Relation between Different UI Information Representation Methods and User Cognition

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Abstract. This paper focuses on services with unique information expressions that differ from existing content services against the background of distributing a large amount of video content and differentiating them from similar services in the market, as well as the impact of differences in information expressions on user recognition and user load. In this study, research was conducted on mobile applications of existing over-the-top (OTT) services. First, we investigated the user's operational process in OTT services and found that visual and cognitive aspects of thumbnails were responsible for actions taken. Next, to clarify the influence of thumbnails on cognition and load in information representation, we conducted an experiment using a sample of thumbnails broken down into their constituent elements. The results showed that thumbnails could alter the impression made on users by focusing on the combination and arrangement of the elements. We also confirmed the influences of user gender, preferences, and differences in experience on genre judgment. In OTT services, changing thumbnail components according to user characteristics may induce interest and attention, leading to continued use of the service.

Keywords: Over-The-Top, Thumbnail, User Interface.

1 Introduction

With the development of information and communications technology (ICT) and smart devices, it has become easier to provide a variety of information content to customers, and OTT services based on subscription systems have attracted attention. OTT services offer a unique user interface (UI) that differs from existing content (that presents a series of information in a linear fashion) to distribute a vast amount of video content and differentiate themselves from similar services in the market. Such UI has a greater direct impact on a user's overall understanding and operation of service content than mere operability. Therefore, we believe that the UI of OTT services, which is characterized by a large amount of information on a single screen, can increase the number of user choices and complicate the information being visualized and perceived, thus making information processing more difficult and placing a burden on user understanding and operation. In services that handle a large amount of content, users evaluate, select, and share information, which is an active, user-driven consumption behavior; thus, the ongoing relationship between the customer and the

company will affect profits. Therefore, companies such as Amazon and Netflix, which offer member-centric services such as subscriptions, require enduring customer-oriented engagement to profit [1]. As the representation of information in content and services is the gateway between the user, company, and service, the existence of a UI that considers usability through accurate information perception in service use is a very important factor in maintaining customer relationships. Studies on user perception and load have mainly focused on the usability of websites. However, there are few studies on the analysis of UI consisting of specialized thumbnail-like objects, such as those used by OTT services, and the relationship between information representation and perception in mobile devices. In the case of services that handle a huge amount of visual content (e.g., movies and dramas), which are the focus of this study, it is possible to improve usability by designing a UI that use operations that have become habitual in other services or that follow already formed mental models, rather than making users perceive complex information in an unfamiliar way. We believe that intuitive decisions and operations by users can be realized. In addition, simplifying the overall operation of a service and improving the ease of recognizing its visual information may reduce the burden incurred by users. Based on the above, this study aimed to clarify the effects of different information representations in UI for information transfer and service differentiation of the content of OTT services on user cognition and load.

2 Literature: Information Representation and User Cognition and Load

This This research deals with information representation in a graphical user interface (GUI), which plays an important role as the boundary between the user and computer by objectifying information in the form of color, sound, language, and gestures that can be viewed and manipulated by directly touching what is projected on the liquid crystal display (LCD) [2,3,4].

2.1 Human Processing Processes for Information Representation

The representation of information in a UI is manipulated through sensory, perceptual, and cognitive information processing (Fig. 1). In sensation, information input to the eyes and other receptors is efficiently processed by transmitting the information to the sensory memory of the brain, followed by the processing and enhancing of the information [5]. Perception selects and combines multiple types of visual information to generate output representations for decision-making and action [6]. We also find meaning and value in actively received visual information based on our past memories and desires [7,5]. This concept is called affordance, and changes depending on the recipient and the way it is communicated [8]. In the field of design, constraints on affordances intentionally limit user choices [9]. In cognition, information processing is divided into processing based on input information and processing based on past information stored in the long-term memory [5]. The information processing in this

case varies depending on the emotions influenced by the surrounding environment [10]. It is closely related to concept-driven processing in the representation of information on the UI. The more similar a past operating experience or mental model is to the current operating experience, the easier it is to recall, understand, and operate [11,12].

