iSpace: Interactivity Expression for Self-Expression in an Online Communication Environment

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ABSTRACT
In this paper, we suggest interactivity, which defines dynamic and invisible characteristics of an interactive system, as a medium for self-expression in an online communication environment. Since existing means of self-expression are visual- or text-oriented, they cover only a part of one's real self. Interactivity, however, is invisible, but still evokes emotional experiences depending on its value. Therefore, we expected that one's interactivity expression customization would also represent the different dimensions of one's characteristics. This study aims to explore the possibility of interactivity expressions as a new way of self-expression in an online communication environment. By conducting a user study with a social website prototype, namely, iSpace, in which each user's personal site can be distinguished by their different interactivity expressions, this study provides understandings of rationales and patterns of interactivity expressions, and design implications which we expect to inspire designers to consider them strategically in their design practices.

Author Keywords
Interactivity expression customization, Self-expression, Online social networking, Interaction Design

ACM Classification Keywords
H.5.2. User Interface: Interaction styles.

INTRODUCTION
In the early days of the Web, social activities occurred around communities of which features like message board allowed users to talk with others who share a topic of interests. Bonds among users were formed in this virtual space but generally did not exist in the offline world [4]. However, as technology provides ubiquitous access and with the advent of Web 2.0, which has led an increase in the number of user-participatory applications, there has been a fundamental shift in the way people communicate. At present, people communicate with whom they know and care about and they are always online to interact with the real relationships. As one's offline social network is seamlessly linked to his or her online life, crafting one's online identity, which shares many aspects of one's offline identity, is becoming critical for people to define themselves as unique individuals, just like in the real world.

There are numerous means of self-expression on social websites, including the personalization of one's profile, the use of an avatar, and via a personal dashboard. These features, however, only cover the part of one's real self. Although visual representations and text articulation explicitly represent oneself, nonverbal and indirect aspects of individual characteristics also represent the self. For example, we can obtain a snippet of one's personality from the ways in which one moves and speaks. Nevertheless, there is few means to express this dynamic and innate nature of oneself on social websites at present.

In addition, the current trends in the design of social websites increase the need for new methods of self-expression in the online world. At present, the core value of using social websites is not merely building of personal relationships, but sharing of real-time information with one's personal connections. Therefore, it is critical to maintain visual simplicity in the design of social websites so that information can be effectively delivered in real time. Facebook is a typical example of this; it was intentionally designed to eliminate visual elements so that people focus more on communication [8]. People, however, still want to express their characteristics, even in a context such as Facebook; communities even exist, where people share their knowhow as regards decorating their profile background on Facebook.

As a result, it is becoming more challenging to satisfy those conflicting needs, and visual means for self-expression are increasingly being replaced by text-oriented contents. In this new context, this study suggests *interactivity*, the dynamic characteristics of interactive artifacts [10], as a new medium of self-expression in an online communication environment. Since interactivity can be felt only through the actual use of interactive artifacts, it would be possible that its invisible nature makes it easy to express oneself without increasing the visual complexity of social websites. Moreover, its dynamic nature increases the potential to express one's nonverbal characteristics, even during computer-mediated communication.

The goal of this study is to explore the possibility of interactivity expression as a method for self-expression and

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their effects on online social interactions. For this purpose, we conducted a user study by devising an online social website in which each user's personal site can be distinguished by that individual's different interactivity expressions. As a starting work in this approach, we present rationales and patterns of interactivity expressions, and design implications which we expect to inspire designers to consider them strategically in their future design practices.

BACKGROUND

Identity and virtual social interaction have been studied for the past several decades in HCI research. The studies have shown detailed understandings about various elements for self-representation in the online contexts; the colors of homepage background, avatar representation characteristics, and profile items have all been investigated [3, 15]. Designers who consider self-expression in the current social websites, however, are facing new challenges to meet the need for self-expression tools as well as the needs of visual simplicity in their designs, because visual-oriented approach has been typical in developing means for self-expression. Despite of this challenge, there have been few attempts to explore solutions to this design problem.

In this study, we posit interactivity expression customization as a new way of self-expression in a virtual communication environment. Interactivity indicates the interactive characteristics of *invisible and dynamic* aspects of interactive artifacts, and the quality of interactivity can be *felt* by using them [10]. These aspects of interactive artifacts have great potential to be customized so that they deliver one's specific characteristics through the experience of using interactive systems. Zimmerman [18] also pointed out that interactive products offer a new opportunity for designers in that their behaviors can be designed so that they are much more explicit collaborators in a user's identity construction activities.

In spite of its possibility, interactivity has not been readily used as a design material for identity construction activities, as there is lack of design languages for crafting invisible and intangible characteristics of interactivity. In recent work [11], however, Interactivity Attribute framework was proposed. There are seven interactivity attributes, specifically *Concurrency, Continuity, Movement Speed, Movement Range, Response Speed, Expectedness* and *Proximity.* Each interactivity attribute has two dichotomized values; concurrent and sequential interactivity for Concurrency, and narrow- and wide-range interactivity for Movement Range. Since this framework enables us to clearly and concretely describe the dynamic characteristics of interactivity, we also utilized it for this study when we think and implement interactivity.

