Measurement of User Emotion and Experience in Interaction with Space

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Abstract

Designer-oriented space design has been transferred to user-oriented space design that considers users' emotions as well as the functions of the space, producing a multi-sensory space. Further, with the advent of embedded digital media and information technology in a space, various interface functions of the space have been developed and the user experience in the space has been much extended. This research investigated user experience and emotional aspects of a space's design, which have been sparsely researched previously. Further, authors emphasize not only the emotion expression of the space, but also the interaction of people and space for the embodiment of the emotions from a wider perspective. Authors reviewed multidisciplinary literatures and compared various methodologies of measurement. Based on the understanding of the studies on the measurement of emotion, authors developed measures of emotion in interaction associated with spaces. The strength of the research is the focus on the integration of the space with technologies and user experiences from a new perspective in emotion research, rather than concentrating only on the architecture components of the buildings themselves. Through empirical studies, the measurements of emotion in architectural spaces can be verified and elaborated.

Keywords: emotion measurements; interaction; space; user experience

1. Introduction

Designer-oriented space design has been transferred to user-oriented space design that considers users' emotions as well as the functions of the space, producing a multi-sensory space. Further, with the advent of embedded digital media and information technology in a space, various interface functions of the space have been developed and the user experience in the space has been much extended (Shaer and Hornecker 2010). The new space embodied by digital technologies enables users to create their own experience, which allows a new communication channel between the space and the users (Essa 2000). Although user emotion and experience in a space become critical in buildings, little research exists on user emotion and experience in the architectural domain. There is much research on POE (post occupancy evaluation); however, the focus of the research is on functions of the buildings, not user emotion and experience. Even though the importance of user experience and emotion has been acknowledged, few empirical studies have been done in this area. Emotion has become a crucial influence in the design domain from the 20th century onwards.

This research deals with the measurement of user emotion and experience in a space. In order to understand user emotion and experience, and to develop measurements for them, multidisciplinary literatures including psychology, social science, neuroscience, industrial technology and Human-Computer Interaction (HCI) are analyzed. By assessing and comparing various methodologies of measurement, authors discuss affective and emotional aspects of interaction embedded in spaces. This paper provides an overview of current research theories and studies into the measurement of emotion to develop measures of emotion in interaction associated with spaces. The consolidation of knowledge related to the measurement of emotions should be provided to develop appropriate ways to measure emotion in interaction design associated with spaces.

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2. Emotion Measurements

To develop a measurement of emotion that can be applied to users in a space, authors reviewed various measurement methods in the field.

2.1 Emotional States

Issues of emotion have been a matter of primary concern in philosophy, psychology and physiology. The various domains focus on different phenomena of

emotions (Laurans *et al.* 2012). Authors are interested in the definition of emotion proposed by psychologists, in which emotion is regarded as a process of changes in different components rather than a homogeneous state (Scherer 2001). In general, the emotions can be largely categorized from two perspectives: discrete and dimensional. The two perspectives differ in how they conceptualize and describe emotional states (Mauss and Robinson 2009).

The discrete emotion theories were inspired by Darwin (Darwin 1965). Researchers proposed a set of basic emotions from which emotion experiences are constructed (Ekman 1992). From the discrete emotions perspective, each emotion corresponds to unique components in experience, physiology, and behavior (Ekman 1999; Panksepp 2007). The discrete emotions approach depends on the categorization reflected in the semantic fields for emotion in natural languages. It seems that the language-based categories correspond to unique response patterns, such as emotion-category specific patterns of facial and vocal expressions and physiological responses. The dimensional model, which specifies emotions according to their position in an n-dimensional space, was proposed by Wundt (Wundt 1902). There are a few fundamental dimensions that organize emotional responses in dimensional models (Mauss and Robinson 2009). The most common dimensions are valence, arousal, and approach (Lang *et al.* 1997; Russell and Barrett 1999). The valence dimension is a continuum of states from positive to negative, whereas the arousal dimension is a continuum of states from calm to excited. Approach motivation is characterized by tendencies to approach stimuli, whereas avoidance motivation is characterized by tendencies to avoid stimuli (Wong 2006; Mauss and Robinson 2009). Heidt (Haidt and Keltner 1999) argued that it is possible to reconcile dimensional and discrete perspectives to some extent. Each discrete emotion can represent a combination of several dimensions by offering a hierarchy that groups similar emotions into families, each family being subdivided into small subsets.

