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Analysis of the Effects of Lifelike Characters on Computer-mediated Communication

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Dedicated to the memory of My Dad, Shiro Koda.

Abstract

The goal of this thesis is to clarify the effects of lifelike characters on computer mediated communications. In this research, lifelike characters are defined as personified agents and avatars which are represented as human-like characters with a face and facial expression on the computer screen.

Most research within the field of personified agents has been focused on creating believable characters that act autonomously as we humans do, while the research focus on avatars has been creating systems and templates that correspond to a user's intended emotions of gestures.

However, the implementations of agents or avatars in the above research are based on two assumptions. The former assumption is that lifelike characters on the interface have positive effects on human-character interactions or human-human interactions via characters. There are arguments that personification of agents may cause users' higher expectation in their perceived intellectuality than they actually have. The latter assumption is that lifelike characters and their facial expressions are recognized universally across cultures. There are only few studies that compare users' interpretations of character's facial expressions between two countries, and none among multiple countries. There should be research that verifies the effects of using lifelike characters on the interface, and whether the appearance of characters is equally interpreted across any cultures.

With respect to the above research issues, this thesis verified the effects of using lifelike avatars in the following communication domains.

1. The effects of using lifelike characters on a personified interface

In order to study the effects of lifelike characters with a face and facial expressions in the interface, a series of experiments was conducted to compare subjects' responses to and evaluation of different faces and facial expressions. The experimental results obtained demonstrate that: 1) lifelike characters help users engage in a task, and are well suited for an entertainment domain; 2) people's impressions of a character's face in a task are different from ones of the face in isolation. Perceived intelligence of a character's face is determined not by the character's appearance but by its competence; 3) there is a dichotomy between user groups which have opposite opinions about personification. Thus, an interface with lifelike characters should be flexible to support the diversity of users' preferences and the nature of tasks.

2. The effects of using lifelike characters on a network communication tool

Next evaluation of the effects of using lifelike characters and facial expressions was made using a P2P communication tool. The tool features various character templates and facial expressions to enable users to express their emotions with avatars. The tool has been used by more than 380,000 users since its launch in 1998. The user study shows that featuring characters and facial expressions realized a new communication media where expressing one's emotions is the main purpose for communication. The reasons are; 1) More than 75% of the communications are aimed for expressing one's emotion by using the facial expressions provided. The frequency of using facial expressions did not decline during the research period. These indicate characters and facial expressions are used not as means to complement verbal information such as emotions but as an expressive communication media. 2) More than 80% of the users answered the reason for using the tool is that they can change the characters and facial expressions. 3) Use of the tool did not affect the frequency of email communication. This means the tool was used for different purposes from emails. The communication tool with lifelike characters has also proved

it’s sustainability as it has maintained many users at home and communities as well as offices for seven years.

3. The effects of using lifelike characters on intercultural communications

Next evaluation was made by using lifelike characters for intercultural communication. The experiment was conducted as a series of discussions on a multilingual BBS with lifelike characters between China and Japan. The results show the existence of lifelike characters improved user experiences and interactions among participants and build enthusiasm toward participation and friendliness in intercultural communications. However, some characters and facial expressions used in the experiment were interpreted completely differently and used for different purposes between Chinese and Japanese participants. As avatars are widely used for international business communications as well as daily casual ones via instant messengers, this finding rises an important research questions, i.e., what is an appropriate character representation for intercultural communication, what kind of character traits are suitable for intercultural representation, what kind of facial expressions are universally understood and interpreted, and so on.

4. Cross-cultural analysis of interpretations of avatars’ facial expressions

This section aims to elucidate the following two issues: 1) Identifying cultural differences in interpreting avatars’ facial expressions. This is done by applying psychological findings on cultural differences in human facial expression recognition to the case of avatar expressions. 2) Identifying design features that cause cultural differences in avatar facial expression interpretation. An open web experiment was conducted to gather users’ interpretations of various avatar facial expressions from eight countries within Asia, North and South America, and Europe. The results confirmed that 1) there are cultural differences in interpreting avatars’ facial expressions among the participating countries, and the psychological theory

that suggests physical proximity affects facial expression recognition accuracy is also applicable to avatar facial expressions. Japan had the highest recognition accuracy for avatar expressions designed by Japanese designers, followed by Korea. 2) There are wide differences among cultures in interpreting positive expressions, while negative expressions had higher recognition accuracy regardless of culture. 3) Use of gestures and gesture marks designed by one culture sometimes causes misunderstanding by other cultures.

The conclusion is that lifelike characters have positive effects in the following issues:

1) Personification of software agents improves user experience without causing users' misassumption that the agents would have higher intelligence that they actual have at least in entertainment domain, which had been argued by former studies.
2) Avatars in a network communication tool enhance sentiment communications which main focus is to express users' emotions, and improve user experience in intercultural communications.

However, this research showed that we should be careful designing the appearance of lifelike characters in the following issues:

1) People's opinion about personification causes opposite appreciation to the appearance of the lifelike characters.
2) There are cultural differences in interpreting characters' facial expressions. Physical proximity affects facial expression recognition accuracy.

Chapter 1. Introduction

1.1. Backgrounds

The metaphor of face-to-face communication has been applied to human-computer interface design. In order to achieve face-face communication on the computer interface, virtual characters are frequently used. Virtual characters are used as a metaphor of a human figure, personified agents, or avatars. Some of them have animated faces and gestures. This thesis uses the term “lifelike characters” to refer to personified agents and avatars with faces and facial expressions.

This chapter describes research on lifelike characters. The related research stems in four areas: interface agents, believable agents, avatars, and evaluation of lifelike characters. The second half of this section describes psychological research on personification.

1.1.1. Interface Agents

Many software agents are personified in terms of a human or caricature face. "Phil" in Apple's Knowledge Navigator [Laurel90] and Apple's "Guides" project [Oren90] are the early introductions of the human figures as interface metaphors. The above research is based on the hypothesis that personification in the interface is effective because we can easily predict how a character is likely to think and behave by its external trait [Don92]. We know how to communicate with other people, and utilize that knowledge to personify animals, objects, and computer software [Nass94].

Laurel also states in defense of personification that the key for applying character metaphors or personification to an agent is to provide the appropriate set of traits for the given agent [Laurel90]. The danger is that people may expect human-like intelligence, understanding, and actions from personified characters [Laurel90].

The research of Nass et al.'s on "computers are social actors" has proven that people apply social rules to human-computer interaction [Reeves96]. Their research has been used as a basis for personified agents, such as Microsoft Persona Project [Bell96], interface agents, such as the Maxims system [Lashikari94] and Newt [Sheth94]. They used faces to help users understand the agent's characteristics or behaviors. These studies hypothesize that if the interaction with computers has a social nature, using a character in the interface is a natural way to support the interaction.

1.1.2. Believable Agents

Believable agents are defined as characters that have autonomy, which focus is on implementing the verbal and nonverbal communication potential [Cassell00a]. They are also called as embodied conversational agents [Cassell00a]. Most of the research within the field of believable agents concentrates on generating guideline or models for believable individual variety among characters [Maldonado04]. There are several approaches in the research of building believable agents. [Cassell00b] focus on developing agents that understands discourse and gestures, [Blumberg94] on building agents that have biological behaviors, [Nass00] on building psychological personally models, [Elliott94] and [Elliott95] on building emotion models, and [Bates94] and [Maldonado04] on emotional engagement through role playing.

This research hypothesizes that users interact with agents more comfortably when they are able to predict the agent's characteristics and behaviors on the basis of its external traits. Though the research described so far reports positive results for a personified interface, the results are obtained by observation or interviews, not by quantitative analysis. The

primary focus of their research is on implementation rather than on user testing.

1.1.3. Avatars in network communication tools

Instant messenger and chat services are frequently used in our daily communication beyond nationality and languages. In these tools, emoticons and expressive avatars are widely used to provide nonverbal cues to text-only messages [MSN06, Yahoo06, Askjeeves06, Damer97]. Avatars are defined as proxy representations of the user, which expressions and gestures are controlled by the user and usually don't have autonomy.

Studies on avatars report positive effects on computer-mediated communication. Those studies indicate that emoticons and avatars improve user experiences and interactions among participants [Kurlander96, Smith00, Persson03] and build enthusiasm toward participation and friendliness in intercultural communication [Koda04, Isbister00].

However, the focus of avatar research is implementing systems and templates so that the user can easily control the avatar's animation [DiMicco02, Bodine03, Kaliouby04]. These avatars are used based on an implicit assumption that avatar expressions are interpreted universally across cultures. There are only few studies that compare users' interpretations of avatar's facial expressions between two countries, but none among multiple countries. Since avatars work as graphical representations of our underlying emotions in online communication, those expressions should be carefully designed so that they are recognized universally. We need to closely examine cultural differences in the interpretation of expressive avatars to avoid misunderstandings in using them.

1.1.4. Research on Users' Impression on Lifelike Characters

The research described so far reports positive effects of lifelike characters.

However delightful a lifelike character seems, it is important to verify these intuitions. This section introduces quantitative analyses of users' experiences with lifelike characters. Interestingly, some of this research indicates that adding faces to an interface does not necessarily provide better human-computer interactions.

Study of Using a Human Face in a Questionnaire Survey

Walker *et al.* [Walker94] studied how having a face and facial expressions for a computer application affects users' performance and productivity. They compared subjects' responses to an interview survey under three conditions: questions spoken by a synthesized face with a neutral expression, spoken by a face with stern expression, or text-only. Subjects who responded to the spoken face made more effort in answering the question by spending more time, writing more comments, and making fewer mistakes. Those who responded to the stern face spent more time, wrote more comments, and made fewer mistakes than those who dealt with the neutral face. Walker *et al.* reports that having a face is engaging and takes more effort and attention from the user. A face with more expression in an interface leads to greater engagement, but does not always makes the experience for users better if it is added incautiously.

"Situated Agent"

Takeuchi *et al.* [Takeuchi94] compared users' impressions of an agent which helped them to win a card game. The agent was represented either as an arrow or a synthesized face. The result shows that users respond differently to systems having a face than to those without. The arrow was recognized as useful and reliable, while the face was rated as fun and entertaining. A face in an interface takes more effort from the user and leads to a lack of concentration on the task because of these reasons: a face in an interface catches more attention, and people try to interpret the meaning of the face. However, Takeuchi argues that it is not necessarily a negative effect in terms of involving the user.

Study on Appraisal of Agents

King *et al.* [King96] conducted an experiment on people's reactions to different objects (geometric shapes, etc.) and faces, such as Chernoff faces, caricatures, and realistic 3D human faces. Faces were rated to have more intelligence and agency than any objects. Within faces, subjects attributed minimal agency and intelligence to Chernoff faces, and maximum intelligence to a 3D human face with blinking eyes. King's results show that there are differences in the initial appraisal of visual representations based on whether they are objects or human forms, symbolic or realistic, or static or lively. King's research also points out that users' initial impression of an agent affects how they interact with the agent, and affects the user's model of the agent's ability. Thus a face of an agent has to be carefully chosen to represent the agent's ability properly.

Research on user expression of lifelike characters are usually made only on the appearance of the characters apart from applications they are used.

1.2. Objectives and Approaches

Most of the research within the field of lifelike characters has been focused on creating believable characters that act autonomously as we humans do, while the research focus on avatars has been creating systems and templates that correspond to a user's intended emotions of gestures.

However, most of the above research focuses on implementations of agents or avatars and are based on two assumptions. The former assumption is that lifelike characters on the interface have positive effects on human-agent interactions or human-human interactions via avatars. There are arguments that personification of agents may cause users' higher expectation in their perceived intellectuality that they actually have. The latter assumption is that lifelike characters and their facial expressions are recognized universally across cultures.

This research aims to investigate the effects of using lifelike characters on an agent-mediated interface and communications tools with avatars, and whether the appearance of characters is universally equally interpreted. In investigating these issues, this research takes the following approach: actual applications are developed using lifelike characters, and user evaluations of lifelike characters are made in actual tasks using the Web so as to have as many and versatile subjects as possible, and the results were analyzed quantitatively and qualitatively.

1.3. The Structure of this Thesis

This thesis consists of seven chapters, including this chapter as the introduction.

Chapter 2 evaluates the effects of using lifelike characters on an interface where personified agents and a user interact among each other. The aim of this experiment is to investigate whether personification of agents adds higher perceived intelligence by their human-like appearance, and whether their existence improves user experiences.

Chapter 3 evaluates the effects of using lifelike characters on a network communication tool. A P2P communication tool with faces and facial expressions was developed and monitored its usage in actual communications at corporations.

Chapter 4 observes the effects of using lifelike characters on intercultural communications. The evaluation experiment was conducted as a form of a series of discussions via a multilingual BBS with expressive avatars between Japanese and Chinese researchers. Examining cultural differences in interpreting avatar facial expressions was also observed.

Chapter 5 describes the result of cross-cultural analysis of interpretations of avatars' facial expressions to further investigate the results of the cultural differences observed in Chapter 4.

Chapter 6 analyzes the design considerations that would not lead to misinterpretation of avatars' facial expression using the data obtained in the experiment in Chapter 5.

Chapter 7 concludes this thesis by summarizing the results obtained through this research and the prospect of future directions.

Chapter 2. Effects of Using Lifelike Characters on a Personified Interface

This chapter evaluates the effects of using lifelike characters on an interface where personified agents and a user interact among each other. The aim of this experiment is to investigate whether personification of agents adds higher perceived intelligence by their human-like appearance, and whether their existence improves user experiences.

2.1. Personified Agents

There is a growing interest in software agents which assist a user in performing daily computer tasks. Software agents will make software more active and work autonomously without waiting for a user's command. Negroponte suggests that this "agent-based" interface should be social and active to support cooperative tasks between a user and an agent [Negroponte95]. Maes addresses that the key HCI issue in building a successful software agent is to help the user understands what the agent's capacities are, its limitations, and its way of operating, etc. [Maes94].

Many software agents are personified in terms of a human or caricature face. "Phil" in Apple's Knowledge Navigator video [Laurel90] and Apple's

"Guides" project [Oren90] used salient human figures as interface metaphors. The work on social interface by Nass *et al.* [Nass94] has been used as a basis of several studies, such as Microsoft's Persona Project and their software products [Bell96]. These studies hypothesize that if the interaction with computers has a social nature, using a character in the interface is a natural way to support the interaction. Maxims system [Lashikari94] and Newt [Sheth94] used faces to help users understand the agent's characteristics or behaviors. This research hypothesizes that users interact with agents more comfortably when they are able to predict the agent's characteristics and behaviors on the basis of its external traits. Though the research described so far reports positive results for a personified interface, the results are obtained by observation or interviews, not by quantitative analysis. The primary focus of their research is on implementation of a prototype rather than on user testing.

However, other research with quantitative analysis indicates that adding a face to an interface does not necessarily result in better human-computer interactions. Walker *et al.* [Walker94] report that having a face is engaging and takes more effort and attention from the user. A face with more expression in an interface leads to greater engagement, but does not always makes the experience for users if it is added incautiously. Takeuchi *et al.* [Takeuchi94] report that users respond differently to systems having a face than to those without. They suggest that a face in an interface takes more effort from the user because people try to interpret the human images.

The research reported in this chapter includes both implementation and quantitative analysis of subjects' impression about a personified interface. This research argues that employing a face as the representation of an agent is engaging and makes a user pay attention. As Don [Don92] says, personification can be useful if we understand its strengths and weaknesses. It is possible to make advantages of personification outweigh the drawbacks by using faces in appropriate application domains, where conveying the agent's behavior to the user is important for making a user comfortable with the system, or in an entertainment domain where engagement is crucial and users don't try to minimize efforts. This paper reports the results of an

investigation on people's impressions of faces in an interactive entertainment environment.

2.2. Design of the Experiments

We built an application to test agent-based interfaces, namely a poker game, and experiments were performed on the Web so as to allow users to participate in the experiment exactly the same way as they work in normal conditions. There is a need to conduct experiments on the Web because of two reasons. One is that the nature of the experiment needs participants from various backgrounds and age ranges. The other is that current software agents are mostly used on the Web.

2.2.1. Research Questions

The questions asked in this study are as follows:
1) Do people pay attention to a face or facial expressions of an agent?
2) Are people distracted by the face or facial expressions?
3) Does having a face increase people's engagement in a task?
4) Do people use information from the face to interpret the agent's behavior?
5) What kind of facial features (gender, level of humanity, level of realism) make the agent look intelligent, likable, and comfortable to interact with?
6) Is people's impression of an agent determined based on its appearance or on its performance or both?
7) Does people's opinion about personification affect their impression of the faces?
8) Is there any difference between the subject's genders in subjects' impression of faces?

2.2.2. System Design

We designed and built a web-based poker game in which computer poker

playing agents play against each other and a user. The task for the user is to play this poker game against the poker playing agents which have personified representations. The game of poker was chosen to observe to what extent subjects concentrate just on their hands, or pay attention to the faces of opponents and try to interpret their facial expressions. Figure 2-1 shows the interface for the game.

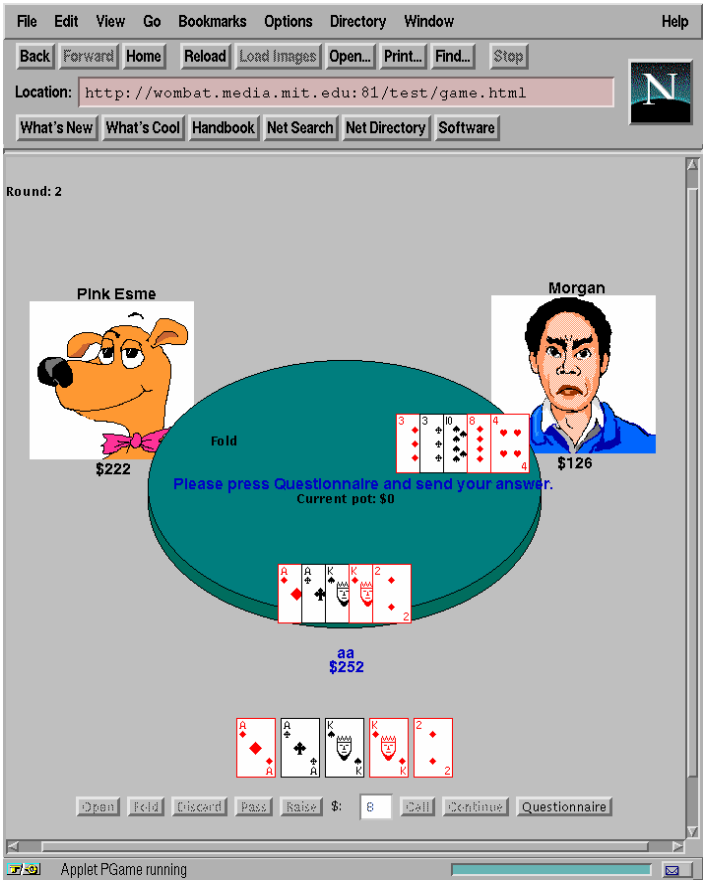


Figure 2-1: Web interface for the poker game

Character Design

The poker playing agents used in the experiments have seven different graphical representations: Realistic Human Male/Female faces, Caricature Human Male/Female faces, a Caricature Dog's face, a line-drawn Smiley face, and the Invisible Man, which is a white square without a face (see

Figure 2-2). They vary in terms of gender, humanity, and realism.