Although the concept of customizing interactivity expression is new to this research area, we see its possibility from the characteristics which interactivity expressions share with the self-expression that human use in offline communication. First, even simple interactivity expressions can elicit an abstract emotional experience. Although each dichotomized interactivity attribute value represents very simple characteristics of its dynamic quality, each value clearly differentiates one from the others both perceptually and characteristically. For example, wide range movement evokes light and soft feelings, while narrow one evokes heavy and hard feelings. This also arises when we interact with other people. The encounter's simple gestures or facial expressions can be used to infer the encounter's characteristics. Also, this often enables us to have smooth and rich communications with others.

Moreover, interactivity expression also reflects one's uniqueness, as does one's behavioral self-expression. Individuals have their own somatic style, which reflects one's gender, age, or subcultures of aesthetic preferences [14]. In our earlier work [7], it was revealed that one's innate personality is correlated with one's *Interactivity Preferences*. The discovered correlations can be explained more fundamentally based on the relations between one's personality and his or her behavioral characteristics, as discovered in many studies on personality psychology. For example, personality psychologists have shown that people with higher neuroticism experience worse feelings when they think about or observe unpleasant things [9]. The earlier work also found a relationship between higher neuroticism and preference for continuous interactivity; participants who preferred continuous interactivity articulated feelings of discontinuous interactivity with negative expressions such as "*stiff*," "*distracting*," and "*unnatural*." This explanation enhances the possibility that interactivity naturally reflect one's innate uniqueness.

Research in HCI has also shown that the simple dynamic characteristics of interactive artifacts can be interpreted as the personality of the interface. The tone of voice in a speech interface helped listeners to interpret the personality of a computer agent. Moreover, people showed similarity-attraction effects even for computer interfaces of which personality was interpreted as a good match with their own personality [13]. These works demonstrate that simple dynamics can assist our understanding of more complex social behaviors. However, the dynamic factors used in the aforementioned studies are not directly related to an exploration of the means of expressing one's characteristics through interactivity expressions so as to enrich the self-representation in the virtual social media.

Hence, this study aims to uncover the possibility of interactivity expression for self-expression in an online communication environment. Specifically, we aim to address the discussions on the two research questions:

i) What are the rationales and patterns of interactivity expression customization?

ii) What are the effects of individuals' interactivity expressions in virtual social media on their online social interactions?

PRELIMINARY EXPLORATION

Despite the potential of interactivity expression, there has been little insight shown in the design of an interface that allows control of the interactivity values from user's perspective. Several works were conducted based on the aforementioned Interactivity Attribute framework [11] to help interaction designers utilize their understanding of interactivity in their design practices. Examples include Interactivity Sketcher and Interactivity Attributes Tutorials [17, 10]. Although these works discovered the necessity of these types of supporting tools for designers and their effects on design outcomes, they were mainly focused on designers instead of ordinary users. Therefore, we considered that the potential participants in our user study might not have much experience in controlling the interactivity of an interactive artifact. This led us to conduct a focus group to explore possible design considerations before devising the prototype of the social website which requires users' active involvement with interactivity controls so as to express their own characteristics.

The major subject of the discussion concerned participants' experiences on customizing the system properties of interactive artifacts; it is because that allowing the control of interactivity value in our prototype can be regarded as a type of customization activity. We discussed their interactivity customization experiences regardless of whether they were not directly aiming at self-expression, as the customization of the functional features of interactive artifacts is much more common for ordinary users compared to their customization for self-expression. Nevertheless, a customized outcome reflects one's preferences even if they were not directly aiming at self-expression [1, 16]. Accordingly, we decided to discuss general interactivity customization experiences without constraining the purpose only to self-expression.

Six participants were recruited for the focus group. They were graduate students who were studying interaction design. We considered that they would share their opinions and experiences of using interactive artifacts much more effectively, as they had been trained to think about the interaction quality of such artifacts. The focus group took about an hour to share and discuss their experiences of customizing interactive features and the difficulties they had during those experiences. As a result, we found two barriers that should be considered in our prototype design: the psychological barrier and the conceptual barrier.

Psychological Barrier: Overall, we found that the participants did not actively use customization options in interactive artifacts. Four of the six participants had at least one experience of interactivity customization, but the others did not. Only one of the four participants was actively using the options, whereas the others were selectively using them. Also, the range of the interactivity customization experience was limited to the features of the input devices, e.g., the mouse cursor speed, the scroll speed, and the sensitivity of their tablet pen. The main reason for the inactive use of interactivity customization options was primarily the psychological barrier standing in the way of performing interactivity customization. The following excerpts from the focus group interview provide evidences of the psychological barrier.

