The effects of olfactory cue on affective behaviors in digital content

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The effects of olfactory cue on affective behaviors in digital content*

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Abstract

　Digital contents producers and developers are taking notice of olfactory cues fulfilling the user's needs to the digital contents. Compared to such attention, the study of how to apply and develop the olfactory cue still lacks. Therefore, this research demonstrated the upcoming environmental feature, the olfactory cue's effect to the user's affective behaviors. In addition, this research specifically examined the olfactory effect considering every possibility of being conveyed from both internally and externally to the digital contents. The result showed that the olfactory cue has a significant influence on the affective responses such as attitude, experience, satisfaction, and intention. In this light, this research has a meaning in the aspect of eliciting olfactory technology's development direction and proposing olfactory effects as a new service method in digital contents.

Key Words ; digital content; computing environment; ambient cue; olfaction; affective behavior

Ⅰ. Introduction

　People enjoy the digital content more widely than before not only via network,

but also through the imaging technology such as a high-definition screen and high-resolution graphics. However, users constantly demand a new experience that can be even more convenient, realistic and immersive through various techniques(e.g., Heo & Lee, 2018; Lee et al., 2018). In other words, it would be difficult for the users who have no hands-on experience to know the digital content exactly as most contents have a limitation, for example, in delivering a finite sensory sensation. Depending on the visual, the auditory, and both visuo-auditory technology, users cannot feel a wide range of sensation. Unlike the computing environment, physical environment provides the user a haptic and olfactory sensation as well as a visual and auditory sensation by creating atmospherics. Atmospherics can produce emotional effects within environment (Eroglu, Machleit, & Davis, 2003) that enhance the affective behaviors (Hausman & Siekpe, 2009; Menon & Kahn, 2002). In this respect, it is necessary to improve the level of expression on digital content by using technology to create new environmental features.

Digital content is consisted of content, design, and technology. Among these components, technology is considered as an important factor in configuring the environmental features. As far as it is the dominant technology, digital content has to be dependent on the visual technology, referring to graphics, color, texture, shape, text (Rui, Huang, & Chang, 1999) and auditory technology involving in voice and sound, because vision and hearing takes a big share when processing information (Schifferstein & Cleiren, 2005). Studies on the visual and the auditory-centric have so far been actively done, but there has not been much progress in the research on other new senses, such as tactile and olfaction. Users may feel touch sensation when they access the digital content through electronic devices. However, users cannot detect the traces of the olfactory cue in the digital content.

Olfactory cue as a new environmental feature can be digitalized by technology, such as an olfactory display (Matsukura, Yoneda, & Ishida, 2012) and a wearable display (Yamada et al., 2006). As olfaction is connected to the limbic system (Wilkie, 1995) that allows us to think and feel easily, and acts to shape experience, olfactory cues convey the vividness of imagery and experience (Dubois, 2000; Fiore, Yah, & Yoh, 2000). In addition, olfactory information is intimately linked to mood and memory (Wilkie, 1995). The characteristics of the sense of smell enable people

to construct visual representations in working memory. In particular, olfactory cues help reinforce the recognition towards objects, visual content, in cooperation with the eyes (Seo et al., 2010; Bone & Ellen, 1999).

While studies on olfactory effect have demonstrated in a physical environment (Doucé & Janssens, 2013; Schifferstein, & Cleiren, 2005; Spangenberg, Crowley, & Henderson, 1996), with the pace of olfactory technology improvement in digital content, the mainstream of the research is changing. In order to enable the olfactory service, the technology is important because it can establish a new service platform in computing environment like olfactory service provided in external environment and thus induce affective behavioral change of users. In short, it needs to demonstrate olfactory effect in computing environment and examine whether to lead to the effect of olfactory cue induced by a physical environment.

Indeed, olfactory cue is uncommon in this computing environment. In an external context, the olfactory cue acts as a powerful motivator for sales (Wilkie, 1995), tends to draw consumer attention (Bone & Ellen, 1999), and affects the vividness of the consumer subjective experience (Dubois, 2000); thereby, olfactory cue as successful triggers should be reflected in computing environment in order to enhance user's affective response.

In general, olfactory cues act as trigger to evoke affective behavior by emotional state (Kim & Shin, 2016). Thus, to fully utilize the olfactory cue, it is essential to investigate affective behaviors such as attitude, experience, satisfaction, and intention at the same time. In this light, this study considers that olfactory cue is able to simultaneously evoke affective behaviors, which were not considered in previous research on affective behavior's connection. Existing studies were separately confirmed that the olfactory cues have changed affective responses (Kim & Shin, 2016; Hulshof, 2013; Chebat & Michon, 2003; Fiore et al., 2000). In addition to olfactory cues, it is considered as equally important to make users feel pleasure and arousal. In other words, olfactory cue not only plays a key role in inducing various feelings while smelling but also let users change their affective behavior. Due to the reason, olfactory cues are considered as important tool for digital content depending on their characteristic. Therefore, the application of olfactory cue is not confined to evoke affective response, but induces emotional states by their properties. To make the

above services feasible for olfactory cue in digital content, it is essential to investigate the types of olfactory cue from previous studies (Fox, 2006; Warrenburg, 2005; Field et al., 2005; Mattila & Wirtz, 2001) and examples in fields; and figure out how to enhance olfactory effects. Summarizing an aspect of olfactory cue, the types of olfactory cue are relevant to user's affective behavior with emotional states.