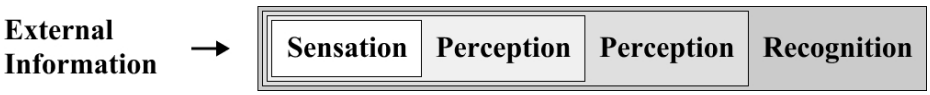

Fig. 1. Human cognitive processes for external information

2.2 The information foraging theory

Information foraging theory is based on a series of behavioral mechanisms that wild animals use to gather food, such as selecting a feeding ground, finding food, acquiring it, and eating it, and is applied to our behavior when we gather information to give it significance [13]. This theory is valid when it contains information that we can interpret for objects with which we have no experience and is used to predict human processes in searching for information in the external world [14]. The most important concept in information foraging theory is "information scent". Information scent encompasses the subjective values and costs of obtaining information based on perceptual cues [15]. We estimate how much useful information can be obtained in our surroundings, and after seeking information, we compare the actual results to our prediction. When we have exhausted the information, we move on to another source. To be an efficient information forager, it is important to accurately perceive information. In the information foraging theory, the optimal feeding ground model is an information processing flow that focuses on how to choose a feeding ground (Fig. 2). Operations in OTT services involve browsing while foraging for information. Therefore, this study investigated user operations in OTT services from the perspective of information foraging theory.

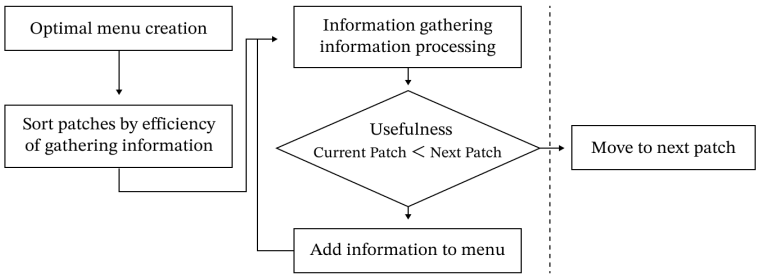

Fig. 2. Optimal feeding field model in the information foraging theory

2.3 The information foraging theory

Cognitive load theory (CLT) presents a model that describes various aspects of load associated with learning experiences for the purpose of constructing cognitive schemas. The construction of this cognitive schema occurs in working memory, which has a limited capacity. The causes of cognitive load can be broadly classified into three categories: intrinsic, external, and close [16]. From the perspectives of CLT and information processing, we show the relationship between learning experiences and cognitive load based on UI manipulation. The simpler the information representation, the easier it is to understand, and the easier the operational procedure, the smaller the cognitive load [17]. At the product development scale, these three burdens can be reduced by considering "function determination", "design", and "user cognitive process assistance".

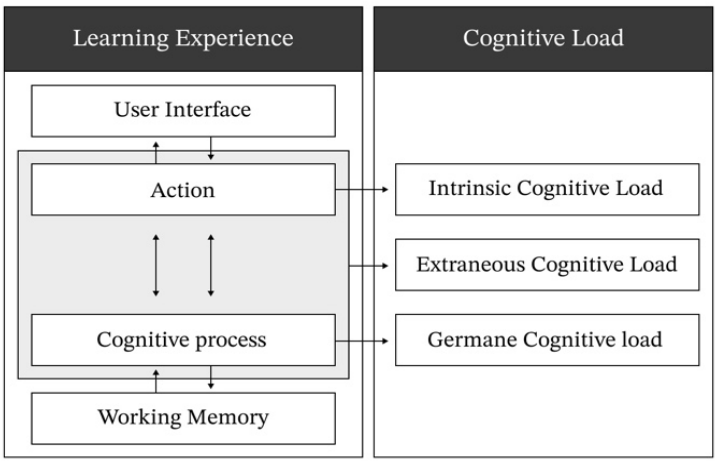

Fig. 3. Relationship between learning experience and cognitive load.

