Master's Thesis

The Role of Aesthetic Interaction in Sound Experience

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The Role of Aesthetic Interaction in Sound Experience

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Executive Summary

In this paper, I examined how Aesthetic Interaction, which plays an important role in HCI, affects the evaluation of human emotion and product image when applied to products that provide an auditory experience. For this, I used a Research through Design approach and built a prototype with three elements of “Aesthetic Interaction”. This could be measured through a self-emotion report, 29SD. The Friedman test also showed statistically significant results. These results suggest that in designing products that can provide an auditory experience, we can apply aesthetic interaction to the emotions and images that designers intentionally project.

Keywords: Aesthetic Interaction, Sound Experience

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Introduction

1.1 Backgrounds

In the field of HCI, many studies have shown that Aesthetic is not just a cosmetic, but a whole experience of use. (Flore 2005), (Mahlke, 2005), (Petersen, 2004) And, some studies have shown that this correlates with usefulness. (De Angeli, 2006), (Hassenzable, 2004), (Tractinsky, 2000) These studies are less useful in terms of interaction design. I have focused on examples that can more actively reflect the elements that make up the aesthetic interaction in the design. (Lim, 2007), (Dijajadiningrat, 2004) In particular, Dijajadiningrat is expressed as “form part of an invitation for action” and “the affective aspects of affordance”, with a greater emphasis on physical artifact characteristics.

This paper attempts to solidify the concept of aesthetic interaction, organized by several scholars, and to show the results of how this can be applied as a physical element. In addition, we will qualitatively evaluate what kind of emotional experiences or objects the user will receive.

1.2 Research Aim and Methodology

This paper aims to show empirical results on how the emotional experiences of users and the different ways of evaluating products are achieved through three different aesthetic interactions. Therefore, we will proceed to creating a prototype that reflects the elements of aesthetic interaction, to measure how emotions arouse the user, and to a semantic measure of the product.

1.3 Research Scope

This paper follows a research-through-design approach. This means that the integrated design process, from iterative brainstorming, sketching, prototyping and testing, is used as a tool for research. This provides an opportunity for various theories and concepts to be applied to prototypes as material stimulants, and to explore ways in which knowledge derived from prototypes can be applied. (Frens, 2006) (Stappers, 2007) (Zimmerman, Forlizzi, & Evenson, 2007).

This study begins by collecting data on aesthetic interactions through literature studies. This establishes the concept of aesthetic interaction. The design workshop will build prototypes based on a variety of ideas that apply this concept. Empirical data obtained by testing prototypes with three types of stimulants; The results of the emotional experience and the results of the evaluation of the product will be a guideline for the process of producing a prototype based on the theoretical frame-work, and will allow for a new application.

1.4 Thesis Structure

This paper consists of six chapters.

In the first chapter, it is organized in the following order: background, research aim and methodology, and research scope.

In the second chapter, the literature, related to aesthetic interaction, is used to analyze concepts, attributes, and various cases.

In the third chapter, the concept of aesthetic interaction was refined as a guideline, how the idea of prototyping was extracted through the design workshop, how was the process of producing prototypes as stimulants and trial and error? Participants are described in detail how they performed the experiment.

In the fourth chapter, data obtained from user survey results are analyzed statistically and presented in various charts and graphs.

The fifth chapter contains the results of the design aspect through data analysis, how to apply it to the design in the future, and the limitations of this study and how to proceed further.
In the sixth chapter, we discuss the findings of this paper.

2

Literature study

2

Literature study

In terms of interaction, Aesthetic does not have a 'universal definition' or 'single definition'. However, it can be seen that the ambiguity is being increasingly defined by various scholars. The table below shows the results of defining aesthetic interactions by several scholars.

Table 1. Definition of Aesthetic Interaction (adapted from Mõttus, M., & Lamas, D 2015)

Reference	Description
Hassenzahl, M. (2011)	Aesthetics of interaction is a set of principles concerned with the nature and appreciation of beauty of interactive products (derived from dictionary definition of aesthetics). Aesthetic value also acts as quality dimension of user experience (UX) together with usability and pleasure of use
Djajadiningrat, T., Wensveen, S., Frens, J., & Overbeeke, K. (2004).	Aesthetics of interaction uses all general principles concerning beauty of appearance (appeal) and adds new dimension to it: the beauty of use. The beauty of use concerns the aesthetic experience provided by process of interaction with technology. Appeal and beauty of interaction are interrelated to each other and must therefore be addressed in holistic manner.
Lowgren, J. (2008)	Aesthetics of interaction has a hedonic value which is explicitly expressing beauty. This value can be both positive or negative and adjectives “beautiful” and “ugly” are the opposite poles of it. Other terms like “gracious” and “elegant” can be used instead of “beauty” but “good”, “bad”, “nice”, “cool”, etc. require additional information to connect them to the aesthetics. Factual reports like “big”, “green”, “sweet”, “comfortable” etc. are not aesthetic appraisal.

Since this concept was broad in scope, it required specific elements and concepts that could be directly reflected in the design. Djajadiningrat focused on physical artifact characteristics, discussing the physical characteristics inherent in interactive artifacts that provoke specific ways of working and interacting with artifacts. The elements and explanations of the aesthetic interaction he describes are shown in the table below.

Table 2. Factors that play a role in aesthetics in interaction (Djajadiningrat et al., 2004)

Factors	Description
Freedom of interaction	Interaction that has a variety of orders and combinations of actions, not single path of interaction way The product allows for such expressive behavior—not constraining the user
Interaction pattern	Interaction pattern that spins out between the user and product The timing, flow and rhythm, liking user actions and product reaction
Richness of motor actions	Interaction that encourages people wide range of motor skill Design by number. A fair amount of room to man oeuvre between the actions required by those objects

The three factors that play the role of aesthetic interaction are the main concepts of this paper, and the six elements that Mõttus should consider when studying the attributes of aesthetics were discussed.1) Empirical study vs aesthetic theories. Subjective evaluation methods were more successful in past. 2) Though the aesthetics is perceived holistically, addressing single attrivutes is the way how designers can make an input for helping both in avoiding the unpleasant and creatign the pleasant experiences. 3) The aesthetic experience has hedonic nature. The ugliness must be addressed as carefully as beauty. 4) First aesthetic impression is most powerful factor but it won't provide holistic approach without being followed by interaction. 5) Interrupting interaction for collecting data about aesthetics might bias the study result. (holistic approach) 6) Habituation - over time stimulation loses its power to make the product beautiful in the users' eyes.

3

Experiment

- 3.1 Design Workshop
- 3.2 Experiment Stimuli
- 3.3 User Study

3

Experiment

3.1 Design Workshop

3.1.1 Participants

Participants were 7 students who majored in industrial design at UNIST. 4 students were master's students and 3 students were doctoral students. Their age ranged from 25 to 28 years, with three men and four women.

Figure 1. The image of the idea generation session

3.1.2 Materials

- In the idea generation session, it was assumed that 'your design must include four functions: play, next, previous and pause'.

Idea Generation Part 1: Freedom of Interaction

This part aimed to see how freedom of interaction, among the elements of Aesthetic Interaction, can be applied to design. Participants generated the idea according to the following two requirements.

- When a user interacts with a music player, do not restrict them in order or in rules.
- Your design should be free to use in their own way.

Both requirements are based on the description of the property of freedom of interaction. The first requirement clearly reflects that workshop participants should be excluded from being able to impair the application of attributes in their ideation. The second requirement is presented to make it clear that one of the attributes is not a single method within the scope of its function.

Idea Generation Part 2: Interaction Pattern

The second part was to see how the Interaction pattern, among the elements of Aesthetic Interaction, could be applied to the design. Participants came up with the concept considering the following two requirements.

- Your design should apply a pattern of behavior, in which interaction between the user and the product can lead to functionality.
- The timing, flow and rhythm of the user's actions leading to the product's response should be applied to your design.

Both requirements are based on the description of the property called Interaction pattern. The first requirement is given to emphasize that the 'pattern' must be clearly reflected. The second requirement is to provide an element where the 'pattern' can be reflected so that it can be expressed in various ways.

Idea Generation Part 3: Richness of Motor Actions

The third part aimed to see how the richness of motor actions, among the elements of Aesthetic Interaction, could be applied to the design. Participants came up with the concept considering the following two requirements.

- Your design should give the user the opportunity to use a lot of athletic performance.
- The user must go through a series of sequential steps to operate the music player.

Both requirements are based on the description of the property of richness of motor actions. The first requirement is provided to ensure that the nature of the attributes is clearly reflected in the design. The second requirement reflects this property, described as 'design by number'.

3.1.3 Procedure

This design workshop consists of three session: concept of aesthetic interaction, idea generation, and discussion.

The goal of the first session, concept of aesthetic interaction, was to provide participants with an understanding of the concepts and components of aesthetic interaction and to provide requirements for the next session. In the second session, idea generation, participants were asked to develop an idea of various interaction methods for playing music according to the guidelines provided. In the third session, discussions, we were free to give feedback and give feedback on how the ideas developed in the previous sessions came up.

Participants fully understood the concept of what an aesthetic interaction was, the three elements of it, and then received a requirement in the first session, concept of aesthetic interaction, for each element to be clearly applied to the music player. Since then, they have had enough time to answer and answer questions.
In the idea generation session, participants were asked to develop design ideas for various interaction methods that could play music by three aesthetic interaction elements. This was to see design implications with aesthetic interaction. This second session totaled 3 parts; It consists of freedom of interaction, interaction pattern and richness of motor action. Each part lasted for 15 minutes, for a total of 45 minutes, and was continuously delivered through the screen to remind us of the requirements provided in the previous session.

At the end of the design session, participants spent 30 minutes rotating their presentation of how and why the requirements were reflected in their ideas, and everyone was free to give and receive feedback. This session allowed me to refine the idea of a prototype design concept to act as a stimuli. This process was recorded video.

Figure 2. Design workshop procedure

3.1.4 Findings

Various ideas obtained through the workshop were summarized and analyzed. (Appendix 00) In the case of the idea of freedom of interaction, it was found that there was no or minimal contact between the hand and the physical object. In the case of the idea of the interaction pattern, we found that it used a physical object to induce repeated behavior. The idea of the richness of motor-action was cumbersome, and I found that our user had to perform another task to get it working. The keywords obtained as a result of the comprehensive analysis of the idea acted as an element of the stimuli design.

3.2 Experiment Stimuli

3.2.1 Iterative Design Process

Requirement

Based on the findings obtained through the design workshop, the requirements that must be reflected in various concepts were established.

- You must use four bars to perform the play, pause, next, and previous functions.
- A container to hold the four bars must be included in the product configuration.
- The plate on which the bar can be thrown must be included.
- Speakers must be included as media that can produce auditory stimuli.
- The three types of aesthetic interactions should be performed on one product, not on separate products. (Time taken to make and limited budget are taken into consideration.)

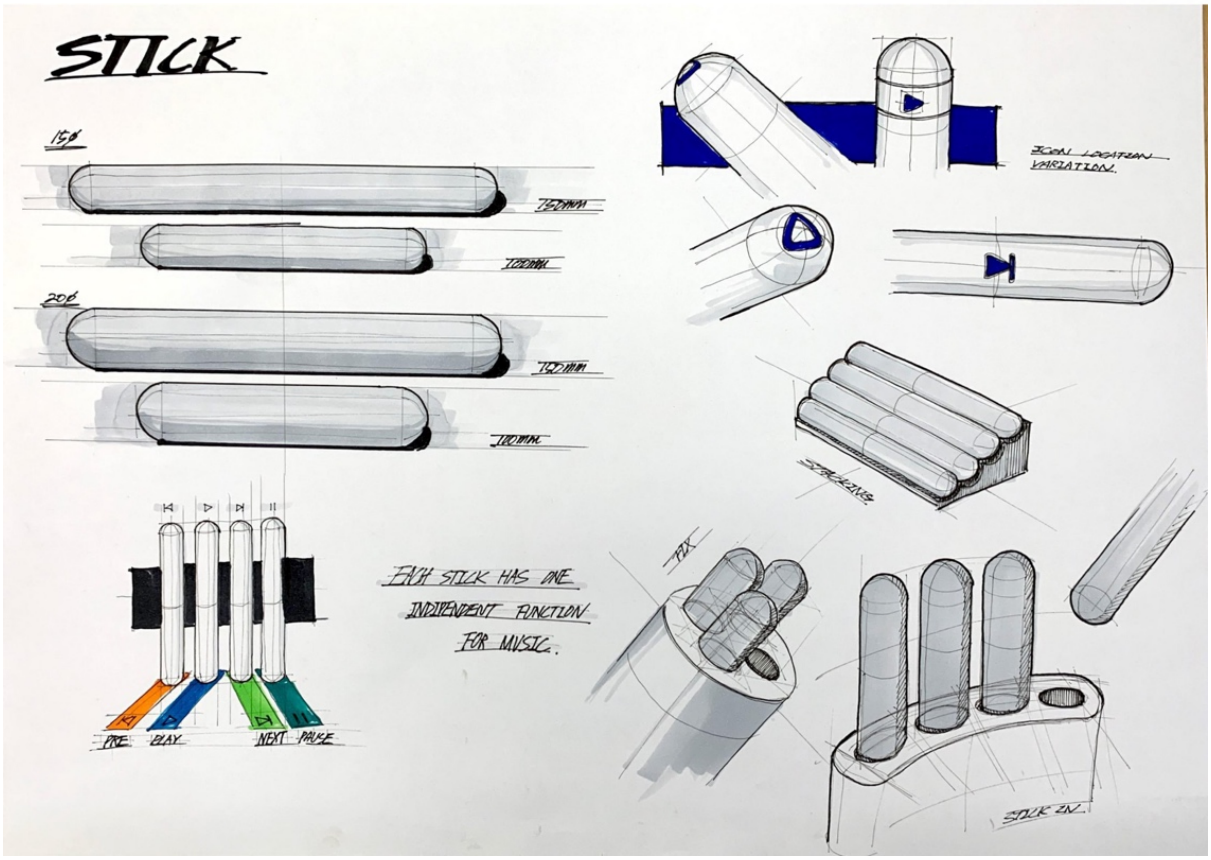


Figure 3. 4 Initial stick sketch

A Type Concept: All separated. (Plate, Speaker, Stick container)

In the early concept, in the case of A type, the composition of the product for the experiment is separated. Plates, speakers, and stick containers exist independently, and they consist of a set. The plate has a thickness of about 5t and is designed to be about 30cm in width and length, and the speaker and stick container have been designed in the form of a cylinder or a cube without a corner. This was mainly inspired by the flat set of office supplies.

This concept raises the possibility that cognitive confusion or error may occur with the user's interaction depending on the location of the speaker. This confusion or error could be a variable in the experiment, so it was necessary to develop a concept of a type where the speaker was not separated.

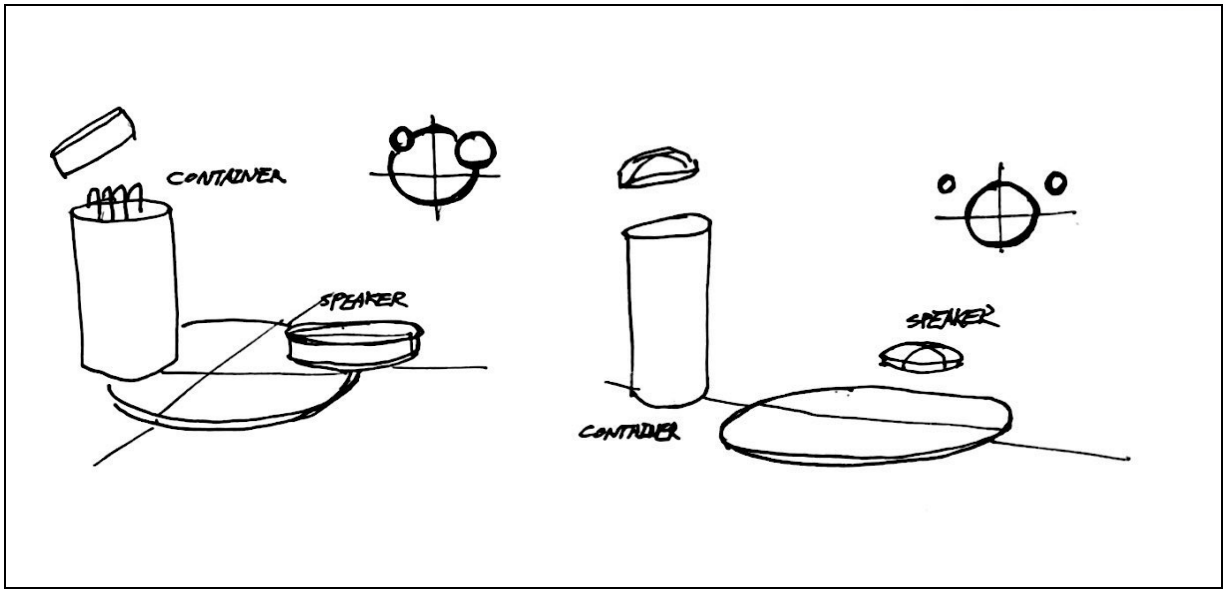


Figure 4. A Type of concept sketch

B Type Concept: Partially separated. (Thick plate with a built-in speaker, Stick container)

After the concept of A type, I decided to put the speaker on the plate. As a result, the plate thickness was naturally thicker than that of the A type. Expected the height of 4 ~ 8cm, the concept evolved. In the case of stick container, the unnecessary lid was removed, and a form in which the hole perforated in the plate may act as a container due to the height of the plate could be proposed.