This study contextually investigates the digital content using olfactory cues, which have an effect on affective behaviors evoked by the emotional states. For this goal, we explore the olfactory effect in accordance with the types of olfactory cue and compare the results with each one. Based on the results, we analyze the olfactory effect on behavior change of users and propose a way motivating adaptation of the new sensory cue to the digital content.

II. Literature review

2.1 Theoretical foundation

From the environmental psychological perspective proposed by Mehrabian and Russell (1974), this study investigates the digital content using environmental features. This model suggested the Stimulus - Organism - Response (S-O-R) framework which observes a way to induce the affective behaviors by leading to emotion. In other words, environmental cues, such as stimuli, draw out the pleasant and arousing emotions like organism which results in affective responses such as approach or avoidance behaviors (Donovan & Rossiter, 1982). The S-O-R framework has been mainly adapted in the marketing field of both offline and online environment (Eroglu et al., 2003; Éthier et al., 2008; Koo & Ju, 2010). Although the S-O-R framework has not yet been applied to the digital content's field in a narrow sense, the application of the S-O-R framework in digital content' context has a significant meaning as marketing in a broad sense is part of the digital contents and aims to drive people to experience various senses. In this light, this research explores the application of the S-O-R framework in a context of the digital content. The stimulus is operationalized, as the ambient factors, organism as emotional states, and response as approach behaviors.

2.1.1 Environmental features

Providers consider environmental features when planning the digital content to draw the user's attention. These determinants evoke emotional or cognitive states by creating the atmospherics, which have a subsequent influence on approach behaviors (Eroglu et al., 2003; Éthier et al., 2008; Hausman & Siekpe, 2009). By strategically manipulating the surrounding cues, providers can initiate the approach behaviors in the affirmative. Eroglu et al. (2003) showed that the environmental features, such as social, design, and ambient factors, affect the organism variables like pleasure and arousal of users. These attributes include social factors such as interaction with people, design factors such as visual cue (e.g., layout, color, and clutter cleanliness), and ambient factors such as non-visual cues (e.g., smells, sounds, and lighting effects). In this study, the stimuli are manipulated as design factors and ambient factors, because these dimensions involved in the web content (Rosen & Purinton, 2004) can be digitized through design and technical aspects of the digital content. The social factors, on the other hand, have not been included as a component of the environmental features for the reason that people cannot be reproduced by technology.

Firstly, the design factors as visual cues are seen as an interface or a digital content itself. Rosen and Purinton (2004) stated that interfaces, including various sensory cues, encourage the users to understand every functions and information. In addition, interface focused on the visual design factors elicits emotions, which plays a significant role in increasing the users' involvement by creating an atmospherics (Kim & Moon, 1998). For example, colors such as blue and red are likely to induce pleasant and arousing feelings (Babin, Hardesty, & Suter, 2003) as it dominates the entire interface (Pelet, 2013). These emotional states modify affective responses (Bellizzi & Hite, 1992). Secondly, the ambient factors are considered as the non-visual cues. Those belong to the technical part of the digital contents. Moreover, the ambient factors can be formed not only from the digital content itself, but also from the environment in which people consume the digital content. One of the ambient factors, the olfactory cue, tends to evoke emotional states by creating atmospherics, which have a subsequent impact on the affective behaviors (Doucé & Janssens, 2013; Spangenberg et al., 1996). As developing of digital content's technologies,

there are chances that the way of delivering various sensations in computing environment might be transformed. With the improvement in a new digital technology, user's interest in ambient factors within digital content is getting increased. The ambient factors, however, have not been studied compared to the design factors. By intensively investigating the ambient factors as much as the design factors of the environmental features, this study contributes to extend affective behaviors in the context of the digital content.

2.1.2 Emotional states

The emotional states such as organism, the second component in the S-O-R framework, involves with the internal process between the stimuli and reactions. As environmental cues act as a trigger for change in the emotional states, it can be expected that it has a positive influence on the affective responses (e.g., attitude, experience, satisfaction, and intention). Virzi (1991) indicated that the emotional states enable the users to have more interaction with the digital content. In diverse fields such as advertisement (Fortin & Dholakia, 2005; Teng, Laroche, & Zhu, 2007), marketing (Eroglu et al., 2003; Éthier et al., 2008; Menon & Kahn, 2002), and digital content such as home computing, games, and e-commerce (Virzi, 1991), the emotional effects have been demonstrated. A feeling induced by watching an advertisement, for example, conveys pleasure and arousal to the users to stimulate a sense of sight. According to the previous studies (Koo & Ju, 2010; Menon & Kahn, 2002), researchers focused on pleasure and arousal in order to enhance the approach behaviors. Menon and Kahn (2002) described the pleasure as goodness, joy, happiness, and satisfaction and the arousal as stimulation, activity, and alertness. Especially, arousal contains a power provoking a change in behavior (Fortin & Dholakia, 2005). In this respect, this study adopts emotional states in two dimensions: pleasure and arousal.