First, interactivity does not critically affect the use of ultimate functions of devices; it only affects this indirectly compared to the core functions. As a result, participants expressed annoyance with going through all of the complex steps to customize interactive aspects of digital devices:

"At first, I didn't like the feeling when I swiped the pictures on my mobile phone… It wasn't smooth enough. However, I became used to these things because I didn't have any problems seeing the pictures." (P3, medium user)

"I don't want all the steps that I have to do for customizations. Sometimes, it feels very awkward when I use another person's mouse. However, I try not to mind it because it is just for a moment." (P5, light user)

Moreover, there was no great expectation of being able to customize the invisible qualities of an interactive artifact, as they felt this was the role of designers or developers. We found that these aspects of interactivity customization build the aforementioned psychological barrier to active involvement, as they instilled in users a passive attitude toward interactivity customization.

"I just bought an iPhone because it looks nice and feels better than any other phone. It was already set up to my liking." (P4, light user)

Conceptual Barrier: As mentioned earlier, we found that their interactivity customization experiences mainly occurred during their use of input devices. Owing to this limited experience, the participants had a strong conception that the customization features of an interactive artifact mainly pertain to the *calibration* of the input device rather than for self-expression. Therefore, we considered that this mental conception could be another barrier that prevents the active involvement of controlling interactivity.

Design considerations

To overcome the two barriers that people have to interactivity control, we determined that design considerations for the following two points are necessary when designing the website prototype: i) maximizing the clarity of the concept that controlling interactivity is a means of self-expression, and ii) minimizing the complexity and difficulties when controlling the invisible qualities of interactivity.

As a response to the first point, which is related to the conceptual barrier, we decided to design the prototype by adopting the GUI of an existing social website instead of designing a wholly new GUI style. By doing this, the only difference for the prototype compared to existing SNS was the feature of interactivity customization. We expected that this gave a clear understanding of the role of the difference as a means for self-expression to potential participants.

We selected Facebook from the many existing social websites, as its characteristics are a good match as regards the purpose of this study. First, Facebook has a visually simplified interface design and does not have many visual features that support self-expression. This context serves the exact design challenge we described earlier, finding ways to support self-expression while maintaining visual simplicity. In addition, we can effectively minimize the effects of other means of self-expression, such as the use of an avatar or profile decoration, and focus to examine the effect of interactivity expression.

Secondly, it has a familiar and motivating platform for sharing personal postings with friends. On Facebook, users usually have links to acquaintances or people with whom they share a community, such as same school or interest group. As a result, people feel more comfortable when they share their personal lives and express themselves comparing to the use of SNSs like Twitter, where people more actively interact with others who are not personally close to them (e.g. celebrities). In addition, Facebook users continuously extend their social network by interacting with potential friends in the shared community. This motivates users to express themselves actively and interact with others. In this study, these familiar and motivating atmospheric setups are necessary so that the participants naturally express their own characteristics to others.

Based on this interface design scheme, we determined the details of the design while retaining the second consideration point, which is related to the psychological barrier. We describe the rationales in the following section.

ISPACE: A SOCIAL WEBSITE WITH A TOOL FOR INTERACTIVITY EXPRESSION CUSTOMIZATION

Self-Expression through Interactivity

Based on these design considerations, we devised a social website prototype, namely, iSpace, which enables users to customize their interactivity expressions. All iSpace users have their own iSpace with the *default interactivity* settings initially. With the *Interactivity Expression Tool*, individual users can define the interactivity of their own iSpace to their liking. We term this *customized interactivity*. The owner as well as other visitors can then experience one's iSpace with the customized interactivity. One's customized interactivity is valid only on the individual's iSpace page so that the user can clearly distinguish his or her expressions from those of others.

iSpace Design

iSpace uses a desktop-based GUI platform with a mouse interface. As the first study to examine the roles and effects of the customized interactivity expression in social media, we selected this very basic form of computer-human interface because the interactivity should be able to be experienced regardless of the type of interface. We considered that, if this basic form works, with its limits on the variety of interactivity expression compared to other newly emerging types of interfaces such as touch and gesture interface, then we can claim that the significance of interactivity expression in an online social environment even stronger. To do this, we explored the ways to enable users to customize interactivity expressions within the essential interface for SNS using the four basic forms of mouse interaction: point, click, drag, and scroll.

Figure 1(a) shows an overview of the design of iSpace. iSpace is divided into a space for SNS activities (the left side of the vertical dashed line) and a space for our user study-related activities, such as the use of the interactivity expression tool and the recording of experiences while participating in the user study (the right side). These two spaces were designed to have a single- or double-depth interface structure so that the users could flexibly use two spaces in a non-complex manner. This allowed them to go back and forth as they experienced individual spaces and to record the feelings they experienced from each space.

In the design of the space for SNS activities (Fig. 1(b)), we kept the basic structure of the 'wall' in Facebook. There is brief information about the owner and the members who are connected to the owner. Users can post their status in text and can comment or 'like' other posts. They can also request a person to be a friend by dragging the person's icon to the group icon and can 'poke' others by clicking the poke button. All of the content in this space is sharable among connected friends.

Within these essential functions, we explored ways to enable users to customize interactivity expressions for their self-expression by applying the selected mouse interactions: pointing, clicking, dragging, and scrolling. In this process, we chose three interactivity attributes which suggest a objective description of the relationship between an input and an output: *Change speed, Response threshold,* and *Response speed*. These attributes are rooted in the original interactivity attribute framework. They are useful when objective value control is necessary, as in this study. For each type of mouse interaction, we repeatedly went through a trial-and-error process with a Flash prototype in order to find well-matched combinations of interactivity attributes and interfaces in terms of the usage behaviors and meanings.