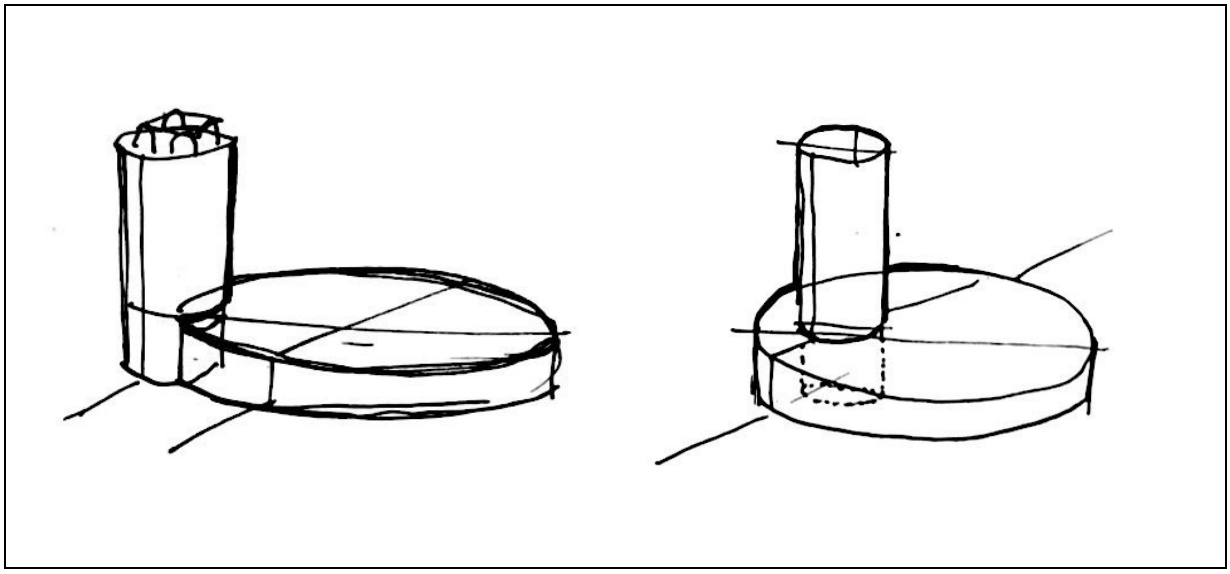


Figure 5. B Type of concept sketch

C Type Concept: All in one. (Final Concept)

Complementing the A type concept and the B type concept, the speaker was finally integrated into the plate and developed a design concept where four sticks could be inserted at the same time. Although there were various forms, the development was carried out by adopting cyan that would not interfere with the space where the bar would interact, that is, cyan where the bar would be attached to the edge of the circular body.

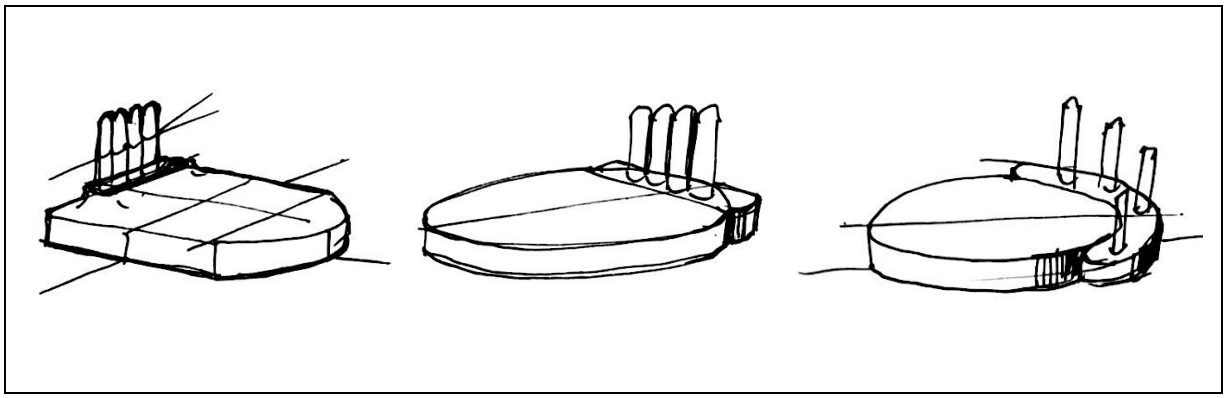


Figure 6. C Type of concept sketch

Production trial and error

There have been several trials and errors in the realization of the concept. The low level of problems included the size of the product, considering the stick being thrown freely, and the hole and strength of the material connecting the top and bottom plates. Furthermore, there was a problem discovered through the first prototyping. First, due to the distance between the station and the main body, the sensor did not recognize it and changed the position of the column and processed it again. Second, due to the position and strength of the magnets inserted inside the sticks, they stuck together when they were plugged into the station. (Figure00) Third, there was a lack of space between the sensors to be attached to the top plate and the module to be inserted inside, so it is rebuilt by using PCB. These problems could be improved to produce the final working prototype. After confirming that perfect working was done, the painting work was started.

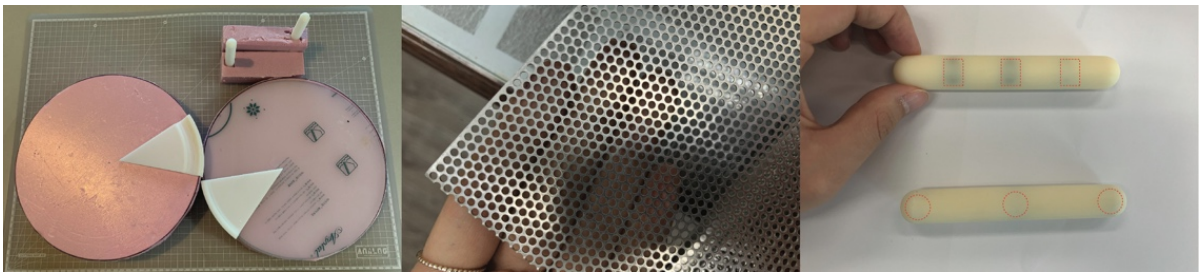


Figure 7. Rough prototype to determine size, material, size and strength.

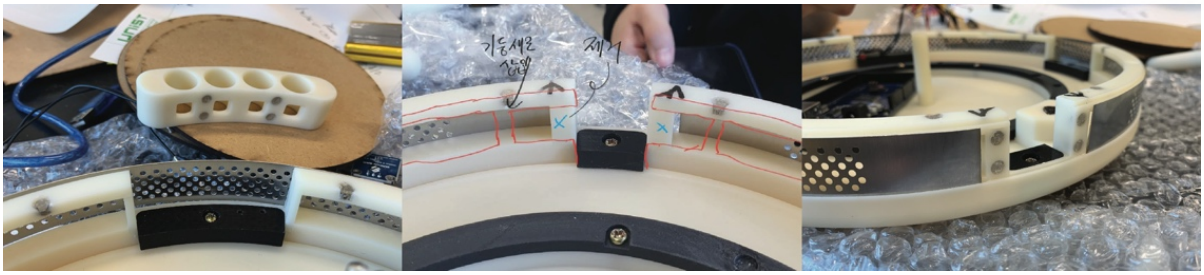


Figure 8. First prototype found sensor recognition problem.

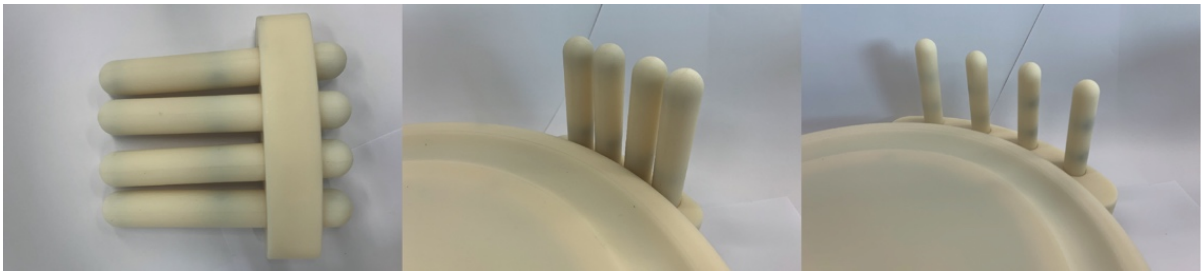


Figure 9. First prototype found interference problems between sticks

Figure 10. First prototype found a conflict between internal modules

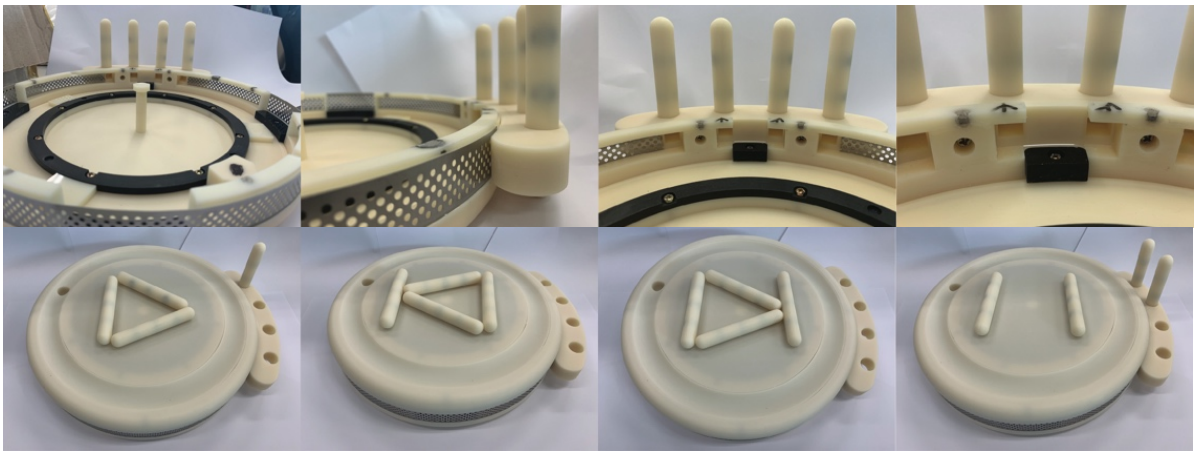


Figure 11. Build and test a final prototype that complements the fix. (Just before painting)

3.2.2 Design Features

This working prototype is designed as a research product to see how the user's emotions and product evaluations change according to the interaction reflecting the three elements of the aesthetic interaction when it is applied to the player which provides music to the user.

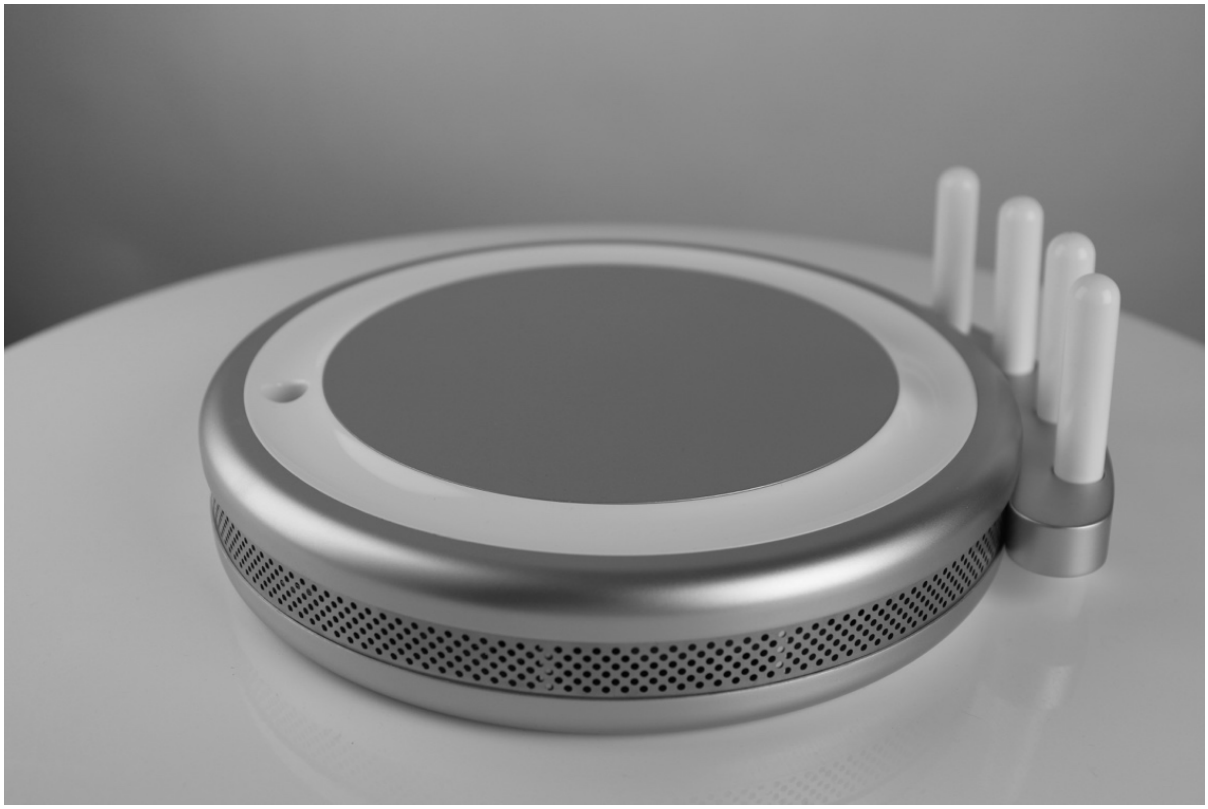


Figure 12. Final working prototype

Figure 13. Final working prototype (zoom view)

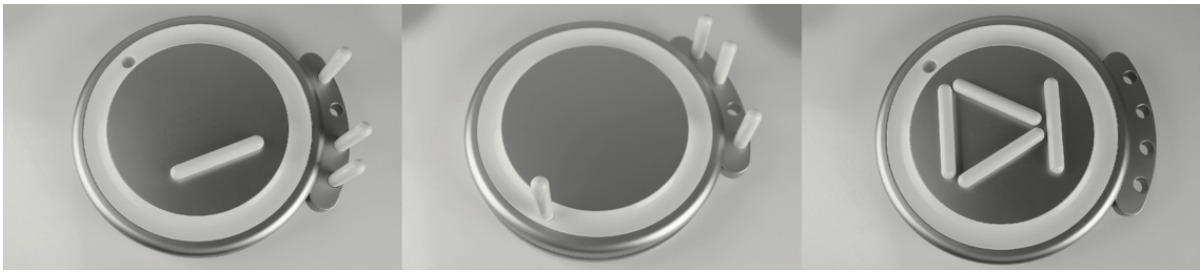


Figure 14. Final working prototype testing

3.2.3 Use of Prototype

Freedom of interaction

The user picks up the stick on the play icon and throws it on the silver plate to start running the product. Then, to execute any other desired function, simply pick the bar on the icon and just throw it. However, you need to pick a different stick after putting the stick back in place.

Figure 15. Use of prototype - freedom of interaction

Interaction pattern

The user picks up the stick on the play icon, plugs it into a hole in the white rotating part, and rotates it once. Then, to execute other desired functions, plug the used stick into place, select the stick in the same way, insert it into the hole and rotate it one turn to execute the function.

Figure 16. Use of prototype - Interaction pattern

Richness of motor-action

The user needs to create an icon shape that we know as play, pause, previous, and next, with four bars plugged in to run the desired function.