2.1.3 Responses

In the S-O-R framework, the final outcome towards the stimuli, the environmental features, is the response including the approach and avoidance behaviors. Mehrabian and Russell (1974) indicated the approach as positive actions and the avoidance as

negative actions by emotional states which is formed by the environmental features. Furthermore, approach behaviors can be regarded as a "desire physical to stay in the environment, a desire or willingness to look around and to explore the environment, a desire or willingness to communicate with others in the environment, and the degree of enhancement of performance and satisfaction with task performances" (Robert & John, 1982, p.37). In previous studies (Eroglu et al., 2003; Éthier et al., 2008; Menon & Kahn, 2002; Teng et al., 2007), it has been demonstrated that the pleasure and arousing evoked by the surrounding cues affect the approach behaviors such as attitude, experience, satisfaction, and intention; hence, this study is focused on the approach behaviors such as attitude, experience, satisfaction, and intention towards the digital content.

2.2 Affective Behaviors

In the S-O-R framework, approach behaviors as a response represents the final component. These behaviors are defined as positive actions, attitude, experience, satisfaction, and intention, evoked by emotional states (Mehrabian & Russell, 1974; Robert & John, 1982) and seem to show different aspects in accordance with the environmental features.

Firstly, attitude tends to be related to the user's interest towards the digital content such as advertisement which inheres in design factors and ambient factors (Clow et al., 2006). Olney, Holbrook, and Batra (1991) measured attitudes in three dimensions - hedonism, utilitarianism, and interestingness; out of these, the hedonic refers to entertaining, the utilitarian refers to useful, and the interestingness refers to liking within an individual. Focusing on these characteristics, attitude identifies the overall effectiveness of an advertisement (Park, Jaworski, & MacInnis, 1986). In environmental features, the olfactory cues affect attitude by depending on the set of surroundings (Ellen & Bone, 1998).

The surrounding cues have an influence on not only attitude, but also experience (Bäckström & Johansson, 2006), satisfaction (Lin, 2007; Kim & Moon, 1998), and intention (Hausman & Siekpe, 2009). Jones, Reynolds, and Arnold (2006) suggested that experience is a hedonic value received from the multisensory, fantasy and emotional states. Forsythe et al. (2006) mentioned that hedonic experience can be de-

scribed as an enjoyable, pleasant, and interesting experience over new experience and which also leads to the change in satisfaction (Szymanski & Hise, 2000) and intention (Forsythe et al., 2006). For this reason, the satisfaction is closely associated with the emotional states. Finally, intention refers to behaviors such as spending time and money, revisiting a store or website (Koo & Ju, 2010; Rosen & Purinton, 2004), and recommending a website to others in an online context (Hausman & Siekpe, 2009). Considering the visual content from this respect, digital content is designed to optimize affective behaviors by providing a wide range of senses reinforced by ambient cues. Therefore, this study is expected to improve affective behaviors such as users' attitude, experience, satisfaction, and intention of how they are seen by depending on the environmental features to induce emotions.

Ⅲ. METHODOLOGY

3.1 Research questions and hypotheses

This study was designed to one (applications: docent or online shopping) by two (Scent: No Scent vs. Citrus-mint) factorial design in order to address these questions. Before the experiment, pretests were conducted to favorably induce affective behaviors and the mutual connection within affective responses. the whole procedure of pretests were explained in Appendix A. The experiment was divided into two levels of mobile applications in Figure 1.

RQ1: What are the factors that influence on emotional states?
RQ2: What olfactory cues can be drawn from affective behaviors?

Therefore, the following hypotheses are proposed:

H1: Olfactory cue has an influence on attitude, using docent application.
H2: Olfactory cue has a positive effect on attitude, using online shopping application.
H3: Olfactory cue has an influence on experience, using docent application.

H4: Olfactory cue has a positive effect on experience, using online shopping application.

H5: Olfactory cue has an influence on satisfaction, using docent application.

H6: Olfactory cue has a positive effect on satisfaction, using online shopping application.

H7: Olfactory cue has an influence on intention, using docent application.

H8: Olfactory cue has a positive effect on intention, using online shopping application.
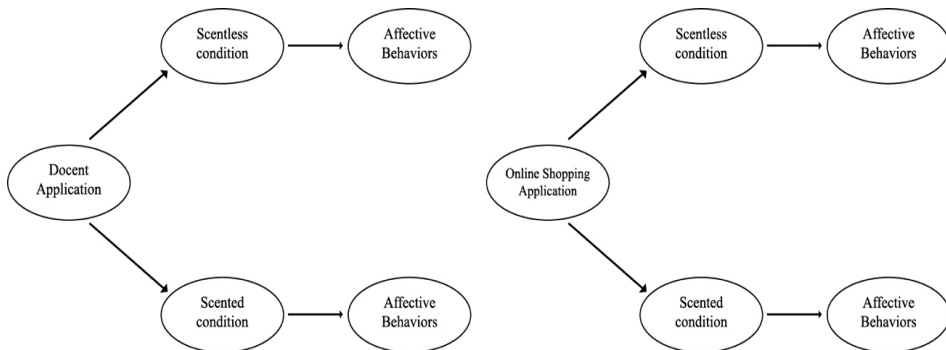
Fig. 1. The model for experiments

3.2 Experiments

3.2.1 Participants and design

Depending on the application manipulation, this study has prepared two laboratory rooms. First, the laboratory rooms were provided one with the docent application service only and the other with both docent application and olfactory cue. In third and fourth conditions, online shopping application and olfactory cue were operationalized in the laboratory room. The overview of the experimental conditions is shown as in Table 1. The first experiment includes condition number 1 and 2, and the second experiment includes condition number 3 and 4. The whole experiment process were designed by the authors and mostly conducted by one of the authors in around May 2016.

