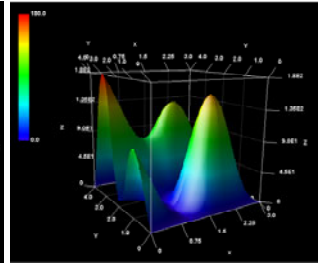
We analyzed the video data captured from overhead to examine the duration of participants' stay in the museum booth. Figs. 4a, 4b, and 4c show typical behaviors that demonstrate how long a participant in cases (i), (ii), and (iii) stayed at each point in the museum booth.



**Fig. 4a.** A participant's behavior in case (i)



**Fig. 4b.** A participant's behavior in case (ii)



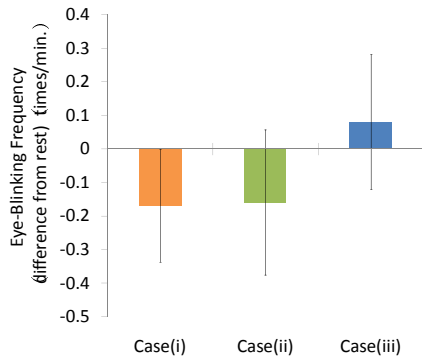
**Fig. 4c.** A participant's behavior in case (iii)

In case (i), when participants were given no information, the total time of stay in the museum booth was short. On the other hand, in cases (ii) and (iii), the participants spent significantly longer time in the museum booth. This is a natural result because the participants appreciated the paintings while referring to the additional information sets one by one. Further, by comparing cases (ii) and (iii), we find that the participants in case (iii) tended to stay longer in the museum booth than those in case (ii). This finding leads us to the following expectation regarding our primary question of whether providing additional information with a proper gap from participants' inner characteristics enhances their enthusiasm. That is, in case (iii), when consistent processes were applied to choose the additional information that had a proper gap from the participants' inner characteristics, the effect of enhancing enthusiasm would work on every participant while viewing any painting.

### 3.2 Eye-Blinking Frequency

Previous studies report that eye-blinking frequency changes when emotions related to enthusiasm, such as interest and those imparting satisfaction, are enhanced [19]. Therefore, we analyzed video data of the participants' relaxed faces captured before the museum booth experience and that of their faces as they appreciated "The Tower of Babel." Next, we calculated the difference in eye-blinking frequency between them. Fig. 5 shows the difference of the eye-blinking frequency of each case.

Eye-blinking frequency was significantly higher in case (ii) than in case (i) ( $p < .05$ ) and in case (iii) than in case (ii) ( $p = .11$ ). Because it is said that eye-blinking frequency particularly increases when the amount of interest and attention becomes more than steady, we can understand that the participant's enthusiasm was more enhanced in case (ii), when additional information was provided, than it was in case (i), when additional information was not provided, and further effectively enhanced in case



**Fig. 5.** Difference in eye-blinking frequency

(iii), when the additional information constructed in consideration of the participant’s inner characteristics was provided compared to in case (ii), when additional information was constructed without this consideration.

### 3.3 Subjective Reflection

It is said that elaborate ideas and emotions emerge as a result of processes that induce enthusiasm in processes that induce enthusiasm [20] [21]. Thus, we analyzed the self-evaluation form completed by the participants after the museum booth experience and examined whether providing information involving a proper gap from the participant’s inner characteristics helped participants in developing their ideas, thoughts, and emotions. In particular, we examined sentences that the participants used in their answers to eight questions (see Table 3). We divided them into the following three levels:

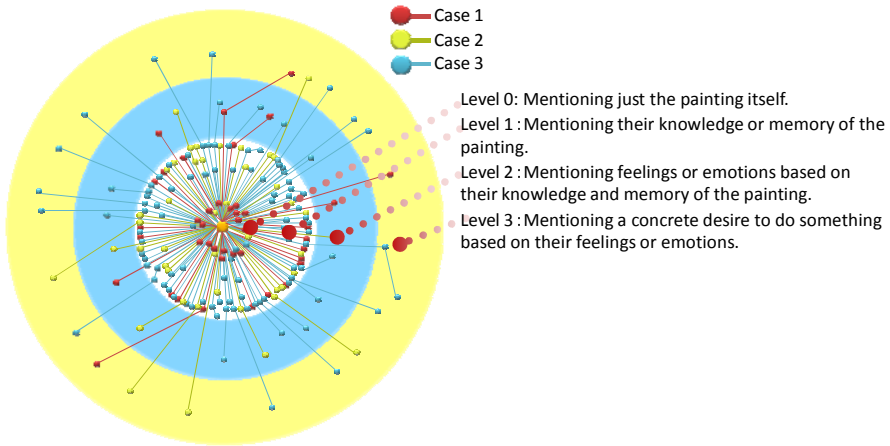
Level 0: Mentioning just the painting itself.

Level 1: Mentioning their knowledge or memory of the painting.

Level 2: Mentioning feelings or emotions based on their knowledge and memory of the painting.

Level 3: Mentioning a concrete desire to do something based on their feelings or emotions.

If a participant wrote two or more sentences, we classified each separately. Fig. 6 shows the result of classification of a total of 153 sentences. This chart also reflects the case where a sentence included multiple parts to be classified into different levels.