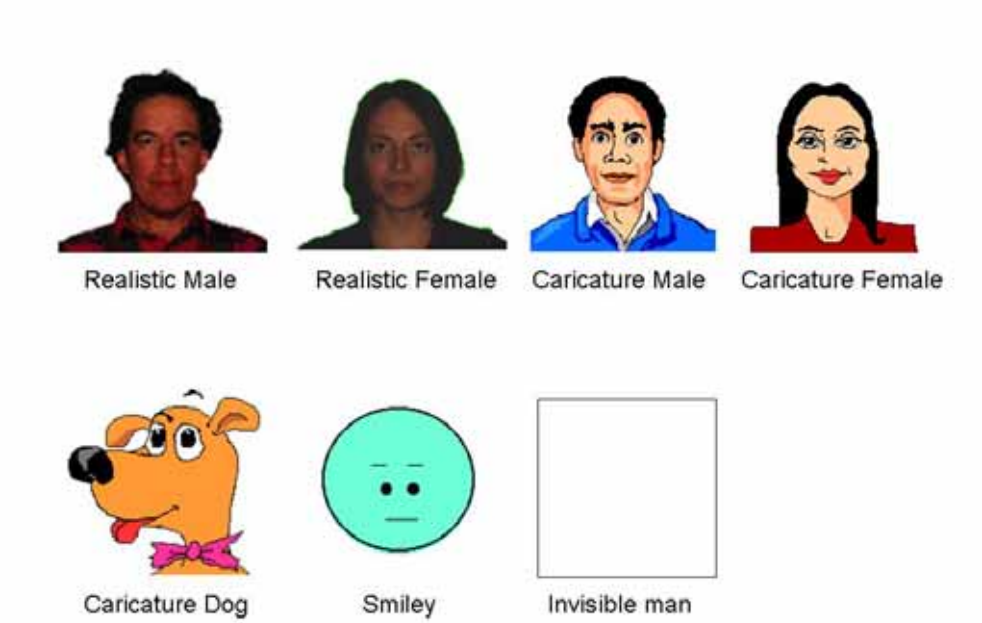
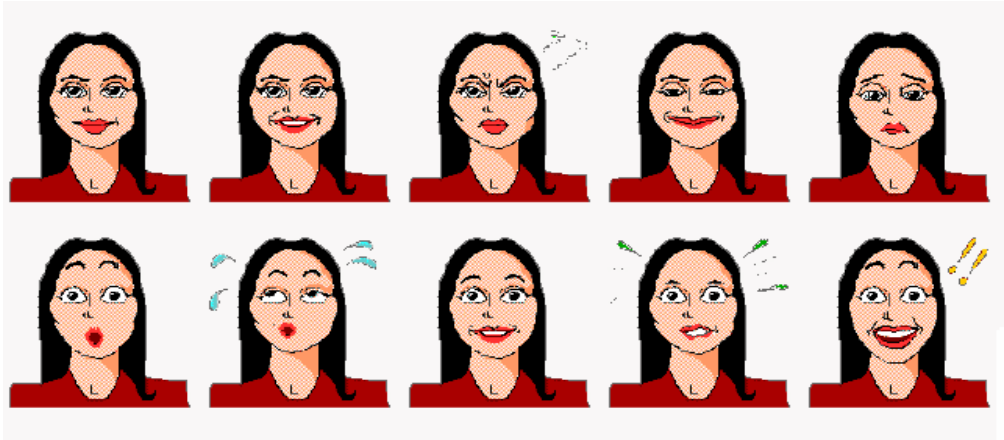


Figure 2-2: The graphical representations of the poker playing agents

Facial Expression Design

Each agent has ten facial expressions (neutral, pleased, displeased, satisfied, disappointed, surprised, relieved, excited, anxious, and very excited). It changes its expressions when it deals, bets, and wins/loses. For example, the Dog's face might show an exited expression while betting, or show a disappointed face when it loses. Figure 2-3 shows the ten expressions of the Caricature Female face in the same order as described above.



Note: from top left, neutral, pleased, displeased, satisfied, disappointed, surprised, relieved, excited, anxious, very excited.

Figure 2-3**:** Ten facial expressions of the Caricature Female face.

The emotions were derived from the Ortony, Clore, and Collins (OCC) model of emotion types [Ortony88]. Figure 2-4 shows the structure of the OCC model. The OCC model assumes that emotions are the result of valanced-- positive or negative--reactions to situations which a person experiences. For example, when we compare the winning lottery number and the lottery we have, this event leads to a pleased emotion when we win, or a displeased emotion when we lose. In this model, the world consists of events, agents, and objects. Valanced reactions to combinations of these result in emotions. The model leads to different emotional states depending or whether the reaction is positive or negative (see Figure 2-4). A more complicated emotion structure exists for reaction to events and agents, and depending on whether the situation affects the self or someone else.

In the poker game situation, I assumed that the world consists of events. To keep the model simple, reactions to other agents are not considered in the poker game. Thick arrows and gothic characters in Figure 2-4 show the modified structure of the emotion types used in designing the possible emotions for the poker playing agents. The modifications were made after

interviewing two experienced poker players. Figure 2-5 shows the rules that lead to the ten emotion types expressed by the agents while playing the poker game. When a poker playing agent sees its hand, that is an *event*, which leads to a valanced reaction of a **pleased** or **displeased** emotional state (see A in Figure 2-4 and Figure 2-5). Betting is an *event*, which focuses on the consequences for *self-prospects*. The betting event derives a valanced reaction of **hope** or **fear**, which is represented by an **excited** or **anxious** expression (see B in Figure 2-4 and Figure 2-5). The emotion intensifies as another betting round goes on, especially when the agent is bluffing. At the final stage, the agent shows a **satisfied** expression when it wins (*hope confirmed*), **disappointed** expression when it loses (*hope disconfirmed*), **relieved** expression when it folds (*fear disconfirmed*), or a **surprised** expression when the result is not what was expected (*unexpected*) (see C in Figure 2-4 and Figure 2-5). The OCC model does not include "surprise" in their emotion types. However, "surprise" is a common emotion in a real poker game environment.

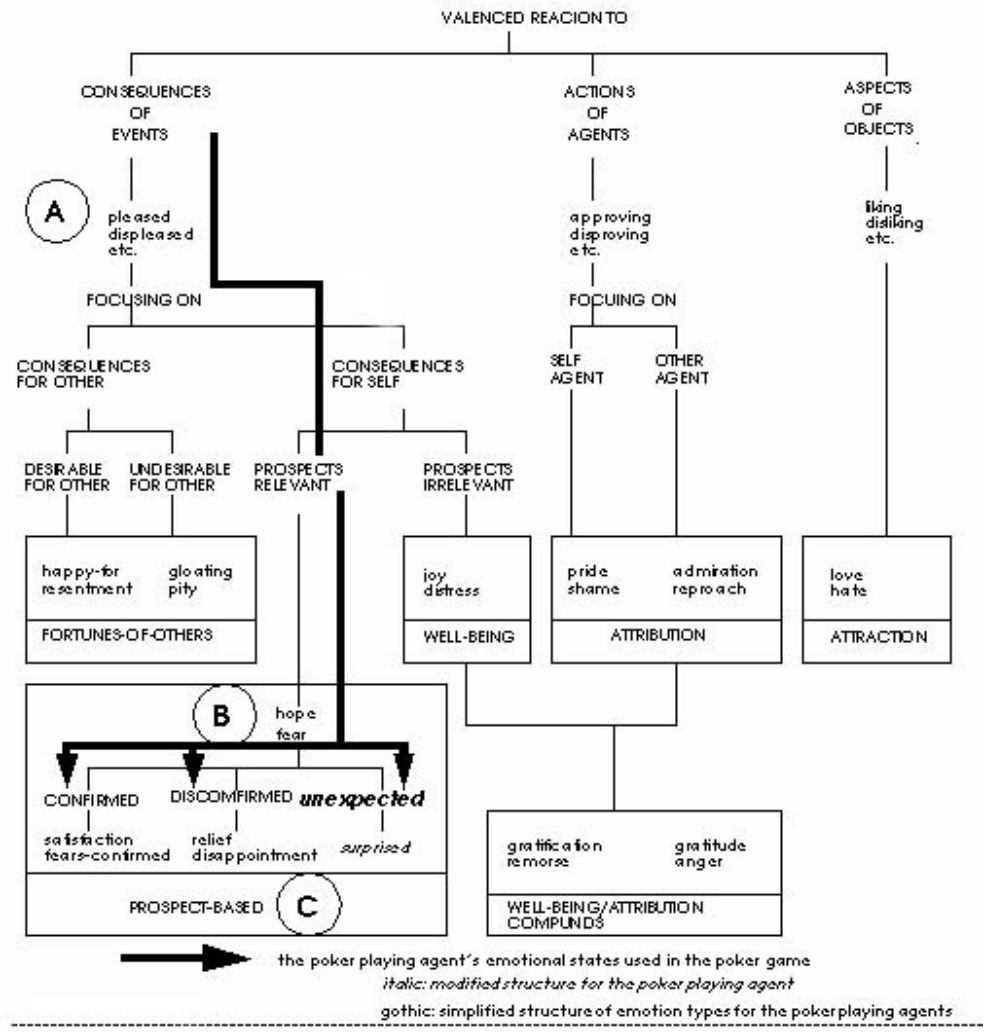


Figure 2-4: Global structure of emotion types in the OCC model adopted from [Ortony88]

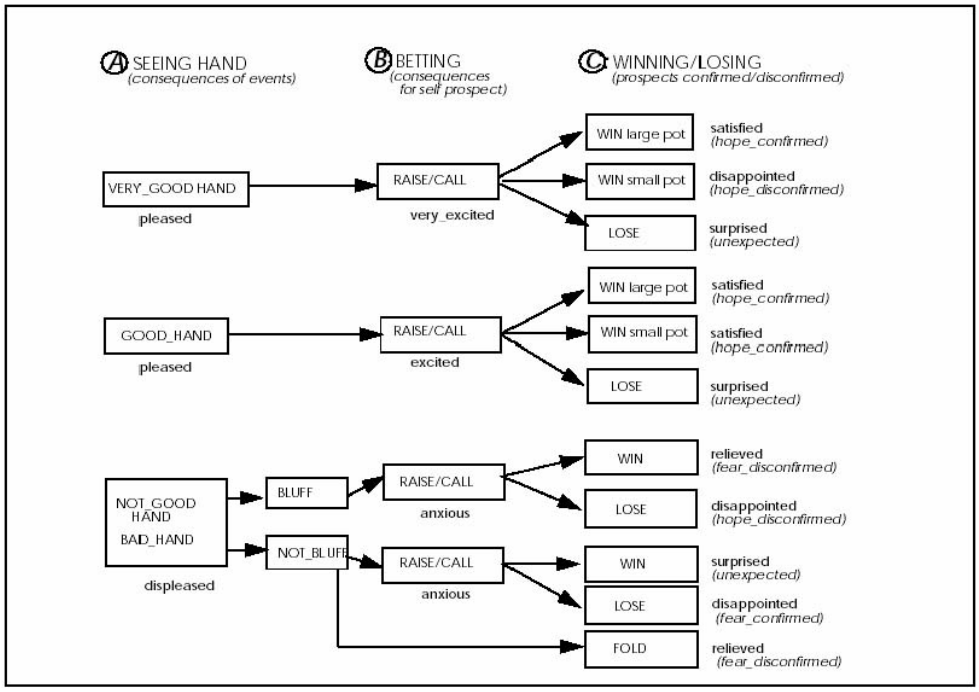


Figure 2-5: The rules that lead to the ten emotion types expressed by the agents while playing the poker game

2.2.3. Experiment Procedure

A typical scenario of an experiment is as follows:

A subject accesses the poker game web site. The subject reads the consent form and instructions, agrees to participate in the experiment, and submits an electronic agreement form. The subject sees the poker playing agents faces to familiarize himself/herself with the agents' faces and facial expressions. The poker game program is downloaded to the subject's computer from the server computer. The subject plays a poker game with one out of five conditions for 15 rounds, which takes from 10 to 15 minutes to complete. The subject's and agents' hands, actions, and the ending money state are logged into the server. A questionnaire appears after playing 15 rounds. The subject answers and submits the questionnaire. The answers are

stored in a server disk.

2.2.4. Conditions of the Experiments

There are five web-based experiments which are randomly assigned to a user. The FACE experiment is designed to study the effect of having a face. The representations are the Caricature Female face and the Invisible Man. Figure 2-6 shows the poker game screen of the FACE experiment. The GENDER experiment studies the difference in subjects' impressions of characters' gender. The representations used in this experiment are the Realistic Male and the Realistic Female face. Figure 2-7 shows the poker game of the GENDER experiment. The HUMANITY experiment is designed to compare the difference in subjects' impressions between a human face and a non-human face. The representations used are the Caricature Male face and the Dog's face. Figure 2-8 shows the poker game screen of the HUMANITY experiment. The REALISM experiment uses three faces to compare three different levels of realism. The representations used are the Realistic Male face, the Caricature Male face, and the Smiley face. Figure 2-9 shows the poker game screen of the REALISM experiment. The EXPRESSIVENESS experiment has three players with the same facial representation. This experiment was designed to evaluate the difference in subjects' impression between three modes of expressiveness. The Caricature Female face with different color of clothes is used to distinguish each face. One agent has Honest expressions, the other has Deceiving expressions, i.e. the player is expressive but the facial expressions don't correspond to their actual emotions, and the last one has Stoic expressions, i.e. the player shows only neutral and pleased expressions regardless of its hand. Figure 2-10 shows the poker game screen of the EXPRESSIVENESS experiment. Table 2-1 summarizes the facial representations used in each experiment. All facial images used in the experiments have the same size, the same resolution, and the same background color. Except for the EXPRESSIVENESS experiment, all poker playing agents are in Honest mode. The agents play poker game using exactly the same poker playing

strategy, which the subjects were not made aware of.