Table 1. The overview of experimental conditions.

Condition number	Application manipulation	Scent manipulation	N
1	Docent service	No-scent	30
2	Docent service	Citrus-Mint	30
3	Online shopping service	No-scent	30
4	Online shopping service	Citrus-Mint	30

One hundred and twenty participants without visual impairment, anosmia, and allergy were involved in all conditions. In addition, they already had an experience of using docent and online shopping applications. Thirty participants were randomly arranged in accordance with each conditions. In experiment 1, participants were consisted of 27 males (45%), 33 females (55%). Their ages ranged from 18 to 45, with a mean of 29.32 (SD = 7.646). In experiment 2, participants were consisted of 18 males (30%) and 42 females (70%). The average age of the participants was 24.47 years (SD = 3.061) in age category of 17-37.

To measure the overall affective behaviors in response to the visual stimuli, mobile applications (docent and online shopping service) were manipulated as an experimental task. Automatic aroma spray was chosen for the olfactory condition because the spraying will occur whenever the participants enter. Although the olfactory techniques exist (Matsukura et al., 2012; Yamada et al., 2006), it is not universally developed; thereby this study reproduced the technical and environmental condition that allows the participants to easily recognize the olfactory cue as much as possible by means of an existing apparatus. A scented candle and diffuser was also used in order to fill the laboratory room with scent before the experiment.

3.2.2 Procedures and questionnaires

The experiment was conducted in a laboratory room modifying the situation to use each mobile application. This study prepared the laboratory' setting prior to the experiment in accordance with the experimental conditions. Then smartphone was set up for the individual user in order to perform the task, for example, adjusting the setting, and installing the applications onto the smartphone and the icon towards the digital questionnaire. The olfactory stimulus such as a candle or a diffuser was

used in the laboratory two hours before, and an automatic aroma spray was used hidden from the participants during the experiment in order to maintain the olfactory cue. The whole procedure of the experiment was conducted over four stages.

All participants given written permission to make use of the data anonymously were told that the purpose of the study was to examine the affective behaviors toward the application service and explanation/procedure of the experimental performance except for the olfactory cues. In experiment 1, participants were required to use the docent application while admiring the displayed artworks in the laboratory. They read the descriptions of the artworks and interview videos by entering into the specific category in Fig 2. The average time of the experimental tasks was 20 minutes. The experiment was conducted by group of five to seven in order to reproduce situation in context of the museum.
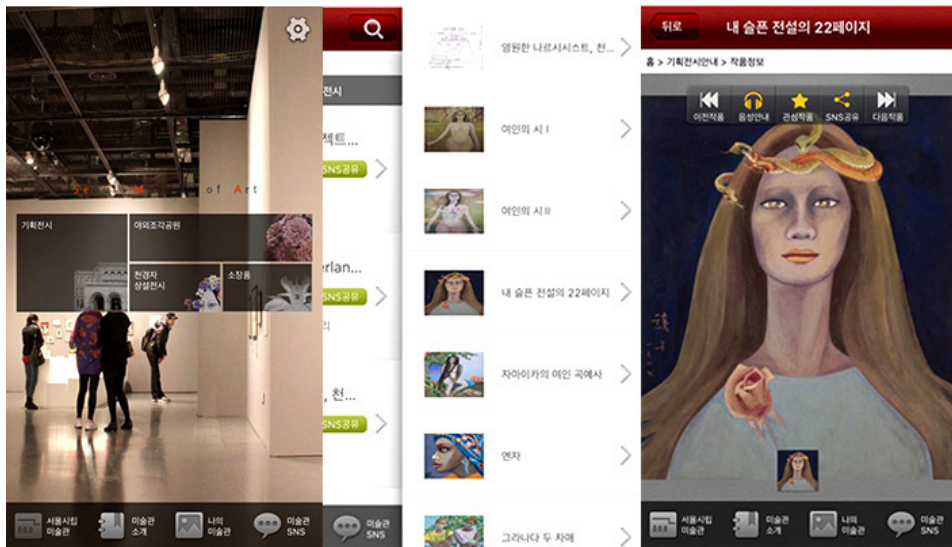
Fig. 2. Docent service mobile application (Seoul Museum of Art)