Figure 17. Use of prototype - richness of motor-action

3.2.4 Implementation

Hardware

The main body of the product is a symmetrical top plate (b, c, d) and bottom plate (b ', c', d ') centered on a 20 mm sus strip (a) in which 2 ø holes are etched to make sound easier. In the upper plate (b, c, d), freedom of interaction and interaction pattern are possible among aesthetic interactions, and in the lower plate (b ', c', d '), richness of motor-action is possible. First, the top plate (b, c, d) can be opened and closed like lid. This is because the internally mounted mp3 chip (figure20.e) must be replaced each time the participant changes. In this module, 6 songs from the experiment participants is added and stored. It's also because repairs are needed for any failures that may occur. b and b ’are the frame of the product and do not have any special features. In the case of c, a neodymium magnet is mounted directly underneath the hall to enable the 'interaction pattern', which is activated immediately after passing through the hall sensor (figure20.h). Participants can rotate it by plugging in stick (f). In the case of 'c’', it doesn't have to turn when the 'Richness of motor-action' is executed, so it's the same shape as the top plate but it doesn't rotate. 'd' is where bar (f) is thrown when performing freedom of interaction. The hall sensor (figure20.h) is attached directly underneath to recognize the impact of the impact. 'd’' is where the sticks (f) are placed during the richness of motor-action. The cylindrical shaped neodymium (figure20.g) embedded in the stick (f) and the flat neodymium (figure20.g) attached to the back of the d 'are attached to each other, and the hall sensor operates when the magnet is released at the designated position. (figure 21) 'e' is the station to which sticks (f) are plugged. The play, pause, previous, and next icons are ‘colorease’ because the interaction on the top should look as if each function had been assigned to each bar. In fact, each bar does not have a function, but rather a function that recognizes where the bar is missing. Thus, there are four holes at the edges of the main body, and the built-in hall sensor can recognize that each sticks (f) is inserted and removed through this hole. Sticks (f) have a cylindrical neodymium in the center and at both ends, which are only needed for richness of motor-action.

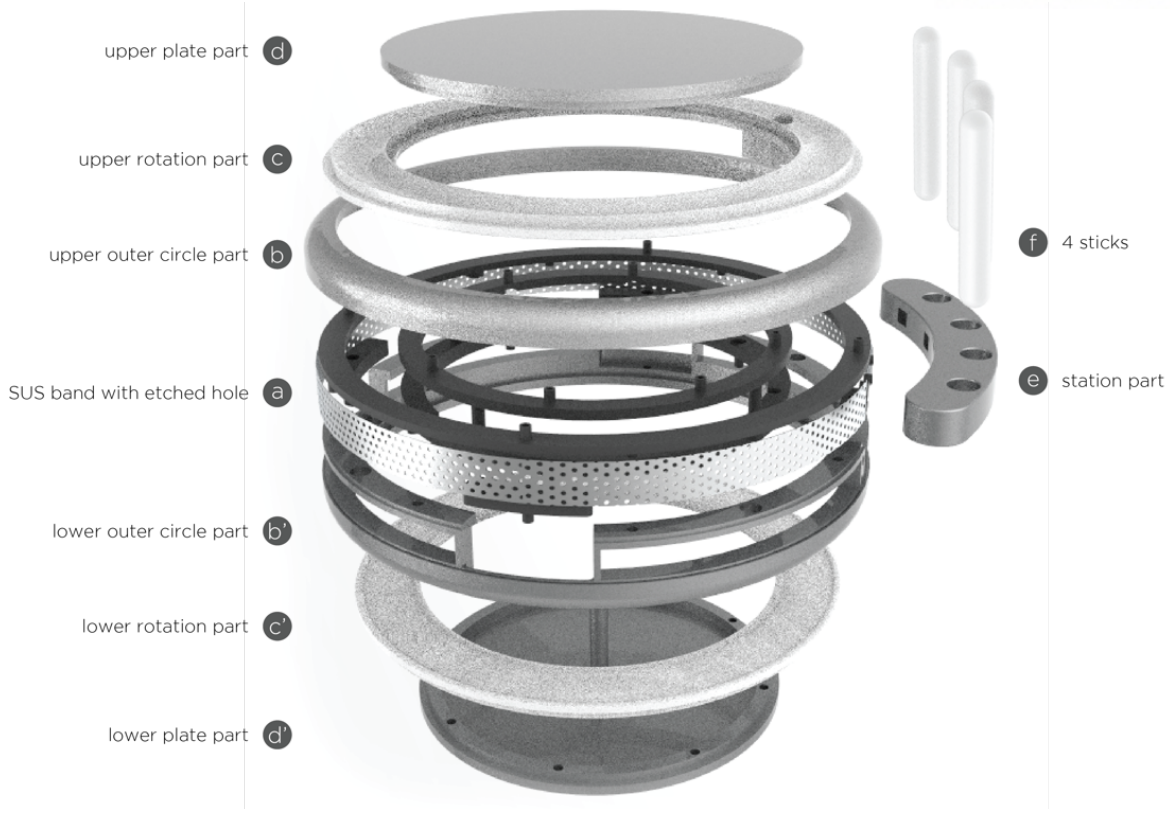


Figure 18. Exploded view of prototype

Figure 19. Assembly view of prototype

Figure 20. Internal components of prototype

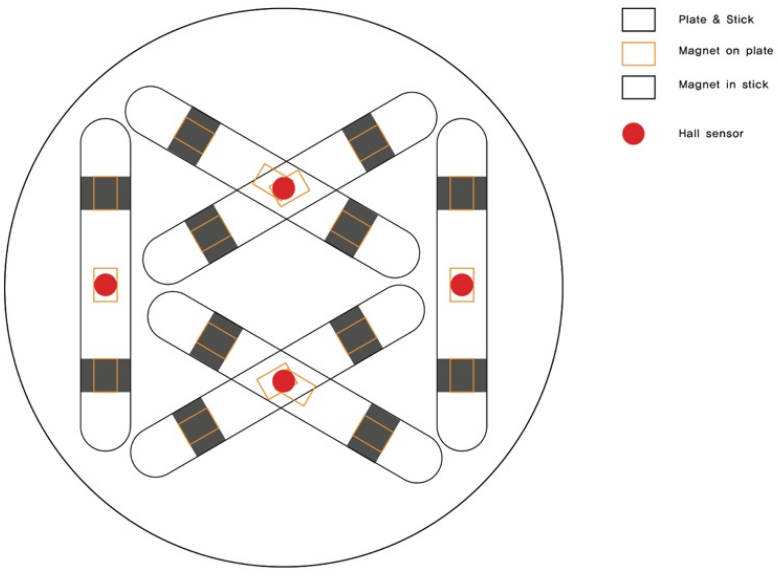


Figure 21. Position of neodymium magnet and hall sensor

Software

In order to facilitate the experiment of the three types of aesthetic interaction, a remote controller was needed to control all functions related to the product. So I used Android phone and BT chat application. (figure22) This allows the functions to be executed, stopped, and changed in variable values necessary for determining the status. Interaction experiment number was assigned. When an experiment is conducted on one interaction, the function for the other two interactions is disabled. This completely blocks malfunctions and variables that occur during the experiment. Number 1 is Aesthetic interaction 1: Freedom of interaction, number 2 is Interaction 2: Interaction pattern, number 3 is interaction 3: richness of motor-actions. For example, if you enter 1 in the input box of the phone, only the functions related to interaction1 are activated, and the functions for the remaining interactions 2 and 3 are deactivated.

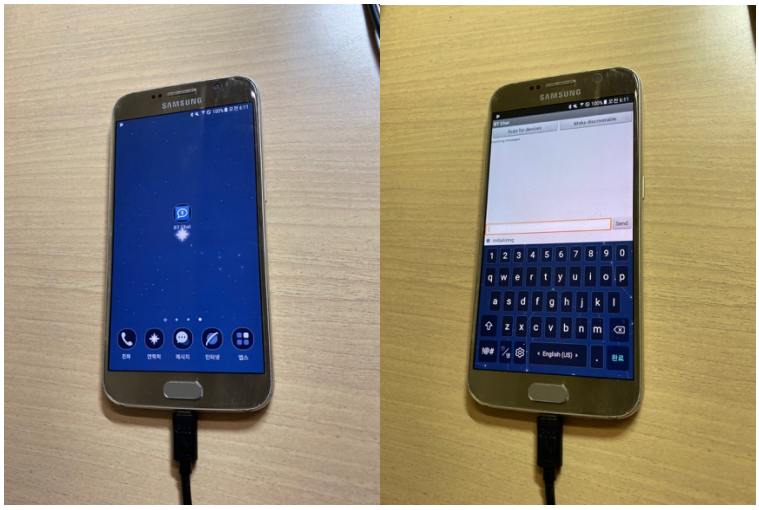


Figure 22. Phone and BT-chat used in the experiment

3.3 User Study

3.3.1 Participants

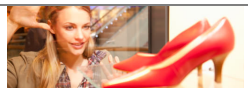
The experiment lasted for 10 days and included 48 students who liked and enjoyed music at UNIST. (22 women, 26 men, their ages were 19-29 years old.) Prior to the experiment, they were asked for six favorite songs these days. The received playlist is inserted into the mp3 module of the product. This was to give the user an emotional familiarity as if it were their personal product.

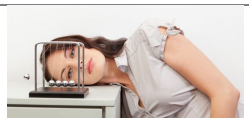
3.3.2 Material for Measurement

Emotion self-report

The main goal was to get information about what emotions dominated by aesthetic interaction. The emotions given for users to choose were six positive emotions (desire, satisfaction, pride, hope, joy, fascination) and six negative emotions (disgust, dissatisfaction, fear, shame, boredom) used in PreEmo. Table 3 is a detailed description and image of the emotions that users have received. This information was delivered via ppt to the MacBook, and the user was asked to be fully aware before using the product. Occasionally, if a user wants to be reminded in writing a self-emotion report after using the product, the image and explanation can be shown again or a question can be asked. The user then wrote a five-point measure of emotion, written in a Google form, after sufficient product use. (Measured from 1 to 5, meaning that the closer the emotion is to 1, the smaller the emotion is; the closer to 5, the stronger the emotion.)

Table 3. 12 emotions presented to participants

Emotion	Explanation	Image
Desire	Desire is experiencing a strong wish for something to happen or to enjoy, and the urge to consume or own something.	
Satisfaction	Satisfaction is enjoying the recent fulfillment of a need, expectation, or desire.	
Pride	Pride is enjoying a sense of self-worth or achievement and feeling vigorous.	
Hope	Hope is a feeling of desire and expectation that things will go well in the future.	
Joy	Joy is a feeling of great happiness.	
Fascination	Fascination is the state of being greatly interested in or delighted by something.	
Disgust	Disgust is a feeling of very strong dislike or disapproval (=revulsion)	
Dissatisfaction	The feeling of being unfulfilled when something happens that is different from what you expected. You	

	feel that it should be changed to meet your expectations.	
Fear	The feeling when you encounter or think about a thing or person that can harm you. You have the urge to avoid or get away from the threat.	
Shame	Shame is an uncomfortable feeling that you get when you have done something wrong or embarrassing, or when someone close to you has.	
Boredom	The feeling when there is nothing interesting or engaging for you to do.	
Sadness	Sadness is an emotional pain associated with, or characterized by, feelings of disadvantage, loss, despair, grief, helplessness, disappointment and sorrow.	

Semantic Differentials scale

In addition to the emotions the user receives through aesthetic interaction, 29 different semantic differential scales were used to determine how the evaluation of the product would vary. This is an easy measuring tool and method to assess the meaning and impression of a product by contrasting opposing adjectives at a glance. There are four types of social values and positions (SVP), usability and interaction (UI), qualities of form (QF) and personality characteristics (PC), each containing 5, 8, 6, and 10 adjective pairs. This is a seven-point scale. It is neutral to feel that 4 points do not correspond to either emotion. Based on this, 3 and 5, 2 and 4, and 1 and 6 were pairs of the same intensity, and in order, the intensity of emotion is strong.

3.3.3 Procedure

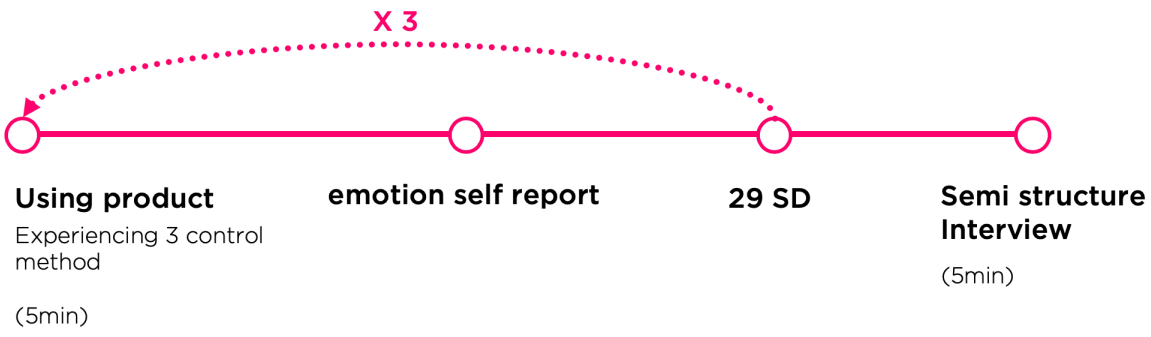


Figure 23. Experiment Procedure

Participants are not told at all about the concept of aesthetic interaction. They are told that they will experience three ways to control music. Participants are then provided with information on 12 emotions. The participants were then asked to use each interaction method in less than five minutes. They were then asked to create a 5-point scale for feelings immediately after use, followed by 29SD. After going through this process three times because it was three methods, the participant had a short semi structure interview of five minutes. The interview was recorded for qualitative analysis.

4

Results

- 4.1 Measuring Emotions
- 4.2 Semantic Differentials Scale
- 4.3 Affinity Diagram

4

Results

4.1 Measuring Emotions

The Friedman test was performed using SPSS to identify the emotional differences between the three different interaction methods. (A detailed Friedman test analysis of Emotion is attached to the appendix.) Because the population does not follow a normal distribution, we chose the Friedman test, a nonparametric test of ANOVA. The independent variable is a stimuli with three different aesthetic interaction methods, and the dependent variable is 12 different emotions (positive emotion: 6, negative emotion: 6). The population is a random sample.

Figure 24 shows the mean value of the 48 subjects' emotions for each of the three stimuli. The three Stimuli have the fact that each triggers a different intensity of emotion. In the case of positive emotions, all three stimuli showed statistically significant differences. (Positive emotion: Asymp. Sig. = 0.000, $p < 0.01$). Among them, Stimuli 3 had significantly higher levels of positive emotions of all kinds compared to the other two stimuli. In particular, the values for Joy and fascination are the highest. (Joy: M = 4.50, SD = 0.652, fascination: M = 4.04, SD = 0.944). Stimuli1 has the same curvature as Stimuli3, but the numbers are slightly lower. (Joy: M = 4.27, SD = 0.893, fascination: M = 3.65, SD = 0.978). On the other hand, Stimuli2 showed all positive emotions as low as 3 or less on average, and Joy only showed 3 or higher. (Joy: M = 3.46, SD = 1.184). Overall, the three stimuli showed high Joy and Fascination, and the lowest pride and hope. (Stimuli1; pride: M = 3.06, SD = 1.156, hope: M = 3.27, SD = 0.984, Stimuli2; pride: M = 2.50, SD = 1.011, hope: M = 2.54, SD = 0.967, Stimuli3; pride: M = 3.54, SD = 1.091, hope: M = 3.67, SD = 0.930). (see table4, 5)

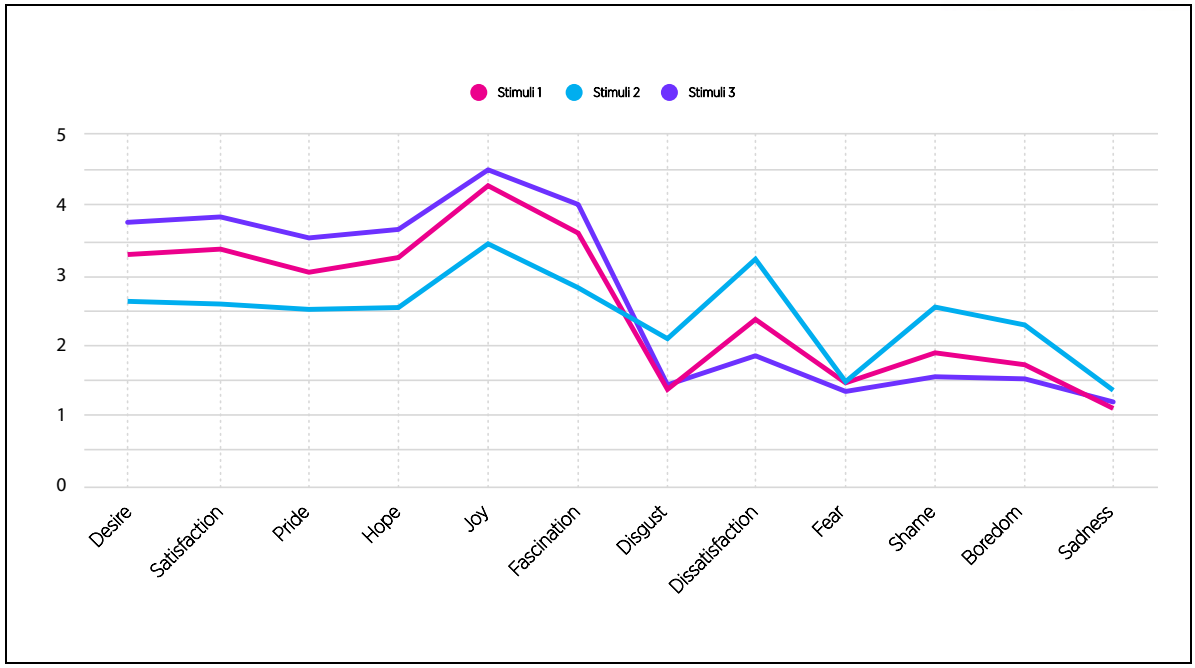


Figure 24. Emotional responses to the three of aesthetic interaction

For negative emotions, the three stimuli showed statistically significant differences except fear (Asymp.Sig = 0.664, $p < 0.05$) and sadness (Asymp.Sig = 0.062, $p < 0.05$). (All three stimuli had very low levels of fear and sadness with $M \leq 1.5$). In the case of Stimuli2, Dissatisfaction (M = 3.25, SD = 1.313), Shame (M = 2.56, SD = 1.382 and Boredom (M = 2.33, SD = 1.136) were relatively higher than those of the other two stimuli. On the other hand, dissatisfaction (M = 1.85, SD = 1.072), which was the highest in stimuli3, was about 2 times lower than that of Stimuli2, ie the least negative of the three stimuli.