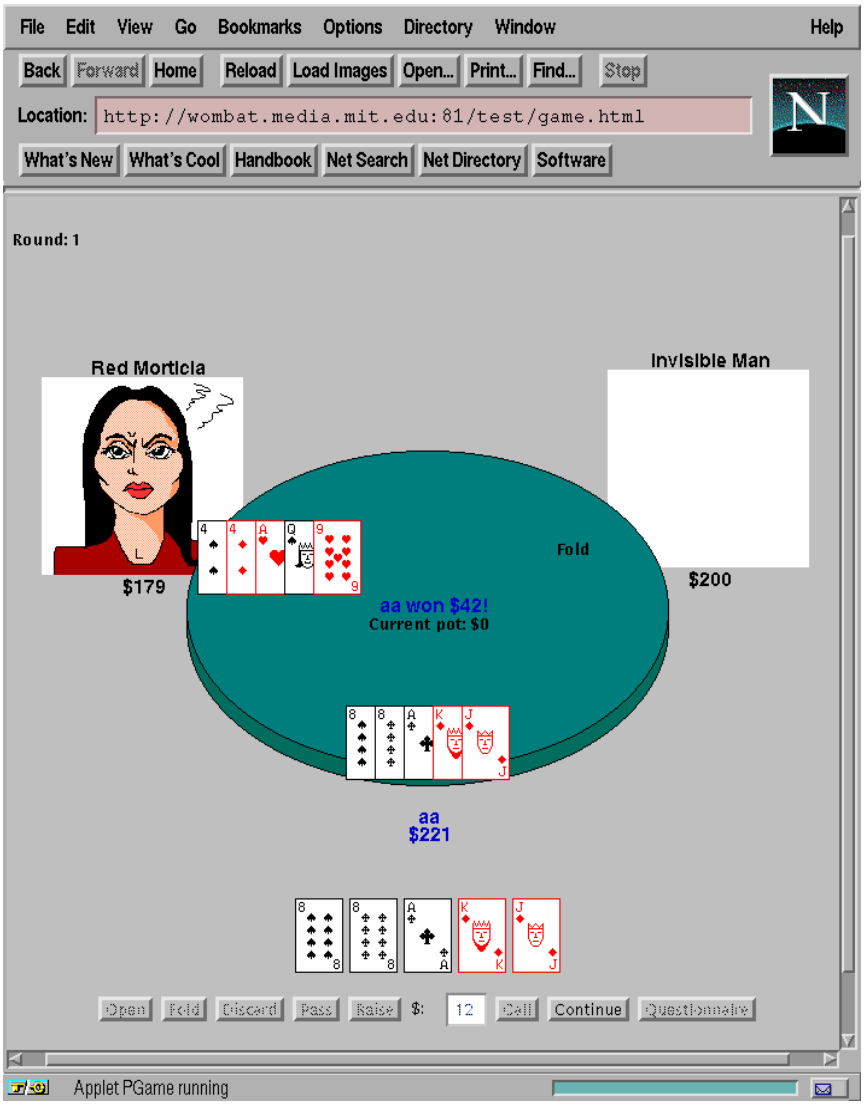


Figure 2-6: The poker game screen for the FACE experiment

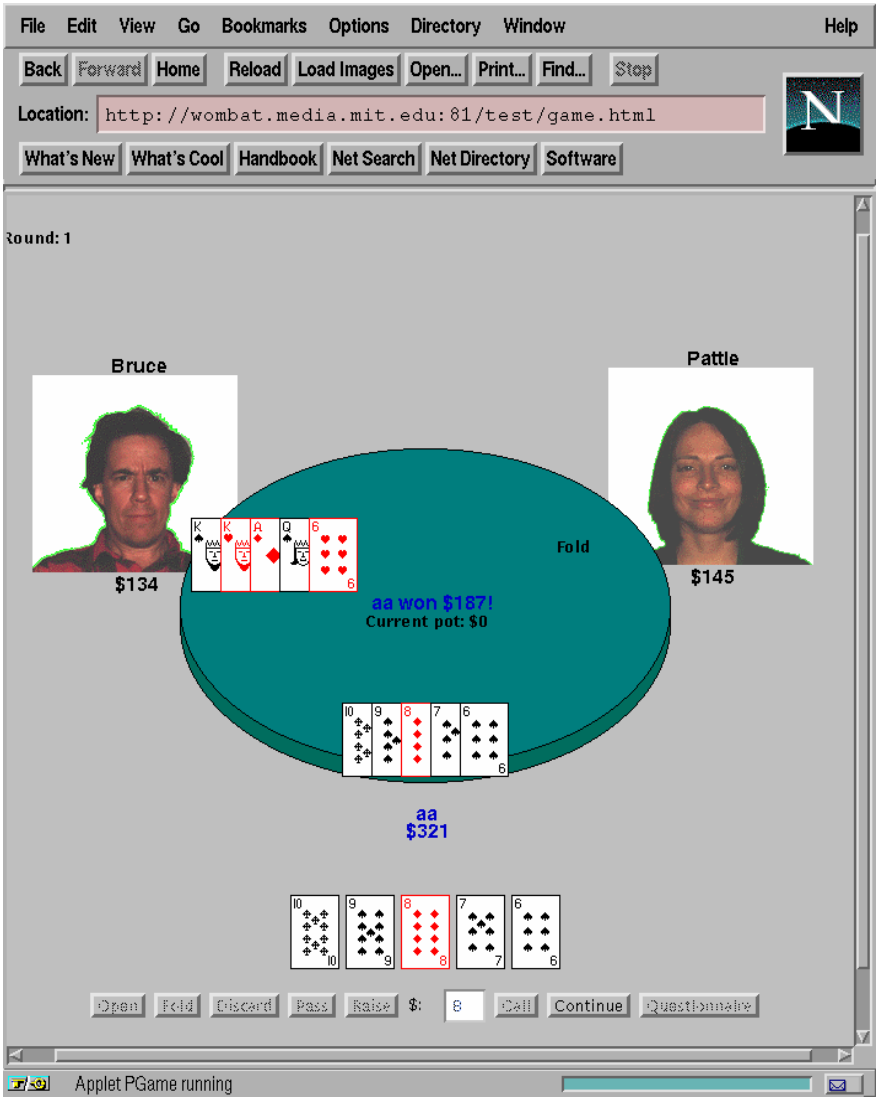


Figure 2-7: The poker game screen for the GENDER experiment

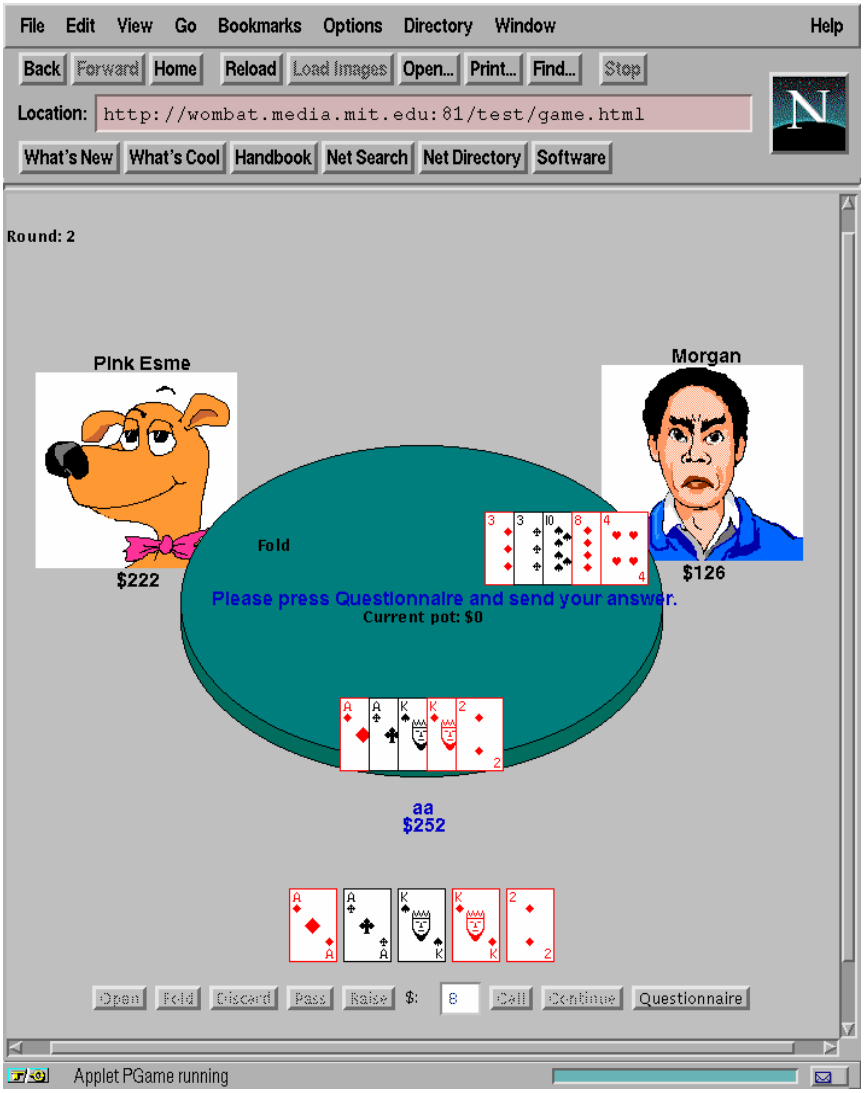


Figure 2-8: The poker game screen for the HUMANITY experiment

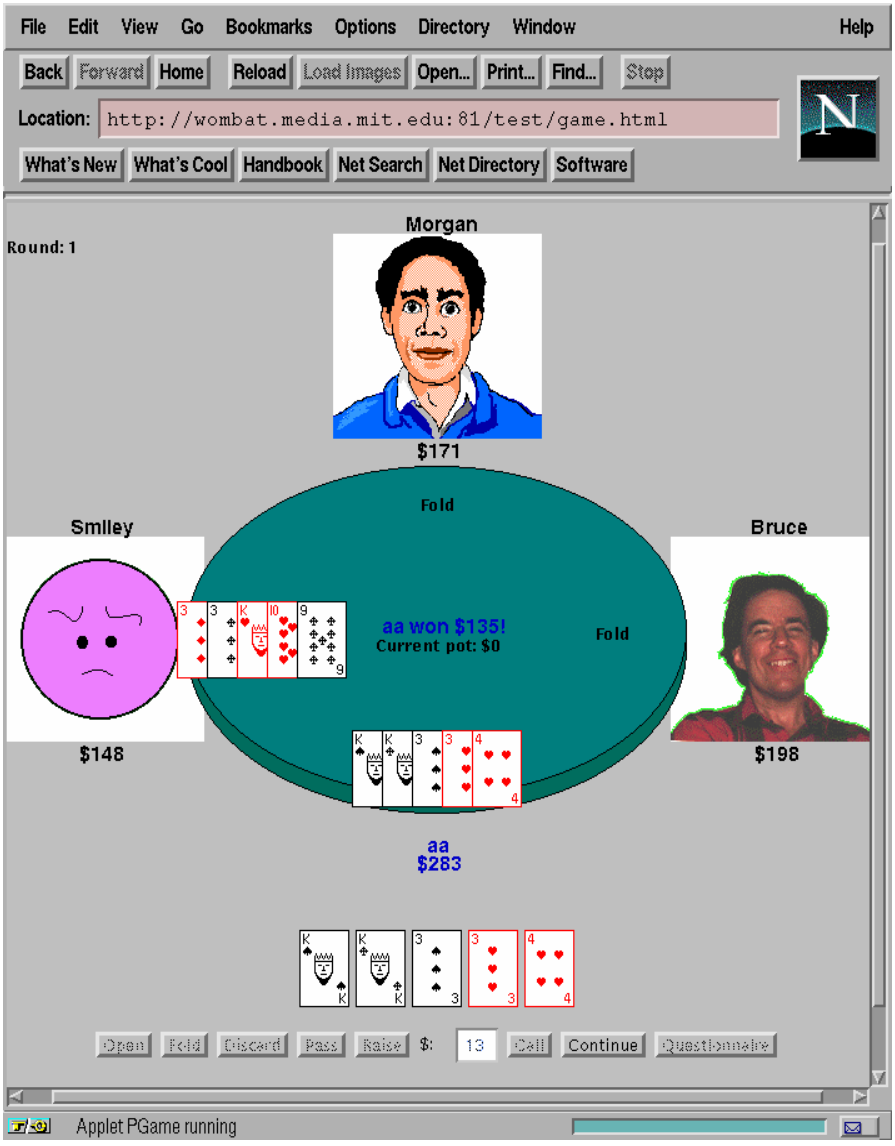


Figure 2-9: The poker game screen for the REALISM experiment

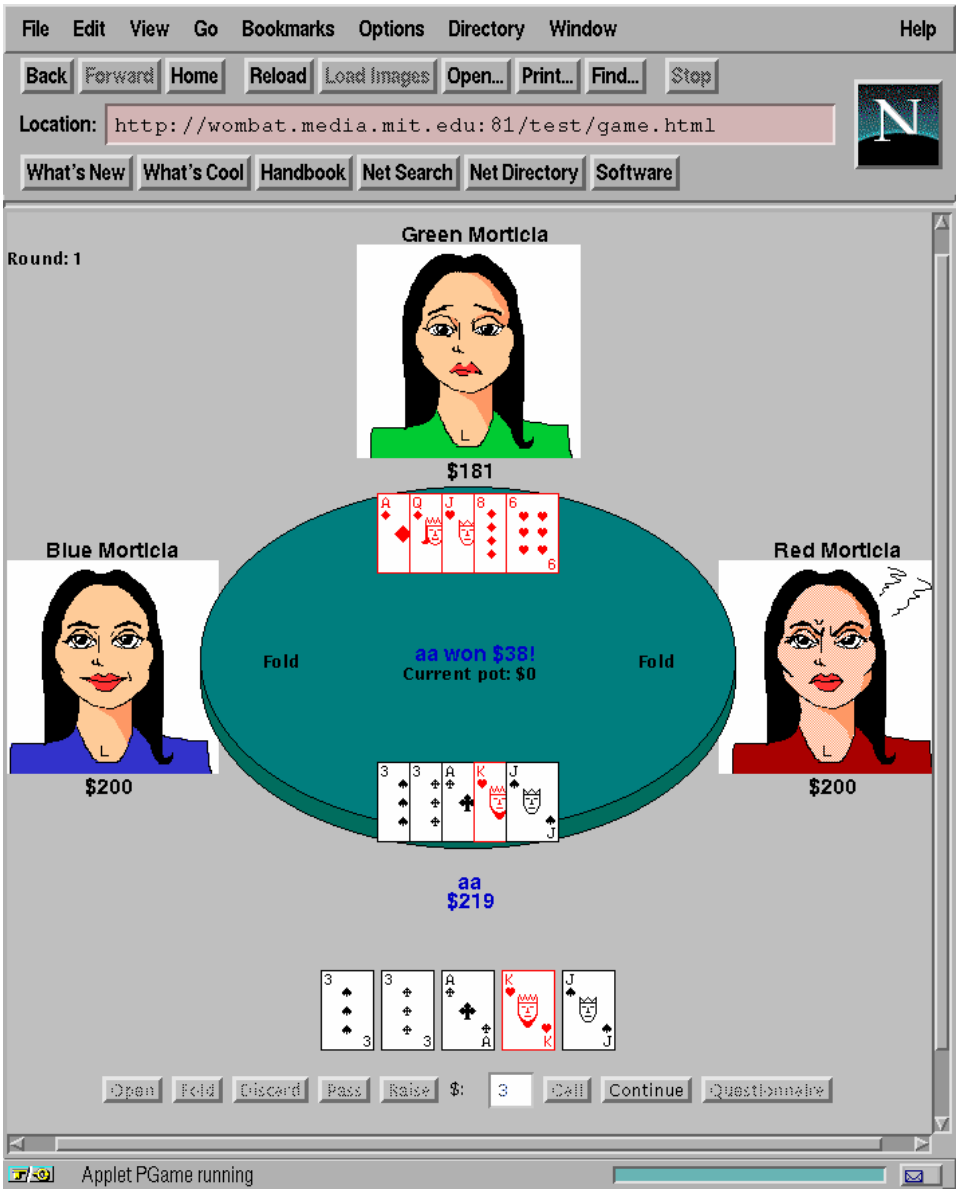


Figure 2-10: The poker game screen for the EXPRESSIVENESS experiment

Table 2-1: The facial representations used in each experiment

	Player 1	Player 2	Player 3
FACE	Caricature Female	Invisible man	-
GENDER	Realistic Male	Realistic Female	-
HUMANITY	Caricature Male	Caricature Dog	-
REALISM	Realistic Male	Caricature Male	Smiley
EXPRESSIVENESS	Honest Caricature Female	Deceiving Caricature Female	Stoic Caricature Female

2.2.5. Lab Experiments

Three pilot experiments were conducted prior to the five web-based experiments. The purpose of the pilot experiments was to collect subjects' impressions of each face based solely upon its visual appearance. Subjects were shown one of the sets of faces used in the GENDER, HUMANITY, and REALISM experiments with a neutral expression. The subjects answered questions about each face's perceived intelligence, likability, and engagingness as an opponent poker player, just by looking at the facial representations.

In addition to the web-based experiments, seven subjects participated in a lab experiment. The lab experiment used exactly the same procedure as the web-based ones, except that subjects were videotaped while playing the poker game and had interviews about their experience after playing the poker game.

2.2.6. Questionnaire

Questions varied according to the experiment. There are 4 background questions (subject’s gender, age, computer expertise, and their opinion about personification), and 4 to 8 questions about the subjects' impressions

of the faces against which they played poker. The questions about their impressions are answered on a seven point scale (1: strongly disagree to 7: strongly agree).

The common questions across the experiments are perceived intelligence, likability, engagingness, and level of comfort for each face. Perceived intelligence is measured by how good at playing poker each player is perceived to be. Likability is measured by how much the user say they enjoyed playing against each player. Engagingness is measured by how engaging playing poker against each player is considered to be. Comfortableness is measured by how much the user wants to play poker with the same player.

Specific questions are required attention and level of distraction (for the FACE and the EXPRESSIVENESS experiments), level of correspondence to the actual intelligence of the player (for the HUMANITY and the REALISM experiments), believability of the facial expressions, and the usefulness of the facial expressions (for the EXPRESSIVENSS experiment). To measure level of distraction, subjects are asked to rate how much they were distracted by the existence of the face or facial expressions on a 7 point scale. Subjects measure the level of correspondence of a face by how suitable the face is in representing the actual poker playing skill of the player. Believability is measured by how much the user believed each player was honest in its facial expressions about its poker hand. Subjects measure the usefulness of a player's facial expressions by how helpful those facial expressions are in understanding the player's strategy.

2.2.7. Subjects

Experiments continued for one and a half months. Subjects participated in the experiments voluntarily from all over the world using the World Wide Web. More than 1,000 people accessed the poker game site and 157 of them answered the questionnaire, for a response rate of 15%. Of these subjects, 78% were male. The age range of the subjects was from 10 to 50 years old. Fifty-seven percent of them were in their 20's, 26% were teens, and 14%

were in their 30's. Fifty-two percent of them rated themselves as advanced computer users, 40% as intermediate users. When asked about personifying an interface, 51% of them supported having a face on the screen (AGREE group), the rest were against having a face (DISAGREE group).

2.3. Results

2.3.1. Impressions Based on Appearance

The pilot experiments evaluate subjects' impressions based solely on agents' appearance, in particular, gender, humanity, and realism. The result of the comparison for gender shows that there is no difference between people's impression of the Male face and Female face in terms of its perceived intelligence, likability, and engagingness, as shown in Table 2-2. The result of the difference for level of humanity shows that the Human face is perceived as more intelligent than the Dog's face based on visual appearances ($t(15)=3.10$, $p<.01$), but less likable ($t(15)=-3.13$, $p<.01$) and engaging ($t(15)=-5.57$, $p<.01$) as a representation for a poker player, as shown in Table 2-3. In the experiment to compare different levels of realism, subjects rated the Realistic face to be more intelligent ($F(6.12,2)$, $p<.01$), likable ($F(5.06, 2)$, $p<.05$), and engaging ($F(6.25, 2)$, $p<.01$) than the Caricature face and Smiley, as shown in Table 2-4.

Table 2-2: The mean value of impressions for the Male and Female face based on appearance

Variables	Male (n=15)	Female (n=15)	t (paired)
INT (Intelligence)	4.73	5.13	t(14) = -.88
LIKE (Likability)	4.80	4.73	t(14) = .19
ENG (Engagingness)	5.13	4.80	t(14) = .77

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

Table 2-3: The mean value of impressions for the Human and Dog's face based on appearance

Variables	Human (n=16)	Dog (n=16)	t (paired)
INT (Intelligence)	3.88	2.63	t(15) = 3.10*
LIKE (Likability)	3.81	5.37	t(15) = -3.13*
ENG (Engagingness)	3.50	5.56	t(15) = -5.57*

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

Table 2-4: The mean value of impressions for Smiley, the Caricature, and the Realistic face based on appearance

Variables	Smiley(n=16)	Caricature (n=16)	Realistic (n=16)	F(value, df)
INT (Intelligence)	3.53	3.59	4.94	F (6.12, 2)*
LIKE (Likability)	3.76	4.06	4.88	F (5.06. 2)**
ENG (Engagingness)	3.65	3.82	5.12	F (6.25, 2)*

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

2.3.2. Difference for Face and Noface

As shown in Table 2-5 and Figure 2-11, subjects paid attention to the face (ATT=5.28, where 4.0 is neutral), but were not distracted by the existence of the face (DIS=2.84, where 4.0 is neutral). Observations and interviews in the lab experiment support this result. Subjects rated having a face to be significantly more likable ($t(24)=2.76$, $p<.05$), more engaging ($t(24)=2.85$, $p<.01$), and more comfortable to play against ($t(24)=3.36$, $p<.01$), than not

having a face. However, both poker playing agents are rated to be equally intelligent regardless of the existence of a face.

Table 2-5: The mean value of impressions for the Caricature face (Face) and the Invisible Man (NoFace) in the game

Variables	Face (n=25)	NoFace (n=25)	t (paired)
INT (Intelligence)	3.64	3.80	t(24) = -.27
LIKE (Likability)	5.08	3.72	t(24)=2.76**
ENG (Engagingness)	4.60	3.32	t(24) = 2.85*
COM (Comfortableness)	4.88	3.36	t(24) = 3.06*
ATT (Attention to the face)	5.28	-	-

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

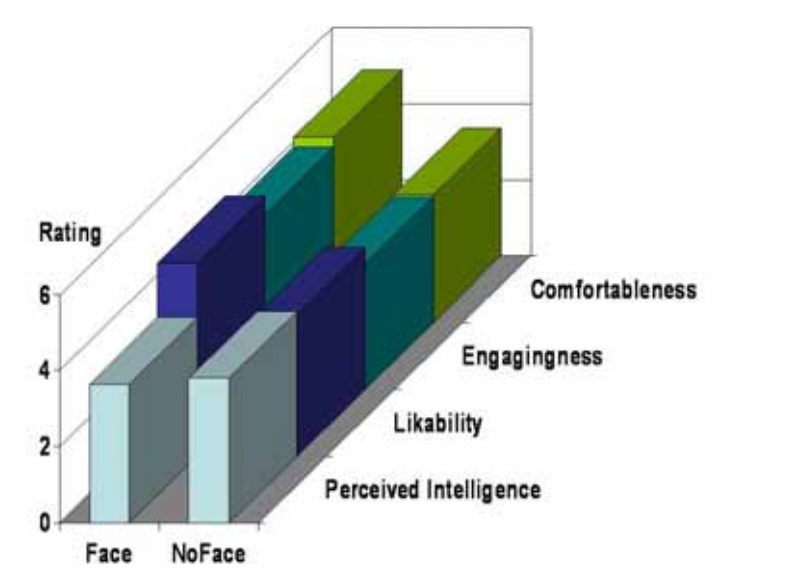


Figure 2-11: The mean value of impressions for the Face vs. NoFace condition

2.3.3. Difference for Characters' Gender

As shown in Table 2-6, there is no main effect of the agent's gender in any variables. However, there are significant interactions between people's opinion about personification (VOTE) and perceived intelligence ($F(4.73, 1)$, $p<.05$), and slight interactions between VOTE and likability ($F(3.62, 1)$, $p<.10$). The AGREE group (those who are for personification) rated perceived intelligence and likability for the Male face higher and the Female face lower. While the DISAGREE group (those who are against personification) rated the Male and the Female face in the opposite way.

Figure 2-12 shows the mean value of perceived intelligence of each face rated by each group. No other 2-way or 3-way interactions were found.