**Fig. 6.** Classification of the participants’ self-reflection sentences into four levels

Focusing on the result of the classification of each case, we find the following characteristics. Most of the sentences written by participants after the museum booth experience under the conditions of case (i) were about primary impressions given by the paintings, and more than 40% were classified as level 0. On the other hand, for case (ii), more than 50% of the sentences mentioned the participant’s own knowledge,

memory, and experience associated with a painting, which corresponds to level 2. Furthermore, for case (iii), there were more sentences that included the desire for action inspired by interest in a painting than for the other cases. These results suggest that the participants' ideas and emotions generated through the museum booth experience became more spontaneous in case (ii) than in case (i) and in case (iii) than in case (ii). Based on the above, it was suggested that providing additional information on each painting made the museum booth experience more impressive, and that adding the effect of a proper gap to the additional information triggered development of users' enthusiasm.

## 4 Conclusion

This study experimentally examined a service for providing annotative information with an adequate gap based on each user's characteristics during a museum booth experience; moreover, it evaluated whether this experience evoked their enthusiasm from multiple viewpoints. The results of the experiment suggested that the service enabled users to enjoy the museum space more profoundly. Moreover, the results suggested that users' enthusiasm can be raised to a greater extent by applying a scientific method to compute an adequate gap in accordance with each person's characteristics.

In the present day scenario, when many well-developed products and services are available with no apparent differences among them, objects that can move people's hearts are of significant interest to those who provide products and services. Moreover, designing products or services in consideration of people's feelings and emotions in addition to functions and performance is a way to satisfy today's users.

## Acknowledgement

We would like to thank Mr. Tomohiro Sato and Mr. Makoto Nomura (Brother Industries, Ltd) who provided helpful comments and suggestions.

## References

1. Deci, E.L., Ryan, R.M.: Self-Determination Theory and the Facilitation of Intrinsic Motivation. *Social Development, and Well-Being, American Psychologist* 55(1), 68–78 (2000)
2. Deci, E.L.: *Intrinsic motivation*. Plenum Press, New York (1975)
3. Harlow, H.F.: Learning and satiation of response in intrinsically motivated complex puzzle performance by monkeys. *J. Comp. Physiol. Psychol.* 43, 493–508 (1950)
4. Harlow, H.F.: Mice, monkeys, men, and motives. *Psychological Review* 60, 23–32 (1953)
5. Deci, E.L., Ryan, R.M.: *Intrinsic Motivation and Self Determination in Human Behavior*. Plenum Press, New York (1985)
6. Harter, S.: Effectance motivation reconsidered: Toward a developmental model. *Human Development* 21, 34–64 (1987)



7. Harter, S.: A new self-report scale of intrinsic versus extrinsic orientation in the classroom: Motivational and informational components. *Developmental Psychology* 17, 300–312 (1981)
8. Berlyne, D.E.: Conflict and choice time. *Brit. J. Psychol.* 48, 106–118 (1957)
9. Vallerand, R.J., Bissonnette, R.: Intrinsic, extrinsic and motivational styles as predictors of behavior: A prospective study. *J. Pers.* 60, 599–620 (1992)
10. White, R.W.: Motivation reconsidered: The concept of competence. *Psychological Review* 66, 297–333 (1950)
11. Hunt, J. McV: Motivation inherent in information processing and action. In: Harvey, O.J. (ed.) *Motivation and Social Interaction: Cognitive Determinants*, pp. 35–94. Ronald, New York (1963)
12. Hunt, J. McV: Intrinsic motivation and its role in psychological development. In: Levine, D. (ed.) *Nebraska Symposium on Motivation*, vol. 13, pp. 189–282. University of Nebraska Press, Lincoln (1965)
13. Ministry of Internal Affairs and Communication: Survey of Time Use and Leisure Activities.: Table 60-1. Participants in Hobbies and Amusements by Sex, Usual Economic Activity and Age (2006)
14. Deci, E.L.: Intrinsic motivation, extrinsic reinforcement and inequity. *J. Pers. Soc. Psychol.* 22, 113–120 (1972)
15. Berlyne, D.E.: Conflict and choice time. *Brit. J. Psychol.* 48, 106–118 (1957)
16. Dember, W.N., Earl, R.W.: Analysis of exploratory, manipulatory, and curiosity behaviors. *Psychological Review* 64, 91–96 (1957)
17. Berlyne, D.E.: *Structure and direction in thinking*. John Wiley & Sons, Chichester (1965)
18. Yasuma, Y., Nakanishi, M., Okada, Y.: Can "tactile kiosk" attract potential users in public. In: *Proceedings of the 3rd International Conference on AHFE (Applied Human Factors and Ergonomics)*, CD-ROM, Miami, USA (2010)
19. Hall, R.J., Cusack, B.L.: The measurement of eye behavior: Critical and selected reviews of voluntary eye movement and blinking. U.S. Army Technical Memorandum, pp. 18–72 (1972)
20. Horie, T., Inuzuka, A., Ikawa, Y.: The Effects of Intrinsic Motivation on Knowledge Creating Behavior. *Journal of the Japan Techno-Economics Society* 504, 66–71 (2009)
21. Miwa, K., Ishii, N.: Cognitive Approaches to Creative Activities. *Journal of the Japanese Society for Artificial Intelligence* 19(2), 1–9 (2004)