Table 4. Emotion Descriptive Statistics

Emotion Descriptive Statistics

	Stimuli 1 (Freedom of Interaction) (n = 48)		Stimuli 2 (Interaction pattern) (n = 48)		Stimuli 3 (Richness of motor-skill) (n = 48)	
Measure	**M**	**SD**	**M**	**SD**	**M**	**SD**
Desire	3.31	0.993	2.63	1.003	3.75	1.021
Satisfaction	3.40	1.125	2.58	1.145	3.85	0.799

Pride	3.06	1.156	2.50	1.011	3.54	1.091
Hope	3.27	0.984	2.54	0.967	3.67	0.930
Joy	4.27	0.893	3.46	1.184	4.50	0.652
Fascination	3.65	0.978	2.83	1.098	4.04	0.944
Disgust	1.42	0.613	2.10	1.134	1.46	0.771
Dissatisfaction	2.38	1.104	3.25	1.313	1.85	1.072
Fear	1.50	0.945	1.50	0.825	1.35	0.699
Shame	1.90	1.096	2.56	1.382	1.56	0.848
Boredom	1.73	0.917	2.33	1.136	1.52	0.772
Sadness	1.10	0.309	1.35	0.729	1.19	0.445

*p < .05. **p < .01.

Table 5. Emotion Test Statistics

Emotion test statistics				
Measure	N	Chi-Square	df	Asymp. Sig.
Desire	48	34.188	2	0.000**
Satisfaction	48	29.213	2	0.000**
Pride	48	27.79	2	0.000**
Hope	48	34.483	2	0.000**
Joy	48	33.831	2	0.000**
Fascination	48	31.191	2	0.000**
Disgust	48	19.763	2	0.000**
Dissatisfaction	48	29.156	2	0.000**
Fear	48	0.818	2	0.664
Shame	48	21.236	2	0.000**
Boredom	48	16.993	2	0.000**
Sadness	48	5.547	2	0.062

*p < .05. **p < .01.

4.2 Semantic Differentials Scale

To determine the semantic differences in the types of aesthetic interactions in providing an auditory experience, 29 semantic differentials were used to measure the meaning of the product delivered in each type of stimuli. Participants responded to 29 pairs of 29 corresponding adjectives and all responses were coded with a total of 7 points. Four points are the median between these two adjectives. Figure 25 below shows the average response of 48 participants. It can be seen at a glance that there are significant differences in 29 items among the three stimuli.

As with the measurement of Emotion, the population does not follow a normal distribution, so the Friedman test, a nonparametric test of ANOVA, is performed. In addition, the analysis is divided into four categories: social value and position, usability and interaction, quality of form, and personality characteristic. First, measure the differences in terms of social value and position when the auditory experience is delivered according to the type of aesthetic interaction. Table 7 shows statistically significant differences among all five SVP values (SVP: Asymp. Sig. = 0.000, $p < 0.01$). (see the Table 7) Participants experienced the interaction of Stimuli1, which has the property of Freedom of Interaction, and stimuli3, which had the property of richness of motor action. They felt that the product was contemporary, high technology and judged to be close to high class, expensive and global. Stimuli3 was more dominant between stimuli1 and stimuli3, and participants felt the most 'contemporary' of the five SVPs ($M = 5.75$, $SD = 1.212$). In the case of stimuli2, which has the property of interaction pattern, all SVP values are close to 4, so there is no significant semantic characteristic for SVP. However, it was judged as the most traditional among the three stimuli ($M = 5.69$, $SD = 1.114$).

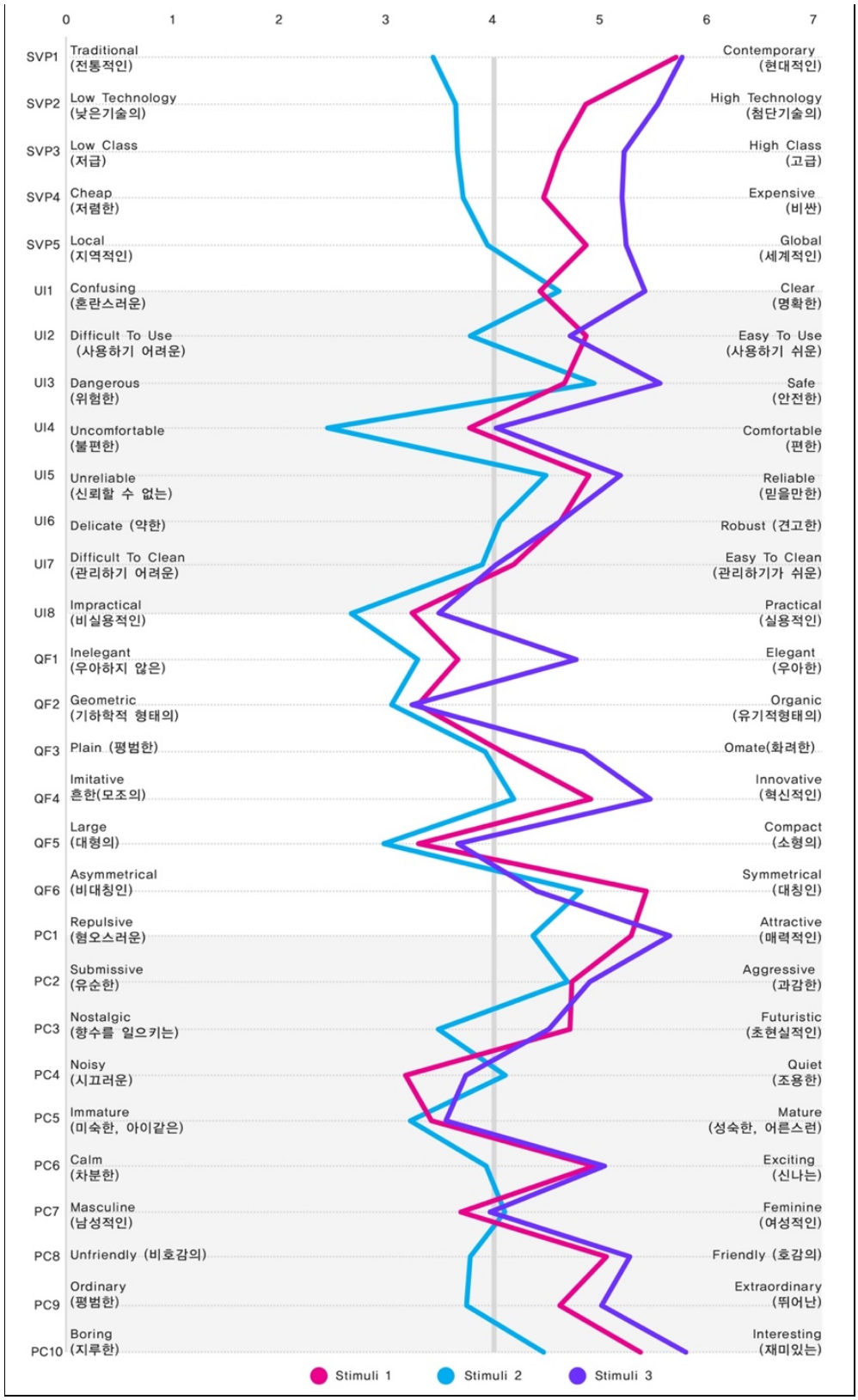


Figure 25. 29 Semantic Differential scale to the three of aesthetic interaction

Table 6. 29SD Test Statistics

29SD Test statistics					
	Measure	N	Chi-Square	df	Asymp. Sig.
SVP-1	**Traditional / Contemporary**	48	53.460	2	0.000**
SVP-2	**Low Technology / High Technology**	48	40.792	2	0.000**
SVP-3	**Low Class / High Class**	48	32.955	2	0.000**
SVP-4	**Cheap / Expensive**	48	37.097	2	0.000**
SVP-5	**Local / Global**	48	29.762	2	0.000**
UI-1	**Confusing / Clear**	48	11.231	2	0.004**
UI-2	**Difficult to Use / Easy to Use**	48	10.272	2	0.006**
UI-3	**Dangerous / Safe**	48	5.623	2	0.060
UI-4	**Uncomfortable / Comfortable**	48	25.148	2	0.000**
UI-5	**Unreliable / Reliable**	48	13.733	2	0.001**
UI-6	**Delicate / Robust**	48	4.971	2	0.083
UI-7	**Difficult to Clean / Easy to Clean**	48	2.028	2	0.363
UI-8	**Impractical / Practical**	48	16.155	2	0.000**
QF-1	**Inelegant / Elegant**	48	29.862	2	0.000**
QF-2	**Geometric / Organic**	48	3.267	2	0.915
QF-3	**Plain / Ornate**	48	12.416	2	0.002**
QF-4	**Imitative / Innovative**	48	25.480	2	0.000**
QF-5	**Large / Compact**	48	6.513	2	0.039*
QF-6	**Asymmetrical / Symmetrical**	48	20.364	2	0.000**
PC-1	**Repulsive / Attractive**	48	40.460	2	0.000**
PC-2	**Submissive / Aggressive**	48	2.556	2	0.279
PC-3	**Nostalgic / Futuristic**	48	12.116	2	0.002**
PC-4	**Noisy / Quiet**	48	9.391	2	0.009**
PC-5	**Immature / Mature**	48	4.101	2	0.129
PC-6	**Calm / Exciting**	48	14.627	2	0.001**
PC-7	**Masculine / Feminine**	48	1.867	2	0.393
PC-8	**Unfriendly / Friendly**	48	35.932	2	0.000**
PC-9	**Ordinary / Extraordinary**	48	33.179	2	0.000**
PC-10	**Boring / Interesting**	48	30.263	2	0.000**

*$p < .05$. **$p < .01$.

Table 7. 29 SD Descriptive Statistics [SVP]

29 SD Descriptive statistics [SVP]										
SVP source	Stimuli	Ranks	N	Mean	Std Deviation	Mini-mum	Maxi-mum	Percentiles		
		Mean rank						25th	50th (Median)	75th
Traditional/ Contemporary	S1	2.34	48	5.69	1.114	2	7	5	6	6
	S2	1.21	48	3.48	1.637	1	7	2	3	5
	S3	2.45	48	5.75	1.212	2	7	5	6	7
Low Technology /High Technology	S1	2.09	48	4.85	1.458	1	7	4	5	6
	S2	1.38	48	3.67	1.730	1	7	2	4	5
	S3	2.53	48	5.54	1.304	2	7	5	6	7
Low Class / High Class	S1	2.07	48	4.65	1.296	1	6	4	5	6
	S2	1.44	48	3.69	1.417	1	7	3	4	5
	S3	2.49	48	5.23	1.077	2	7	5	5	6
Cheap/ Expensive	S1	1.95	48	4.52	1.255	2	7	4	5	5
	S2	1.49	48	3.75	1.391	1	6	3	3	5
	S3	2.56	48	5.23	1.035	3	7	5	5	6
Local / Global	S1	2.04	48	4.87	1.196	2	7	4	5	6
	S2	1.50	48	3.92	1.381	1	6	3	4	5
	S3	2.46	48	5.25	1.120	2	7	5	5	6

This study measures the semantic differences in terms of Usability and Interaction when an auditory experience is made through Stimuli, which has three different aesthetic interactions. 'Dangerous – Safe' (Asymp. Sig = 0.06, $p < 0.05$), 'Delicate-Robust' (Asymp.Sig = 0.083, $p < 0.05$), and 'Difficult to Clean-Easy to Clean' (Asymp. Sig = 0.363 , $p < 0.05$), and there were no statistically significant differences in the three items. Participants felt that all three stimuli were close to safe and robust, and neither was easy nor difficult for Clean. On the other hand, stimuli2 and stimuli3 were the salient features of the remaining five semantic items with significant differences. In the case of stimuli2, uncomfortable (M = 3.83, SD = 1.642) was most dominant, followed by impractical (M = 3.31, SD = 1.401). Stimuli3 felt clear without any confusion when compared to the rest of the stimuli (M = 5.44, SD = 1.236) and felt trustworthy. (M = 5.21, SD = 1.148)

Table 8. 29 SD Descriptive Statistics [UI]

29 SD Descriptive statistics [UI]

UI source	Stimuli	Ranks	N	Mean	Std Deviation	Mini-mum	Maxi-mum	Percentiles		
		Mean rank						25th	50th (Median)	75th
Confusing / Clear	S1	1.79	48	4.48	1.473	2	7	3	5	5.75
	S2	1.85	48	4.60	1.723	1	7	3	5	6
	S3	2.35	48	5.44	1.236	2	7	5	6	6
Difficult To Use / Easy To Use	S1	2.19	48	4.90	1.601	2	7	3	5	6
	S2	1.65	48	3.81	1.875	1	7	2	3	6
	S3	2.17	48	4.77	1.666	2	7	3	5	6
Dangerous / Safe	S1	1.83	48	4.69	1.728	1	7	3	5	6
	S2	1.94	48	4.98	1.682	2	7	3.25	5	6.75
	S3	2.23	48	5.56	1.183	3	7	5	6	6.75
Uncomfortable / Comfortable	S1	2.24	48	3.83	1.642	1	7	2.25	3	5
	S2	1.46	48	2.44	1.319	1	6	2	2	3
	S3	2.30	48	4.06	1.719	1	7	3	4	5.75
Unreliable / Reliable	S1	2.06	48	4.90	1.387	1	7	4	5	6
	S2	1.66	48	4.46	1.336	1	6	3.25	5	6
	S3	2.28	48	5.21	1.148	2	7	5	5	6
Delicate / Robust]	S1	2.07	48	4.65	1.509	2	7	3	5	6
	S2	1.78	48	4.10	1.462	2	6	3	4	5.75
	S3	2.15	48	4.65	1.280	2	7	4	5	5
Difficult To Clean / Easy To Clean	S1	2.13	48	4.19	1.709	1	7	3	4.5	6
	S2	1.83	48	3.87	1.525	1	7	3	4	5
	S3	2.00	48	4.04	1.663	2	7	2	4	5
Impractical / Practical	S1	2.18	48	3.31	1.401	1	7	2	3	4
	S2	1.59	48	2.65	1.296	1	6	2	2	3
	S3	2.23	48	3.50	1.488	1	6	2	3	5

Next, measure the difference in terms of product quality. There was no statistical difference in feeling that all 3stimuli were Geometric (Asymp = 0.915, p <0.05), but statistically significant difference for the other five semantic items. Most notable features include Stimuli3 Innovative (M = 5.48, SD = 1.111), Ornate (M = 4.77, SD = 1.341), Elegant (M = 2.54, SD = 1.246) and Stimuli2 Large (M = 3.29). , SD = 1.501) and Inelegant (M = 3.73, SD = 1.554). Stimuli1 compared with stimuli2 and stimuli3, the semantic value was the median between the two values, but for the 'asymmetrical-symmetrical' (M = 4.79, SD = 1.429) category, it was the most dominant of the three and felt close to symmetrical.