Table 2-6: The mean value of impressions for the Male and Female face in the game

Variables	Male (n=37)	Female (n=37)	t (paired) F(value, df)
INT (Intelligence) Vote Agree (n=18) Vote Disagree (n=19)	3.35 3.94 2.78	3.83 3.55 4.10	t(36) = -1.33 F(4.73, 1)**
LIKE (Likability) Vote Agree (n = 18) Vote Disagree (n = 19)	4.49 5.11 3.89	4.62 4.83 4.42	t(36) = -.55 F(3.62,1)***
ENG (Engagingness)	4.32	4.43	t(36) = -.55
COM (Comfortableness)	4.00	3.92	t(36) =.30

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

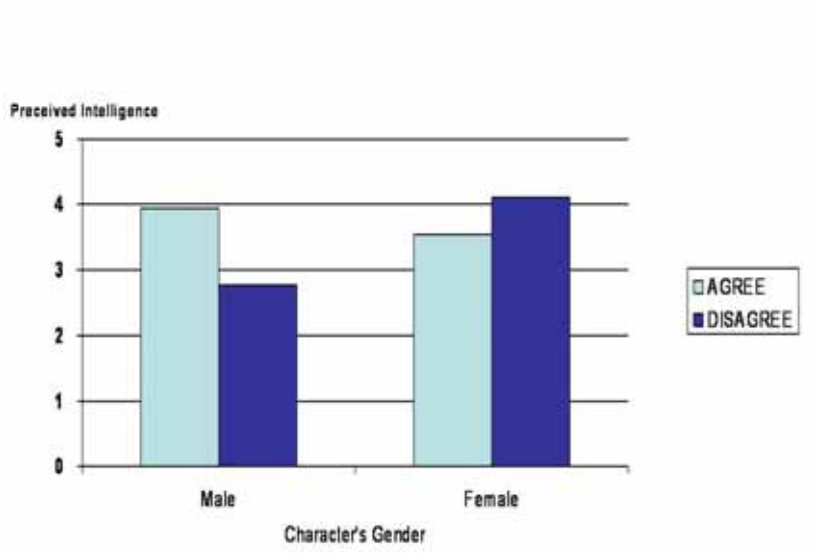


Figure 2-12: The mean value of perceived intelligence for the Male and Female face rated by the AGREE and DISAGREE group

2.3.4. Difference for Level of Humanity

As shown in Table 2-7, there is no main effect of level of humanity (Human or Dog's face) in any variables. However, there are significant interactions between VOTE and likability ($F(5.40, 1)$, $p<.05$), comfortableness ($F(11.42, 1)$, $p<.01$), and level of correspondence to the actual poker playing skill ($F(6.97, 1)$, $p<.05$). The AGREE group rated likability, comfortableness, and correspondence of the Human face significantly lower, while they rated the Dog's face significantly higher. The DISAGREE group rated the Human and the Dog's face in the opposite way.

Figure 2-13 shows the mean value of comfortableness of each face rated by each group. There are also interactions between subjects' gender and likability ($F(9.24, 1)$, $p<.01$), engagingness ($F(5.94, 1)$, $p<.05$), and comfortableness ($F(7.26, 1)$, $p<.05$). The result suggests that male subjects rated the Dog's face as more likable, engaging, and comfortable than the Human face, while female subjects rated in the opposite way.

Table 2-7: The mean value of impressions for the Human and Dog's face in the game

Variables	Human (n=23)	Dog (n=23)	t (paired) F(value, df)
INT (Intelligence)	3.73	3.82	t(22) = -.18
LIKE (Likability)	4.56	4.39	t(22)=.53
Vote Agree (n = 11)	4.72	4.73	F(5.40,1)**
Vote Disagree (n = 12)	4.45	4.09	
Male subject (n = 17)	4.47	4.65	F(9.24,1)*
Female subject (n = 6)	4.83	3.67	
ENG (Engagingness)	3.95	4.13	t(22) = -1.00
Male subject (n = 17)	3.88	4.29	F(5.94, 1)**
Female subject (n = 6)	4.17	3.67	
COM (Comfortableness)	4.08	4.04	t(22) = .13
Vote Agree (n = 11)	3.91	4.55	F(11.42, 1)*
Vote Disagree (n = 12)	4.27	3.55	
Male subject (n = 17)	4.29	4.41	F(7.26, 1)**
Female subject (n = 6)	3.50	3.00	
COR (Correspondence)	3.91	3.50	t(22) = 1.16
Vote Agree (n = 11)	3.82	4.18	F(6.97, 1)**
Vote Disagree (n = 12)	4.00	2.82	

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

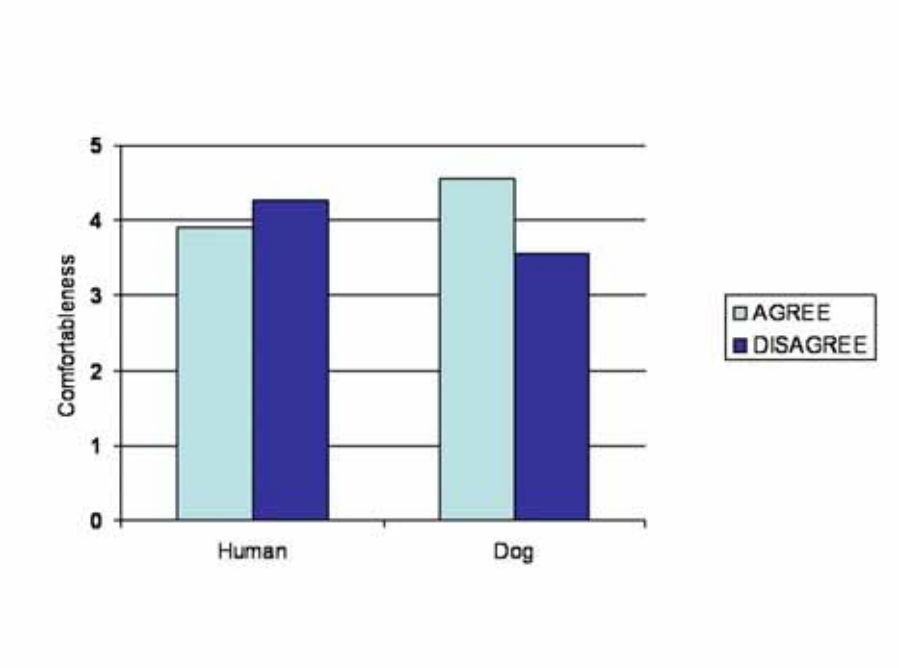


Figure 2-13: The mean value of comfortableness for the Human and Dog's face rated by the AGREE and DISAGREE group

2.3.5. Difference for Level of Realism

As shown in Table 2-8, there is no main effect of level of realism in perceived intelligence, likability, and engagingness. The results show that the Realistic face is slightly more intelligent, likable, engaging than the Caricature and Smiley, though not significantly so. There are main effects of level of realism in comfortableness ($F(.05, 2)$, $p<.10$) and correspondence to the skill level ($F(.18, 2)$, $p<.5$) as shown in Figure 2-14. The Realistic face is rated as more comfortable to play against than the Smiley face. While in terms of correspondence to the actual poker playing skill, subjects rated the Smiley face as the most appropriate representation, and the caricature and Realistic faces are less appropriate. No 2-way or 3-way interactions were found.

Table 2-8: The mean value of variables for Smiley, Caricature, and Realistic face in the game

Variables	Smiley (n=30)	Caricature (n=30)	Realistic (n=30)	F(value, df) t (paired)
INT (Intelligence)	3.37	3.53	3.70	F (.30, 2)
LIKE (Likability)	4.20	4.10	4.70	F (.59, 2)
ENG (Engagingness)	4.17	4.13	4.76	F (.58, 2)
COM (Comfortableness) Smiley vs. Caricature Caricature vs. Realistic Smiley vs. Realistic	4.07	4.00	4.63	F (.05, 2)*** t(29) =.14 t(29) = -1.60 t(29) = -1.71***
COR (Correspondence) Smiley vs. Caricature Caricature vs. Realistic Smiley vs. Realistic	4.67	3.90	4.03	F (.18, 2)** t(29) = 2.25** t(29)= -.36 t(29) = 2.00**

** p<.01, ** p<.05, *** p<.10, no mark = not significantly*

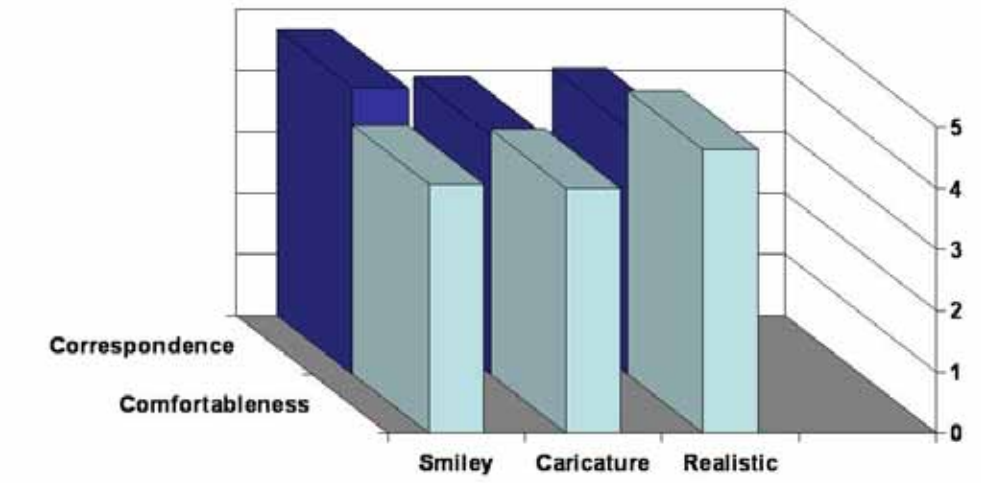


Figure 2-14: The mean value of comfortableness and correspondence for Smiley, the Caricature, and the Realistic face

2.3.6. Difference between Levels of Expressiveness

As shown in Table 2-9, there is no main effect of level of expressiveness in any variables. However, there are significant interactions between VOTE and perceived intelligence ($F(8.91, 2)$, $p<.01$, see Figure 2-15) and comfortableness ($F(4.47, 2)$, $p<.05$, see Figure 2-16). The AGREE group rated the Honest face as most intelligent, while the DISAGREE group rated the Stoic face as the most intelligent and the Honest face as the least. The AGREE group rated the Stoic face as least comfortable, while the DISAGREE rated the same face as most comfortable.

Table 2-9: The mean value of impressions for the Honest, Deceiving, and Stoic face in the game

Variables	Honest (n=20)	Deceiving (n=20)	Stoic (n=20)	F(value, df)
INT (Intelligence)	3.84	3.37	3.89	F(1.98, 2)
Vote Agree (n = 10)	4.20	3.10	3.30	F(8.91, 2)*
Vote Disagree (n = 10)	3.44	3.66	4.55	
LIKE (Likability)	4.37	4.37	4.68	F(1.28, 2)
ENG (Engagingness)	3.95	4.21	4.21	F(.56, 2)
COM (Comfortableness)	3.95	3.74	3.95	F(.14, 2)
Vote Agree (n = 10)	3.90	4.10	3.60	F(4.47, 2)**
Vote Disagree (n = 10)	4.00	3.33	4.33	
BEL (Correspondence)	4.79	4.79	4.63	F(6.44, 2)
ATT (Required attention)	4.32	4.47	4.37	F(1.46, 2)
DIS (distraction)	3.26	3.21	3.37	F(5.26, 2)
USE (usefulness)	4.21	4.42	4.11	F(1.81, 2)

** p<.01, ** p<.05, *** p<.10, no mark = not significant*

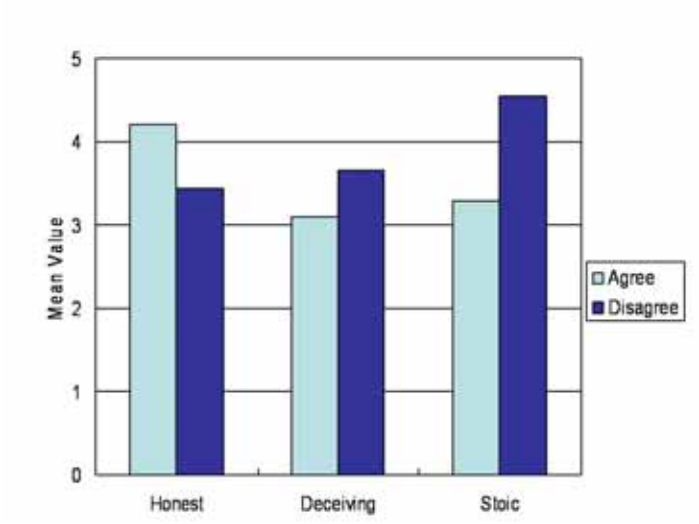


Figure 2-15: The mean value of perceived intelligence for the Honest, Deceiving, and Stoic face rated by the AGREE and DISAGREE group

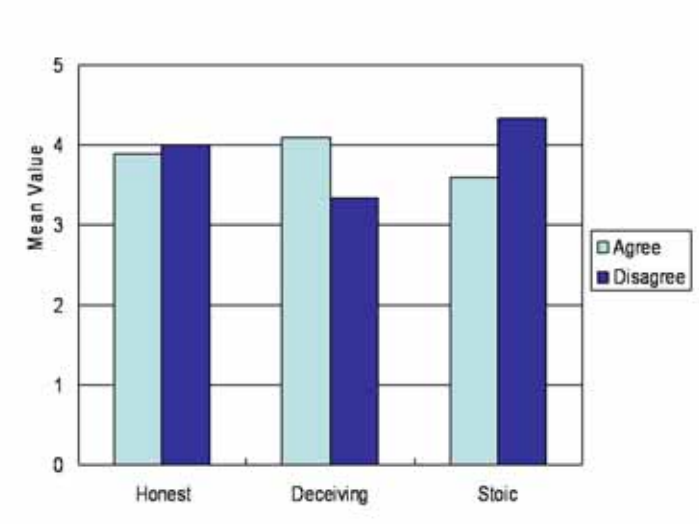


Figure 2-16: The mean value of comfortableness for the Honest, Deceiving, and Stoic face rated by the AGREE and DISAGREE group

2.3.7. Observations, Interviews and Open Comments

Interviews and observations suggest that subjects tried to read the agent's poker playing strategy from its face. They attributed different personalities and characteristics to each face and thought each agent had a different playing strategy. Subjects wrote many comments at the end of the questionnaire. Some subjects used "attitude" or "personality" to describe the characteristics of the players in their comments. Comments show that the subjects first tried to figure out whether the faces gave them clues on the player's hands and strategies. Then they noticed that the players' facial expressions gave information about their hands. This suggests that subjects used the faces to interpret the agents' behavior.

2.4. Discussion

Subjects rated a poker playing agent with and without a face as equally intelligent. This suggests that attaching a face did not add any perceived intelligence to the poker player. However, having a face is considered more likable, engaging, and comfortable to play against regardless of subjects' opinion about personification. As described earlier, Takeuchi's [Takeuchi94] and Walker's [Walker94] studies show a similar result, namely that having a face is engaging. It is encouraging that the face did not create a negative effect on the subjects' opinions about likability, even to those who have a negative opinion about personification; contrary to what Walker's study found [Walker94]. This difference may be caused by the different nature of the tasks and faces used in these studies. Walker used a woman's synthetic talking face in a questionnaire survey, while this study used a caricature female face in a poker game environment.

Subjects' responses to the Human and the Dog's face, and Smiley, the Caricature, the Realistic face in a pilot experiment in which they evaluated the faces in isolation showed reasonable expectations from the appearance of each face. King's study [King96] shows a similar result in perceived

intelligence, namely that human forms are perceived to be more intelligent than other forms. King also suggests that fully articulated human forms are rated to have higher intelligence and agency than either caricatures or Chernoff faces (corresponding to the Smiley face in this experiment). However, subjects rated the same faces as equally intelligent (or unintelligent) in the poker game. For example, though people attributed different levels of perceived intelligence, likability, and engagingness to the Human face and the Dog's face, or Smiley, the Caricature, and the Realistic face when they evaluate the faces based on their appearance, there were no differences when they rated the same faces in the poker game. This means that they did not rate a player's intelligence based on its appearance. Their impressions are based on the player's actual competence in playing poker.

However, subjects' opinions about personification affect their attitude toward each of the faces. For example, in the HUMANITY experiment, the AGREE group are more "strict" about personification, since they prefer the Dog's face to the Human face, felt more comfortable with the Dog's face, and considered the Dog's face more appropriate for representing the actual competence of the player in playing poker. On the other hand, the DISAGREE group are more "flexible" about personification. The subject's gender works in the same way as the subjects' opinion about personification. Males personification. However, due to the small number of female subjects, further study is needed to conclude that users' gender truly affects impressions of agent personification.

It is interesting that people's opinion about personification also affects the way they feel about expressiveness. The AGREE group rated expressive faces (Honest and Deceiving) to be more comfortable, and the Honest face to be most intelligent. The DISAGREE group rated the stoic face as most intelligent and comfortable. This means the DISAGREE group is more strict about simulating a real poker situation, where players are not expected to show honest expressions.

2.5. Summary

The first finding is that having a face is considered more likable, engaging, and comfortable to see in a poker game environment. People did not feel distracted by the presence of a face or facial expressions. Moreover, people tried to interpret the faces and facial expressions, which makes the users pay attention to the face and engage in the task. Walker [Walker94] describes the advantages and disadvantages of personification as follows: "This can lead to improved performance if the task is not very complex or to degraded performance if the task is complex." It is clear that faces are useful for entertainment purposes, since engagement is essential for games and people don't care about taking more effort for entertainment. Hence it may also be useful for applications which require an engaged user for success, such as education and training as evaluated in [Andre98]. [Andre98] reports that the subjects rated learning tasks presented by an animated agent as less difficult than the presentations viewed without an animated agent.

The second finding is that people's impressions of a face are different when they see a face in isolation versus when they interact with a face within a task. People evaluate a face not based on appearance but on competence or performance. Most psychological HCI studies use static facial images separately from applications. One thing we learned from this study is that we have to evaluate effects of personification within a context--i.e. the context of software agent applications. As Don [Don92] says, the key issue for personification is to understand the nature of the task and the way of communication with the task. Of course not all software agents require personified interfaces. The goal of HCI work should be to understand when a personified interface is appropriate.

The third finding is that there is a dichotomy between user groups which have opposite opinions about personification. Differences in facial features such as character's gender, humanity, and expressiveness cause opposite evaluations by these two subject groups. Some of the experiments performed indicate that there is also a potential difference in evaluation of a

human face and a non-human face between the subjects' gender. Subjects' computer expertise and age range should also be taken into consideration. We need to consider the target users when designing a personified interface. The future personified interface should be flexible so that it can provide options to choose a preferred face or no face at all for each user.

Chapter 3. Effects of Using Lifelike Characters on a Network Communication tool

This chapter evaluates the effects of using lifelike characters on a network communication tool. A P2P communication tool with faces and facial expressions was developed and monitored its usage in actual communications at corporations.

3.1. Usage of Emoticons and Lifelike Characters in Network Communication Tools

There are variety of network communication tools provided for your daily use, i.e., emails, instant messengers (IM for short), chat systems, online bulletin boards, email on mobile phones, and so on. Those tools are designed and used mainly to exchange verbal information. Studies on computer mediated communication (CMC for short) states verbal information tends to trigger a “frame” (insulting criticism or remark meant to incite anger) in network communications, since text information lacks emotional content and often leads to misunderstanding [Eshita00, Wallace01].

Emoticons are often used to complement the lack of emotional content in textual messages in network communication tools. A former study on the effect of emoticons indicates they improve the user's satisfaction of using the system although they don't affect the content of communication [Rivera96].

Commercial IMs, i.e., MSN messenger and Yahoo! Messenger, have animated emoticons to improve the quality of graphical representation of the user's emotions. However, these popular IMs are still based on the design of the original messaging system, which is to mainly exchange verbal information. Emoticons are used to add nuances or to express happy or surprise but the IM tool itself it not used to expression the user's emotions.

Avatars are also used for chat systems as a more graphically rich form of expressing emotions. CMC studies on the effects of presenting avatars indicate that avatars improve user experiences and interactions among participants [Kurlander96, Koda04, Isbister00]. However, studies on the effects of avatars on communication contents shows avatars play little role on communication contents in chat systems, and most of all communications can be achieved by exchanging text messages only [Salem00]. Usage of avatars decreases over time, resulting in users' using text information only in chat systems [Smith00].

Network communication tools with emotions and avatars still have flaming problem, although emoticons and avatars are used to complement the emotional content and prevent miscommunications. Thus, there is a need to realize a network communication tool that enables users to express their emotions not supplementary but mainly, and investigate its effects on communication content and sustainability.