3 Method

First, a survey was conducted on the information representation and operation of OTT services, followed by an experiment focusing on thumbnails. The main flow of the survey is as follows (Fig. 4).

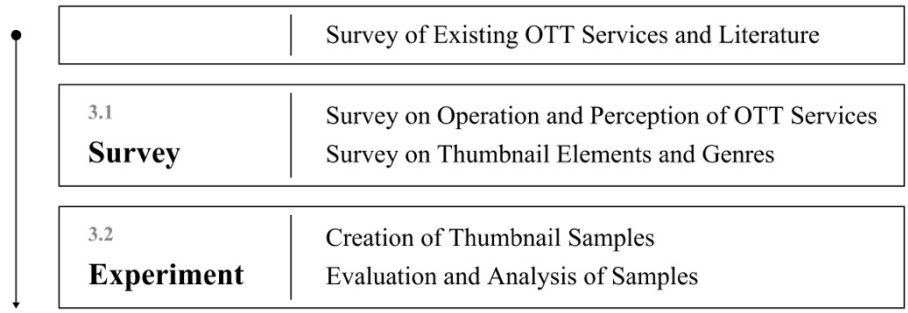

Fig. 4. Main flow of investigation and experiment.

3.1 Survey on Operation and Cognition when Using OTT Services

We conducted a walk-through evaluation of the Netflix smartphone application, in which 20 men and 20 women Netflix students were given the task of browsing until they found a movie they wanted to watch when they had no objective. A checklist was used during the observation, and pain points and emotions during the operation were recorded through post-observation interviews.

3.2 Investigation of The Relationship between Thumbnail Components and Genre

In order to clarify the thumbnail components that users use to judge genres from thumbnails, we conducted a questionnaire survey using the KJ method, using 30 thumbnails of those available on Netflix as cards. The study population consisted of three college students who had experience using OTT services. The survey was conducted using the following procedure.

1. Grouping the thumbnail cards
2. Naming the classified groups
3. Enumeration of thumbnail elements as reasons for steps 1 and 2

Next, in order to clarify the influence of the thumbnail factors on the judgment of genre for each group and to confirm individual differences, we used the design of experiment method to create 48 samples, 8 samples for each of the 6 groups, from L8's (25) direct-row table, using the top 5 factors that were frequently mentioned for each group obtained from the previous survey as factors [18]. The thumbnail samples created are shown below (Fig 5). A questionnaire regarding the samples was then administered for evaluation and analysis. In the questionnaire, 8 samples were presented to those who had experience using OTT services for evaluation, and they were asked to select one sample that gave the strongest impression of the group name.