2.2 Emotional Response

People respond emotionally to stimuli or situations in various ways, not just one fixed way; thus, there is no one standard method for the measurement of emotions. Three main components of emotional response can be categorized: experiential response, physiological response, and behavior response. This research deals primarily with two components, experiential response and behavior response, since they are more accessible and practical measurements that can be applied for user emotion and experience in architectural spaces.

2.2.1 Experiential Response

The individual can be aware of an emotional state and describe it with a rich emotional lexicon to communicate his/her response to certain stimuli (Caicedo and Beuzekom 2006). Verbal self-report instruments assess the subjective feeling component of emotions (Titchener 1908). The most popular instruments require respondents to report their emotions using a set of rating scales or verbal protocols. The rating scales can be assembled to represent any set of emotions as well as mixed emotions (Desmet 2004). Verbal reports of affects have a great richness and subtlety of discrimination, with a lot of emotionally descriptive words (Lang *et al.* 1998). To assess verbal reports adopting the discrete emotions approach, scales with nominal, ordinal or interval characteristics are often used. For example, the respondent is alternatively asked either (1) to check terms that best describe the emotion experienced (nominal scale), or (2) to indicate on a 3- to 5-point scale whether the respective emotion was experienced a little, somewhat, or strongly (ordinal scale) (Mauss and Robinson 2009).

2.2.2 Behavior Response

Each emotion is associated with a particular pattern of expression (Ekman 1994; Mauss and Robinson 2009). For example, anger is accompanied by a fixed stare, contracted eyebrows, compressed lips, brisk movements, and a raised voice (Desmet 2004). Emotional states can be linked to action dispositions (Frijda 1986). In this research, authors regard the pattern of expression as a motor expression and the action dispositions as an emotional state according to action tendencies. There are two major motor expression instruments: measuring facial and measuring vocal expressions (Desmet 2004). Generally, visible expressions captured on stills or short video sequences are analyzed. Similar to the facial expression instruments, vocal instruments measure the effects of emotion in multiple vocal cues, based on theories that link patterns of vocal cues to emotions (Johnstone and Scherer 2001). Tendencies to approach or avoid its object are a fundamental aspect of emotion. Evaluation of a stimulus seems to be reliably associated with a behavioral tendency to approach pleasurable stimuli and to avoid negatively valenced stimuli (Chen and Bargh 1999; Bamford and Ward 2008).

3. Emotion Measurement in an Architectural Space

By reviewing related research on emotion, authors investigated what kinds of components in an architectural space arouse people's emotions. In this research, authors regard the components as environmental stimuli that trigger people's emotional responses. Emotional stimuli in a space can be divided into two main aspects, emotional expression and emotional exchange, which are produced according to the users' interaction with the space. The former deals with the user emotion itself in a space, while the latter emphasizes the interaction of the user and a space. A conceptual framework for emotion measurement in an architectural space was developed as shown in Fig.1.

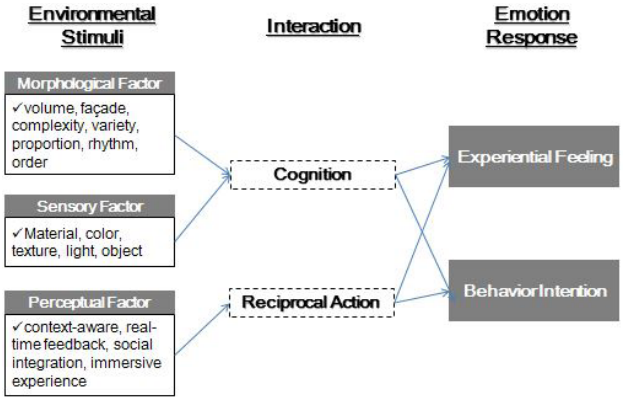

Fig.1. The Conceptual Framework for Emotion Measurement in an Architectural Space

3.1 Environmental Stimuli

When users experience a building or a space, they may respond to the architect's design intention emotionally. Architects try to express their message in the space while users can perceive the space and obtain their own experiences of it. Emotional expression can be driven by architects as a one-way conduit to users. There are two general approaches to users' perception of architectural space. One is to examine the visual composition of buildings—such as volume and façade—associated with people's response and experience (Lang 1988). Morphological features reflect the idea of order and variables, such as complexity, proportion, and rhythm. (Nasar 1997). Order expressed in the morphological configuration of building facades would increase user legibility (Sanoff 1991). Recently, various structural features—such as liberal curves and non-geometrical forms—have been applied to spaces irregularly, leading to the arousal of the emotions. Users' perception of structure in the organization of the elements provokes a reaction to the stimulus (Weber 1995).