Research on network communication tools that can express the user's emotions are focusing on detecting emotions automatically, i.e., an IM that transmits the sender's emotions detected by galvanic skin reflex (GSR) with text messages [DiMicco02], detecting the sender's emotions by the typing pressure [Bodine03], changing the avatar's facial expressions by analyzing the image of the sender's facial expressions [Kaliouby04]. However, these IMs have a long way to go until they are widely used since they require

additional sensors or cameras and high-performance PCs. In addition to the technological issues, these IMs cannot stay away from the possibility of misrecognitions of the sender's emotions.

This study defines a network communication tool which main purpose is to express one's emotions not as a supplemental function such as emoticons or avatars as an "expressive communication tool." This section describes the following two research issues:

1) To realize an expressive communication tool mainly used to express one's emotions
2) To realize a sustainable expressive communication tool

The following describes the design and implementation of the expressive communication tool, usability and sustainability analyses of the tool for the past several years. The tool has been used by more than 380,000 users (65% of female users) (as of June, 2005) since its launch in 1998 [Petaro06].

3.2. Design Concept of the Expressive Communication Tool

This section describes the background and design consideration of developing the expressive communication tool.

The time when Petaro [Petaro06] was developed was the time when intranets were being spread into workplaces in Japan. Intranets enabled office workers to have their own PCs and constant connection to the internet. Among them were female office workers in charge of administrative tasks who did not have enough computer skills. The main communication tool within the workplace was email. According to the survey we conducted among the female workers in September, 1997, 73% of female workers are given email addresses from their company. 67% of them exchanged emails during the office hours, 52% after the office hours, and 38% from their home, which suggests email exchanges occurred mostly at their workplaces. 70% of email messages exchanged other than business purposes were used

for chitchatting among their friends within the workplace. However, some workplaces banned email use for private purposes and censored the messages. Our further observation at the workplaces suggested that private communications that cannot be made on emails were made at bathrooms or corridors to avoid censorships.

On the other hand, paper-based administrative communications were made using a paper slip, i.e., 3M Post-it®, on many occasions, with cute characters, i.e., animals or human figures, attached on documents. The main reason for using paper slips with characters is “to smoothing the communication when telling administrative issues that might sound harsh with text message only,” according to our interviews with office workers.

The expressive communication tool “Petaro” was designed based on the user survey in the workplace. The tool features a digitalized version of the character based paper slip as shown in Figure 3-1*1. The digital slip has an animal shaped template, which consists of three components. The first is the facial expression area, where users can choose “smiling face” or “crying face” etc. according to their feelings. The second is a text input area where users type in their messages. The third is a text new area with a linkable URL from a service administrator.

Figure 3-2*1 shows various character-based templates. Users can choose a character-based template from various selections according to their preferences. Each template has seven facial expressions; namely, “neutral”, “happy”, “angry”, “sad”, “tense”(sweat-on-the-dace), “surprised” and “aloof” (closed-eyes), as shown in Figure 3-3*1. Those expressions are selected from frequently used emoticons in chats and IMs. Users can choose an appropriate facial expression to add an emotional context to their text message. The default expression is set to the “neutral” expression (the top left expression in Figure 3-3). Each template has two sides: the front side has a message area and the back side is used for hiding the message (the left-bottom in the right figure of Figure 3-3).

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*1: © 1998-2005 Hakuhodo DY Media Partners Inc. & TYO-ID Inc. & Ergo-Brains inc. (applicable to all *1 notes in this chapter)

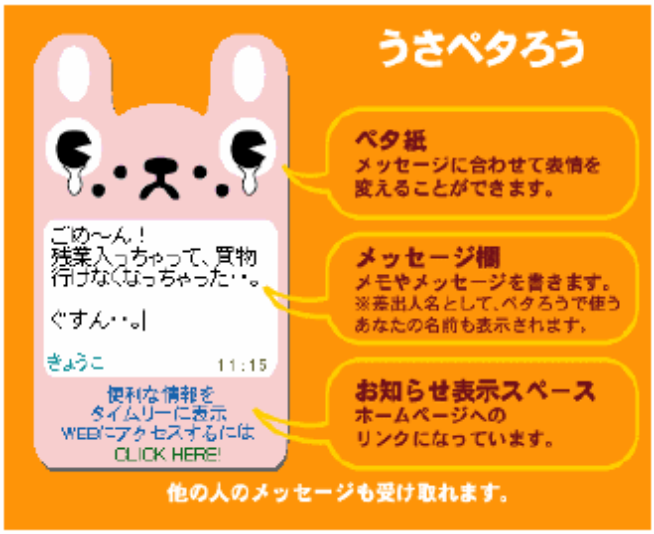
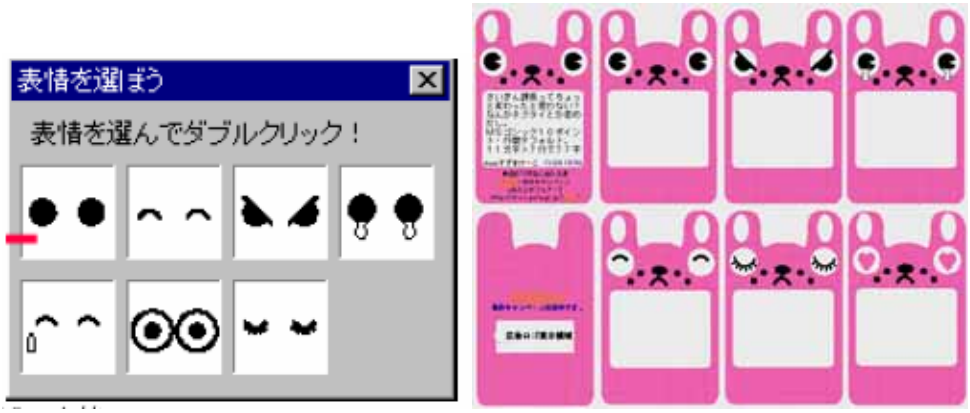


Figure 3-1: A Petaro slip’s template structure (the front side)

Figure 3-2: Examples of Petaro templates



Notes: Left: The selection panel shown when a user selects a facial expression. From top left, "neutral", "happy", "angry", "sad", "tense" (sweat-on-the-face), "surprised", and "aloof".
right: Examples of facial expressions of a rabbit template. The left bottom shows the backside of the template.

Figure 3-3: Facial expressions provided by Petaro System Design of the Expressive Communication Tool

3.2.1. System Structure

The expressive communication tool uses the P2P communication as shown in Figure 3-4*2. The program runs on the user's PC and is not connected to the external servers over the internet except the following three exceptions. Those are: 1) when downloading the new version of the program or new templates at the user's option, 2) when downloading new text news at the user's permission, 3) when uploading user information (i.e., a user's handle name and IP address) and number of used message slips. Messages sent among users inside the user's LAN network would not be sent to the servers.

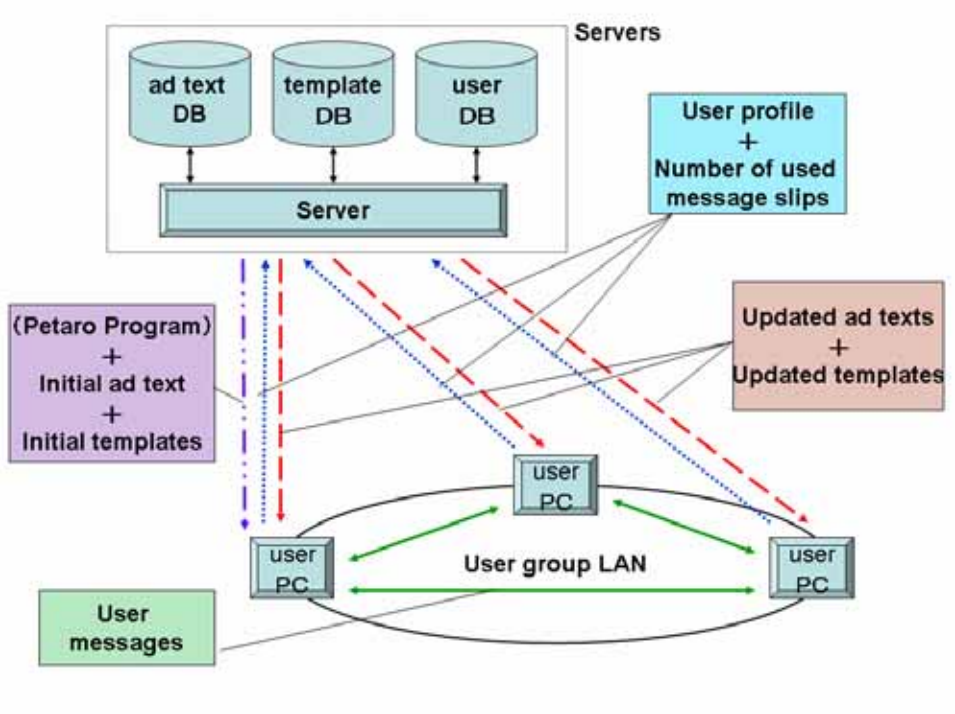


Figure 3-4: System structure of Petaro

3.2.2. Network Communication

The communication protocol used among the programs within a LAN network is TCP/IP, and both TCP and UDP are used as transport protocols. Communications among programs occur in the following three occasions:

1) A broadcasting message (about 80 bytes) is transmitted in the LAN network when loading and closing the program and searching a user. The PCs received the broadcasting message also send a broadcasting message to update the active users list reciprocally. The transport protocol for broadcasting is UDP and an independent protocol for the upper level.

2) The transport protocols used when sending a message are TCP and an

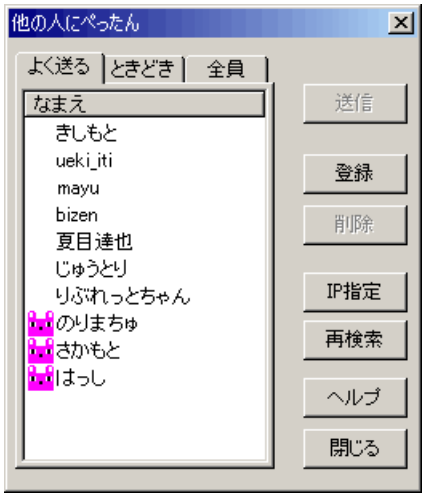
*2: Adopted from the document in US Patent No. 6678866B1

independent protocol for the upper level. The data size transmitted to the LAN network when sending a message is fixed (about 1700 bytes) regardless of the message length. The program updates the active user list with users' handle names, users' PC names, IP addresses, and port numbers.

3) The protocol used when downloading text news from the ad server on the internet is HTTP. The data size is about 40 KB.

As described in 3.1, the expressive communication tool should provide a simple function and ease-of-use for PC novices. Users don't have to set up network configurations before starting to exchange messages. Handle names of active users are displayed and updated automatically in the active user list as shown in Figure 3-5*1, so that users don't have to remember recipients' IDs or IP addresses.

However, in order for users to exchange messages with users beyond the same LAN network, users need to input the recipients IP addresses. The network communication tool hides the detailed configuration function in the depth of the configuration panel for novice users.



Note: Active users are shown with a pink mark

Figure 3-5: User list panel

3.2.3. Menu Structure

The menu structure is designed to be simple without using technical terms. A pop up menu is displayed when clicking the right mouse button on the template (Figure 3-6*1). The menu items have easy casual words such as “Petttan-suru” (to send a message slip), “Suteru” (to delete a message slip), “Huseru” (to turn over the slip), “Chiisakusuru” (to minimize the message slip). “Ookikusuru” (to maximize the message slip), “Select a character” (to select a character based template). Cascade menus are not used except “Pettan-suru.” When selecting the “Pettan-suru” menu item, there are two cascade items; “to self” and “to others.” “To self” means saving the message on the user’s desktop, and “to others” means sending the message to other users.

Figure 3-7*1 shows a desktop when a message was received. A sent message is shown with the backside of the template. The recipient can read the message by clicking the template.

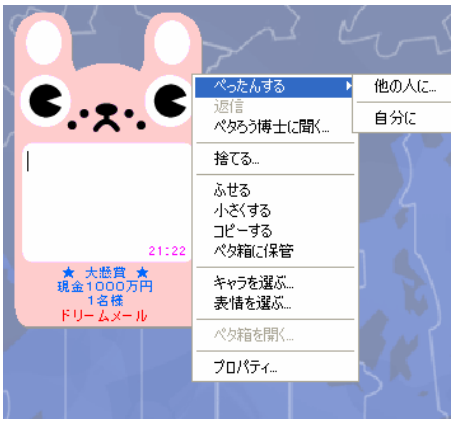


Figure 3-6: Menu structure of Petaro

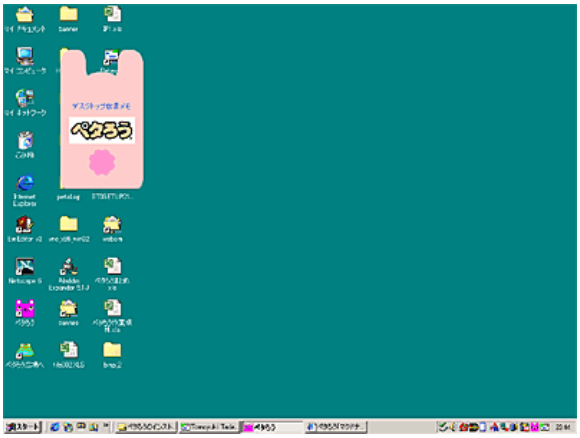


Figure 3-7: A desktop where a Petaro message has arrived

3.3. Usage of Expressive Communication in Workplaces

We conducted a monitor test within actual workplaces for 100 days before starting a commercial service in 1998. The monitor test was conducted by a paired monitor (main monitor and sub monitor) from 100 companies by using the tool in their workplace. The monitors are female office workers in their 20's and 30's.

Monitors are instructed to use the tool for daily communication in their workplace. The tool was introduced as a communication tool that can exchange messages directly on the desktop. They were not informed that the tool uses P2P protocol. We conducted questionnaire surveys 10 days, 40 days, and 100 days after starting to use the tool. The following sections describe the result of the questionnaire surveys on the usage of the expressive communication tool in workplaces.

3.3.1. Analysis of Usage and Sustainability

This section describes the result of the questionnaire survey on the usage and sustainability of the expressive communication tool within workplaces. The following describes the mean number of message slips used per person per day, the purpose of using the tool during the 100 days of the monitoring period, and intention of using the tool after the monitoring.

Table 3-1 shows the mean number of slips per person per day used 10 days, 40 days, and 100 days after starting the monitor test. The mean number of slips used through out the 100 days of the monitoring period was 7.

The purpose of using the tool, as shown in Table 3-2, was that more than 80% of the messages were used for private communication and the rest (20%) was for business purposes constantly during the monitoring period. The recipients are, as shown in Table 3-3, for self use (used as a to-do list) was 16% and the majority (84%) was used for sending messages to others. By considering the results from Table 3-2 and Table 3-3, the monitors used one slip for self and 6 slips for sending messages to other users per day through out the monitoring period.

Table 3-4 shows the monitors opinion about the continuous use of the tool after the monitoring period to examine its sustainability. About 90% of the monitors showed positive opinions about continuing using the tool.

As a summary, the expressive communication tool was used mainly for private communication in the workplace, by sending 7 messages per person per day. The number of messages used per day has not changed through out the monitoring period, and the users need for its continuous use is high. These results suggest that the expressive communication tool has been accepted as a tool for private use that would be used continuously in the workplace.

Table 3-1: Numbers Petaro messages used per person per day (n=100)

Days used	Number of messages used per person per day
10 days later	7.4
40 days later	6.9
100 days later	7.1

Table 3-2: Purpose of using Petaro (n=100)

Purpose of using Petaro	10 days later	40 days later
For private communication	84%	84%
For business communication	16%	16%

Table 3-3: Recipients of communication (n=100)

Purpose of communication	Percentile
As a self to-do list	16%
As a message sent to recipients	84%

Table 3-4: Answers to whether users want to continue using Petaro (n=100)

Users opinion about continuous use of Petaro	Percentile
Want to use it very much	55%
Want to use it	33%
Don’t want to use it very much	12%
Don’t want to use it at all	0%

3.3.2. Acceptability of Lifelike Characters as a Communication Channel

This section describes the results of questionnaire surveys on the acceptability of the expressive communication tool. The evaluation indexes are monitors' subjective evaluation of the tool's interestingness and frequency of changing the facial expression of the templates.

Table 3-5 shows the monitors' evaluations of "interestingness" of the tool 10 days and 40 day later. Table 3-6 shows the answers to why the monitors think the tool is interesting. Table 3-7 shows the frequency of changing the facial expression of the templates. As seen in Table 3-5, about 90% of the monitors evaluated the tool as interesting through out the monitoring period. Negative evaluations are made by only about 10% of the monitors, in which none of them evaluated as "not interesting at all." The tool was evaluated as interesting mainly because the users can change facial expressions (51%) and they can use cute character templates (26%) as shown in Table 3-6. On the other hand, user evaluations on the features of a P2P communication tool, namely, "can send messages quickly" and "can use it freely like daily conversation" are in mid-teen percentage. Table 3-7 supports the results stated above, that the tool's expressiveness (facial expressions) attracted the monitors. 75% of the monitors changed the facial expression of the template, which default is set to neutral. The examples of how the facial expressions were used are described in 3.4

In summary, the expressive communication tool was evaluated as "interesting," due to its feature of changing the character template and facial expressions, and 3/4 of the monitors changed the expression when using the tool. These results suggest that the existence of character faces and facial expressions attract users and facilitate the use of the communication tool.

Table 3-5: User evaluation of Petaro's Interesting-ness 10 days later and 40 days later (n=100)

Evaluation	10 day later	40 days later
Very interesting	28%	30%
Interesting	60%	63%
Not very interesting	11%	7%
Not interesting at all	0%	0%

Table 3-6: Answers to why users think Petaro is interesting (n=100 Multiple selection)

Reason for Petaro being interesting	Percentage
Can change facial expressions	51%
Cute characters	26%
Can send messages quickly	18%
Can use it freely like daily conversation	15%

Table 3-7: Frequency of changing Petaro's expressions (n=100)

Use of Petaro's expressions	Percentage
Change facial expressions	75%
Don't change facial expressions	25%

The monitors also evaluated the convenience of the tool. 66% of the monitors evaluated the tool as convenient 10 days later, and 82% 40 days later. The reason for the tool's convenience was "can send messages quickly" and "can use it freely like daily conversation." This suggests the immediacy of a P2P communication tool, i.e., users don't have to check the mail server, is evaluated as convenient by the monitors.

3.3.3. Impacts on the Email Usage

Table 3-8 shows the frequency of email use before and during using the expressive communication tool. 80% of the monitors answered that their email frequency has not changed after started using the expressive communication tool. This suggests that the expressive communication tool is used differently from email communication. The expressive communication tool has not activated the email use nor replaced emails but used for different purpose.

Table 3-8: Frequency in use of Email while using Petaro (n=100)

Frequency of using Email	Percentage
Having increased	4.5%
Having decreased	14.6%
Have not been changed	80.9%

In summary, the expressive communication tool was used mainly for private purposes at workplaces; the main reason for using the tool was the existence of characters and facial expressions; was used as a different communication media from email; and was evaluated as a tool that would be used sustainably.

3.3.4. Reason for using Lifelike Characters

This section describes the examples of expressive communication conducted during the monitoring test by quoting user comments. Table 3-9 shows the monitor's open comments on the tool by categories, and Figure 3-8 shows the percentages of open comments by categories. The categories are "on characters and templates", "contents of the communication (chitchat)", "convenience" and others. As seen in Figure 3-8, 38% of open

comments made by monitors were on the character templates and facial expressions, followed by contents of the communication (chitchat) (23%), convenience (18%), and quickness (16%). As described in 3.3.2, users have higher interest in character templates and facial expressions of the tool rather than its convenience in evaluating the expressive communication tool.