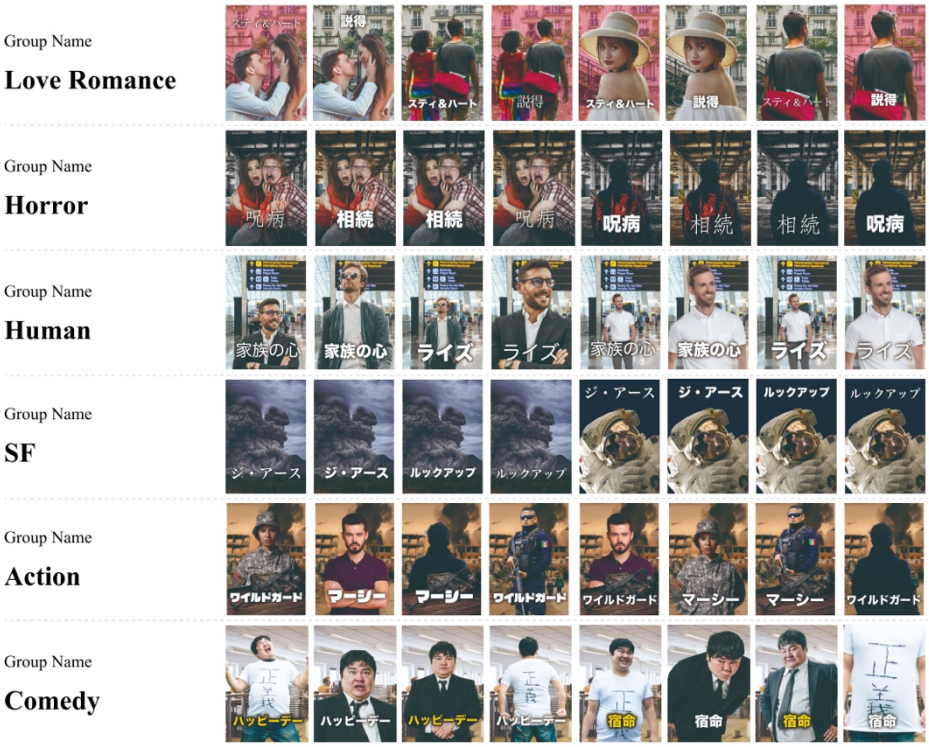

Fig. 5. Sample thumbnails created for each of the six genres.

4 Results and Discussion

4.1 Survey Results on OTT Service Use

Based on the information foraging theory and the results of the walkthrough study, we present a graphical representation of the user's operation process (Fig. 6). The user's operation on Netflix is similar to the optimal feeding ground model, with the genre row as a patch. The user repeatedly collects and processes thumbnail information and semantic information of details on-screen, leading to the viewing of the content. Thumbnails emit information in the patch and play an important role in assisting the user's movement through the patch and transition to the detail screens. Thumbnails in UI are widgets that influence the search experience in a general visualization format for video content [19]. Based on the above, we believe that by focusing on the information representation in thumbnails in the UI of OTT services and clarifying their relationship with user cognition, it may be possible to simplify overall service operations and improve the ease of recognizing visual information, thereby reducing user's cognitive load.

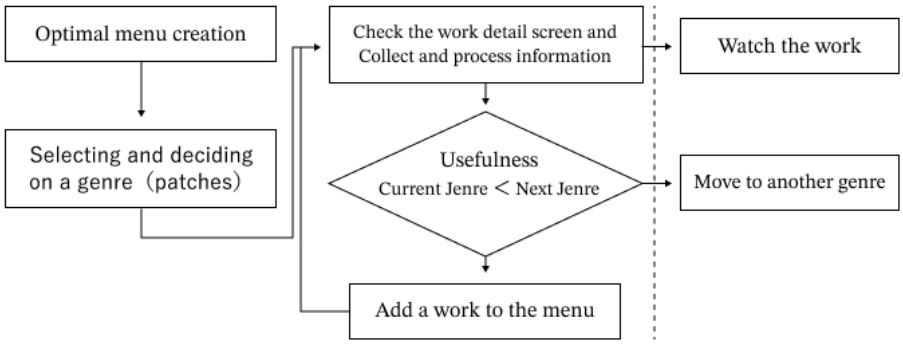

Fig. 6. User Operation Process

4.2 Survey Results on Thumbnails and Genres

The 30 thumbnails used in the KJ method were classified into six categories: "Love Romance," "Horror," "Human," "Science Fiction," "Action," and "Comedy." In addition, a total of 180 thumbnail elements were listed. Comparing each group, it became clear that there were differences in the elements that were mentioned frequently, and that elements had characteristics for each group. In addition, thumbnail elements could be classified into three elements: "Person," "Text," and "Background." These results suggest that thumbnails can be divided by component and that users pay attention to each element in the thumbnails and use them to determine the genre. Next, we conducted a one-way ANOVA using the questionnaire results and the experimental design table and organized the results into four categories: overall, male, female, and genre-preferring viewers, using the influence of each element in the thumbnails on users' genre judgments as the main effect value. The higher the main effect value, the greater the influence of that element on the user's genre choice. The results and discussion for each genre are presented below.

Love Romance. The results of the one-way ANOVA for "Love Romance" are shown in Table 1.