For the pointing interaction, we applied the mouse cursor's response speed interactivity; the time spent upon reaching the location where a user's actual input points. We could foresee the possibility that one can experience individual differences from the movement of the mouse cursor from P5's mention in the preliminary exploration. This led us to provide for control of the cursor's response speed interactivity. So as not to disturb the usability of the mouse, we set the maximum delay time to 1 second.

Click interaction was combined with the poke button click. We applied a response threshold to the output, i.e., poked or not poked, for the user's input, i.e., the duration of pressing the button, in other words, the degree of poking. This was

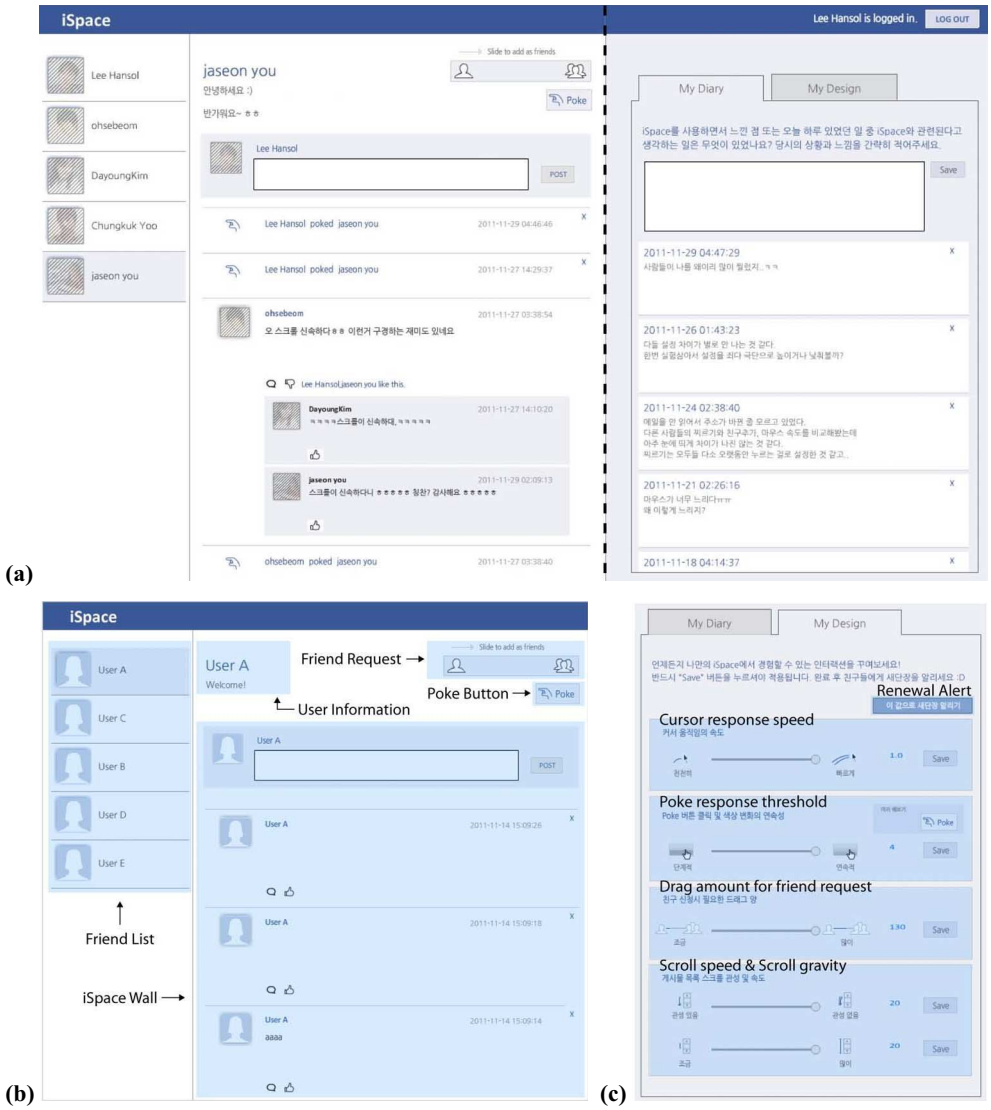

Figure 1. (a) iSpace overview: the left side of the vertical dashed line is for SNS activities, and the right side is for the interactivity expression tool and the user diary (b) Elements of the space for SNS activities (c) Elements of the interactivity expression tool

done because the 'poke' function does not limit a specific objective but instead leaves a message, such as, *'Tom has poked Amy'*. The users, by themselves, then interpret the meaning and objective of the function in their context. This aspect was expected to show how individuals use it differently as well as to evoke interesting discussions related to this work. We allowed poked user to control to the degree of poking from 0s (the lowest threshold) to 1s (the highest threshold). In order to give feedback to a user who was trying to poke another user, iSpace displayed an alert message depending on the friend's setup and the actual duration for which the person poked the friend: *'Poke more!*', when one's poking was not enough; and *'Poked!*', when one succeeded in poking the other. It also leaves a message that shows *'who poked whom.'*

For the drag interaction, the user's input is determined by the degree of the dragging of an object. Taking the natural input behavior, we applied response threshold interactivity to the friend request feature. Users can control the amount of dragging, which determines how much their friends have to drag the person's icon, so as to send a friend request. This type of interface is not typically used in the Facebook GUI, but we intentionally modified the typical button interaction for a friend request to explore how individuals use interactivity expressions in this different manner of making a friend request.