The monitors' open comments in Table 3-9 suggests that character templates and facial expressions are used to express the sender's emotions that cannot be expressed appropriately with verbal information. Some communications occurred using only a facial expression without using verbal information at all. Effects of using facial expression for communication are bi-directional; not only on the sender's expressing her emotion but on the recipient's understanding the sender's emotion easily.

The monitors' open comments revealed that monitors used the expressive communication tool mostly because of it enables them to express their emotions. There are cases of using templates and facial expressions as symbols, i.e., to identify sender by the template used, to categorize the urgency and contents by the template and facial expressions used.

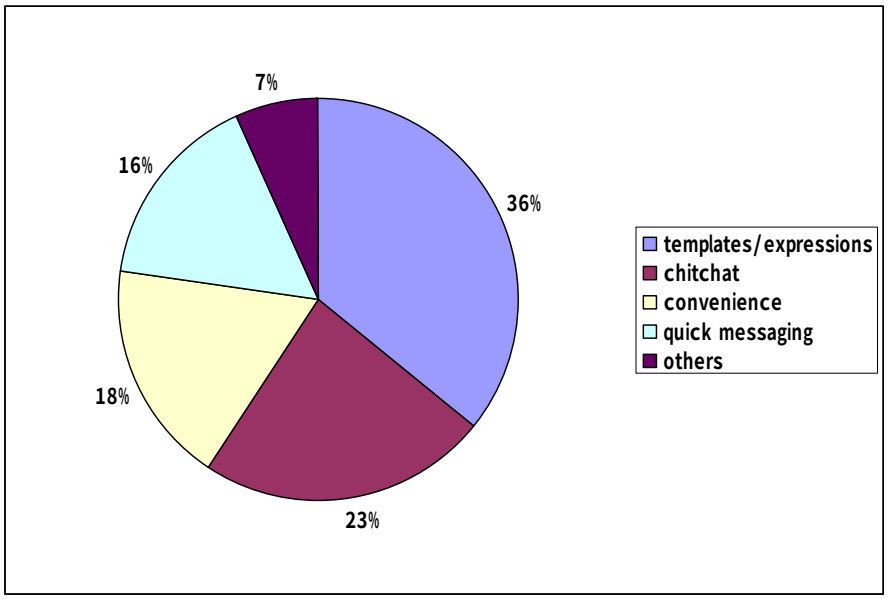


Figure 3-8: Number of users' open comments per category

Table 3-9: User comments on Petaro

Category	Users' comments
Templates and expressions (n=58)	<Using facial expressions as a replacement of verbal texts>（Similar comments n=21） ● I can tell my feelings that cannot be expressed by verbal languages because I can change facial expressions ● Petaro is very convenient because I can tell subtle feelings that cannot be expressed by text. ● Petaro is convenient when I express things that are bashful or awkward. ● I can tell my emotions with facial expressions without writing text messages. <Express users' feelings by using facial expressions> (Similar comments n=32） ● Emails tend to give harsh impressions to the recipient when asking for a favor as they are written with texts. Petaro is useful since it can deliver my feelings. The recipient understood my feeling when I asked for her favor with the "crying" expression. ● I use the "crying" expression when I am blue, "smiling" expression when I am happy. I can also understand the sender's feeling before I read the message. ● I enjoy using Petaro since there are no other messaging systems that I can express my feelings. ＜Other usage of templates and expressions＞（Similar comments n=5） ● It is easy to tell who the sender is since we use fixed characters. ● I feel it very convenient to know the urgent level and the content of a message since we settle on the rules that use fixed templates and expressions.
Chitchat (n=38）	● Petaro is useful for relaxation during work. ● We can send a tidbit of gossip quickly and privately which we cannot talk over the phone.
Convenience (n=29)	● Great tool to leave a phone message ● Very convenient as a To Do list for myself
Quickness (n=26）	● Sending and receiving email messages tale time. Exchanging messages via Petaro does not have any time lags.

3.4. Usage of Expressive Communication at Home and Communities

This section introduces extensive use of Petaro other than inside workplaces. There are usage reports of the expressive communication tool on the internet since its launch in 1998. Especially after 2000, the tool has been used at communities and homes for beginners and children.

3.4.1. Usage at Schools

Below introduces several examples of the tool's usage at schools.

1) FUKUSHIMA National College of Technology (2001) [*1]

Petaro has been used to teach "information ethics" in computer literacy lectures. The tool is used to learn net manners when exchanging messages with a person without meeting face to face.

2) Kumano #4 Elementary School (2001) [*2]

Petaro has been used to teach information ethics as a communication tool within classrooms, among students and the principal, administrators, and school nurses. Students learn net manners by starting communications via the tool by self introducing them and write greetings to teachers who thay have not met. The report describes the reason for using Petaro is the character templates and facial expressions make the students familiarize with the tool easily and the tool itself is easy to set up.

1: http://www.cec.or.jp/books/H13/E-square/02/1_02_zissen/09.html

http://www.ciec.or.jp/wg/ps-ed/SocietyForTheStudyInfo.html

2: http://www.fine.lett.hiroshima-u.ac.jp/010915/enosaki.html

3) Kuzumaki Elementary School in Mituske City, Niigata[*3]

Petaro is used as a “school mail,” a communication tool among within and among classrooms. They report that the tool has made the students get more interested in computers because of its easy operation and cute characters.

4) Nakahara Elementary School in Kashiwa City, Chiba[*4]

Petaro has been used as a practical tool to teach information ethics on the in-school LAN network.

As a summery, the expressive communication tool has been used at schools in the following objectives and reasons:

- As a private communication system within a school
- As a communication tool to teach computer literacy by experiencing how to write messages and sending/receiving them among students
- As a communication tool to teach information ethics by exchanging messages to teachers as well as among students

The reasons for using the tool are its familiarity with characters, ease-of-use, and closed messaging service.

3.4.2. Usage at Home

Other than usage at schools, home uses have been increasingly reported during the last couple of years as the spread of home LAN networks.

These cases are:

3:http://www.mitsuke-ngt.ed.jp/~kuzumaki/h12_6gakunen6.htm

http://www.mitsuke-ngt.ed.jp/~kuzumaki/h12_kuzumaruti1.htm

4.http://www.ciec.or.jp/wg/ps-ed/SocietyForTheStudyInfo.html

As a practice tool for children to learn how to use email at home (2001) [*5]

As an in-house communication tool between children and their mother, who formerly used Petaro at her workplace (2000)

As an in-house communication tool between a daughter and her father, who feels awkward to talk to the daughter face to face (2002)[*6]

As a communication tool between students and a teacher at a cram school, which wanted to have a closed communication system (2005)[*7]

The reasons for using the tool at home are:

The tool's cute characters appeals children of any age compared to other communication tools that have a dry interface.

The tool provides a closed and safe communication system that is not open to the internet for safety and privacy. Emails and other IMs are open to outer network, which parents consider to be harmful to children.

As a summary, although the expressive communication tool was developed for female office workers as a communication tool at workplaces originally, it has been extensively used at schools and home as a communication tool for any gender and age, especially for children, because of its character templates with expressions, simple interface, and safe communication service.

3.5. Summary

This section described the design and usability of the expressive communication tool. The tool features various character templates and facial expressions to enable users to express their emotions. The usability and sustainability tests indicated the following two issues;

1) Featuring characters and facial expressions realized a new communication media where expressing one's emotions is the

5: Nikkei Ryutsu Shinbun 01/5/4）

6: http://www.chara-labo.com/repo41.pdf

7: http://okweb.em-net.ne.jp/kotaeru.php3?q=1228096

main purpose for communication.

The results support the above issues are;

- More than 75% of the communications are aimed for expressing one's emotion by using the facial expressions provided. The frequency of using facial expressions did not decline during the research period. These indicate characters and facial expressions are used not as means to complement verbal information such as emotions but as an expressive communication media.
- More than 80% of the users answered the reason for using the tool is that they can change the characters and facial expressions. The actual usage of the tool also showed that users changes the facial expressions frequently.
- Use of the tool did not affect the frequency of email communication. This means the tool was used for different purposes from emails.

2) The emotionally expressive communication tool realized a sustainable media that is used at home and communities as well as workplaces regardless of gender and age.

The results support the above issues are;

- The tool has been used by more than 380,000 users (65% are female) since its launch in 1998, expanding users from workplaces to homes and schools.
- The usage rate of the facial expressions did not decline during the 100 days of monitoring period.

Chapter 4. Effects of Using Lifelike Characters on Intercultural Communications

This chapter observes the effects of using lifelike characters on intercultural communications. The evaluation experiment was conducted as a form of a series of discussions via a multilingual BBS with expressive avatars between Japanese and Chinese researchers. Examining cultural differences in interpreting avatar facial expressions was also observed.

Since instant messenger and chat services are frequently used in our daily communication beyond nationality and languages, emoticons and expressive avatars are widely used to provide nonverbal cues to text-only messages [MSN06, Yahoo06, Askjeeves06, Damer97]. Studies on emoticons and avatars report positive effects on computer-mediated communication. Those studies indicate that emoticons and avatars improve user experiences and interactions among participants [Kurlander96, Smith00, Persson03] and build enthusiasm toward participation and friendliness in intercultural communication [Koda04, Isbister00].

However, these avatars are used based on an implicit assumption that avatar expressions are interpreted universally across cultures. Since avatars work as graphical representations of our underlying emotions in online communication, those expressions should be carefully designed so that they are recognized universally. We need to closely examine cultural differences

in the interpretation of expressive avatars to avoid misunderstandings in using them.

As business becomes global and the Internet is used beyond languages and cultural boundaries, there is a need to survey what kind of characters/character traits are universally understood, and whether emoticons and facial expressions are understood and used similarly across countries.

4.1. Experiment with Avatars on a Multilingual BBS

The experiment was conducted using a multilingual BBS called TransBBS that incorporates translation service among Chinese, Japanese, and English ([Nomura03]0 for more details on TransBBS). An expressive character interface is added to a text-based bulletin board on TransBBS.

The objective of the experiment is to understand what kind of character representations are commonly understood between China and Japan and what kinds are not, and whether commonly used facial expressions or emoticons are similarly interpreted between the two different cultures.

4.1.1. Experiment Procedure

Nineteen subjects from Japan and 16 subjects from China participated in the experiment. Participation in the experiment was invitation only. The subjects discussed pre-determined research topics on TransBBS for two weeks using their native languages, namely Chinese and Japanese. The subjects selected one character as their avatar from 20 different character representations (see Figure 4-1*1). Each character representation has 7 different facial expressions (see Figure 4-2*1). They selected one facial expression that corresponded to their underlying feeling when they posted a

*1: © 1998-2005 Hakuhodo DY Media Partners Inc. & TYO-ID Inc. & Ergo-Brains inc. Used by permission (applicable to all *1 notes in this chapter)

message. The message is displayed with an original text (written in their native language, either Chinese or Japanese), translated texts (English and Chinese/Japanese) with a character representation with the corresponding facial expression. Figure 4-3*1 shows posted messages with character expressions on TransBBS.

The subjects completed a questionnaire after a two-week discussion on TransBBS. The questionnaire answers were analyzed together with message logs.

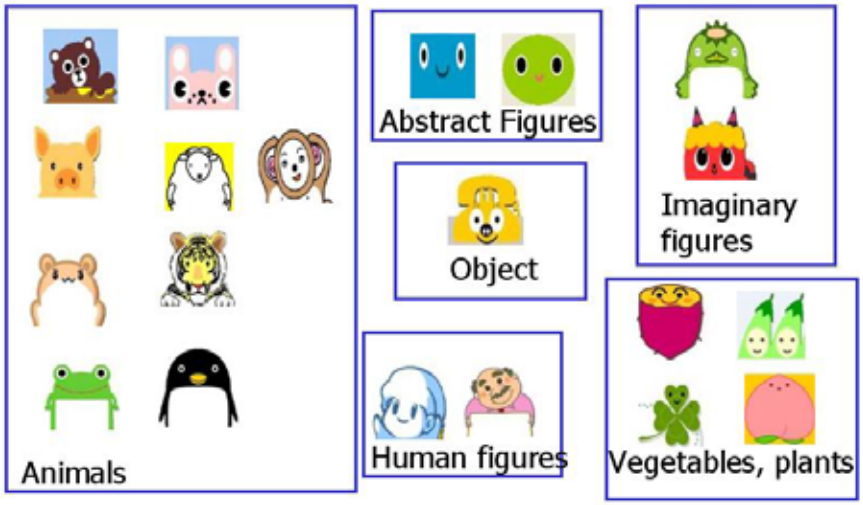


Figure 4-1: Twenty character representations used as users' avatars on TransBBS

Figure 4-2: Seven facial expressions used to show users' feelings

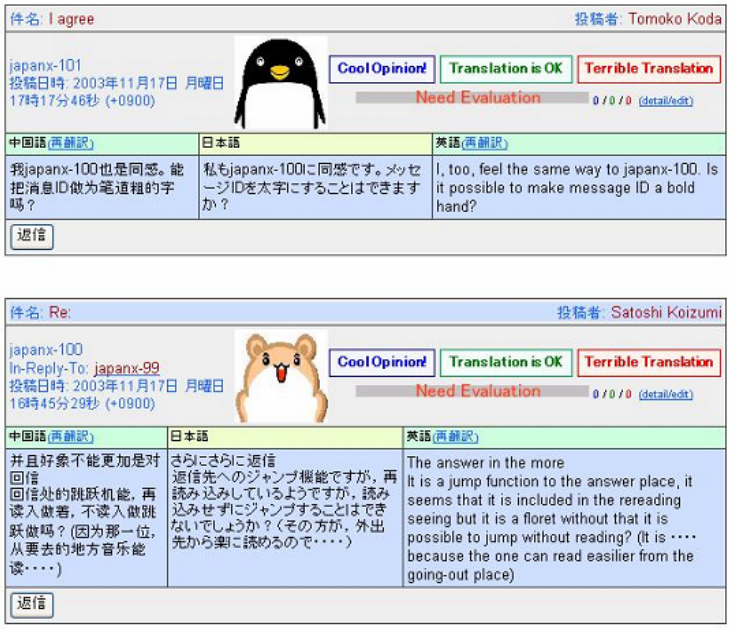


Figure 4-3: Posted messages with character expressions on TransBBS

Character Representation / Facial Expressions

The 20 characters and 7 facial expressions are taken from a character based instant messaging service in Japan known as “Petaro [Petaro06].” The characters used in the experiment are categorized into 6 groups as shown in Figure 4-1. These are human figures, animal figures, abstract figures, imaginary figures, object, and vegetables/plants. The imaginary figures appear in old Japanese tales, while they are not known in China.

The seven facial expressions are presented as an eyeball expression to the subjects as shown in Figure 4-2 when they select an expression. The seven expressions are selected from most frequently used expressions in handwritten messages and emoticons in emails in Japan when Petaro was developed in 1997 (see Chapter3). There was no textual description of the facial expressions shown to the subjects. Thus selection of a facial expression solely depends on a subject’s interpretation of a visual representation of each facial expression.

Figure 4-3 shows posted messages with corresponding character expressions. A character representation as a poster's avatar with a facial expression, message with the original language, and translated messages are shown on a bulletin board.

Questionnaire

A questionnaire survey was conducted to understand the subjects' subjective evaluation of the characters. The questionnaire had the following questions:

1) Subjects' interpretation of each character.
2) Subjects' interpretation of each facial expression and description of the situation when they use the expression.
3) Facial expressions that were not present in the experiment but needed for intercultural communication.

4.2. Results

Thirty-four subjects from China and Japan actively discussed two separate topics in two different rooms. Characters are used in 82% of the total messages posted (547 messages with characters out of 671 messages) during the experiment. The subjects evenly select the 20 characters as avatars, in other words, each subject selected different character as his/her avatar.

4.2.1. Difference in Character Interpretation between China and Japan

The questionnaire answers to interpretation of characters shows an interesting result. There are some characters that are interpreted completely differently between the Chinese and Japanese participants. As shown in Table 4-1, four characters, namely "hamster", two imaginary figures "kappa" and "ogre", and "clover", had a common interpretation among the Japanese subjects, while Chinese subjects' interpretations are different from those of Japanese as well as among individuals.

Those “misunderstood” characters have the following characteristics:

1) A character that has a special meaning in one culture (i.e., commercially popular character such as a “hamster”)
2) An imaginary character in old tales in one culture (“kappa”, “ogre”)
3) A symbolic character that is popularly known in one culture (“clover”)

Table 4-1: Characters that have different interpretations between China and Japan

Character representation	Japanese interpretation	Chinese interpretation
	Hamster (popular pet in Japan), “Ham-taro” (a popular comic character)	Bear, mouse, panda, squirrel, unknown
	“kappa” (a water sprite that appears in old Japanese tales)	Animal, seal, bird, chicken, unknown
	“oni” (an ogre; This red “oni” is known as a sympathetic “good” ogre in Japan.)	Cat, tiger, ghost, squirrel, unknown
	Clove, four-leaf clover (known as a symbol of happiness)	Leaf, flower, bee, kite, butterfly

4.2.2. Difference in Interpretation and Usage of Facial Expressions between China and Japan

Interpretations of the seven facial expressions also show differences between two countries. Table 4-2 shows the subjects' interpretations of the facial expressions and the situations of using each expression.

The interpretation and usage of "neutral", "happy", "angry", and "sad" expressions are the same for both in China and Japan. However, other expressions ("in trouble", "surprised", and "sleepy") are interpreted and used differently among individuals and between cultures. Especially, several Chinese subjects interpreted the "surprised" expression (as for Japanese) as "intelligent" and actually used the expression when they stated their opinions or started a new topic on TransBBS. We observed that the Japanese subjects tried to confirm the meaning of the Chinese subject's message with the "surprised" expression. This is one example of communication gaps caused by different interpretations of avatar expressions between the two countries.

The interpretations of the "sleepy" expression are more diverse. Some use the "sleepy" expression to show they are thinking hard, while others use it to express "not thinking or tired." We should be careful in using the "sleepy" expression both for inner and inter-cultural communication.

The frequency in use of each facial expression shows a supporting result of the differences in its interpretations. As shown in Figure 4-4, "neutral" and "happy" expressions are the most frequently used expressions. Those two expressions don't have a negative connotation, and are frequently used to activate the discussion and to enhance a friendly atmosphere, as their usage are when one has "no need to express emotions" (neutral), or one is "agreeing or happy to receive a response" (happy) (see Table 4-2).

However, confusing expressions such as "in trouble", "surprised", and "sleepy" (as in Japanese interpretation) were not used frequently. The subjects either did not encounter a situation where those expressions are needed or simply could not figure out when to use them. The "angry" expression was used rarely in spite of the common interpretation. The

subjects' comments show that they tried to avoid using expressions that have negative connotations and may lead to misunderstandings.