The second approach is to consider the pleasurableness of the sensation received from the buildings. It involves the arousal of people's multidimensional perception, resulting from the colors, odors, sounds, and textures of the environment (Lang 1988). The process of perception relates to sensorial experience with the environment, dealing with the effect of elements on the senses. Thus, sensory features are important components of people's response to architecture (Lang 1987). Some authors have suggested that the visual richness of environmental appearance depends on a certain level of complexity, characterized by well-ordered surfaces with colors, lighting, textures, and movement of objects (Stamps 2000). This implies that the effect of these aspects must be understood for environmental design to produce pleasurableness. As shown in Fig.1., five sensory factors are considered in this research.

Perceptual Factor is a reciprocal action by perceiving human emotion. It is the research on emotional perception from the users' aspect. In HCI (Human-Computer Interaction), it is believed that an interaction between humans and computers can be improved by allowing emotional communication (Dormann 2003). The research on emotion in HCI can be discussed under two different approaches. One is assigning human emotion onto a system and the other is reciprocal action by perceiving human emotion. The former is the research on emotional expression from the developers' aspect and the latter is the research on emotional perception from the users' aspect. Applications respond to users' emotional states, which mean a computer not only expresses emotion but also interacts with humans.

3.2 Emotion Response and Measurement

The multi-componential response of emotion provides a useful model to organize emotion measurement tools and consider their applicability to design research. Based on the review of emotion measurement, an instrument for measuring emotions in a space was developed.

3.2.1 Experiential Response

Two scales were constructed for measuring experiential response in an architectural space: the environmental scale—for experiential response to the space itself, and the processing scale—for experiential response to the information processes of the space. The scales required respondents to indicate their responses to six bipolar adjectives using a 5-point interval scale. The former is associated with emotional variables such as memory, attraction, pleasure, stimulation, contents and satisfaction. The latter is derived from the function of the space, e.g. museum or library, and associated with emotional variables such as awareness, perception, intention, configuration, immersion and information load, as shown in Table 1.

3.2.2 Behavioral Response

Emotional states are expressed in some actions, so it is expected that a person's emotional state can be inferred from whole-body behaviors. In this research, authors concentrate on the common measures, namely approach and avoid.

Table 1. Emotion Measurement in an Architectural Space

Emotional Response and State			Measure
Experience	Valence and Arousal	Evaluation of space	Memory, Attraction, Pleasure Stimulation, Contents, Satisfaction
	Valence and Arousal	Appraisal of process	Awareness, Perception, Intention Configuration, Immersion, Information load
Behavior	Approach	Action tendencies	Approach-Avoid

The action tendencies are an essential component of behavior responses because tendencies to approach or avoid an object are regarded as a fundamental aspect of emotion that accounts for its adaptive value, allowing a quick response to threat and opportunity in

the environment. According to Russell and Mehrabian (Russell and Mehrabian 1978), people's behavior in an environment is influenced by the emotions, and people tend to approach pleasant settings more. Authors utilized the approach-avoidance items for action tendencies.

4. A Case Study

To verify the proposed framework for emotion measurement in an architectural space, a case study was carried out. The method and results are as follows:

4.1 Method

The field survey was conducted at exhibition halls that are considered to be appropriate for emotion evaluation.

4.1.1 Exhibition Halls

First, several exhibition halls that seem to regard user experience and emotion importantly were selected by two professionals, and they visited these halls. Three exhibition halls that differ in morphological features and spatial depths were chosen. A description of the exhibition halls' design types and spatial features are shown in Table 2.