For the scrolling interaction, two interactivity controls were applied to the list of wall posts: the scroll speed and scroll gravity. The scroll speed is the change speed, the list's movement distance difference when the user gives the same amount of scroll input. Scroll gravity can be explained in terms of the response speed, the duration difference when

the list moves the same distance; a delayed response speed results in a longer time to reach the same distance, causing users to feel this as greater gravity.

In the study-related space (Fig. 1(c)), we provided a tool through which users can customize these interactivity expressions. The interactivity expression tool was designed to be easy to use so that participants do not have a psychological barrier when controlling the invisible qualities of interactivity. To do this, we provided a slider-type controller and clearly showed the value of each interactivity attribute. Also, we added pictorial illustrations as well as sub-labeling to help users intuitively understand their meanings. Users can freely control the interactivity qualities whenever they want. They can send an alert about the renewing of their iSpace to their friends by clicking the alert button. In addition, users can record their thoughts and feelings in-situ in a diary, which is composed of a simple textbox and a display area (the right side of the dashed line in Fig. 1(a)). All of these features in the study-related space were only accessible by the owner and the researchers.

THE USER STUDY SETUP

To explore the first research question regarding the methods of interactivity expression, we conducted an experience prototyping session for individual participants using the iSpace prototype. We asked the participants to customize the interactivity expressions as they wanted and let them think aloud regarding what they were thinking when controlling the interactivity. After doing this, we had a debriefing interview about the rationale behind their interactivity expressions. We recorded the entire session with a video camera for further analysis.

To explore the second research question regarding the effects of individuals' interactivity expressions in the virtual social media on their online communications, we grouped the participants who were also involved in the individual experience session and then asked them to use iSpace for two weeks with their own members. Each week, we respectively provided the iSpace where we *allowed* interactivity expressions with iSpace and where we did *not allow* it. In the order of providing iSpace with and without such interactivity, we termed each group as the Condition A or the Condition B group.

For the Condition A group, we provided iSpace without the interactivity expression tool for the first week and then provided it with the interactivity expression tool during the second week. Under this condition, we were interested in exploring how social interactions can change when interactivity expressions are available compared to their interaction during the first week. For the Condition B group, we provided iSpace with the interactivity expression tool for the first week and then provided it without this tool during the second week. In this case, we attempted to explore how one's first impressions are created through his or her interactivity expressions and how this affects their social activities.

For the Condition A group, individual experience prototyping sessions were necessary after finishing with iSpace without the capability of interactivity expression so that the participants would not develop prejudice or make assumptions about the concept of interactivity expression during the first week. For the Condition B group, these sessions were necessary immediately before providing iSpace with the interactivity expression capability so that we can set each user's interactivity, as determined in the individual session. In doing this, each user's user study process was determined depending on his or her Condition group. After finishing the two-week user study, we had a debriefing interview about the influences of interactivity expression customization that participants experienced when they interacted with other members.

We were also interested in the participant's individual characteristics, which we could not observe through the video analysis or in the two-week user study. Therefore, we conducted a survey that included questions related to the factors that cause individual differences in emotional processing [5]. These included generic factors, personality, and previous experiences. For the generic factors, only gender and age, which designers can control and consider in the design practice, were included. The personality factors were examined with 20 questions from Big Five personality factors [6]. The experience factors included 30 questions related to Facebook usage patterns (e.g., how frequently visit and post content), customizing experiences of identity-related features (e.g., decorating their profile or avatars), and their overall interactive product use experiences (e.g., how much time they used their computer per day). To avoid burdening the participants, the survey was conducted in two parts. The first part, which included questions for demographic factors, Facebook usage patterns, and interactive product experience, conducted at the beginning of the experiment. The second part included personality factors and customizing experiences. It was done at the end of the experiment because its questions were closely related to the purpose of the user study.

30 participants (15 males and 15 females, 23.6 years old on average) who use Facebook at least once a day were recruited. 15 participants were assigned to each condition group. To observe the interactions among the group members effectively, they were again divided into three small groups: Groups A-1, A-2, and A-3 and Groups B-1, B-2, and B-3. The criteria for this group assignment were to group familiar friends as well as to provide potential friend lists so that participants could be motivated to build relationships while feeling comfortable with their familiar friends. In doing this, we grouped participants such that all or some of the members shared at least one community, such as club, major, and year.