Table 9. 29 SD Descriptive Statistics [QF]

29 SD Descriptive statistics [QF]

QF source	Stimuli	Ranks	N	Mean	Std Deviation	Mini-mum	Maxi-mum	Percentiles		
		Mean rank						25th	50th (Median)	75th
Inelegant / Elegant	S1	1.93	48	3.73	1.554	1	7	2.25	4	5
	S2	1.53	48	3.33	1.478	1	6	2	3	4.75
	S3	2.54	48	2.54	1.246	1	7	4	5	6
Geometric / Organic	S1	1.90	48	3.23	1.519	1	7	2	3	4
	S2	2.17	48	3.40	1.484	1	6	2	3	5
	S3	1.94	48	3.21	1.543	1	7	2	3	4
Plain / Ornate	S1	1.84	48	4.06	1.210	2	6	3	4	5
	S2	1.79	48	3.92	1.412	1	6	3	4	5
	S3	2.36	48	4.77	1.341	2	7	4	5	6
Imitative / Innovative	S1	2.05	48	4.94	1.262	2	7	4	5	6
	S2	1.52	48	4.21	1.458	1	6	3	5	5
	S3	2.43	48	5.48	1.111	2	7	5	6	6
Large / Compact	S1	1.99	48	3.29	1.501	1	6	2	3	4.75
	S2	1.80	48	2.96	1.429	1	6	2	3	4
	S3	2.21	48	3.67	1.506	1	6	2	4	5
Asymmetrical / Symmetrical	S1	2.42	48	5.44	1.147	3	7	5	6	6
	S2	1.92	48	4.79	1.429	1	7	4	5	6
	S3	1.67	48	4.38	1.453	2	7	3	4	5

Finally, we measure the differences of stimuli for the product characteristics with 10 opposing adjectives. There was no statistically significant difference in Submissive- Aggressive (Asymp = 0.279, p <0.05), Immature-Mature (Asymp = 0.129, p <0.05), and Masculine-Feminine (Asymp = 0.393, p <0.05). All three Stimuli felt close to 4 on all three, slightly aggressive, close to immature, and almost perfectly neutral. Looking at the remaining seven items with statistically significant differences, Stimuli3 is attractive (M = 5.65, SD = 0.934), exciting (M = 5.04, SD = 1,271), friendly (M = 3.77, SD = 1.325), interesting The values for (M = 5.79, SD = 0, .944) were dominant over the other two stimuli. For the remaining stimuli, stimuli1 felt noisy (M = 3.15, SD = 1.473) strongly, but not stimuli2, but stimuli2 felt nostalgic (M = 3.46, SD = 1.398).

Table 10. 29 SD Descriptive Statistics [PC]

29 SD Descriptive statistics [PC]

PC source	Stimuli	Ranks	N	Mean	Std Deviation	Mini-mum	Maxi-mum	Percentiles		
		Mean rank						25th	50th (Median)	75th
Repulsive / Attractive	S1	2.13	48	5.31	0.926	3	7	5	5	6
	S2	1.40	48	4.37	1.123	2	6	4	4	5
	S3	2.48	48	5.65	0.934	4	7	5	6	6
Submissive / Aggressive	S1	1.91	48	4.75	1.407	2	7	4	5	6
	S2	1.93	48	4.69	1.240	2	7	4	5	6
	S3	2.17	48	4.83	1.449	1	7	4	5	6
Nostalgic / Futuristic	S1	2.14	48	4.67	1.059	2	7	4	5	5
	S2	1.64	48	3.46	1.398	1	6	2	3	5
	S3	2.23	48	4.46	1.584	1	7	4	5	5
Noisy / Quiet	S1	1.71	48	3.15	1.473	1	6	2	3	4
	S2	2.26	48	4.13	1.453	2	7	3	4	5
	S3	2.03	48	3.81	1.179	2	7	3	4	5
Immature / Mature	S1	2.06	48	3.46	1.473	1	6	2	3	4.75
	S2	1.80	48	3.25	1.466	1	6	2	3	4
	S3	2.14	48	3.50	1.368	1	6	2	4	4
Calm / Exciting	S1	2.14	48	5.02	1.329	1	7	5	5	6
	S2	1.60	48	3.96	1.329	1	6	3	4	5
	S3	2.26	48	5.04	1.271	2	7	5	5	6
Masculine / Feminine	S1	1.88	48	3.69	1.035	1	7	3	4	4
	S2	2.04	48	4.04	1.304	1	7	3	4	5

	S3	2.08	48	4.00	0.923	2	7	4	4	4
Unfriendly / Friendly	S1	2.20	48	5.06	0.998	2	7	5	5	6
	S2	1.40	48	3.77	1.325	1	6	3	4	5
	S3	2.41	48	5.31	0.903	3	7	5	5	6
Ordinary / Extraordinary	S1	2.09	48	4.65	1.021	2	6	4	5	5
	S2	1.47	48	3.75	1.120	1	5	3	4	5
	S3	2.44	48	5.04	1.148	3	7	4	5	6
Boring / Interesting	S1	2.08	48	5.38	1.044	2	7	5	5	6
	S2	1.49	48	4.48	1.353	2	7	3	5	6
	S3	2.43	48	5.79	0.944	3	7	5	6	6

4.3 Affinity Diagram

Retrospective interviews were briefly conducted after using the three stimuli to identify the auditory experience and impressions of the products according to each aesthetic interaction. In this interview, participants were asked what they experienced after using the product. Forty-eight subjects responded differently, and the words or expressions they mentioned were analyzed according to affinity diagram, divided according to whether they were positive or negative. The figures below are graphs of the results of the analysis, grouped by header keywords.

Figure 26 is a graph of the positive response to Stimuli1. (The number in parentheses below is the number of times mentioned) It can be seen that (24). First of all, the participants mentioned in the category of 'Evoke fun emotion' include 'Having fun' (2), 'Interesting' (5), 'Exciting' (2), and 'Like a board game' (2). , 'joy' (1), 'feeling a ride' (1), 'A feeling of drumming' (1), and 'Attractive' (1) and were included in the category of 'Arouse amazing emotions' The expressions were 'Amazing' (11), 'Innovative' (5), 'Be novel' (3), 'New' (2), 'Stimulates curiosity' (1), and 'Surprise' (1). Participants felt simple and efficient in terms of usability because 'the usage is simple and simple' (12), and the 'dominant opinion is that it is efficient due to few necessary movements' (6), 'practical' (4), The opinion that 'it is good to be able to throw' (2) followed. (See table11)

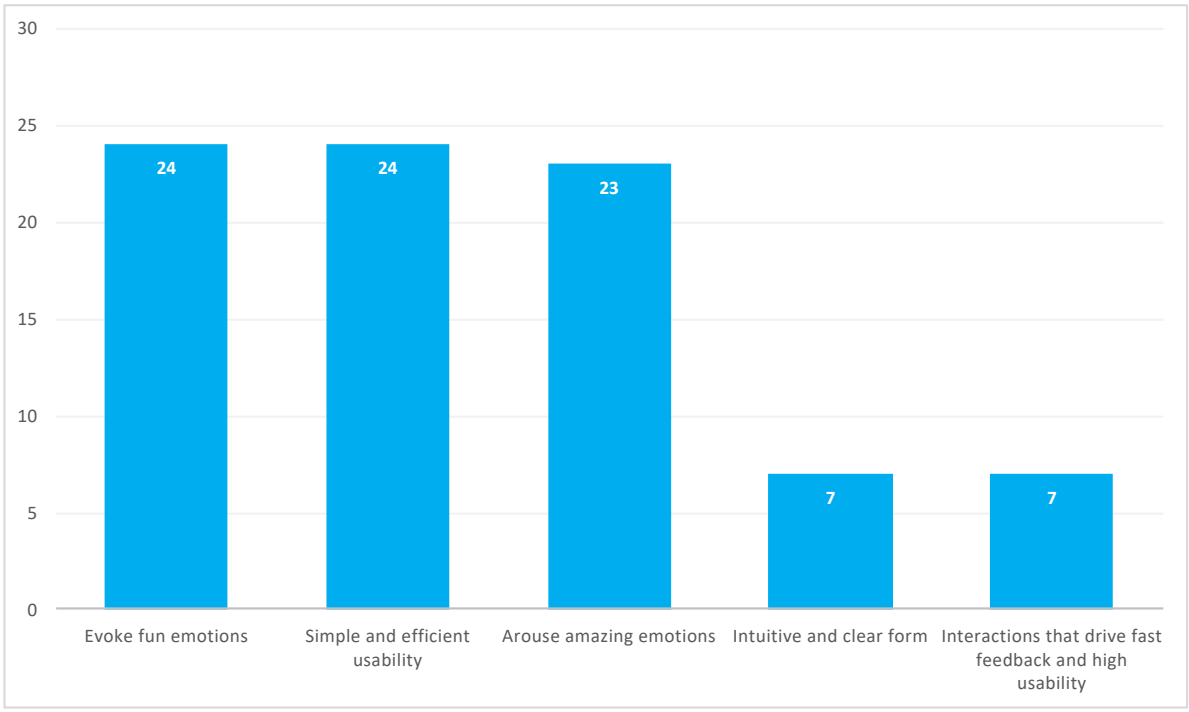


Figure 26. Frequency of positively describing to S1

Table 11. The results of coding of positive emotion of S1 (Freedom of Interaction)

The results of coding of positive emotion of S1 (Freedom of interaction)		
Header	Keyword	Mentioned number
Evoke fun emotions	Have fun	11
	Interesting	5
	Exciting	2
	Like a board game	2
	joy	1
	Feeling a Ride	1
	A feeling of drumming	1
	Attractive	1
Simple and efficient usability	This was simple and brief to use.	12
	It was efficient because it required the least number of actions	6
	This is practical	4
	Good for throwing	2

Arouse amazing emotions	Amazing	11
	Innovative	5
	Be novel	3
	new	2
	Stimulates curiosity	1
	surprise	1
Intuitive and clear form	Function is independent on each bar, so it can clarify.	4
	This has an intuitive interaction	2
	This is intuitive	1
Interactions that drive fast feedback and high usability	The reaction is fast.	2
	It means that I manipulate the product directly	2
	I can concentrate on music because I have to manipulate it with my own eyes	2
	I can feel the usage-feeling while using the tool	1

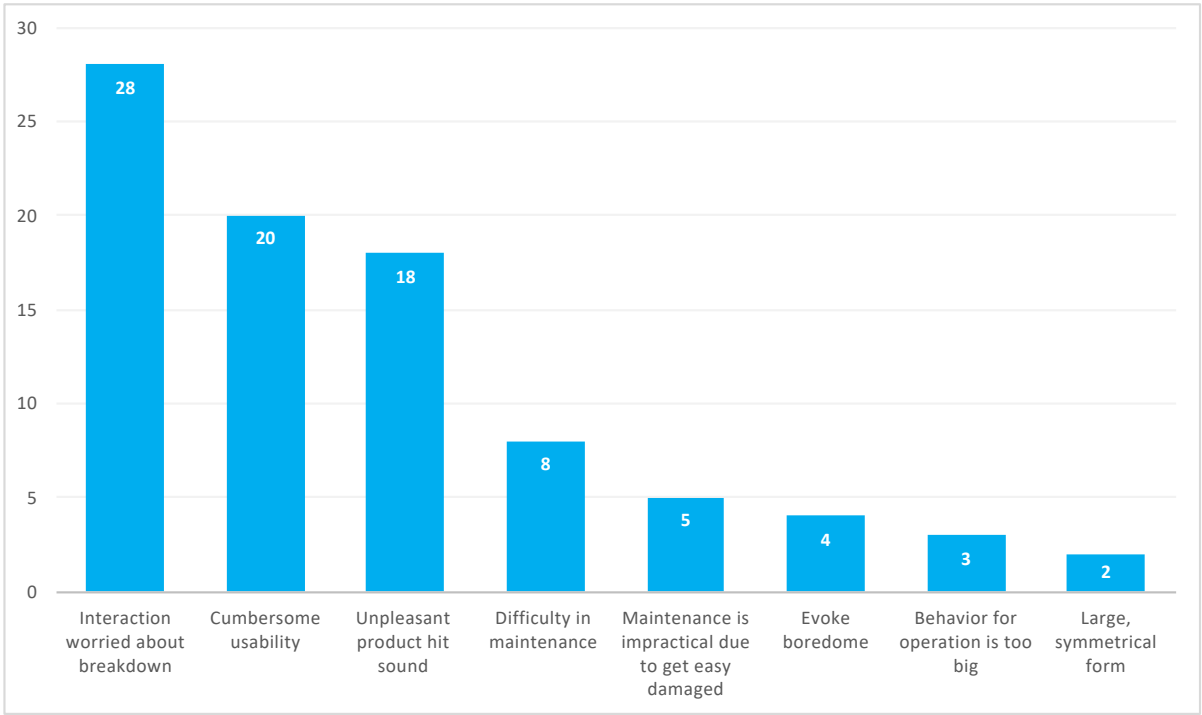


Figure 27. Frequency of negatively describing to S1

Table 12. The results of coding of negative emotion of S1 (Freedom of Interaction)

The results of coding of negative emotion of S1 (Freedom of interaction)		
Header	Keyword	Mentioned number
Interaction worried about breakdown	I am worried that this might break down.	13
	I had a trial-and-error to figuring out how intense the stick should be thrown.	8
	Be cautious when throwing a stick	4
	It feels like the stick is rolling down	2
	I worry that I will get hurt when I throw this.	1
Cumbersome usability	It is a hassle because the functions are independent on each stick.	12
	Using a throwing method is not intuitive.	4
	I was awkward to change the stick to work	3
	It was hard to use at first.	1
Unpleasant product hit sound	The sound of the sticks hitting the plate is disturbing	18
Difficulty in maintenance	It feels like I'm going to lose the sticks.	6
	It is likely to be difficult to distinguish if the sticks are mixed	2
Maintenance is impractical due to get easy damaged	the plate and sticks could easily get scratches	3
	Impractical.	2
Evoke boredom	boredom	2
	Chubby	1
	A blunt feeling.	1
Behavior for operation is too big	Behavior is dynamic.	3
Large, symmetrical form	Size is unnecessarily large	1
	The shape is too symmetrical overall.	1

Figure 27 is a graph of negative responses to Stimuli1. Participants felt “Interaction worried about breakdown” (28). 'I'm worried about the failure' (13) was a direct reference. He also recognized that music was an electronic product and recognized it as an electronic product, which caused him to 'try several times while grasping the strength of the rod' (8), 'be careful when throwing' (4), The feeling that the rod is likely to roll down (2) and the fear of being thrown away (1) were mentioned as failure factors. The reason why I felt troublesome about usability was because 'functions were independent of

each bar' (12). And as the rod hits the plate, I wrote, 'I felt an unpleasant' (18), about a particular blow, directly by nearly half of the participants. (See table12)

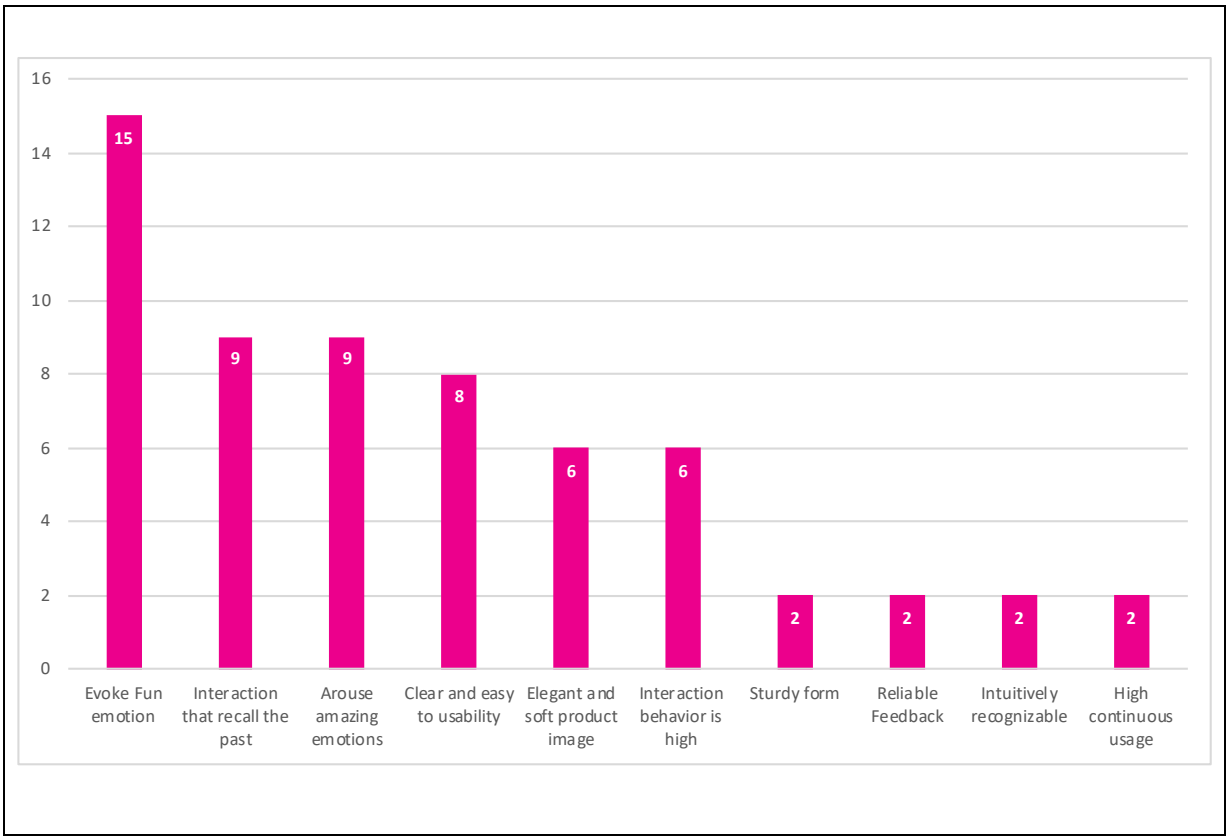


Figure 28. Frequency of positively describing to S2

Table 13. The results of coding of positive emotion of S2 (Interaction pattern)