In experiment 2, participants were instructed to start with clicking on the online shopping icon anchored towards the designated product category in order to process the task in Fig 3. To identify the exact effects of the olfactory cues, electronics and their accessories that are typically neutral colors such as black, gray, and white and scentless were chosen with a reference to Kim and Shin (2016). Depending on the

congruency effect, the color and the inherent scent were consciously excluded from the product selection. The participants were asked to carry out the tasks, for example, shopping via the Internet by looking for the desired products within a controlled category for 20 to 30 minutes. The experiment was conducted individually in order to let the participants concentrate on the tasking.
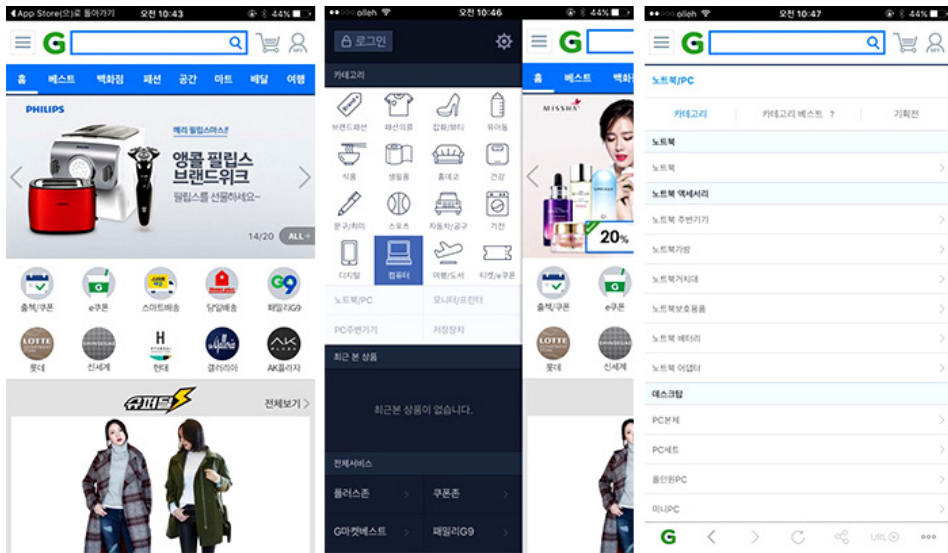
Fig. 3. Online shopping service mobile application (G−market)

Upon completion, the participants were forwarded to the digital questionnaire on affective behaviors. This questionnaire was displayed on the screen by means of an icon. All responses were consisted of four dimensions such as attitude, experience, satisfaction, and intention on a seven-point Likert scale (*1= strongly disagree to 7= strongly agree*) for 24 items in Table 2. The questionnaire's measurement scales on affective behaviors as dependent variables are shown as in Table 3.

After completing the questionnaire, participants were debriefed. In approximately forty minutes, the participants finished the experimental performance and were asked to fill out the digital questionnaire for each individual. The whole experiment period took place seventeen days from 10:00 till 17:00.

Table 2. The questionnaire's constructs and items on dependent variables.

Dependent Variables	Construct	Source	Items
Attitude	Hedonism Utilitarianism Interestingness	Olney et al. (1991)	12
Experience	-	Lin (2007)	5
Satisfaction	-	Oliver and Swan (1989)	3
Intention	-	Koo and Ju (2010)	4
The total number of Items			24

Table 3. Measurement scales on dependent variables.

Dependent Variables	Measurement Scales	Cronbach's α
Attitude	Hedonism : Pleasant-Unpleasant; Fun to watch-Not fun to watch; Entertaining-Not entertaining; Enjoyable-Not enjoyable	.786
	Utilitarianism : Important-Not important; Informative-Uninformative; Helpful-Not helpful; Useful-Not useful	.828
	Interestingness : Makes me curious-Does not make me curious; Boring-Not boring; Interesting-Not interesting; Keeps me attention-Does not keep my attention	.860
Experience	When I use docent/online shopping applications, I'm : Pleasant-Unpleasant Satisfied-Unsatisfied Happy-Unhappy When I use a docent/online shopping application, it is : Good job-Bad job Wise choice-Unwise choice	.917
Satisfaction	The docent/online shopping application's information content meets my needs It is possible for me to use docent/online shopping application from app store Overall, I am satisfied with docent/online shopping experience	.857
Intention	I will keep use of this docent/online shopping application in the future I will use this docent/online shopping application rather than other docent/online shopping application I will frequently use this docent/online shopping application in the future I will recommend others to use this docent/online shopping application	.932

IV. RESULTS

4.1 Experiment 1

A one-way multivariate analysis of variance (MANOVA) was conducted to evaluate the effects of olfactory cue as ambient cue on dependent variables of affective behaviors: attitude, experience, satisfaction, and intention. Table 4 shows the correlations among the dependent variables in Experiment 1.

Table 4. Correlations among the dependent variables in Experiment 1.

	Attitude	Experience	Satisfaction	Intention
Attitude	1	.869**	.796**	.761**
Experience	.869**	1	.789**	.822**
Satisfaction	.796**	.789**	1	.678**
Intention	.761**	.822**	.678*	1

** shows correlation is significant at the 0.01 level and * at the 0.5 level(2-tailed).

The MANOVA using Pillai's Trace as algorithms showed a significant effect for olfactory cue on affective behaviors such as attitude, experience, satisfaction, and intention, $F = 4.078$, $p < .01$. Table 5 presents means and standard deviations on the dependent variables for olfactory conditions, in detail.

Table 5. The results for olfactory conditions on affective behaviors in Experiment 1.