ANALYSIS & FINDINGS

Rationale behind Interactivity Expression

After the detailed video analysis of the individual experience prototyping session, we observed the patterns in the interactivity expression behaviors. For each interactivity value that we provided in iSpace, the participants roughly explored its left- and right-end value first and then repeatedly controlled and experienced this value at the micro-level in order to find which one they preferred. The perceived interactivity was not always linearly matched with its numerical value; it was a subjective matter as to how one perceived which value range belongs to which side of an interactivity expression. When they controlled the mouse cursor's response speed, for example, some participants reported that only 1.0 (a response speed of 1 frame rate; no delay) was felt as a prompt response, whereas others reported 0.6 (a response speed of 6/10 frame rate; a slight delay) still promptly responded to their input. This *perception unit* formed the ground rationale for the value selection and resulted in the distribution of the participants' interactivity expressions. In what follows, we summarize four specific criteria as used by the participants for interactivity expressions. In some cases, several criteria were closely related, and occasionally one of the criteria was more influential on their value selection than the others. However, there was no fixed hierarchical order among them.

Criterion 1: Preference toward a perceived interactivity

After they explored interactivity value range at the macro-level, they established the direction of their preference for one of the dichotomized values; this decision was made almost immediately after one or two trials for each value. It was more of an individual aesthetic judgment rather than a rationale decision which often involves logical thought.

Criterion 2: Preference toward Usability

Usability issues were another criterion for interactivity expression. This criterion may not be equally applicable for every type of interface; however, for some that are constantly used for all of the tasks, such as the use of a mouse or a keyboard, this criterion may be more significant than other types of interfaces when controlling the interactivity. For example, when the participants tried to control the mouse cursor's response speed, of which the usability is critical, 90% of the participants said that they prefer a prompt response. Interestingly, although their interactivity expressions tended to follow a similar trend, the actual value perceived by each participant as a prompt response differed depending on their perception units. This also reflects one's characteristics even in the case where people tend to have a consensus preference.

Criterion 3: Preference toward Metaphorical Meaning

In some cases, controlling the interactivity was metaphorically interpreted and determined to imply certain meanings. The participants interpreted the interactivity attribute, for example, *response threshold*, which was applied to the poke button and the friend request, as *a level of a social barrier* to others who will visit and try the interactivity they set up: *"I want a sincere relationship, even in an online social network. If somebody wants to be my friend, then I want them to drag at least this much [almost 80% of the line]. It's not to burden them, but I think it's a type of social manner." "Poking each other would be fun. I want to enable my visitors to poke me easily and frequently. I'm ready to play with them!"*

Criterion 4: Reflection of One's Habitual Behaviors

This criterion was discovered by our repeated video analysis of focusing on each participant's unconscious behaviors throughout the experience prototyping session. When they selected the interactivity value for the scroll speed and scroll gravity, the individual's usage habit strongly but often unconsciously affected their selection. Some of the participants set the interactivity to have a wide range of finger movements when they scrolled down the lists, which resulted in a fast scroll speed; others set the interactivity in the opposite way, as they considered it to be comfortable and natural when they scrolled slowly.

Although most of the participants did not perceive how different their usage habits were, in some cases the participants had a specific intention toward their habitual behaviors related to the online social interaction: *"I usually slowly scroll down lists especially in an SNS environment, so that I will not skip any single comment on my wall. I don't want to disappoint others by carelessly missing the opportunity to reply to their comments."* Whether it was perceived or not, this finding was quite interesting, as an individual's natural somatic style was reflected, as in their offline interactions.

Styles of Interactivity Expression

To explore styles of interactivity expressions and how they differ from each other, we conducted a K-means clustering analysis based on the participants' customized interactivity value. We were interested in discovering what emotional experiences they tried to evoke through the interactivity that each set for the five features. Hence, we encoded numerical data for the interactivity value into their perceived interactivity attribute referring to each participant's verbal expressions and then replaced them with the characteristics that can be perceived through the perceived interactivity, according to [11], which discovered the relationship between emotion and each interactivity attribute value.

Style	Preferred characteristics	Interactivity value
Style A (30%) Slow Harmony	Heavy, Soft, Blend, Deep, Complex, Ambiguous, Exotic, Sympathetic, Natural, Analog	Slow cursor speed, Long button click, Slow scroll response, Slow scroll speed
Style B (27%) Fast Harmony	Light, Hard, Vivid, Shallow, Simple, Clear, Mundane, Unsympathetic, Digital	Fast cursor speed, Short button click, Fast scroll response, Fast scroll speed
Style C (43%) Slow-Fast Combination	Artificial	Fast cursor speed, Slow scroll response, Fast scroll speed

Table 1. Interactivity expression styles

From the result, we found that three-group clustering best illustrates both the quantitative and qualitative data. The qualities that distinguish one style from another were primarily as follows: i) *speed-related interactivity attributes* such as the movement speed and response speed, and ii) *interactivity harmony*, which indicates whether or not the five selected interactivity values for each of the five features commonly evoke similar characteristics. In this sense, we can re-label each interactivity expression style as *Slow Harmony* (Style A), *Fast Harmony* (Style B), and a *Slow-Fast Combination* (Style C) (Table 1).