The results of coding of positive emotion of S2 (Interaction pattern)		
Header	Keyword	Mentioned number
Evoke Fun emotion	Fun	12
	Interesting	1
	Feeling to cook	1
	Club DJ Feeling	1
Interaction that recall the past	the using method reminds people the click-wheel of iPod	4
	It delivers a good feeling over familiarity	3
	An old feeling	1
	It reminds people an old rotary dial phone.	1
Arouse amazing emotions	Novelties	6

	Stimulates curiosity	1
	Innovative	1
	special	1
Clear and easy to usability	The usage was clear	5
	The most logical way to work	1
	Easy to use	1
	Must be fully focused on use	1
Elegant and soft product image	Elegance	2
	Calmness	1
	Soft feeling	1
	The feeling of enjoying listening matches well with the softness of turning	1
	Low noise	1
Interaction behavior is high	Action is large and active	5
Sturdy form	It seems strong.	2
Reliable Feedback	A sense of accomplishment from being able to hold and turn	1
	High reliability	1
Intuitively recognizable	Easy to recognize	1
	Intuitive	1
High continuous usage	Useful	1
	Practical	1

Figure 28 shows the result of a positive response to Stimuli2. Stimuli 2 caused the participants to have the most fun (15). The direct mention of "Fun" was dominant (12), and there were mentions of "Feeling to cook" (1) and "Club DJ feeling" (1). The second most significant expression of experience was that the interaction patterns that were executed led users to recall the past (9). ‘Arouse amazing emotion’ (9). Participants first thought of the click-wheel of the iPod (4), and also mentioned that "there is a good feeling of familiarity" (3). There were also mentions of “I thought of the rotary dial” (1) and “I feel old” (1). In addition, the feeling of 'Amazing' (9) was conveyed due to 'Novelties' (6), 'Stimulates curiosity' (1), 'Innovative' (1), and 'Special' (1). (5), the expression 'interaction behavior is large and active' (5) shows that this acted as a positive element of experience. (See table13)

Figure 29 shows a graph of negative responses to Stimuli2. 'Uncomfortable and hard interaction' (48) was overwhelming than other positive expressions. The expression 'Turning a wheel is inconvenient'

(15) and 'Hard' (10) accounted for about half, followed by expressions such as 'stiff' (8) and 'not soft' (4). It took a lot of weight, and it was 'inefficient' (3), 'annoying' (2), 'annoying' (2), 'many unnecessary movements' (1) 'I feel like I'm exercising because I have a lot of movement' (The same expression as 1) is mentioned. In addition, in terms of UI, the rotating point is confusing (5), and in terms of interaction motion, it was expressed as 'I am ashamed to use it in front of people'. (See table14)

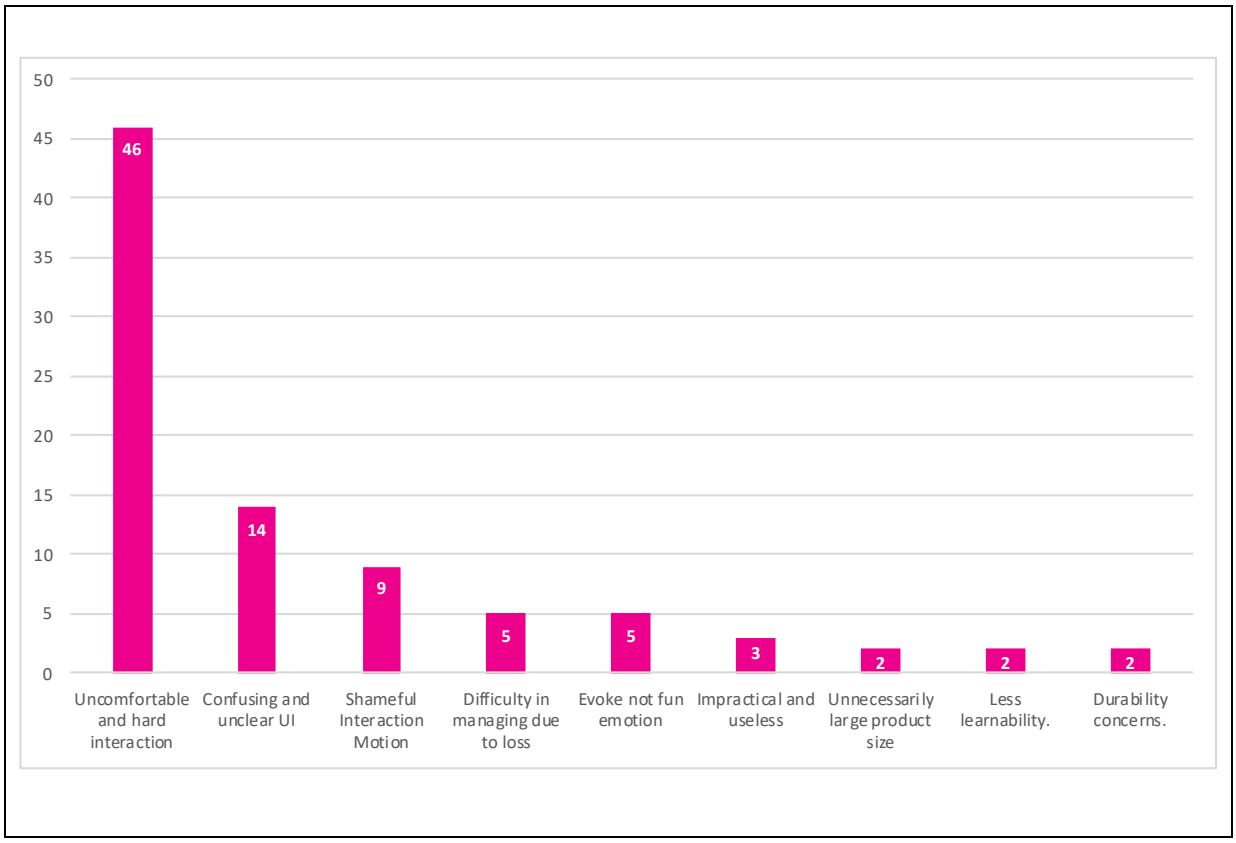


Figure 29. Frequency of negatively describing to S2

Table 14. The results of coding of negative emotion of S2(Interaction pattern)

The results of coding of negative emotion of S2 (Interaction pattern)		
Header	Keyword	Mentioned number
Uncomfortable and hard interaction	Turning a wheel is inconvenient	15
	hard	10
	It is too stiff	8
	Not smooth	4
	Inefficient	3
	Annoying	2
	Cumbersome	2

	Many unnecessary actions	1
	The movement is so big that I feel like I'm exercising.	1
Confusing and unclear UI	The rotation point was confusing	5
	I doubt whether it is running properly	2
	Difficult to use	2
	Not familiar with turning	1
	It takes a long time to react.	1
	It'll be fun just for the first time.	1
	If I continue to use it, I will get used to do it	1
	I was not immediately sure which stick I was using at the moment	1
Shameful Interaction Motion	I am ashamed to use it in front of people	5
	Primitive	2
	It feels like grinding beans	1
	The traditional way is embarrassing	1
Difficulty in managing due to loss	It seems to lose the sticks	3
	Management seems to be difficult	1
	If I continue to use it, it is likely to trouble	1
Evoke not fun emotion	No Fun	3
	It is conventional	1
	Monotonous	1
Impractical and useless	Impractical	1
	It is difficult to use if I am doing other things	1
	Not likely to use	1
Unnecessarily large product size	Size is unnecessarily large	2
Less learnability	It is unnatural to have to use different sticks to activate each function	1
	It seems like to take a long time to adapt	1
Durability concerns	Carefulness	1
	Worried about breaking down	1

Figure 30 shows the result of a positive response to Stimuli3. “Evoke fun emotion” had a header of 53, which was much higher than other items. There were 28 direct references to "Fun". And compared to other stimuli, such as' Feeling like a children's play '(6),' Feel like educational tool '(4),' Feeling to build or assemble lego '(3),' Childlike '(1)' It was characterized by many metaphorical expressions. In addition to ‘Fun’, there were ‘Interesting’ (5), ‘It’s good to be used when I ’m bored’ (2) and ‘Exciting’ (1). The next highest header was ‘Evoke amazing emotion’ (24). It is expressed in various emotional adjectives such as 'Amazing' (12), 'Innovative' (3), 'Novelty' (3), and 'Newness' (2). Participants expressed the same opinions as 'Intuitive' (6), 'It is good to be able to check the current state (mode) physically' (5), arguing that stimuli3 had an intuitive and easy to recognize UI. The same opinion as 'It feels like dominate the equipment directly' (6) could be summarized as having 'Reliable interaction'. (See table15)

Figure 31 shows a graph of negative responses to Stimuli3. Significantly less negative than Stimul1,2. Participants expressed expressions such as 'Discomfort' (8), 'Hassle' (5), 'Bother' (4), 'Inefficient' (2), and 'Operation process is complex and slow' (2). An inconvenient and cumbersome interaction ' Also, the expressions such as 'difficult to use' (2) and 'It is difficult to make a shape because of magnetism' (2) can be seen as 'limited sticks position makes it difficult to use'. In addition, 'Impractical' (4) and 'It seems to lose the sticks' (4) showed opinions such as 'Continuous usage is low' and 'Difficulty to keep and maintain'. (See table16)

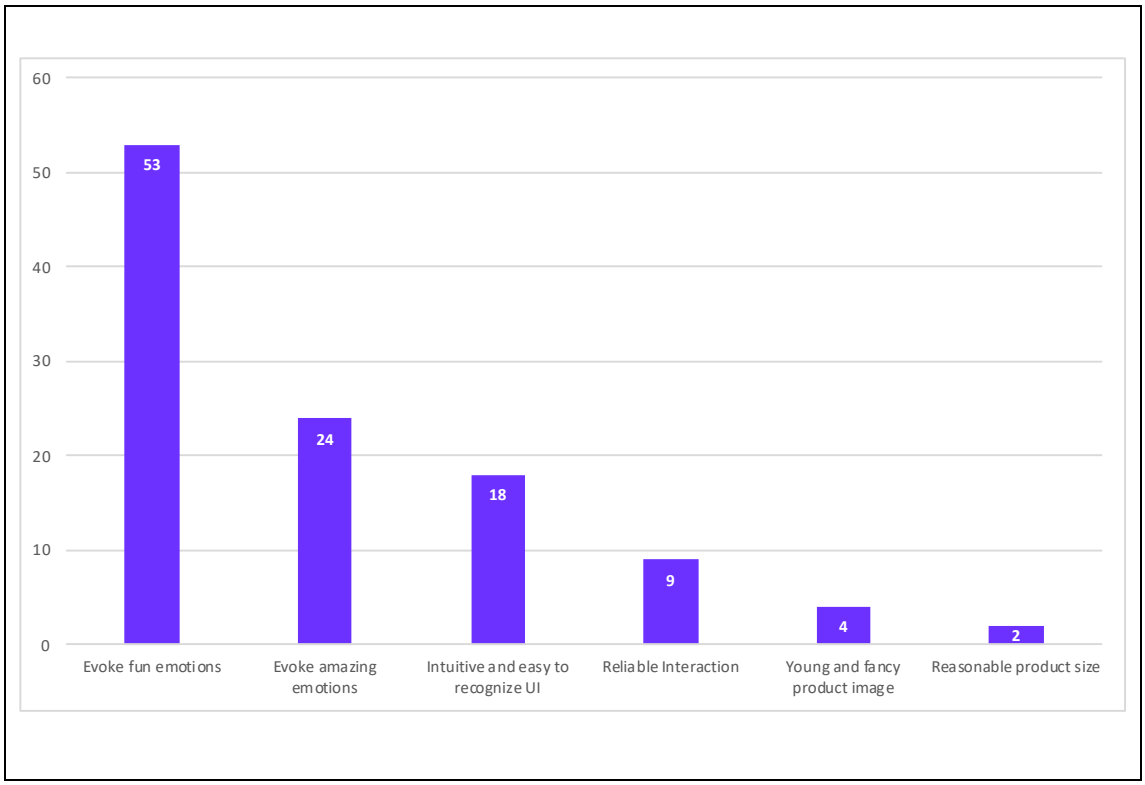


Figure 30. Frequency of positively describing to S3

Table 15. The results of coding of positive emotion of S3 (Richness of motor action)

The results of coding of positive emotion of S3 (Richness of motor action)		
Header	Keyword	Mentioned number
Evoke fun emotion	Fun	28
	Feeling like a children's play	6
	Interesting	5
	Feel like educational tool	4
	Feeling to build or assemble lego	3
	Feeling like a toy	2
	It's good to be used when I'm bored	2
	Childlike	1
	Feeling to play with a toy	1
	Exciting	1
Evoke amazing emotion	Amazing	12
	Innovative	3
	Novelty	3
	Newness	2
	The most modern feel like 3D	1
	curiosity	1
	Creative	1
	Technical	1
Intuitive and easy to recognize UI	Intuitive	6
	It is good to be able to check the current state (mode) physically	5
	Easy to understand how to use	4
	Easy to use	2
	It is convenient because there is no sticks division	1
Reliable Interaction	It feels like dominate the equipment directly	6
	As soon as the shape changes, it works without clogging and is very satisfactory.	1
	High reliability	1
	Fast reaction	1
Young and fancy product image	Attractive	1
	Cuteness	1

	Sensational	1
	It gives the impression that it rouse recollection of childhoods	1
Reasonable product size	The size is justified, and it is suitable	2

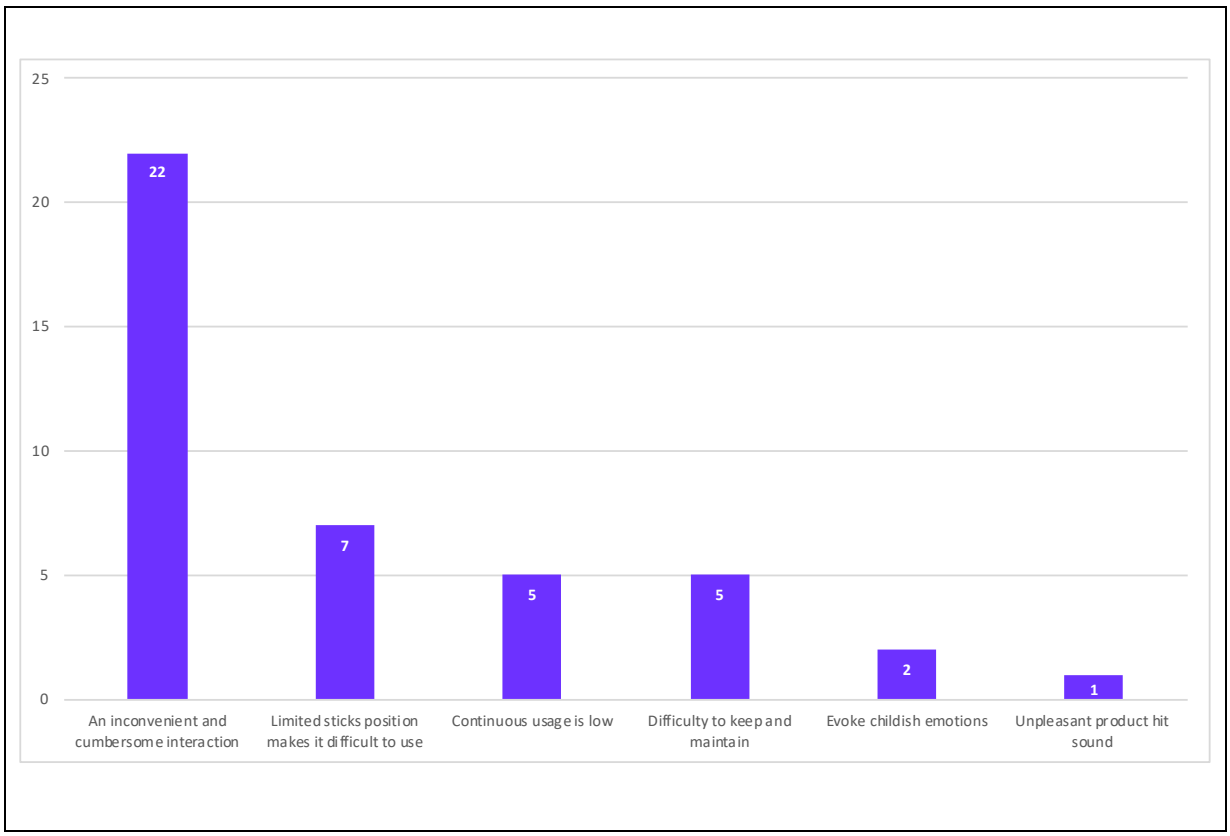


Figure 31. Frequency of negatively describing to S3

Table 16. The results of coding of negative emotion of S3 (Richness of motor action)

The results of coding of positive emotion of S3 (Richness of motor action)		
Header	Keyword	Mentioned number
An inconvenient and cumbersome interaction	Discomfort	8
	Hassle	5
	Bother	4
	Inefficient	3
	Operation process is complex and slow	2
Limited sticks position makes it difficult to use	Difficult to use	2
	It is difficult to make a shape because of magnetism	2

	UI was not convenient	1
	Limited sticks position	1
	Limited sticks area makes reduce interesting	1
Continuous usage is low	Impractical	4
	I think I will use this very occasionally.	1
Difficulty to keep and maintain	It seems to lose the sticks	4
	Only the part where the bar is recognized is likely to wear out easily	1
Evoke childish emotions	Immature	1
	Too obvious	1
Unpleasant product hit sound	Noisy	1

5

Discussion

- 5.1 Emotion Arousal by Aesthetic Interaction

- 5.2 Product Image by Aesthetic Interaction

5

Discussion

Three elements of aesthetic interaction were adopted to determine how aesthetic interaction affects emotion and image evaluation of a product in a product that provides an auditory experience. Design guidelines for each type of aesthetic interaction have been formulated. The first is 'Freedom of Interaction', which represents a fixed or unordered type of interaction, which can be operated in various ways. The second is the 'Interaction pattern', which indicates the match of the movement between the user's actions and their response to the action. The behavior of the user and the response of the packaging are naturally linked in terms of timing and flow. The last was the 'Richness of Motor action', which represents an interaction consisting of a series of sequential procedures based on multiple tasks that require user's cognitive skills. By adopting a research-through-design approach, we designed a prototype with three different types of operation. This prototype was used to measure people's feelings and image evaluation of the product. Participants' emotions were collected through a self-emotion report, and product images were collected through 29SD.