- The main effect size was higher for poses related to Love Romance because they are easy to accept at a glance, such as a men and a women facing each other.
- The fact that the thumbnails are composed of a men and a women also contributes to the judgment of the genre.
- Men tend to judge genres by looking at the person only, while women tend to judge genres by looking at both the person and the title.
- The inclusion of the two elements "Person: Relationship" and "Person: Pose" has a very strong influence on the judgment of genre in Love Romance. This is because the relationship between characters is the main point of the story in works classified as Love Romance.

Table 1. Love Romance Results.

Factors and Levels	Love Romance			
	All	Men	Women	Preference
Person: Relationship	18.2	17.5	17.3	16.8
Person: Pose	19.2	17.5	19.2	14.8
Text: Meaning	14.2	11.8	15.4	12.8
Text: Font	13.2	8.0	17.3	16.8
Background: Color	13.2	9.9	15.4	12.8

Horror. The results of the one-way ANOVA for "Horror" are shown in Table 2.

- The main effect value of the element "Person: Facial Expression N/A" was higher because the fear of not being able to see the face matched the image of "Horror".
- The main effect of text on women's genre judgments was considered to be small, since men focused on the thumbnails as a whole and women focused on the people and backgrounds.
- It is clear that those who prefer to watch horror movies and dramas do not pay attention to the element "Text: Meaning". We believe that this result is due to the fact that many famous horror movies have titles that have nothing to do with Horror at all (e.g., HOPE, Midsummer, Ring).

Table 2. Horror Results.

Factors and Levels	Horror			
	All	Men	Women	Preference
Person: Facial Expression N/A	15.25	10.8	18.3	17.9
Background: Decoration	8.25	8.0	7.7	3.6
Background: Brightness	8.75	7.1	9.6	6.0
Text: Font	3.25	5.2	1.0	8.3
Text: Meaning	4.75	7.1	1.9	-6.0

Human. The results of the one-way ANOVA for "Human" are shown in Table 3.

- In this thumbnail, the element "Background: Landscape" is used to express the presence or absence of the element by changing the screen ratio of the background by adjusting the size of the human figure. In addition, since the genre "Human" is a story centered on people, the main effect value would be higher if the element "Background: Landscape" was omitted and the people were displayed in a larger size.
- In the genre "Human" the development is basically more serious than humorous. In this thumbnail, "Person: Facial Expression" is expressed with a smiling face, so

"Person: Facial Expression N/A", in which the face of the person is hidden, is considered to have a higher main effect value.

- The main effect values of each element in the genre "Human" were low and varied in all categories due to the lack of a clear level for each element.

Table 3. Human Results.

Factors and Levels	Human			
	All	Men	Women	Preference
Person: Pose	9.75	12.7	5.8	4.5
Text: Meaning	5.75	7.1	3.8	4.5
Background: Landscape N/A	3.75	8.0	-1.0	0.0
Person: Facial Expression N/A	6.75	11.8	1.0	2.3
Text: Font N/A	11.25	12.7	8.7	9.1

SF. The results of the one-way ANOVA for "SF" are shown in Table 4.

- In this thumbnail, the element "Text: Meaning" is titled "The Earth". Since the definition of "SF" can be interpreted and received in various ways, it was not possible to set a clear standard for how the element should be expressed. However, the name of the text is related to the universe, which is one of the interpretations of "SF", making it an easily accepted element with a particularly high main-effect value.
- Since all categories in Group 4 "SF" had similar results, we believe that the influence of individual differences on genre judgments is minimal.

Table 4. SF Results.

Factors and Levels	SF			
	All	Men	Women	Preference
Background: Landscape	1.25	4.2	-1.9	4.4
Text: Meaning	16.25	14.6	16.3	19.1
Person: Personally N/A	1.25	4.2	-1.9	4.4
Person: Not Including N/A	1.25	4.2	-1.9	4.4
Text: Font N/A	1.25	1.4	1.0	1.5

Action. The results of the one-way ANOVA for "Action" are shown in Table 5.