Dependent Variable	No-Scent		Citrus-Mint		F	P	partial n^2
	Mean	SD	Mean	SD			
Attitude	4.67	.836	5.13	.776	5.081	.028	.081
Experience	4.54	.853	5.11	1.06	5.254	.026	.083
Satisfaction	4.54	1.08	5.22	.712	8.198	.006	.124
Intention	4.27	1.08	5.24	1.23	12.977	.001	.183

As following results, the attitude was significantly higher for participants in scented condition compared to participants in scentless condition. Therefore, Hypothesis 1

was supported by the data. The experience was again statistically significant and hence, Hypothesis 3 was also supported. In other words, participants scored a higher rating on experience exposed to olfactory cue. The effects for olfactory cue on satisfaction, however, were not significant in accordance with Levene's Test ($F = 5.416$, $P < .05$). Therefore, Hypothesis 5 does not received support from the data. Finally, it is found that participant's intention in scented condition scored higher rating rather than their intention in scentless condition. Hypothesis 7 was supported by the data.

Results revealed that whereas attitude, experience, and intention was statistically significant in using digital content while the satisfaction was not significant. In Experiment 1, Hypothesis 3 gave rise to the argument on the affective effect of olfactory cue, independent variable. On the other hand, previous research (e.g., Kim & Shin, 2016) suggested a relationship between olfactory cue and satisfaction. Given the laboratory' setting in Experiment 1, it is possible that the stimulus may have interacted with other environmental features.

4.2 Experiment 2

Table 6 shows the correlations among dependent variables in Experiment 2.

Table 6. Correlations among the dependent variables in Experiment 2.

	Attitude	Experience	Satisfaction	Intention
Attitude	1	.478**	.433**	.264*
Experience	.478**	1	.925**	.622**
Satisfaction	.433**	.925**	1	.709**
Intention	.264*	.622**	.709**	1

** shows correlation is significant at the 0.01 level and * at the 0.5 level(2-tailed).

As can be seen in Table 7, the effects for olfactory cue on overall affective behaviors was significant, using Pillai's Trace ($F = 8.554$, $p < .01$). Table 7 presents means and standard deviation of affective behaviors. Participants in scented condition evaluated on a significantly higher rating of attitude than their counterparts in the scentless condition. Therefore, Hypothesis 2 was supported by the data. The experience was significantly higher for participants in scented condition than in

scentless condition and hence, Hypothesis 4 received support from the data. In addition, the effects of olfactory cue on satisfaction and intention were statistically significant. The satisfaction and intention by participants exposed to olfactory cue was a higher scored. Therefore, Hypothesis 6 and 8 was also supported by the data.

Table 7. The results for olfactory conditions on affective behaviors in Experiment 2

Dependent Variable	No-Scent		Citrus-Mint		F	P	partial n^2
	Mean	SD	Mean	SD			
Attitude	3.59	1.03	4.81	.780	26.725	.000	.315
Experience	3.94	.977	4.85	.933	13.608	.000	.190
Satisfaction	3.74	1.06	4.64	1.17	9.651	.003	.143
Intention	3.30	1.27	4.20	1.17	8.305	.006	.125

Supports for Hypothesis 2, 4, 6, and 8 in Experiment 2 lead us to conclude a relationship between olfactory cue and affective behaviors. Table 8 shows the result and summary of hypotheses in Experiment 1 and 2.

Table 8. The result and summary of hypotheses in Experiment 1 and 2

Number	Hypotheses	Support
H1	Olfactory cue of docent application → Attitude	Yes
H2	Olfactory cue of online shopping application → Attitude	Yes
H3	Olfactory cue of docent application → Experience	Yes
H4	Olfactory cue of online shopping application → Experience	Yes
H5	Olfactory cue of docent application → Satisfaction	No
H6	Olfactory cue of online shopping application → Satisfaction	Yes
H7	Olfactory cue of docent application → Intention	Yes
H8	Olfactory cue of online shopping application → Intention	Yes

Ⅴ. CONCLUSION

Digital technology conveying olfactory cue in digital environment is one of the rising areas of interest. Though existing technology delivering visual and auditory cues has made much progress, the users are gradually accustomed to new experience and stimulation provided by such sensory cues and tends to be insensitive. The researchers are making an effort in technological development conveying haptic as well as olfactory cues within digital environment as the needs for more direct and empirical experience are increasing. The olfactory technology is not yet commercialized compared to the haptic technology; however, it is under developing progress supplementing the olfactory technology's drawbacks. The technology has only literally developed, and application, field, and scope about how to utilize it is not specifically established. Such discussion can be held after the technical development. However, one can efficiently develop olfactory technology and commercialize it rapidly in specific fields if where and which purpose to utilize it can be specifically established in the initial stage of development.

This research aims to investigate whether olfactory effect can be considered as a new environmental feature in digital contents and whether olfactory cue can arouse a higher level of affective behavior; which focuses on the term environmental features for this. Although environmental cues as such a stimulus is actively studied in psychology, cognitive science, and marketing, environmental features have not been largely studied in digital content field. Intensive analysis is needed regarding that environmental cues stimulate emotional states and effectively elicits affective behaviors. The environment of user being conveyed a variety of sensations arrived with the digital technology development. Therefore, digital contents providers or designers continually invest the application of the environmental features, considering design changes that inspire users to attract their attention. In this light, this study contributes to a different context on digital content for environmental features to have emotional effects to the user by using environmental psychology. The pleasant and arousing emotions evoked by environmental cues subsequently influences affective behaviors.