Table 2. Selected Exhibition Halls' Design Features

Name	Design Features	Architect/ Location/ Year
National Science Museum	Streamlined shape Dynamic façade High-tech image: use of metals and glasses Experience- and participation-oriented exhibition space	SAMOO Architects/ Gwacheon, Seoul/ 2008
Yoon Dong Ju Literature Museum	Historical story associated with neighbouring environment and contents of Yoon Dong Ju Stimulation of memory via courtyard, light, and exposed concrete Sensory experience through poems and images	Sojin Lee, Ateliers Lion Seoul /Jongro, Seoul/ 2012
DDP Museum	Three-dimensional atypical architecture No boundary between roofs and walls Open space and continuously connected circulation	Zaha Hadid/ Dongdaemun, Seoul/ 2014

The main building of the National Science Museum has the shape of a futuristic airplane, with streamlined silver shining wings and a spherical observatory that appears to float on the surface of the water. The exhibition area contains nine exhibition halls and a laboratory. The exhibits provide experience and participation using a high-tech exhibition technique, offering an opportunity to learn about science. The Advanced Science & Technology Hall was chosen as a target research area.

Fig.2. National Science Museum
(Exterior, Advanced Science and Technology Hall)

The deserted Cheongun pumping station was remodeled into Yoon Dong Ju Literature Museum. The museum consists of three exhibition halls. The 1st exhibition hall exhibits a facsimile edition of Yoon Dong Ju's novels and poems, divided by his lifetime achievements from elementary school until his death. The 2nd and 3rd exhibition halls were redesigned from two water tanks (area 55m^2, height 5m, each), and reddish rust stained walls remain like a stratum indicating that the space used to store water.

Fig.3. Yoon Dong Ju Literature Museum (Exhibition Hall 1, 2, 3)

Dongdaemun Design Plaza (DDP) consists of four stories above ground and three below ground level (height 29m). DDP is an atypical architectural structure, with a refined curve and an outsized roof. The museum was chosen for a target space to be studied. It is located from the 2nd level below ground to the 4th level above ground and has a beautiful molding staircase and is surrounded by a 533m design walking trail. The museum contains an exhibition space, an experience hall for children and a café. There are no columns and the space is designed with a streamlined organic form.

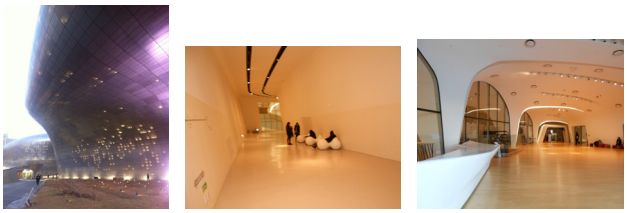

Fig.4. DDP Museum (Exterior, Dolle-gil, Design Playground)

4.1.2 Subjects and Questionnaire

Three university students, aged 20 and over, were recruited for the field survey that was performed on 18 December 2014. Participants were interior architecture students with similar education backgrounds and experiences; thus, they were supposed to respond to the given spaces keenly and similarly. They were asked to visit three exhibition halls in series and look around the exhibition at liberty after the survey procedures

were explained. While they were looking through the exhibition, a trained observer recorded a video. When participants finished with the exhibition, interviews were provided in a form of questionnaires. Time spent in each exhibition hall ranged from 20–40 minutes, with an average of 30 minutes. Based on the proposed framework, the questionnaire was developed. The detailed information on questions was included with results in the next section. Table 3.-5. show questions on environmental stimuli and experiential feeling consisting of space evaluation and process appraisal. Questions on behavior intention are also included subsequently.

4.2 Results

Users' emotional responses to different exhibition halls were measured and the results are as follows.

4.2.1 Environmental Stimuli

Based on the assumption that users experience emotion through an architectural space, this study investigated how users were emotionally stimulated by design factors. Participants replied to 16 questions in the survey, with a five-point scale ranging from 'not at all' to 'extremely so' about morphological, sensory and perceptual factors. As shown in Table 3., of the morphological factors, volume and style (M=4.22) affected users' emotions the most, and of the sensory factors, color (M=4.11) was the most affective.