From the video analysis, we were able to observe the characteristics of participants whose thoughts and behaviors seemed to be related to their interactivity expression style. For example, the participants who belonged to the Style A group tended to approach the process of interactivity expression emotionally. They wanted to express how much they care about others by controlling interactivity values such that they provide a comfortable experience. This intention is closely related to the soft, natural, and sympathetic characteristics of the slow harmony style. On the other hand, the participants who belonged to the Style B group tended to approach the process of interactivity expression practically. It was important for them to obtain prompt and clear feedback. Therefore, they preferred light, simple, and digital feelings from the fast harmony. For those who belonged to the Style C group, they basically preferred fast-speed interactivity but tended to enjoy new feelings from the slightly lowered speed. They set a fast scroll speed with a slow scroll response, which made them feel more gravity that they cannot be experienced in the lists of usual websites.

The Effects of Interactivity Expression Customization on Online Social Interaction

For the second research question, regarding the effects of individuals' interactivity expressions in the virtual social media on their online social interactions, we reviewed our entire set of data, including the statements and comments, the user diaries, the interactivity control history, and the debriefing interview transcripts of each group, in detail several times with different foci, including how one's interactivity expressions were interpreted and in what ways those interpretations affected how they understood others and communicated with them. In the following paragraphs, we report the results and the interpretation of these items with actual data instances.

The effects on the first impression

Overall, because interactivity can be felt only through the actual use of the interfaces, the participants were curious about other's own interactivity expressions. This motivated them to obtain some snippets about one's personality from an exploration of another's interactivity: *"For me, iSpace is a type of substitute for each user rather than a communication tool, like the current types of SNS. It's fun to discover how this person is different from others."*

Indeed, participants acquired some snippets of other's personality from this discovery process. Also, the personal characteristics that they described based on the interactivity of others tended to be related to one's behavioral characteristics: *"It is my gut feeling that, he [Style B] is like… how to say, every movement in his iSpace is very wide and quick. He is like a fancy mp3 player, which is trendy and smart. However, this man [the other member, Style A] is like an analogue radio. His iSpace is slow and soft. I guess he [the latter] may be emotional and sympathetic."*

Also, as people have more attraction to those who have characteristics similar to their own in their everyday lives [2], this *similar-attraction effect* was also discovered in iSpace. Some participants reported that they felt a sense of kinship when they experienced a similar quality of interactivity expression in another's iSpace. This led participants to visit friends whose interactivity expressions were similar to theirs frequently and preferentially. Although the impact of interactivity expressions was not as direct as that of visual self-expression, it was interesting that people obtained a first impression and imagined what type of person they may be liked despite the invisible quality of interactivity. These examples enhance the possibility of interactivity as a medium for self-expression in an online communication environment.

Changes in the width and depth of social interaction

The uniqueness that participants experienced in a friend's iSpace addressed changes in the width and depth of their social interactions compared to a case in which iSpace did not allow them to customize their interactivity expressions. First, the discovery process itself *lowered the social barriers* between strangers, as it resulted in a close feeling via the creation of input behaviors to explore another's interactivity expressions: *"It was much easier to comment on her [not familiar member] posts when I could experience her interactivity expressions. I felt closer to her compared to the last week."*

For close friends, interactivity expressions *deepened their understating of the other*. Some participants were able to reconsider the characteristics of their friends owing to their friends' unexpected interactivity expressions: *"I thought I knew her, but her fast scrolling did not quite match her image in my mind. This aspect of her is new to me."* Also, it *deepened the sympathy toward one's emotional status*. In the following example, even a stranger's interactivity expressions evoked sympathy in a participant and made him to leave a comment like: *"Your scrolling is kind of sad. Are there any problems?"*

Since interactivity expressions are ambient and not as direct as visual expressions are, these findings were interesting that the invisible, experience-oriented characteristics of interactivity contributed to an increased amount of attention on others' expressions and that this led to changes in user's social interactions. This implies the possibility that interactivity can overcome the current design challenges of

social applications, which seek a way to support one's uniqueness without increasing visual complexity.

Changes in the manner of online social interaction

The characteristics of interactivity expression changed the methods of online social interaction. First, the invisible nature of interactivity increased the use of non-verbal expressions. In the case of iSpace with interactivity expressions, participants tended to *express some messages by changing interactivity expressions* rather than posting it in text. They hoped others would notice their intention through the experience of the changed interactivity: *"I wanted to whine to others, because I feel bad these days… but it seems that they don't talk much here. Therefore, I just changed my cursor, moving it very slowly, so that they would notice something about me these days and talk with me."* His changed interactivity, indeed, received much attention from others and boosted conversation among all of the members.

Also, interactivity expressions enabled participants to *express their attitudinal characteristics by enhancing or reducing the interactivity values.* This occurred especially in the interfaces, of which the meaning is related to social activities, such as a friend request and the poke button: *"I think I am a person with higher social barriers to be a friend… so I changed the drag amount from 100% to 0% so that I can be more open to others."* These changes caused form its ambient characteristics reveal the potential domains of interactivity expression in which textual expressions cannot cover the purpose of communication.