Synthetically examining both experiments' results, olfactory effect is new sensory

cue in digital environment, but is a sensory cue that has been frequently applied in an external environment. Therefore, which did not elicit significant influence to the level of satisfaction as in Experiment 1's result. Many previous studies have focused on olfactory effects and proved effectiveness; thereby this research has arranged an opportunity to examine olfactory effects not only a physical environment as in previous studies but a computing environment as well through this study's result. Consequently, researchers as well as technicians and developers can arrive at conclusion to new theory and result through existing research result or theory. That is, if a way of applying and utilizing does not follow, however prepared the technical ground, the technology's value cannot be properly realized. In other words, new strategy or service method is established under the user's demand for the olfactory effect and the value of the olfactory effect can be reproduced when this is continued on. Following this, this research anticipates developers referring to the result, effectively selecting technology development direction and advancing olfactory effect.

This research has several limitations in following aspects. First, the olfactory cue delivering technology in the digital environment is in the development stage and not yet popularized, thus this research's experiment reproduced the olfactory sensation through olfactory stimulus or apparatus. Second, this research did not conduct detailed analysis according to the personal traits such as gender and age when investigating the olfactory effect; which does not provide explanation about the effect of personal traits to the affective behavior. Those perspectives should be considered in further olfactory research.

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Appendix A. Procedure of pretests

A.1. Docent applications

Pretests were conducted on manipulation checks before the main experiment. To select relevant docent applications in domestic (e.g., Daelimmuseum, SeMA, Daeguartmuseum, and National Museum of Korea), Sixty-one participants were asked to fill out a questionnaire on mobile application' evaluation by means of digital questionnaire through network. They consist of 30 males (49.2%) and 31 females (50.8%). The mean age of participants was 30.49 years (SD=9.318) in age category of 17-45 years. Digital questionnaire' system randomly indicated one of docent applications, mentioned the purpose of survey, and asked participants to answer items. All questionnaires were adapted from Kim and Stoel (2004), using a five-point Likert scale (1=strongly disagree, 5=strongly agree). Their questionnaires address dimensions of website quality, which provide user information, content and so on; thereby questionnaires were used to measure user's perception of mobile application in common with computing environment. In the context of docent service, the pretest study captures evaluation with four dimensions: appearance, entertainment, informational fit-to-task, and response time. Table A.1 shows the factor, number of items, and source of scale. The data on docent application was analyzed with a repeated measure ANOVA.

Table A.1. The factor, number of items, and source of scale on docent application

Factor	Items	Cronbach's α	Source
Factor1: Appearance	6	.794	
Factor2: Entertainment	6	.848	Kim and Stoel (2004)
Factor3: Informational fit-to-task	4	.742	
Factor4: Response time	3	.892	
The total number of items	19		

The results are shown in Table A.2. Overall, a National Museum of Korea application scored higher than the other docent applications. In addition, four applications were significantly differed on appearance (Mdaelim=3.63, MSeMA=3.75, Mdaegu=

3.62, Mnational=3.94, F=7.846, p<.01) and informational fit-to-task (Mdaelim=3.77, MSeMA=3.91, Mdaegu=3.73, Mnational=4.08, F=5.741, p<.01). There were no differences on the degree of entertainment (Mdaelim=3.65, MSeMA=3.67, Mdaegu =3.56, Mnational=3.73) and response time (Mdaelim=3.34, MSeMA=3.40, Mdaegu =3.42, Mnational=3.45) among docent mobile applications.

As a result, an application of National Museum of Korea and SeMA was a candidate. While the former one is difficult to use with general users owing to charged service, the latter one does not need service fee so that it's much easier for many people to use; thereby SeMA application was chosen for the main experiment.

Table A.2. Repeated measure ANOVA results of docent application

Applications	Mean	SD	F	P
Daelimmuseum	3.60	.453		
SeMA	3.68	.511		
Daeguartmuseum	3.58	.428	6.296	.000
National Museum of Korea	3.80	.496		

A.2. Online shopping applications

The relevant tool, visual stimulus, was evaluated in advance of the main experiment. Using digital questionnaire' system, thirty participants (17 females (56.7%) and 13 males (43.4%), M = 25.57, from 21 to 36 years, SD = 2.9) were instructed to measure on mobile online shopping application. The questionnaires on online shopping application were randomly displayed with the purpose of questionnaire. Thirty participants answered 25 items on a five-point Likert scale, for example the evaluation of online shopping applications such as 11st, Interpark, G-market, and Auction from strongly disagree to strongly agree. The scale consists of six dimensions: web appearance, entertainment, informational fit-to-task, transaction capability, response time, and trust. These attribute can be manipulated to have an impact on affective behavior in using mobile application. The factor, number of items, and source of scale are shown in Table A.3.