Table 3. Results of Environmental Stimuli

	Design features	Total (Mean)	Science Museum (Mean)	Literature Museum (Mean)	DDP Museum (Mean)
Morphological factor	volume and style	**4.22**	3.33	4.66	**4.66**
	façade	3.66	3.66	3.33	**4.00**
	complexity	3.11	2.66	2.33	**4.33**
	variety	3.22	3.33	2.66	3.66
	proportion	3.77	4.00	4.00	3.33
	rhythm	3.22	3.33	3.66	2.66
	unity	3.77	3.66	**4.33**	3.33
Sensory Factor	Material	3.77	3.66	**4.33**	3.33
	color	**4.11**	4.33	**4.66**	3.33
	texture	3.77	3.66	**4.00**	3.66
	light	3.66	3.66	3.66	3.66
	object	3.66	3.33	**4.33**	3.33
Perceptual Factor	context-aware	2.77	**4.00**	1.33	3.00
	real-time feedback	2.44	2.00	1.66	3.66
	social integration	3.33	**4.66**	2.33	3.00
	immersive experience	3.33	**4.33**	2.66	3.00

Of the perceptual factors, social integration (M=4.66), immersive experience (M=4.33), and context-awareness (M=4.00) scored high in the National Science Museum, and in the Yoon Dong Ju Literature Museum, color (M=4.66), material (M=4.33), object (M=4.33), and texture (M=4.00) scored high. Of the morphological factors, volume and style (M=4.66), complexity (M=4.33), and façade (M=4.00) scored high in the DDP Museum. These results suggest that the environmental stimuli of each exhibition hall are differently sensed by users; that is, architectural factors that stimulate users' emotions are diverse according to build or design. It verifies the argument that users feel a variety of different emotions in architectural spaces that are designed differently.

In the National Science Museum, the perceptual factor (M=3.71) influenced emotions the most. The sensory factor (M=4.20) affected users' emotions the most in Yoon Dong Ju Literature Museum, and the morphological factor (M=3.75) most influenced emotions in DDP Museum, as shown in Fig.5. Morphological features are widely used as design factors stimulating the senses in architecture. However, emotions stimulated by such morphological features were not distinguished among the three exhibition halls; further, the morphological factor scored the lowest points among three factors.

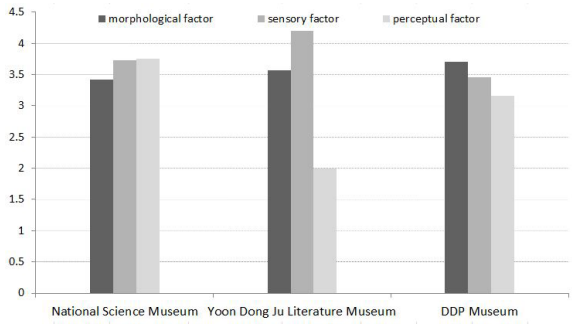

Fig.5. Emotions Influenced by Design Factors

This result suggests that users do not respond much emotionally to the morphological features. On the other hand, there are significant differences in the scores of the perceptual factors among the three exhibition halls. In addition, users responded variously to the sensory factors, compared to morphological factors. These results imply that the features of the perceptual and sensory factors are not represented generally, but purposefully designed and embedded in buildings to stimulate users' emotions.

4.2.2 Experiential Feeling

There was a significant distinction in users' experiential responses to the different designs of the exhibition halls. In this research, a space scale and a process scale were developed to measure experiential response. The space scale consists of 12 items to evaluate users' experience, divided by memory, attraction, pleasure, stimulation, contents and satisfaction. Users responded to these items with a five-point scale ranging from 'never' (0 points) to 'very' (5 points). The results of users' experiential responses to the space are presented in Table 4. The items of 'feeling pleasant (M=4.00)' and 'feeling interested (M=4.33)' in the National Science Museum scored higher than those of the other exhibition halls. The Yoon Dong Ju Literature Museum showed high scores in all items,

Table 4. Results of Space Evaluation

Measurement		Science Museum (Mean)	Literature Museum (Mean)	DDP Museum (Mean)
Memory	·The hall reminds me of an old memory or experience.	3.00	3.66	3.00
Attraction	·The design of the hall appeals to me.	3.00	4.66	3.00
	·I like the ambience of the hall.	3.33	4.33	3.66
Pleasure	·The hall makes me feel happy.	3.66	4.33	3.33
	·The hall makes me feel pleasant.	4.00	3.66	3.66
Stimulation	·The hall makes me anticipate the space.	3.33	4.66	4.00
	·The hall makes me feel interested.	4.33	4.33	3.66
Contents	·There is a story in the space.	2.66	4.33	2.66
	·I can understand a message that the space is providing.	3.33	3.66	2.66
Satisfaction	·The hall offered me a good time.	3.66	4.33	3.66
	·The experience at the hall provided me a rest away from my daily routine.	3.33	4.33	3.33
	·The experience at the hall made me feel enlivened.	3.66	3.66	2.66