Table 4-2: Interpretations of facial expressions and used situations

Note: Black/bold: common interpretation, Blue/Italic: Japanese interpretation, Red/courier: Chinese interpretation)

Expressions	Interpretation before experiment	Situations when the expression is used	Situations (if changed after the experiment)	Reason for the change
	**Neutral**	**No need for expressing emotions. No adequate expressions**	-	-
	Happy, Pleased	**Agreeing, Proposing an idea When received a reply**	*Disagreeing, Being ironic*	*To soften the atmosphere, to receive response*
	**Angry**	**Disagreeing,** *Will not use in any situation*		
	**Sad, Crying, In trouble**	**Sorry that msg was not understood or misunderstood,** *admitting a mistake, received a harsh comment*	*To express keenness,* `To ask for help`	*To show there was a misunderstanding*
	**In trouble,** *Tense,* `Ashamed, Suspicious`	*Be on different wavelengths,To bring an counterargument,* `To set an argument right, don't understand the meaning`	*To express keenness, to correct a mistake*	-
	**Surprised,** `Confused, Intelligent`	*Surprised, To emphasize, To strongly agree, To state a novel idea,* `to ask for opinions, when not understand`	*When received an unexpected opinion/interesting opinions*	-
	Sleepy, *Thinking, Not thinking,* `Tired, Indifferent, Boring, Disagree`	*To express thoughtfulness, when not understand,* `when busy`, **(don't use because the meaning is not clear)**	**When the idea is not clear,** *to send a serious message*	*There is not other adequate expression*

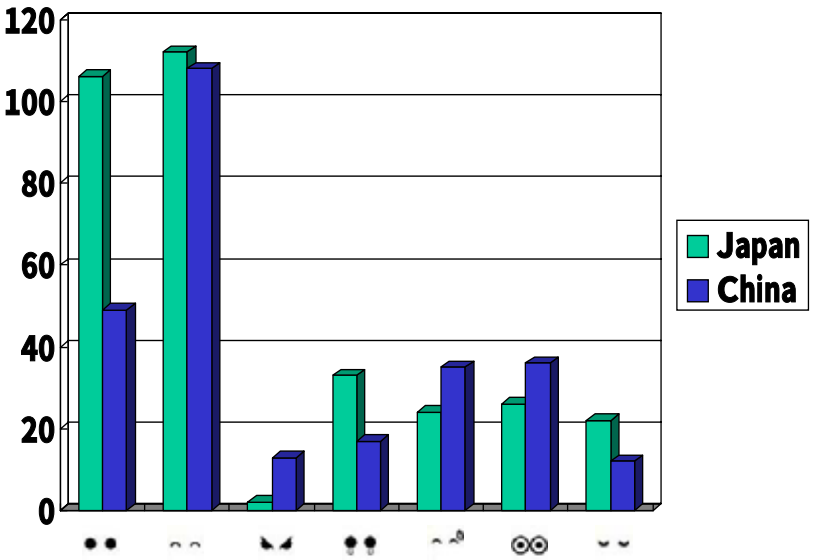


Figure 4-4: Frequency in use for seven facial expressions

4.2.3. Expressions Needed for Intercultural Communication

Subjects' answers to desired additional facial expressions are "having a question", "agreeing", "disagreeing", "apologizing", "asking for a request", "don't understand", and "having an idea." The desired expressions are to show one's cognitive states or opinions rather than emotions. The seven facial expressions used in the experiments are popularly used in daily chat and handwritten messages among close friends. Expressions that show one's emotional states are frequently used for communications among friends as seen in Chapter 3. The subjects' comments indicate that expressions to show one's cognitive states are more necessary for intercultural communication where people don't have enough understandings of each other and there is a big room for misunderstandings.

4.3. Summary

The experiment result shows we should be careful in selecting character representations for intercultural communication. Especially use of characters that have special meaning in one culture, commercially popular characters, or seemingly regarded as a universal symbol may cause misunderstandings among different cultures and countries.

The results show some facial expressions used in the experiment were interpreted completely differently and used for different purposes between Chinese and Japanese. Those "misinterpreted" expressions are "sweat-on-the-face," "wide-eyed (surprised)," and "closed-eyes (sleepy)." We observed several communication gaps caused by different interpretations of avatar expressions between the two countries in this experiment.

The subjects' requests for additional expressions suggest that expressions frequently used in instant messengers and chats are not the same as the ones needed for intercultural communication, especially when a purpose of a communication is to discuss research or business issues on a bulletin board. Difference of media (email and messengers (closed) vs. BBS (open)) may influence the usage of emotional expressions and kinds of expressions. Expressions that show one's cognitive status such as agreeing, disagreeing, proposing, and questioning may play more important roles in intercultural communication.

As business becomes global and the Internet is used beyond languages and cultural boundaries, there is a need to survey what kind of characters/character traits are universally understood, and what kind of emoticons and facial expressions are understood and used similarly across countries.

Chapter 5.
Cross-cultural study of Interpretation of Avatar Facial Expression

This chapter describes the result of cross-cultural analysis of interpretations of avatars' facial expressions to further investigate the results of cultural differences found in Chapter 4.

5.1. Psychological Studies on Human Expression Recognition

As described in Chapter 4, few studies have compared the cultural differences in interpreting avatars. One of those studies compared interpretations of avatars' animated gestures between the Netherlands and Japan [Bartneck04]. Their results showed that there are cultural differences in perceived valance in animated characters between the two countries. Japanese women perceived stronger emotions in some animated gestures of an avatar, i.e., bowing, than the Dutch subjects, although there were no overall differences in interpretation of the presented gestures. In Chapter 4,

we observed the differences in interpreting avatar facial expressions between Chinese and Japanese subjects.

The above two studies were each conducted between only two countries. We need to conduct an evaluation experiment among multiple countries in order to investigate cultural differences in avatar expression interpretation and what kinds of expressions are interpreted universally and what kinds are not. We believe the results would serve as a design guideline for universal avatar expression that would not lead to miscommunication.

In this chapter, we apply findings from psychological studies on human facial expressions, since there have been a much wider variety of studies in psychology on human expressions than on avatar expressions. The most widely accepted findings come from the work of Ekman. He states that seven emotions, namely, anger, fear, disgust, surprise, sadness, happiness and contempt, are universally expressed by all cultures [Ekman03]. However, he also argues the implications and connotations of those facial expressions are culturally dependent, and the degree of allowance in showing or perceiving those expressions socially differs across cultures [Ekman79]. Recent psychological research found evidence for an “in-group advantage” in emotion recognition. That is, recognition accuracy is higher for emotions both expressed and recognized by members of the same cultural group. Elfenbein et al. state, “This in-group advantage, defined as extent to which emotions are recognized less accurately across cultural boundaries, was smaller for cultural groups with greater exposure to one another, for example with greater physical proximity to each other [Elfenbein02].” Also, the decoding rule implies that we concentrate on recognition of negative expressions, since misinterpretation of negative expressions leads to more serious social problems than misinterpretation of positive expressions would cause [Elfenbein03].

This chapter investigates the following two issues:

1) Verifying cultural differences in interpreting avatars’ facial expression; this is done by applying the above psychological findings on cultural differences in human facial expression recognition to the case of avatar expressions.

2) Identifying avatar facial expressions that are recognized differently across cultures.

We conducted an open web experiment to investigate the above research issues by comparing interpretations of avatar expressions from multiple countries. We expect the result to serve as an avatar design guideline for online communication tools.

5.2. Experiment overview

5.2.1. Experimental procedure

The experiment's web site is open to the public [Koda05]. People from all over the world can access this web site and freely participate in the experiment. Participation is voluntarily.

The experiment itself was developed using the application of Macromedia Flash. Subjects first answer a brief questionnaire on their background profile. The main experiment starts after the questionnaire, which is presented as a matching puzzle game (Figure 5-1). Subjects are requested to match 12 facial expressions to 12 adjectives. The 12 facial expressions are displayed in a 4 x 3 matrix and the 12 adjectives as buttons below the matrix. As shown in Figure 5-1, subjects can drag/drop the adjective buttons to/on the 12 expressions and continue changing the location of each button until they are satisfied with their answer. One avatar representation is chosen randomly from 40 avatars, and facial expression images are randomly placed in the 4 x 3 matrix. The adjective buttons are always displayed in the same order, and the 12 adjectives are always the same (see sec. 5.2.3 for the adjectives used in the experiment).

Subjects' answers to the puzzle game and questionnaire, as well as their background profile including gender, age, county of origin, and native language, are logged in the server for later analysis. Subjects can continue the experiment with another set of avatars until they finish evaluating all 40

avatar designs or can stop at any time. Each avatar design is displayed only once to the same subject.

The adjectives can be shown in English, French, German, Italian, Spanish, Chinese, Korean, and Japanese (all validated by native speakers). Subjects from countries where the above languages are primarily spoken can see the adjective selections in their native language according to the background profile. The default language is set to English.

Note: Subjects can drag/drop the adjective buttons to the matching facial expressions.

Figure 5-1:. Experiment screen: Matching puzzle game between facial expressions and adjectives

5.2.2. Avatar design

Commercially used avatars are represented not by photo-realistic images but as caricatures or comic figures. We prepared 40 avatar representations drawn by three Japanese designers using Japanese comic/anime drawing style. By using avatars drawn with techniques from one culture, we can use those avatars as "expressers" and subjects as "recognizers" as in [Elfenbein02]. Accordingly, comparing the answers between Japanese users and those of other countries made it easier to validate the in-group advantage.

Avatars are categorized into five groups, namely, human figures, animals, plants, objects, and imaginary figures (culture-dependant). Figure 5-2 shows examples from the 40 avatar representations.

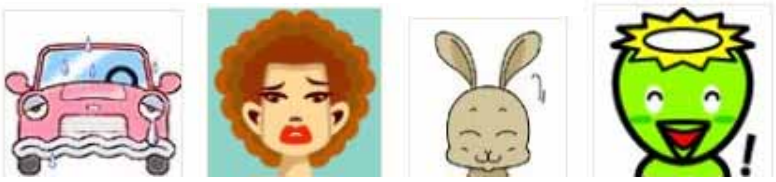


Figure 5-2: Examples of avatar representations

5.2.3. Facial expression design

The 12 expressions used in the experiment are "happy," "sad," "approving," "disapproving," "proud," "ashamed," "grateful," "angry," "impressed," "confused," "remorseful," and "surprised" as shown in Figure 5-3. Those expressions are selected from Ortony, Clore and Collins' global structure of emotion types, known as the OCC model [Ortony98]. These are commonly used expressions in chat and instant messenger systems [MSN06, Yahoo06, Askjeeves06], and they reflect those emotions desired by the subjects for intercultural communication in [Koda04].

These 12 expressions are paired as valanced expressions as defined in the OCC model, that is, negative/positive emotions that arise in reacting to an event or person. “Happy,” “approving,” “proud,” “grateful,” and “impressed” are positive expressions, while “sad,” “disapproving,” “ashamed,” “angry,” “confused,” and “remorseful” are negative expressions, leaving “surprised” as a neutral expression.

Note: From top left, happy, sad, approving, disapproving, proud, ashamed, grateful, angry, impressed, confused, remorseful, and surprised, drawn in Japanese comic style.

Figure 5-3: Twelve facial expressions using one of the avatars

5.3. Results

5.3.1. Subjects and participating countries

We have had 1,240 participants from 31 countries. Subjects’ gender ratio is roughly male : female = 1:1 (676 male subjects and 561 female). Subjects’ age ranges are: 6% are in their 10s, 43% in their 20s, 35% are in their 30s, 12% are in their 40s, and 4% in their 50s.

We have analyzed answers from eight countries having more than 40 participants, namely, Japan (n=310), South Korea (n=322), China (n=50),

France (n=111), Germany (n=62), United Kingdom (n=49), United States (n=75), and Mexico (n=149). The subjects from those eight countries saw the adjectives in their mother tongue. We used answers only in the cases where the subject's native language and the official language of his/her country matched.

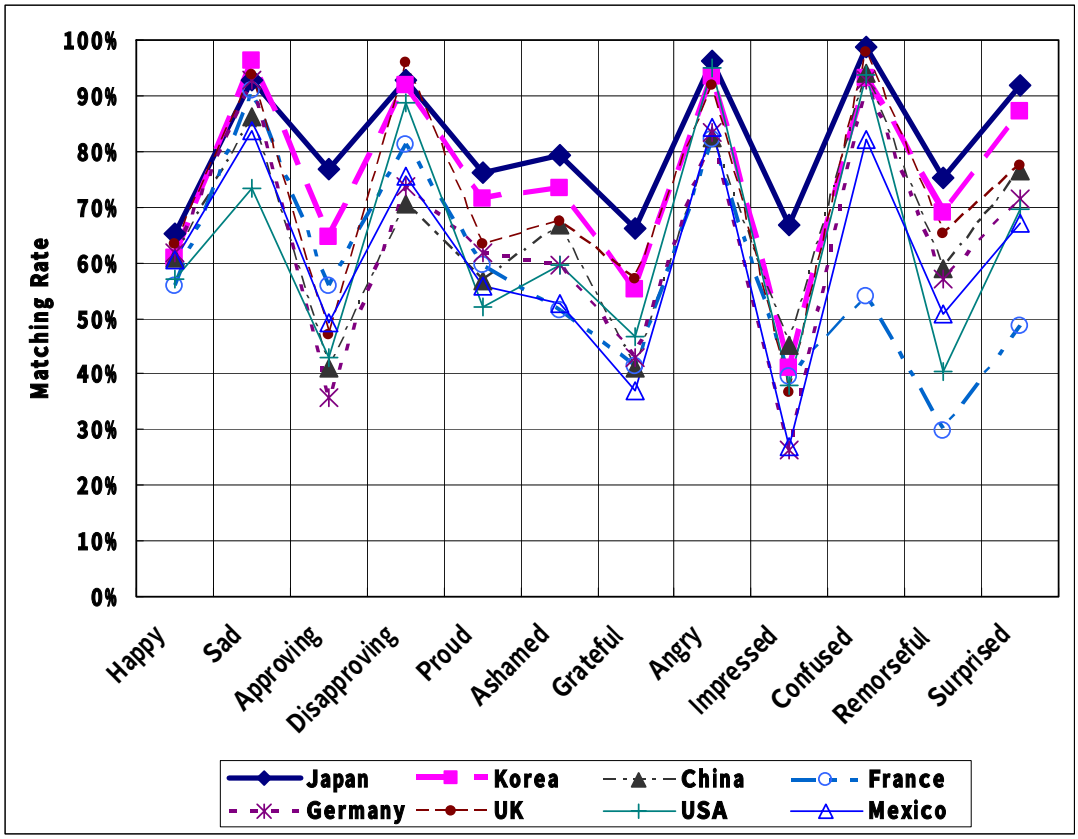
5.3.2. Overall cultural differences in interpreting expressions

Subjects' answers to the puzzle game are analyzed by calculating matching rates between expressions and adjectives. There is no correct answer to the matching puzzle, but the avatar designers' original intention can be used as an expresser's "standard" answer. Each expression and adjective is assigned a number (1-12) within the system. The designer's intended pairs are described as (1, 1), (2, 2), (3, 3), (4, 4) reflecting (expression number, adjective number). We calculated each country's number of "expression-adjective" pairs that are the same as the designers' pairs. Consequently, here, "matching rate" means the percentage of pairs of expressions and adjectives that match the avatar designer's intentional pairs. For example, the matching rate of answer pairs (1, 5), (2, 1), (3, 3), (4, 9) is 25%.

The matching rate for each facial expression by country is shown in Figure 5-4 and Table 5-1. The matching rate of Japanese is significantly higher for all expressions except "sad" and "disapproving" (by chi-squared test and Scheffe's method of multiple comparison, $p<0.01$), followed by Korea. Nevertheless, Japan maintains high matching rates for "sad" and "disapproving" expressions. There are no significant cultural differences in these matching rates among the countries other than Japan and Korea.

As stated in 5.2.2, avatars are designed by Japanese designers using Japanese comic/anime drawing techniques. Thus we can regard the designers as expressers and the subjects as recognizers. Japanese subjects' recognition accuracy of the avatar expressions is significantly higher than that of other countries, while Korean subjects' accuracy is the second

highest. This verifies that there is an in-group advantage within the same country (within Japan) and one between neighboring countries (Japan and Korea).



Notes: Matching rate means the percentage of pairs of expressions and adjectives that match the avatar designer's intentional pairs. Numbers of answers by each country are: Japan: n=310, Korea: n=322, China: n=50, UK: n=49, France: n=111, Germany: n=62, USA: n=75, Mexico: n=149.

Figure 5-4: Matching rate of each expression by country

Table 5-1: Matching rate of each expression by country

	Happy	Sad	Approving	Disapproving	Proud	Ashamed	Grateful	Angry	Impressed	Confused	Remorseful	Surprised
Japan	**65%**	**93%**	**77%**	**93%**	**76%**	**79%**	**66%**	**96%**	**67%**	**99%**	**75%**	**92%**
Korea	**61%**	**96%**	**65%**	**92%**	**71%**	**73%**	**55%**	**93%**	**41%**	**93%**	**69%**	**87%**
China	61%	86%	41%	71%	57%	67%	41%	82%	45%	94%	59%	76%
France	56%	91%	56%	81%	59%	51%	41%	82%	40%	54%	30%	49%
Germany	62%	93%	36%	74%	62%	60%	43%	83%	26%	93%	57%	71%
UK	63%	94%	47%	96%	63%	67%	57%	92%	37%	98%	65%	78%
USA	57%	73%	43%	89%	52%	59%	47%	95%	38%	94%	41%	70%
Mexico	61%	84%	49%	76%	56%	53%	37%	84%	27%	82%	51%	67%

Note: Adjectives with grey background are positive expressions.

5.3.3. Differences between positive/negative expressions

When we focus on the matching rate of each expression, the result shows that positive expressions in valanced expression pairs (happy-sad, approving-disapproving, and grateful-angry) have lower matching rates than the negative expressions in the same pair. Negative expressions (sad, disapproving, angry, and confused) have significantly higher matching rates regardless of country (by analysis of variance and Scheffe's method of multiple comparison, $p<0.01$), while positive expressions (happy, approving, proud, grateful, and impressed) have significantly lower matching rates regardless of country. The matching rate of the "impressed" expression is significantly lower than that of any other expression (by analysis of variance and Sheffe's method of multiple comparison, $p<0.01$).

This indicates that the subjects' interpretations of positive expressions (sad, disapproving, angry, and confused) are similar to the designers' intentions regardless of country and that the subjects' answers to those expressions are similar across countries. On the contrary, the subjects'

interpretation of positive expressions (happy, approving, proud, grateful, and impressed) varies across countries.

We further analyzed the answers for the twelve expressions by principal component analysis. The results show that positive expressions (happy, approving, proud, grateful, and impressed) get mixed up ($p<0.01$). In other words, the reason for the positive expressions' low matching rate is that each of those four expressions is not distinguished from the others. Subjects' comments support this result. Both Japanese and non-Japanese commented that they had difficulty in selecting the expressions matching "approving," "grateful," and "impressed."

5.3.4. Differences in interpreting confusing expressions

We next analyzed the answers to the "impressed" expression, which has the lowest recognition accuracy. Figure 5-5 shows a breakdown of the answers to the "impressed" expression by country. Analysis by chi-squared test and Scheffe's method of multiple comparison indicates that Japanese answers to the "impressed" expression are significantly different from those of other countries ($p<0.01$). In particular, the answers from Germany are most different from those of Japan ($p<0.01$), followed by the United Kingdom and Mexico ($p<0.01$).

As seen in Figure 5-5, 70% of Japanese interpreted the "impressed" expression as "impressed," while the majority of participants in each of the other countries did not make this association. We can assume that this is further evidence for the in-group advantage within a country.

Statistical Analysis (chi-squared test and Scheffe's method of multiple comparison) indicates that the "impressed" expression is mixed up with "happy," "approving," "proud," and "grateful" ($p<0.01$). All of those expressions are positive, supporting the finding in sec. 5.3.3 that positive expressions get mixed up with each other.

We then conducted principal component analyses for the answers for other expressions. The results show that the subjects tend to mix up "ashamed" with "remorseful," "confused" with "surprised," and

"disapproving" with "angry" ($p<0.01$), although negative expressions have higher recognition accuracy as stated earlier.