Table A.3. The factor, number of items, and source of scale on website

Factor	Items	Cronbach's α	Source
Factor1 : Web appearance	6	.729	
Factor2 : Entertainment	6	.928	
Factor3 : Informational fit-to-task	4	.786	
Factor4 : Transaction capability	4	.863	Kim and Stoel (2004)
Factor5 : Response time	3	.901	
Factor6 : Trust	2	.799	
The total number of items	25		

Table A.4. Repeated measure ANOVA results of online shopping application

Applications	Mean	SD	F	P
11st	2.61	.418		
Interpark	2.28	.827		
G-market	2.89	.379	13.537	.000
Auction	2.63	.332		

A repeated measure ANOVA results in Table A.4 show a significantly higher rating on G-market compared to other mobile applications. There were five differences for online shopping application on evaluation such as web appearance (M11st=2.52, MInterpark=2.85, MG-market=2.92, MAuction=2.60, F=7.585, p<.01), entertainment (M11st=2.22, MInterpark=2.53, MG-market=2.55, MAuction=2.40, F=6.360, p<.01), informational fit-to-task (M11st=2.89, MInterpark=2.91, MG-market=3.25, MAuction =2.79, F=5.833, p<.01), transaction capability (M11st=2.93, MInterpark=3.08, MG-market=3.17, MAuction=3.04, F=2.129, p<.05), and trust (M11st=2.08, MInterpark= 2.28, MG-market=2.38, MAuction=1.93, F=4.054, p<.05). In contrast, no difference was found in the degree of response time among online shopping applications. Based on these findings, this research selected G-market applications as visual stimulus.

A.3. Olfactory stimulus

For the purpose of this research, three conditions (no scent vs. citrus-vanilla vs. citrus-mint) were tested in that the smell of citrus induces feelings of pleasure and arousal (Spangenberg et al., 1996). To improve the smell of citrus's effect, multiple scents based on citrus were manipulated as olfactory cues. The smell of citrus-mint as cool type and the smell of citrus-vanilla as warm type can be subdivided into two different scents, depending on previous studies (Doucé & Janssens, 2013; Mattila & Wirtz, 2001). Furthermore, this pretest compared no-scent condition with scent conditions in order to demonstrate the effects of scent to induce emotions; because, cases that olfactory cue is used in web-based environment are not much. That means, the purpose of pretest was to examined the olfactory effect and determine which olfactory cue was favorable.

Seventy-five participants, consisting of 23 males (30.7%) and 52 females (69.3%) were asked to evaluate each condition on a 7-point semantic differential scale. The participant's mean age was 23.97 years (SD=2.013) in age category of 17-29 years. The questionnaires' constructs, items, sources, and measurement scales are shown in Table A.5.

Table A.5. The questionnaire's constructs and items on emotional state by evoked scent

Construct	Measurement scales	Items	Cronbach's α	Sources
Pleasure	Happy-Unhappy/Pleased-Annoyed/ Satisfied-Unsatisfied/Contented-Melancholic/ Hopeful-Despair/Pleasant-Unpleasant	6	.876	Hulshof (2013), Koo & Ju (2010)
Arousal	Excited-Calm/Aroused-Unaroused/Jittery-Dull /Stimulated-Relaxed/Wide Awake-Sleepy/ Frenzied-Sluggish	6	.713	
	The total number of Items	12		

A one-way ANOVA was conducted. Table A.6 gives ANOVA results of the scents. A post-hoc comparison was performed with the Duncan test and indicated that the effects of olfactory cue were larger than that of the no-scent condition. On

the degree of conditions, the smell of citrus-mint scored higher than the other conditions (MNo Scent=4.07, MCitrus-Vanilla=4.78, MCitrus-Mint=4.86, F(2,72)=5.814, p<.01). Participants experienced significantly more pleasure and arousal in citrus-mint condition. As a result, this study anticipates that the smell of citrus-mint as olfactory stimulus has an influence on affective behaviors.

Table A.6 ANOVA results of scent.

Scent	Mean	SD	F	P	η^2	Duncan
No Scent (a)	4.07	.996				
Citrus-Vanilla (b)	4.78	.980	5.814	.005	0.14	a < b,c
Citrus-Mint (c)	4.86	.715				

디지털 콘텐츠 내 정서적 반응에 영향을 미치는 후각 효과

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초 록

후각단서는 디지털콘텐츠에 대한 사용자의 니즈를 충족시키기 위해서 디지털콘텐츠 제작자들이나 개발자들에게 많은 관심을 받고 있는 추세이다. 그러나 이와 같은 관심에 비해, 후각단서를 어떤 방식으로 활용할지, 어떻게 개발하면 좋을지에 대한 연구는 아직 부족하다. 따라서, 본 연구는 새롭게 떠오르고 있는 환경적 특징인 후각단서가 사용자의 정서적 반응에 미치는 영향을 검증하였다. 더 나아가, 디지털콘텐츠 내부와 외부에서 전달될 수 있는 모든 가능성을 고려하여 후각효과를 세부적으로 살펴보았다. 연구 결과, 후각단서는 태도, 경험, 만족도, 의도와 같은 정서적 반응에 유의미한 영향을 미치는 것으로 나타났다. 이러한 결과로 본 연구는 후각효과를 디지털콘텐츠의 새로운 서비스 방안으로 제시한다는 측면에서, 후각기술의 개발방향을 도출한다는 측면에서 시사점을 가진다.

주제어; 디지털콘텐츠, 컴퓨터 환경, 분위기, 후각, 정서적 반응

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