Table 5. Results of Process Appraisal

Measurement		Science Museum (Mean)	Literature Museum (Mean)	DDP Museum (Mean)	F (p-value)
Awareness	·The space is easily recognized.	3.66	4.00	1.66	8.60(0.017)
	·The connection or circulation of the space is clear.	3.00	4.33	2.33	-
Perception	·The space stimulates other senses besides sight.	3.00	3.66	3.00	-
	·The design of the space is multisensory.	3.00	2.33	2.66	
Intention	·The space is well designed to fit its purpose.	3.33	4.33	3.33	-
Config-uration	·The hall's morphological factors are unified.	4.33	4.66	3.00	-
	·The hall's morphological factors are diverse.	5.00	2.66	4.66	8.60(0.017)
Immersion	·Time flew while appreciating the exhibits.	4.00	3.00	2.66	13.00(0.007)
	·I wanted to stay longer than I planned.	3.33	3.66	2.66	-
Information load	·I was satisfied with the hall's environmental information amount.	3.66	4.33	3.33	-

with the highest scores in 'attraction' and 'stimulation'. On the other hand, the scores of all items for the DDP Museum are lower compared to those of the other two exhibition halls. In terms of the environmental stimuli, the DDP Museum has strong morphological features, while Yoon Dong Ju Literature Museum has distinct sensory features. However, in terms of space evaluation, the former has low scores while the latter shows high scores.

These results suggest that the sensory features are a strong stimuli for users' emotions in spaces compared to the morphological features. Thus, designers need to design buildings in more diverse ways, emphasizing sensory factors, not just focusing on morphological factors for design.

The process scale consists of 10 items to identify users' experience divided by 'awareness, perception, intention, configuration, immersion, and information load. Users responded to these items with a five-point scale ranging from 'never' (0 points) to 'very' (5 points). Analysis of variance was carried out and the results of several items were significant, as shown in Table 5. The significant items were 'awareness' ($F=8.60$, $p<.05$), 'diversity' ($F=8.60$, $p<.05$), and 'immersion' ($F=13.00$, $p<.01$). The items of 'awareness' (M=4.00) scored high in The Yoon Dong Ju Literature Museum, while users answered that morphological factors are diverse (M=5.00) and felt that time flew while appreciating the exhibits (M=4.00) in the National Science Museum.

Total scores of all items of the space and process evaluation are shown in Fig.6. The space evaluation (M=4.16) scores are the highest in the Yoon Dong Ju Literature Museum; however, there is no significant difference in scores between the National Science Museum (M=3.66) and Yoon Dong Ju Literature Museum (M=3.69) in terms of the process appraisal. In particular, both the space evaluation (M=3.27) and the process appraisal (M=2.90) scores are the lowest in the DDP Museum. In terms of the environmental stimuli, the DDP Museum—which has strong morphological features—shows low scores in the process evaluation, while the Yoon Dong Ju Literature Museum—with distinguished sensory features—and National Science Museum—with strong perceptual factors—obtained high scores from the process evaluation. In addition, the National Science Museum shows the highest score in 'morphological factors' and 'immersion', with statistical significance. This result suggests that perceptual factors influence emotion more than the space evaluation.