5.1 Emotion Arousal by Aesthetic Interaction

According to the result of emotion measurement through self-emotion report, there was a significant difference in emotion except fear and sadness. It was found that the positive emotions were caused more than the negative emotions. It was also found that all three aesthetic interactions felt Joy the most.

First, in the case of the first Freedom of Interaction, Joy and Fascination felt the most, and the participants described the interaction as having fun, interesting and amazing feelings. It was also dominant because it was so simple to use. However, the user also had anxiety about the failure of throwing the device. This is partly because of the nature of the prototype, and it is important to realize that freedom of interaction is not enough to have those characteristics at the same time.

Second, in the case of the “Interaction pattern,” it was also found that Joy was dominant, and users described it as having fun when interacting with the product. However, many people thought that they had an old image compared to fancy appearance. This is because the interaction behavior reminds us of turning the “metdol”. Through this, it can be seen that the image derived from the social and cultural background can be reflected in the image evaluation of the product.

In the third case of “Richness of motor action,” it was statistically found that Joy and Fascination were the most provoking emotions. In a qualitative investigation, the participants showed that it is not too difficult to be a parish and play equipment right now. This suggests that the implementation of functions through a rather cumbersome way, rather than interaction as the purpose of implementing the function itself, is a way to derive a positive evaluation when applied to other designs.

5.2 Product Image by Aesthetic Interaction

To determine the effect of Aesthetic Interaction on the image evaluation of the product, it was measured on the Semantic Differential scale using 29 opposing adjectives. Through this, it was possible to identify which image each type of aesthetic interaction had. First, the friedman test showed a significant difference in the items except seven items, indicating that aesthetic interaction had a significant effect on the evaluation of the impression or image of the product. This means that by comparing the three interactions, the dominant image can be applied to a product that provides a different auditory experience.

In the case of ‘Freedom of Interaction’, users have been rated as having dominant images of the product, such as ‘contemporary’, 'funny', ‘friendly’, 'exciting' and 'attractive'. In the case of the "Richness of motor action," it was also evaluated to add a similar, but high-tech, "safe", "reliable", "innovative" image. On the other hand, in the case of the ‘Interaction pattern’, in addition to the ‘traditional’ image, it also felt ‘obtrusive’ and ‘inconvenient’, and was somewhat negatively rated as ‘not elegant’. As a result, the effect of aesthetic interaction on the evaluation of the product image is very close. We can design using these aesthetic interactions if we want to receive certain images.

6

Conclusion

6

Conclusion

As part of the flow of various kinds of aesthetic interaction studies, this study was conducted. Based on the concepts and characteristics arranged by previous researchers, the concept of the paper could be determined. As a result, three different interaction methods, reflecting three elements of aesthetic interaction, were able to produce a prototype that was applied to a physical object that gave auditory pleasure. And through quantitative and quantitative analysis of each, it was an opportunity to discover the possibility that each interaction method could be applied to other designs later. I believe that further research will further prove the value of aesthetic interaction by obtaining empirical results through the application to more diverse products.

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Djajadiningrat, T., Wensveen, S., Frens, J., & Overbeeke, K. (2004). Tangible products: redressing the balance between appearance and action. *Personal and Ubiquitous Computing*, *8*(5), 294-309.

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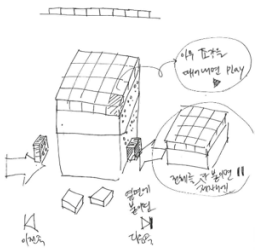
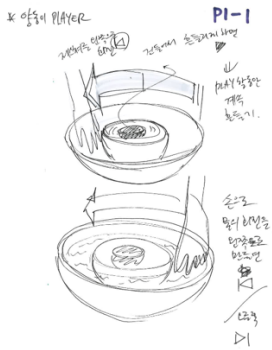
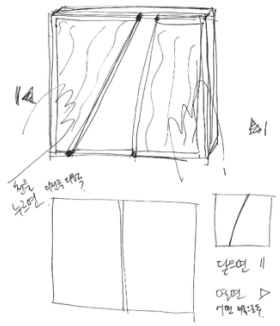
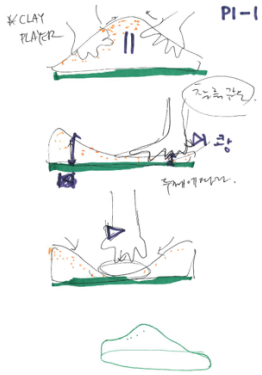
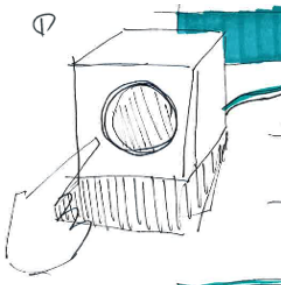
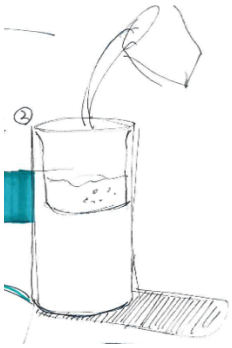
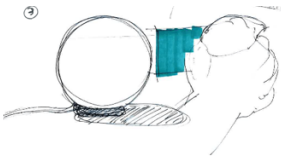
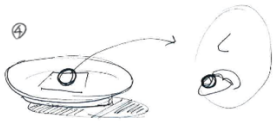
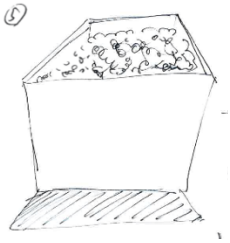
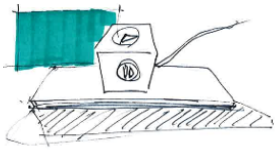
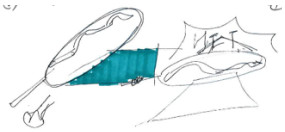
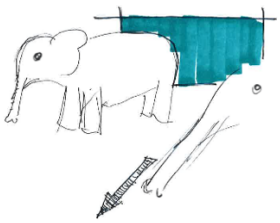
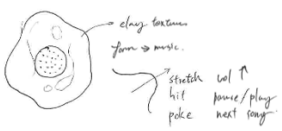
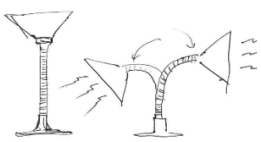
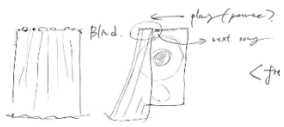
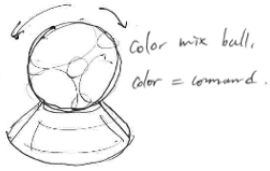
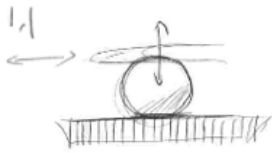
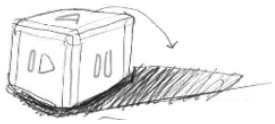
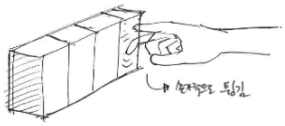
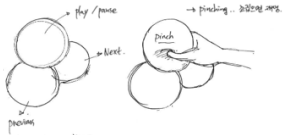
Appendices

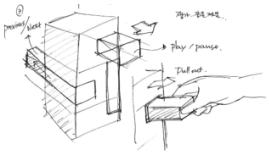
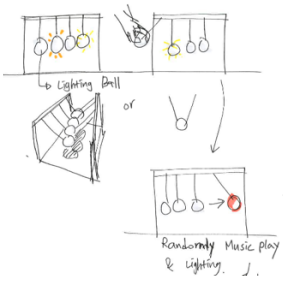
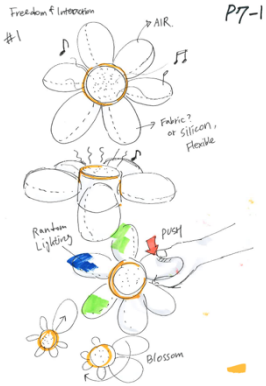
Appendix 01. Concepts generated in the design workshop

Part 1 | Freedom of Interaction

Concept images	Description	Concept images	Description
	Lego player In a cube-shaped body, you can play by removing a piece of Lego from the top. Pasting to the left side plays the previous song and pasting to the right side plays the next song. Lego is put in place (top) to pause.		Bucket player Shake the bucket to play. If you rotate the water in the bucket to the left, you move to the previous song. If you make it to the right, you move to the next song. The song stops when the bucket is stopped.
	Curtain player Open the closed curtain and flip it to play. Tap or shake the left fabric to skip to the previous song. Press or shake the fabric on the right to move to the next song.		Clay player This clay cannot escape a certain space. Start by tapping the middle to create a basin shape. Press the left side to go to the previous song and the right side to go to the next.
	Cube with a circular hole. Insert your finger into the hole to play. Rotate your finger counterclockwise to the previous song; rotate your finger clockwise to the next.		The music is played from the moment it is filled with water. The method of changing the song is not reflected.

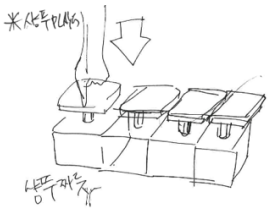
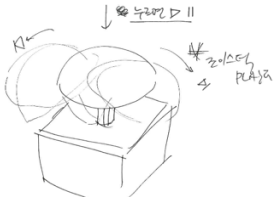
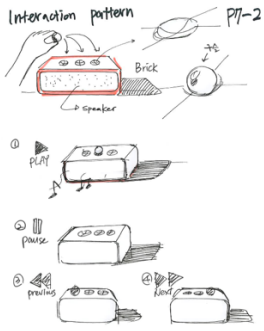
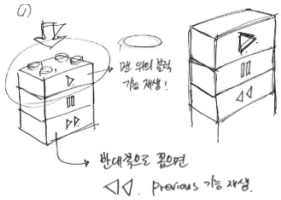
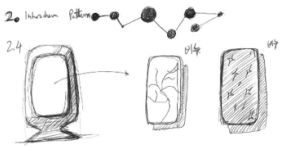
	A spherical object made of silicon. Hold both sides to play. Press the left side to go to the previous song and the right side to go to the next. Squeeze both sides once more to pause.		An object like candy or beads on a plate. The music plays when you put it in your mouth. If you put it to the left in your mouth, it goes to the previous song. Swallowing this will stop the song.
	A box filled with popcorn. Put your hand in the box and stir it up to play the music. The amount of song changes depending on how much popcorn you lifted.		Each side of the cube has the ability to control music. Place the desired function face up to execute.
	Bat player. The function is divided around the winding line drawn on the front of the bat. Play when you hit the front. If you hit the left side, the previous song is played. If you hit the right side, the song changes to the next song.		Elephant player. An elephant in the form of an object. Pull the elephant's nose straight out to play music. Pull the nose to the left to go to the previous song, or to the right to go to the next.
	Egg Fry Player. The white part has a clay-like texture. Pulling the left side straight out plays the previous song, and		It looks like a stand light. It has a spring. The music is played the moment it is bent. Bend to the left to play the previous song. If

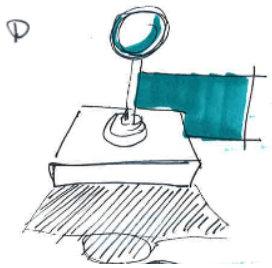
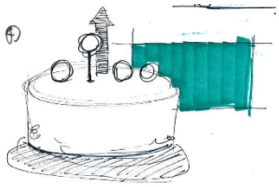
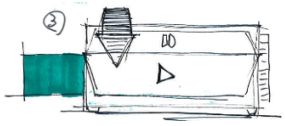
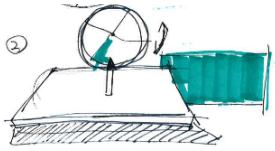
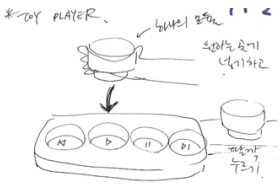
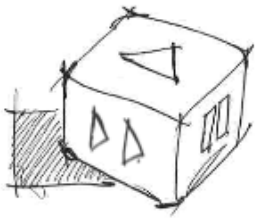
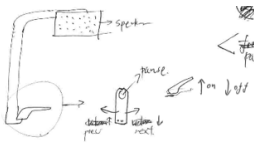
	pulling the right side straight out plays the next song.		you bend to the right side, the song changes to the next song.
	Blind player Open the curtain and the music flows out, and close the curtain to turn off the music. (Ideas for song changes are not reflected.)		A player in the form of a crystal ball mixed with various colors. Color is directly related to the order. The music depends on which color part is in contact with the station. Roll the ball to the station to play. (The method of changing the song is not reflected.)
	Play the ball by rolling it freely on the tray. (Ideas for song changes are not reflected.)		Each side of the cube, like a dice, has the ability to control music. When thrown, the face up function is executed.
	Headstone player. The monument with each function is composed of one set. Just swipe your finger on the headstone of the function you want.		3ball player. The left ball on the first floor has the previous song, the right ball has the next song, and the top ball has play / pause functions. Run by pinching the ball of the desired function.

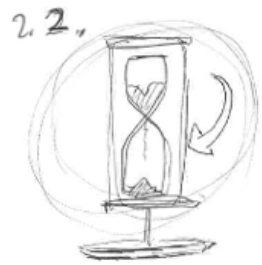
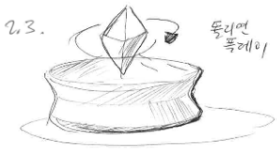
	Jenga player. If you remove Jenga corresponding to Play / pause, the function is executed. The previous / next Jenga on the opposite side changes the song depending on how far it is drawn.		Drop the object, roll it, put your hand in the hole in the center, squeeze or squeeze the body to play music. (The idea of changing the song was not reflected.)
	Pendulum player. Each pendulum has a song. When the pendulum starts to move, it is played and lights up during play. If you lift the pendulum on the far left, the previous song is played. If you lift the pendulum on the far right, the next song is played.		Flower player. Flower petals are flexible materials like fabric or silicone and are filled with air. Press a petal to play music, and the petals light up randomly during playback. The idea of changing the song was not reflected.