- In this thumbnail, the element "Text: meaning" is expressed as "Wild Guard". An action movie is an action play, in which fighting and battle scenes are important. Therefore, we believe that the recognition of the words "Wild" and "Guard", which are related to action movies, may have made it easier for respondents to accept that the movie is an action movie.

- Men and women tend to prefer action movies more than women. Therefore, we believe that women are making judgments based on explicit elements such as "Text: Meaning" without focusing on the characters.

Table 5. Action Results.

Factors and Levels	Action			
	All	Men	Women	Preference
Text: Font	10.75	10.8	9.6	9.5
Person: Facial Expression N/A	4.75	7.1	1.9	7.8
Background: Decoration N/A	4.25	4.2	3.8	3.4
Person: Personally	6.25	9.9	1.9	10.3
Text: Meaning	12.75	10.8	13.5	13.8

Comedy. The results of the one-way ANOVA for "Comedy" are shown in Table 6.

- In this thumbnail, the element "Text: Meaning" is expressed as "Happy Day". Since comedy is interpreted as a work that contains humor, we believe that the recognition of the word "Happy" and other related words may have made it easier to accept it as a comedy.
- In this thumbnail, the element "Text: Meaning" is expressed as "Happy Day". Since comedy is interpreted as a work that contains humor, we believe that the recognition of the word "Happy" and other related words may have made it easier to accept it as a comedy.
- We assume that people who like to watch comedic movies and dramas make comprehensive judgments by looking at various elements in the thumbnails, given that the main effect values seem to vary.

Table 6. Comedy Results.

Factors and Levels	Comedy			
	All	Men	Women	Preference
Text: Meaning	8.75	8.0	8.7	6.9
Person: Facial Expression	7.75	9.9	4.8	8.3
Text: Color N/A	2.25	0.5	3.8	4.2
Person: Pose	4.75	7.1	1.9	0.0
Person: Clothing	3.25	3.3	2.9	-1.4

5 Conclusion

The purpose of this study was to clarify the impact of differences in information representation in the UI for information transmission and service differentiation of content in OTT services on user cognition. After understanding the logical background of a user's cognitive load owing to UI informatization and changes in information representation in information-providing services, we conducted a survey and experiment focusing on thumbnails from the UI of OTT services.

From the experiment, we confirmed the influence of user gender, preference, and experience on genre judgment in each genre. In the case of group 3, "Human," where there was no clear on how to express the elements when the sample was created, we found variation in the results. In addition, since the sample was created using elements obtained from the KJ method survey, some elements moved in the negative direction when all elements should have moved in the positive direction.

As a difference between men and women, it was found that men tended to judge genres based on the overall impression of the thumbnail from Groups 2 "Horror" and 4 "Science Fiction," while women tended to judge genres by looking at specific and clear elements such as the element "Title: Meaning." It was also found that the more people preferred to view content of a specific genre, the more they judged the genre by examining various elements in the thumbnail. Even if the thumbnails were intended to represent the same genre, the impressions made on the users differed significantly depending on the elemental composition.

Thus, we could clarify the impact of differences in information representation in thumbnails on user perceptions from the perspective of thumbnail elements. Recently, artwork visual analysis (AVA) have captured still images of scenes that are suitable as thumbnails in video images. By associating the results of the combinations of thumbnail elements obtained in this study, thumbnail compositions tailored to user characteristics can be used in the UI. We believe that this will simplify the overall operation of the service, improve the ease of recognizing visual information, and reduce the burden on users.

6 Further Work

A limitation of this study was that it was limited to thumbnails consisting of image and text information for UI information representation. However, because the information that users see when using services is not limited, it is necessary to focus on cognition throughout service use. In addition, when examining individual differences among users, this survey only categorized users by genre preference rather than gender. It is necessary to clarify user variables by asking about other factors such as the time of day they operated the service or the surrounding environment. With the acceleration of digital marketing, the number of similar, competing OTT services will increase. To differentiate themselves from competing services, it is essential that companies create a unique selling proposition (USP) for information expression in their

interfaces that connect the user to their service. We believe that a UI that considers user recognition is key to improving the usability of a service.

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