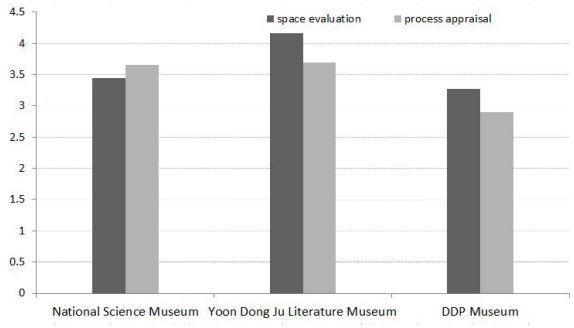

Fig.6. Experiential Feeling

4.2.3 Behavioral Intention

The approach-avoidance items of Russell and Mehrabian (Russell and Mehrabian 1978) were used in order to identify the participants' behavioral responses. In regards to 'approach', 'how much time would you like to spend in this place?', 'how much do you like this place?', and 'how much would you want to explore this place?' were asked. Regarding 'avoid', 'how much would you want to avoid looking around or exploring this place' and 'how hard would you try to avoid ever having to return to this place?' were asked. These five questions affected the participants' approach-avoidance reaction to the space. They responded to these questions with a five-point scale ranging from 'not at all' to 'extremely so'.

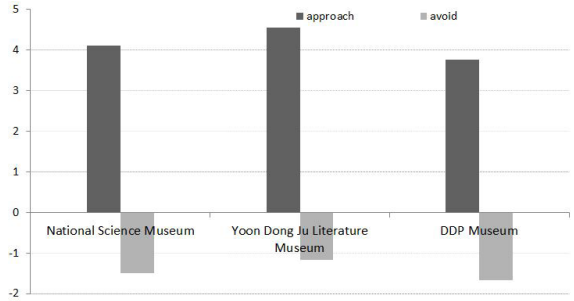

Fig.7. Behavioral Intention

The results are presented in Fig.7. and 'avoid' is shown with negative numbers to differentiate it from 'approach'. In 'approach', the Yoon Dong Ju Literature Museum (M=4.55) scored highest, followed by National Science Museum (M=4.11) and DDP Museum (M=3.77). In 'avoid', the results are shown in the following order: the DDP Museum (M=-1.67), National Science Museum (M=-1.50), and Yoon Dong Ju Literature Museum (M=-1.16).

5. Conclusion and Discussion

In recent times, emotion has become one of the keywords that have had the most influence in design as well as all areas of our society. Many architects have pursued the goal of touching and stimulating users' emotions in space design. While traditional designs for a space express the emotional aspect of the space through the architectural structure components as a one-way conduit from architects, recent emotional aspects of a space place more emphasis on the interaction between humans and the spaces from the user perspective with the advancement of computers and information communication technologies (ICTs) supporting this change. Accordingly, people can communicate with the message of a space and convey their own experiences with a variety of emotional responses, which affect the users' perception of the space itself. That is, a space can be perceived by the relationship of the objects, which allows users to experience new concepts or messages of the space.

In this research, authors firstly reviewed multidisciplinary literatures and compared various methodologies of measurement. Based on the understanding of the studies on the measurement of emotion, authors developed measures of emotion in interaction associated with spaces. The proposed emotion measurement scales reflect both experiential and behavioral aspects of emotions, including space evaluation and process appraisal beyond simple emotional evaluation using vocabularies. To verify the proposed emotion measurement, a case study was conducted. It was found that there are significant differences in users' emotional responses to the three exhibition halls. Users responded emotionally to how each space is designed to the purpose for which it was built. As presented in the existing research, the result shows that morphological, sensory and perceptual factors were the significant factors that influence emotion. Further, the result proves that users experience different emotional stimuli in accordance with the exhibition hall's design. The perceptual factor in particular presents interactive emotion, which has not been focused on in existing research.

Consequently, the results prove the potential of the proposed scales in measuring users' emotions and senses. Using the proposed scales, an understanding of environmental stimuli, users' emotions in space can be gained, and the process by which it was obtained, on which user emotional experience in interaction with space was interpreted in a meaningful way. It is expected that once the proposed measurement is verified with more case studies, it could be utilized effectively in related fields. Authors may also investigate how the same users react differently in the three case studies compared to three different users in three different case studies. The strength of the research is the focus on the integration of the space with technologies and user experiences from a new perspective in emotion research, rather than concentrating only on the architectural components of the buildings themselves. User experience and emotional aspects of a space's design were investigated, which have been sparsely researched previously. Further, authors emphasize not only the emotion expression of the space, but also the interaction of people and space for the embodiment of the emotions from a wider perspective. Although it is

hard to generalize the result of the case study, the case study explored the potential of the developed scales and measurement. Authors expect that this research would contribute to the development of the emotional aspects of architecture in the future.

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