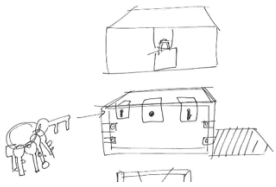
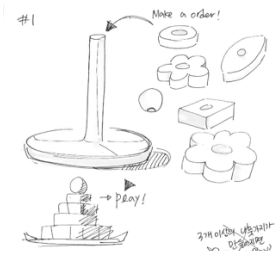
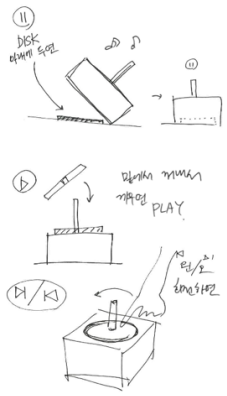
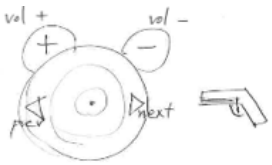
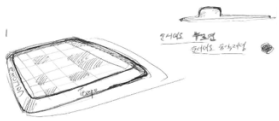
Appendix 02. Concepts generated in the design workshop

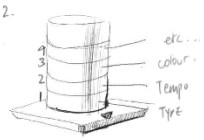
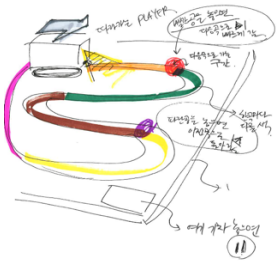
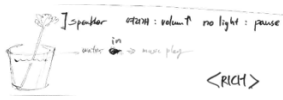
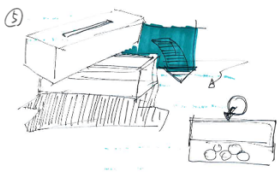
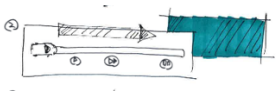
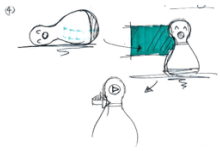
Part 2 | Interaction pattern

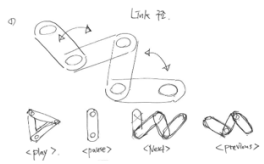
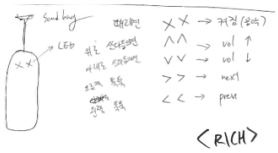
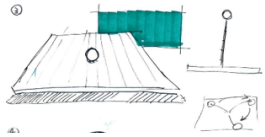
	Shampoo player. It consists of four shampoo bottles. They each have play, pause, previous and next functions. Press it as if you are shampooing it.		Joystick player. Play by pressing the joystick. Tilt left to change to the previous song, tilt right to change to the next.
	Brick player. It consists of a brick-like cuboid with three hollow grooves on the top and a bead. If you put it in the center groove, it plays. If you put it on the left side, the previous song is played. If you put it on the right side, it changes to the next song. If you remove the ball, it will pause.		3 lego block player. Three Lego blocks have play, pause, and previous / next functions. In the case of Previous / next block, the front side is divided into previous and the rear side is next. The function at the top of the block is executed.
	Soap player One soap acts as a playlist. The song plays depending on what soap is left in the station.		Book player. Open the book and music comes out. Turn the left page to go to the previous song and turn the right page to go to the next song. If you place a bookmark between pages, the music will stop.

	Joystick player. There is a function along the east, west, north and south directions, and the function is executed according to the direction of moving the joystick.		The spheres with their respective functions are connected to the top of the cylinder by a string. Pull up the sphere of the desired function to execute.
	Barbeque player Cuboid in a transparent box, with each side functioning. Rotate as desired to execute the function of the face shown when stopped.		Roulette player The roulette board is divided into four parts: play, pause, previous, and next functions. It works the same way as roulette. So you cannot execute the function you want.
	Toy player. Fist-sized cylindrical toy is a module. The station has four function halls to control the player. Insert the toy into the hole of the desired function and click to activate it.		Each side of the cube has the ability to control music. Place the desired function face up to execute.
	Shower handle concept. Same as the operation of the shower handle. If you raise it up, music flows instead of water, and if you turn		If you keep the water in the tank, it will play until it evaporates.

	it to the left or right, the tune changes as the water temperature is controlled.		
	Hourglass player. Turn the hourglass upside down to play music. (The method of changing the song is not reflected.)		The slender octahedron is supported by the magnet in the air. The music plays when the octahedron floats. The song changes according to the direction of rotation.
	The player looks like a tree. The hole drilled in the pillar has one function to execute the player. Insert the tree into the hole with the desired function to execute the function.		

Appendix 03. Concepts generated in the design workshop Part 3 | Richness of motor actions			
	It looks like a timer. There is a function around the timer to control the player. After the precise dial is set correctly, tap the top bead to perform the desired function.		Key and locked box. Each key has the functions of play, pause, previous song and next song respectively. Open the locked box with the key of the desired function to execute the function.
	Consists of various shaped blocks with holes in the middle and stations with long thin pillars in the middle. The completed stacked shape is set to play, pause, previous song and next song. The blocks must be stacked in the correct order in order to execute.		It consists of a disc of a disc and a case with a column covering it. Play the disc when you plug it in. Turn the disc clockwise to play the next track, counterclockwise to play the previous track. If you remove the disc and put it back in the case, the song will stop.
	Gun and target set player. Hit the target to play music. This is done by aligning the target with the icon of the desired function. It won't run until you hit it.		A player that looks like a bingo board. To play a particular song, press the square flat buttons in sequence. (Ideas for song changes are not reflected.)

	The corresponding music is played according to the order in which the discs of different attributes are stacked. If you stack them in a different order, different songs will be played.		Train toy player. From the moment you put the train in place on the rails, it plays. To play the previous song, put the blue ball on the rail and let the train pass by. In the same way, use the red ball for the next song.
	Diffuser player. Plug in one stick to get simple music, plug in two to get complex music.		Water Speakers. The more flowers you put in, the louder the volume will be, and you can change the song according to the direction in which you rotate the flowers.
	It has the form of sticks stacked twisted. If you match this, you play. If you want to move to the next song, you can put a coin.		Depending on the degree of movement of the car, the corresponding function is executed.
	Pebble player. The music is played when a play pebble is placed at the station. If you pile up the pebble of the desired function in sequence, the function is executed.		OTTOGI player. Raise the fallen locust to play. Turn Ottogi's neck clockwise to go to the previous song. Turn counterclockwise to go to the next song.

	Stick puzzle player. It is a link structure puzzle, with the end of the bar connected to the end. If you make it a triangle, it becomes play. If you make it as 1 character, it is pause. If you make it as 'N', the next song. If you make it 'upside-down N', you can turn the song back to the previous song.		Punching bag player. Play a punching bag to play music. Hit left to right to play the next song, or right to left to play the previous song. Depending on the degree of movement of the car, the corresponding function is executed.
	After pulling the sphere over the plate, the function of each seat is executed depending on which side of the plate edge it is placed on.		

Appendix 04. Hardware – Internal components				
	Image	Module	Qty	Purpose
Board		PCB	1	It is used to configure the sensor or actuator modules used in the product configuration in one circuit. In the early work (first work), wiring with jumper wires made it difficult to find and recombine faulty circuits in product movement or repair and improvement work. Therefore, in the second task, most circuits are worked in the pcb board to make a more stable product.
		Arduino Mega 2560 board	1	It is Micro Controller board for overall control of the product, used to process the sensor values and perform functions.
		Bluetooth 2.0 HC-06	1	It is a communication module for information communication between Arduino Mega and mobile phone setting app. It supports Bluetooth 2.0. Arduino and this module use wired serial communication and wireless serial communication between this module and Android device through Bluetooth. It can check the internal operation status of the product by sending the sensor value in the product to the mobile phone, or it can also be used to manually turn on / off the function.

Speaker		Speaker module	1	Disassemble and use speaker amplification module of existing speaker products to amplify speaker signal and combine audio cable. (pre-manufactured product)
		Mp3 module	1	It transmits mp3 format data of SD card inserted in module to speaker, and performs volume control and music control functions (play, pause, previous song, next song change).
Station		CDS cell	4	This is used to determine whether a stick is inserted in the station part using the CDS Ambient Light Sensor. When the stick is not inserted, it recognizes that the stick is not inserted by the ambient light. When the stick is inserted, the ambient light is blocked and it is used to identify it by the sensor value.
Interaction		Neodymium Magnet	12	This is used to get the position of the stick. A total of three magnets were built in the inner ends and the center of the stick. The magnets at both ends are used to fix the position of the stick, and the magnet at the center identifies the position of the stick by recognizing the ‘hall sensor’ embedded in the plate.
		Hall sensor	4	In order to be able to execute the function only by making a specific shape with a stick, the magnetic field generated when it is attached to a specific neodymium magnet embedded in the sitck and plate can be recognized.

power		3.7V 18650 Li-ion Rechargeable Battery	2	
		18650 battery holer	1	

Appendix 05. Experiment – 29SD Form

A - 29 SD

For the interactions you experienced a while ago, check the one that you think is most appropriate among the opposite adjectives. * 4 means neutral.

조금 전에 경험했던 상호 작용에 대해서, 다음의 반대 형용사 중 가장 적절한 것으로 생각되는 것을 확인하십시오. * 4는 중립을 의미합니다.

* 필수항목

Social values and position (SVP)

1. **Social values and position (SVP) - 1** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Traditional (전통적인)	◯	◯	◯	◯	◯	◯	◯	Contemporary (현대적인)

2. **Social values and position (SVP) - 3** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Low Technology (낮은 기술의)	◯	◯	◯	◯	◯	◯	◯	High Technology (첨단기술의)

3. **Social values and position (SVP) - 2** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Low Class (저급)	◯	◯	◯	◯	◯	◯	◯	High Class(고급)

4. **Social values and position (SVP) - 4** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Cheap (저렴한)	◯	◯	◯	◯	◯	◯	◯	Expensive (비싼)

5. **Social values and position (SVP) - 5** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Local (지역적인)	◯	◯	◯	◯	◯	◯	◯	Global(세계적인)

Usability and interaction (UI)

6. **Usability and interaction (UI) - 1** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Confusing (혼란스러운)	◯	◯	◯	◯	◯	◯	◯	Clear (명확한)

7. **Usability and interaction (UI) - 2** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Difficult To Use (사용하기 어려운)	◯	◯	◯	◯	◯	◯	◯	Easy To Use (사용하기 쉬운)

8. **Usability and interaction (UI) - 3** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Dangerous (위험한)	◯	◯	◯	◯	◯	◯	◯	Safe (안전한)

9. **Usability and interaction (UI) - 4** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Uncomfortable (불편한)	◯	◯	◯	◯	◯	◯	◯	Comfortable (편한)

10. **Usability and interaction (UI) - 5** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Unreliable (신뢰할 수 없는)	◯	◯	◯	◯	◯	◯	◯	Reliable (믿을만한)

11. **Usability and interaction (UI) - 6** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Delicate (약한)	◯	◯	◯	◯	◯	◯	◯	Robust(견고한)

12. **Usability and interaction (UI) - 7** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Difficult To Clean (관리하기 어려운)	◯	◯	◯	◯	◯	◯	◯	Easy To Clean(관리하기가 쉬운)

13. **Usability and interaction (UI) - 8** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Impractical (비실용적인)	◯	◯	◯	◯	◯	◯	◯	Practical(실용적인)

Qualities of form (QF)

14. **Qualities of form (QF) - 1** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Inelegant (우아하지 않은)	◯	◯	◯	◯	◯	◯	◯	Elegant (우아한)

15. **Qualities of form (QF) - 2** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Geometric (기하학적 형태의)	◯	◯	◯	◯	◯	◯	◯	Organic(유기적형태의)

16. **Qualities of form (QF) - 3** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Plain (평범한)	◯	◯	◯	◯	◯	◯	◯	Omate(화려한)

17. **Qualities of form (QF) - 4** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Imitative 흔한(모조의)	◯	◯	◯	◯	◯	◯	◯	Innovative(혁신적인)

18. **Qualities of form (QF) - 5** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Large (대형의)	◯	◯	◯	◯	◯	◯	◯	Compact(소형의)

19. **Qualities of form (QF) - 6** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Asymmetrical (비대칭인)	◯	◯	◯	◯	◯	◯	◯	Symmetrical(대칭인)

Personality character (PC)

20. **Personality character (PC) - 1** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Repulsive(혐오스러운)	◯	◯	◯	◯	◯	◯	◯	Attractive(매력적인)

21. **Personality character (PC) - 2** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Submissive (유순한)	◯	◯	◯	◯	◯	◯	◯	Aggressive (과감한)

22. **Personality character (PC) - 3** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Nostalgic(향수를 일으키는)	◯	◯	◯	◯	◯	◯	◯	Futuristic(초현실적인)

23. **Personality character (PC) - 4** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Noisy (시끄러운)	◯	◯	◯	◯	◯	◯	◯	Quiet(조용한)

24. **Personality character (PC) - 5** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Immature (미숙한, 아이 같은)	◯	◯	◯	◯	◯	◯	◯	Mature(성숙한, 어른스런)

25. **Personality character (PC) - 6** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Calm(차분한)	◯	◯	◯	◯	◯	◯	◯	Exciting (신나는)

26. **Personality character (PC) - 7** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Masculine (남성적인)	◯	◯	◯	◯	◯	◯	◯	Feminine(여성적인)

27. **Personality character (PC) - 8** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Unfriendly(비호감의)	◯	◯	◯	◯	◯	◯	◯	Friendly (호감의)

28. **Personality character (PC) - 9** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Ordinary (평범한)	◯	◯	◯	◯	◯	◯	◯	Extraordinary(뛰어난)

29. **Personality character (PC) - 10** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	6	7	
Boring (지루한)	◯	◯	◯	◯	◯	◯	◯	Interesting(재미있는)

Appendix 00. Experiment – Self-emotion report form

A - Self emotion report

Please rate the emotions to express what you felt towards the product.

* 필수항목

1. **Desire** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

2. **Satisfaction** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

3. **Pride** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

4. **Hope** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

5. **Joy** *
   한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

6. **Fascination** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

7. **Admiration** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

8. **Disgust** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

9. **Dissatisfaction** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

10. **Fear** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

11. **Shame** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

12. **Boredom** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

13. **Sadness** *
한 개의 타원형만 표시합니다.

	1	2	3	4	5	
Hardly	◯	◯	◯	◯	◯	Strongly

Executive Summary in Korean

이 논문을 통해, HCI 에서 중요한 역할을 하는, ‘Aesthetic Interaction’이 청각적 경험을 제공하는 제품에 적용되었을 때, 사람의 감정과 제품의 이미지 평가에 어떠한 영향을 끼치는지 알아보고자 하였다. 이를 위해 Research through Design 접근법을 사용하였으며, ‘Aesthetic Interaction’의 세가지 요소가 적용된 프로토타입을 제작하였다. 이는 Self-emotion report, 29SD 를 통해 측정 할 수 있었다. 또한 Friedman test 을 통해 통계적으로 유의미한 결과값들을 얻을 수 있었다. 이와 같은 결과값을 통해, 우리는 청각적 경험을 제공할 수 있는 제품을 디자인 함에 있어, 디자이너가 의도적으로 투영하고자 하는 감정과 이미지를 ‘aesthetic interaction’을 적용할 수 있음을 시사한다.

Keywords: Aesthetic Interaction, Sound Experience

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이 석사 졸업 프로젝트를 진행하며 감사해야 할 분들이 많습니다. 우선 수업을 통해 가르침을 주셨으며 논문에 대한 조언을 해주신 박영우 교수님, 김 황 교수님 감사합니다. 두분 덕에 끝까지 잘 마무리 할 수 있었습니다. 그리고 프로토타이핑을 하며 길을 잃었다고 느꼈을 때 구체적인 솔루션을 제공해주신 이희승 교수님, 석사 생활 중 가장 접점이 많아 다양한 대화를 시도해주시고 들어주신 James self 교수님, 스타일링을 감각을 키울 수 있도록 해주신 정연우 교수님, 힘들었던 순간에 이야기를 들어 주셨던 김관명 교수님 모두 감사합니다. 교수님들의 가르침으로 인해 역량을 키울 수 있었고, 정신적으로 성숙할 수 있었습니다. CDE 를 통해 지원을 해준 KIDP 와 9 층의 모든 관계자분들 에게도 감사의 인사 전합니다.

더불어 이 프로젝트의 설계 및 엔지니어링을 하는 과정에서 큰 역할을 해준 휘수에게 고맙다는 말 전합니다. 나의 부족한 면을 너로 인해 많이 채울 수 있었고, 또 배울 수 있었어. 고마워. 그리고 석사 생활을 하는 동안 함께 성장할 수 있었던 emotion lab 의 임경 언니, 용준 오빠, 혜민이, 광민이, 가이, 봉조, 상현이, 하연이, 소영 언니, CDE 동기인 성호 오빠를 비롯해 지수, 소미, 보민이, 지현이, 진희, 한별이, mantra, murilo, 초은이, 가을이, 원도오빠, 상진이, 소연이, 은준오빠, 원영이 에게도 감사합니다. 함께 였기에 많이 배울 수 있었습니다.

늘 저에게 정신적으로 큰 버팀목이 되어주는 분들에게도 감사합니다. 김성윤이, 채은이, 미란이, 한나, 상윤이, 그리고 슬기를 비롯한 KDM 식구들과 사랑하는 우리가족. 제가 잘 살아 나갈 수 있게 힘이 되어 주셔서 정말 감사합니다. 우리 도선순 할머니, 제가 많이 존경합니다. 마지막으로, 장호 오빠. 우리의 미래를 결코 알 순 없지만, 지금 이 순간 제 옆에 있어줘서 고마워요. 내가 많이 사랑해.

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The Role of Aesthetic Interaction in Sound Experience