DESIGN IMPLICATIONS

In this study, we observed the possibility that interactivity expression customization plays a meaningful social role for individuals. With this new medium, the role of designers is becoming important, as their design outcomes should implement this concept in the form of a tool or a system. Therefore, we summarize considerable design factors with an in-depth discussion of the characteristics of interactivity expressions, which addressed meaningful changes in self-expression and online social interaction. We expect that this discussion will spur designers to consider these factors strategically in their design practices.

The trace of interactivity-mediated social interaction

Participants in the user study interacted more frequently and actively when the interactivity-meditated social interaction left a trace. For example, the poke button generated a trace when a user pressed it and experienced its interactivity, which was customized by the owner of the visited iSpace page. Because they feel one's customized interactivity while leaving a trace, the meaning of the trace in iSpace was also interpreted in a different manner compared to the poke button in Facebook despite the fact that the format of the trace is identical in both cases. In the case of iSpace with the capability of interactivity expression, participants interpreted it as a trace of two-way interaction between the visitor and the owner rather than a one-way poke to the owner. In addition, given that simply clicking the poke button automatically generated the trace, it was easy for them to create a history of 'poking'. These aspects of the trace enabled them to constantly interact with their friends and with those with whom they were not familiar: *"When I poked friends, each of them responded differently. One, whose poking was long, seemed to be playing with me by delaying the response." "It is fun to have a tacit conversation [by poking others]. It keeps me poking others."* As this example shows, it is possible to design methods of leaving a trace intentionally so as to express one's characteristics and foster social interaction among users. This approach can include the format of the trace itself as well as the user's input behavior that triggers the trace.

Text-integrated interactivity expression

Interactivity expressions induced deeper interaction when applied to the interface in which actual conversation occurred. For example, the wall in iSpace directly contained the posting contents. Therefore, the scroll-related interactivity expression was integrated with the text expressions in the wall. As a result, interactivity expressions served as an amplifier which enhanced the meaning of and increases the sympathy toward the post. Moreover, individual users' scroll speeds and scroll gravity choices constantly affected the levels of understanding of other users, because scroll-related interactivity was experienced more frequently than other interactions. Since a posting list is one of the basic elements in a SNS interface, integrating its text content and its interactivity would have similar effects in other types of SNS.

Flexibility of interactivity value control

We designed the interactivity expression tool in a way that enables users to control the interactivity value as finely as possible. On the one hand, participants utilized this full access well when their preferences varied over the entire range of the value, such as the scroll speed or the poke response threshold. On the other hand, participants were concerned only with the direction of the interactivity expression, i.e., the dichotomized interactivity value, when their preferences were polarized as either maximum or minimum. For example, the participants did not care much about or perceive the sophisticated differences in each user's mouse cursor response speed, as most participants preferred a prompt response. Rather, they were concerned whether or not another's cursor response was significantly different. In this case, even this rough perception played a role in understanding others. As shown in these examples, the flexibility of interactivity value control can be intentionally simplified into a minimum number of steps. By doing so, interactivity expressions would be more clearly and effectively delivered to others.

Types of emotional expression through interactivity

Through interactivity customization, participants tended to express long-lasting characteristics instead of momentary feelings. In addition, they did not frequently change interactivity expressions and thought one's interactivity

represents static characteristics. We consider that the spatial concept of iSpace affected their expressions, as usually the space or structure are static and are not frequently changed. Instead of limiting one's interactivity expressions to a specific space, interactivity customization can be applied to a micro-level interface. For example, each message balloon during a real-time chat session or each comment box in SNS can be utilized to enable users to express momentary feelings or daily moods by customizing interactivity value of those types of interfaces. This approach can also enrich online communication and interaction among people, as one participant mentioned when inquiring about 'sad scrolling' and whether the other person had 'any problems'.

Interactivity style construction from personal metadata

In this study, we discovered three types of interactivity expression styles and the related emotional experiences that can be perceived from each style. We expect that one's interactivity expression style would be more explicit if one's characteristics, which are represented by other types of self-expression media, have consistency with the style of interactivity expression. As a way to do this, we can utilize personal metadata generated by a user's activities in SNS. Because SNS allows users to share media content types such as music lists and video clips easily, people like to express their aesthetic preferences by sharing these types of media content [12]. If we extract the emotional characteristics from the history of one's shared media, it would be possible to design a social application which suggests personalized interactivity expressions for individual users. In this way, social applications would be a supportive collaborator for a user's identity construction process, as mentioned in [18].

CONCLUSION & FUTURE WORKS

In this study, we discovered the rationale and patterns in one's interactivity expression customization behaviors. We also summarized the discussions and the implications of the social roles and related effects in an online communication environment. The key implication of these findings pertaining to the design of social applications is that even the invisible expressions of interactivity play a role in presenting one's characteristics, changing the widths and depths of these characteristics and altering the ways people interact in a virtual space. In this research, however, the study was conducted to the controlled social groups within a short period. To truly confirm and thoughtfully utilize this concept in broader design practices, real deployment of iSpace for a longer term should be studied further.

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