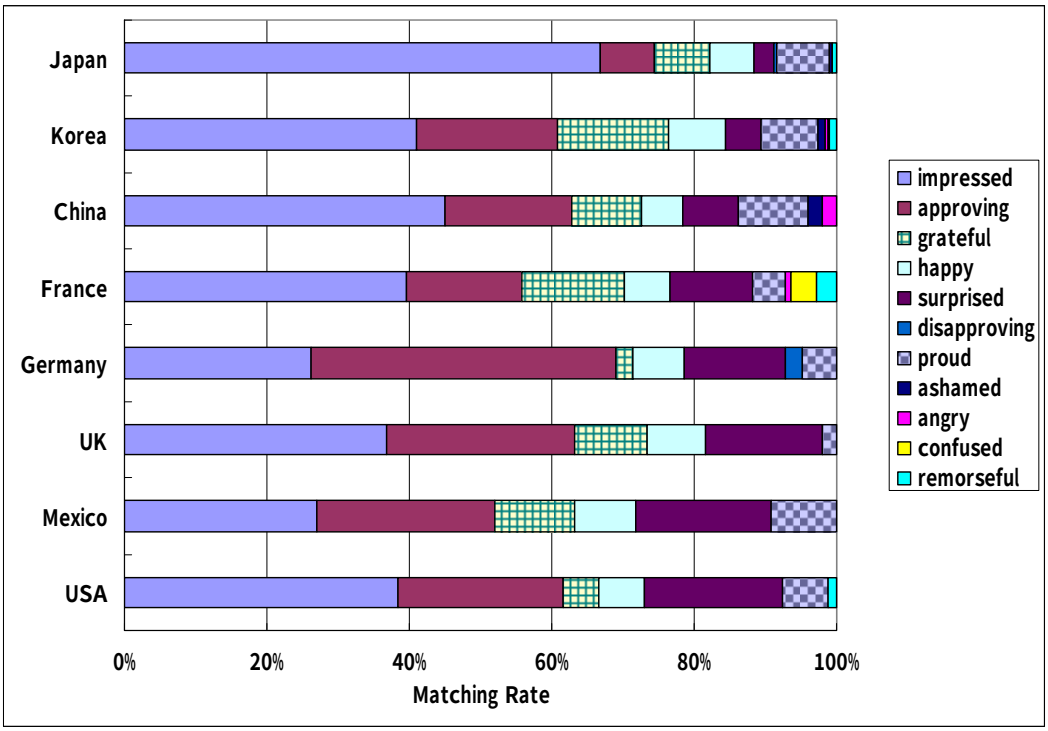


Figure 5-5: Answers to "impressed" expression by country

5.4. Discussion

The results of overall recognition accuracy show that avatar expressions designed by one culture's drawing techniques are recognized with significantly higher accuracy by subjects from the same country than by those of other countries. The recognition accuracy of a neighboring country (Korea in this experiment) is the second highest. The in-group advantage mainly occurs within the same country where the expresser and recognizer belong to the same culture, and the degree of recognition accuracy is next highest between neighboring counties [Elfenbein02]. This result confirms

that the in-group advantage that occurs in human expression recognition is applicable to avatar expression recognition within a country and between neighboring countries.

The results of breaking down the answers to the most confusing expression, “impressed,” show there are cultural differences in interpreting the expression. The expressions that are mixed up with “impressed” within Japan are significantly different from those of other countries. This result provides further evidence of the in-group advantage within a country in interpreting avatar expressions.

The results of the negative expressions having significantly higher recognition accuracy than the positive expressions may indicate that the “decoding rule” in psychological studies is applicable to avatar expressions. Mixing up expressions occurs within positive/negative expression groups other than “confused” and “surprised.” Accordingly, we can be less concerned about misunderstanding positive emotions as negative ones or vice versa. However, connotations and implications of each expression, for example, whether one is approving or grateful within the positive expression group, are not recognized accurately across cultures. For example, the communication gap between China and Japan caused by different interpretations of the “big-eyed” expression in our earlier experiment [8] is one example of a confusing experience for the subjects, although it did not lead to a serious misunderstanding.

5.5. Summary

There have been many psychological studies on human emotion recognition and related cultural differences. However, avatars are used based on the implicit assumption that avatar expressions are interpreted universally among all cultures in online communication across cultures.

In this study, we conducted an experiment comparing cultural differences in recognizing avatar expressions to test this implicit assumption. The experiment was conducted as an open web experiment to gather various

interpretations of avatar expressions from all over the world. We pursued two research issues in this study:

1) Identifying cultural differences in interpreting avatars' facial expressions by applying psychological findings on cultural differences in recognition of human facial expressions to the case of avatar expressions.

2) Identifying avatar facial expressions that are recognized differently across cultures.

The results show the following.

1) Cultural differences do exist in interpretation of avatar facial expressions, which confirms the psychological findings that physical proximity affects recognition accuracy. The in-group advantage was found within Japan and between Korea and Japan.

2) There are wide differences among cultures in interpreting positive expressions, while negative expressions had higher recognition accuracy.

Although misinterpretation is less likely to occur between positive and negative expressions, we need to design avatar expressions carefully to convey accurate emotions regardless of culture. We expect that further investigation of avatar representation and interpretation would serve as a design guideline for universal avatar expressions that could avoid the risk of miscommunication.

Chapter 6. Toward Universal Character Design

This chapter analyzes the design considerations that would not lead to misinterpretation of avatars' facial expression. The goal of this chapter is to identify design features that cause cultural differences in avatar facial expression interpretation.

6.1. Research Design

Chapter 5 conducted an open web experiment to compare interpretations of avatars' facial expressions among 8 countries, namely, Japan, South Korea, China, United States, United Kingdom, France, Germany, and Mexico. The results indicated that there are cultural differences in interpreting avatars' facial expressions, and the in-group advantage was found in interpreting avatar expressions. The next step is to validate each avatar's graphical design and find the design features that would lead to cultural difference in interpretation.

In this chapter, we conduct a further experiment within 5 Asian countries using a more controlled experiment set than the one used in the previous chapter. The reason for conducting the experiment within Asia is to validate the cultural differences found across Asia, Europe, and North America are still applicable within Asian countries, which have less geographical distance.

The goal of this experiment is: 1) to investigate cultural differences in

avatar expression evaluation and apply findings from Psychological study in human facial expression recognition within Asian countries, 2) to identify design features that cause cultural differences in avatar facial expression interpretation.

6.2. Experiment Overview

This section describes an overview of the experiment conducted to investigate the above issues.

The participating countries are Japan, South Korea, China, and Malaysia, Thailand. The experiment site is accessible only to pre-registered participants from the participating countries.

The experiment was developed using the application of Macromedia Flash. Subjects first answer a brief questionnaire on their background profile. The main experiment starts after the questionnaire, which is presented as a matching puzzle game (Figure 6-1). Subjects are requested to match 12 facial expressions to 12 adjectives. The 12 facial expressions are displayed in a 4 x 3 matrix and the 12 adjectives as buttons below the matrix. As shown in Figure 6-1, subjects can drag/drop the adjective buttons to/on the 12 expressions and continue changing the location of each button until they are satisfied with their answer. One avatar representation is chosen randomly from 10 avatars, and facial expression images are randomly placed in the 4 x 3 matrix. The adjective buttons are always displayed in the same order, and the 12 adjectives are always the same (see sec. 5.2.3 for the adjectives used in the experiment).

Subjects' answers to the puzzle game and questionnaire, as well as their background profile including gender, age, county of origin, and native language, are logged in the server for later analysis. Subjects are required to continue the experiment until they finish evaluating all the 10 avatar designs.

The adjectives can be shown in English, Chinese, Korean, and Japanese (all validated by native speakers). Subjects from countries where the above

languages are primarily spoken can see the adjective selections in their native language according to the background profile. Japanese, Chinese, Korean subjects are shown the adjectives in their native language, and Thai and Malay subjects in English. The participants from Thai and Malay are fluent in English.

The experiment procedure and the matching puzzle game was the same as the one conducted in the previous chapter except the following. These changes are made to control the experimental conditions more strictly.

1) Only the pre-registered participants can access the experiment site, while the participants in the previous experiment were freely access the experiment site.

2) The number of avatar design used in this experiment is limited to 10 instead of 40. The 10 avatar designs are selected according to the design features to express emotions in order to clarify difference in interpretations. The designs are categorized into three groups, namely, expression only, expression with a gesture mark, and expression with gesture.

3) Participants evaluate all the 10 avatar designs in this experiment, while the participants could stop evaluating the avatar designs any time in the previous experiment. Thus, the avatar designs and the number of avatars each participant evaluate is the same in this experiment.

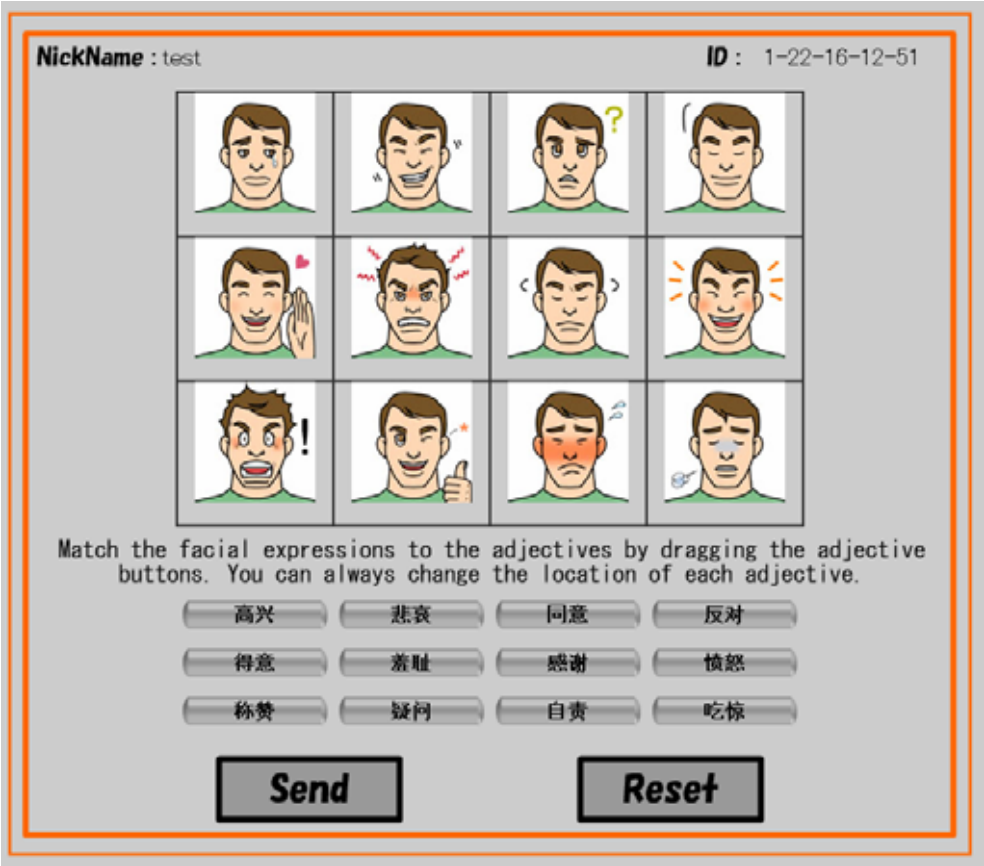


Figure 6-1: Experiment screen for Asian countries (Example screen for Chinese participants)

6.3. Results

This section describes the results of the experiment among Asian countries.

The participants are gathered through research collaboration members among Japan, South Korea, China, Malaysia, and Thailand. Participation was not mandatory, but strongly encouraged among participants. We had twenty to thirty participants from each participating country. They are in

their 20's and 30's, which ratio of male and female was almost the same.

6.3.1. Difference in Interpretation of Avatar Facial Expression

This section aims to investigate whether there is a cultural difference in interpreting avatar facial expressions by applying the in-group advantage to the five Asian countries which geographical distance is smaller than the ones in the previous experiment. We again use the “expression-adjective matching rate” in comparing the answers to the 12 facial expressions.

Figure 6-2 shows the matching rates shown by expression and country. When we focus on the matching rates by country, Japan’s matching rates are the highest in the five countries in all expressions. This means the degree of matching the expresser (avatar designer)’s intention and the answers of the recognizers (participants) is high. Hence the in-group advantage within the same country is identified in this experiment. This result further confirms the results of the previous experiment, in which Japan’s answers had significantly highest matching rates among the eight countries, namely, Japan, South Korea, China, the United States, the United Kingdom, Germany, France, and Mexico. Thus, this result suggests that there are cultural differences among the five Asian countries which geographical distance is smaller.

When we focus on the matching rates by facial expression in Figure 6-2, we again observe that the negative expressions have higher matching rates than the positive ones. Thus, as found in Chapter 5, the result suggests that the decoding rule is applicable to the answers to the five Asian countries.

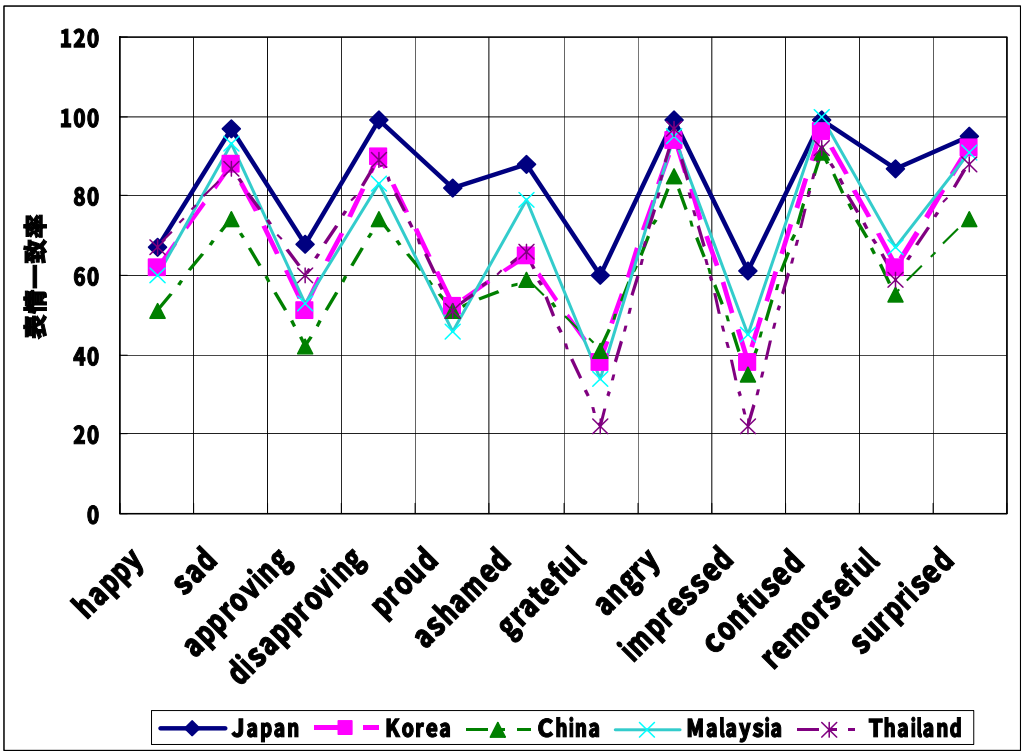


Figure 6-2: Matching rate of each expression by country within Asia

6.3.2. Analysis of Recognition Accuracy by Facial Expression Design

This section analyzes the design features that would cause cultural differences in interpretation of avatar facial expressions. Among the facial expression that have lower matching rate than others, we analyze the answers to the “proud”, “grateful”, and “impressed” expression by country.

The design features that are used in the above three expressions are categorized into three groups, namely, “facial expression only”, “facial expression with a gesture mark, “facial expression with gesture.”

Analysis of the design that uses facial expression only

Firstly, we analyze the answers to the avatar design that uses facial expression only, by using the “proud” expression. As can be seen in Figure 6-2, the difference in the matching rate of Japan and other countries is the biggest in the “proud” expression. Figure 6-3 shows the design examples of the “proud” expression, and Figure 6-4 the answers to the “proud” expression shown by country. As shown in Figure 6-3, “chin-up” expression is use to express “proud” in the avatar design. The detailed answers by country to the proud expression in Figure 6-4 shows that more than 90% of answers to the “proud” expression were “proud”, while other countries’ answers has only about 50% accuracy. The expressions that are mixed up with “proud” are “grateful”, “impressed”, and “happy”, which all categorized as positive expressions.

Figure 6-3: Design samples of “Proud” expression

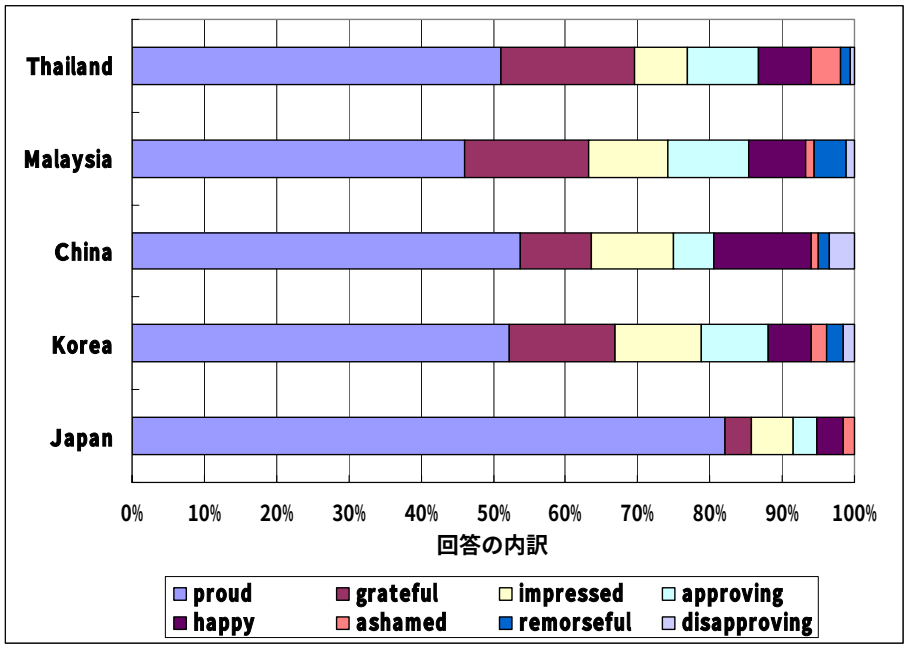


Figure 6-4: Detail answers to “proud” expression shown by country

Analysis of the design that uses facial expression only and facial expression with a gesture mark

Secondly, we analyze the answers to the avatar design that uses both facial expression only, and facial expression with a gesture mark, by using the “grateful” expression. As can be seen in Figure 6-2, the “grateful” expression has one of the lowest matching rates among positive expressions. Figure 6-5 shows the design examples used to express “grateful” expression, and Figure 6-6 shows the detailed answers to the “grateful” expression by country.

There are two designs used to express “grateful” expression. The first used facial expression only to express “grateful”, and the latter used facial expression with a gesture mark (heart mark) as shown in Figure 6-5. Figure 6-6 shows the detailed answers to the “grateful” expression presented by facial expression only, and the ones with a gesture mark.

The answers of Japan to the design with a heart mark has higher matching rate (the percentage of answers that answered “grateful”) than the ones to the design that used facial expression only. While in other countries, using a heart mark does not necessarily result in higher matching rate. Especially in South Korea and Thailand, answers to the design used facial expression only have higher matching rate (the percentage of answers that answered “grateful”) than the ones to the design that used a heart mark. Adding a heart mark to the “grateful” expression design increased the number of answers that answered “impressed” in South Korea and Thailand.

Figure 6-5: Design samples of "Grateful" expression with a heart mark

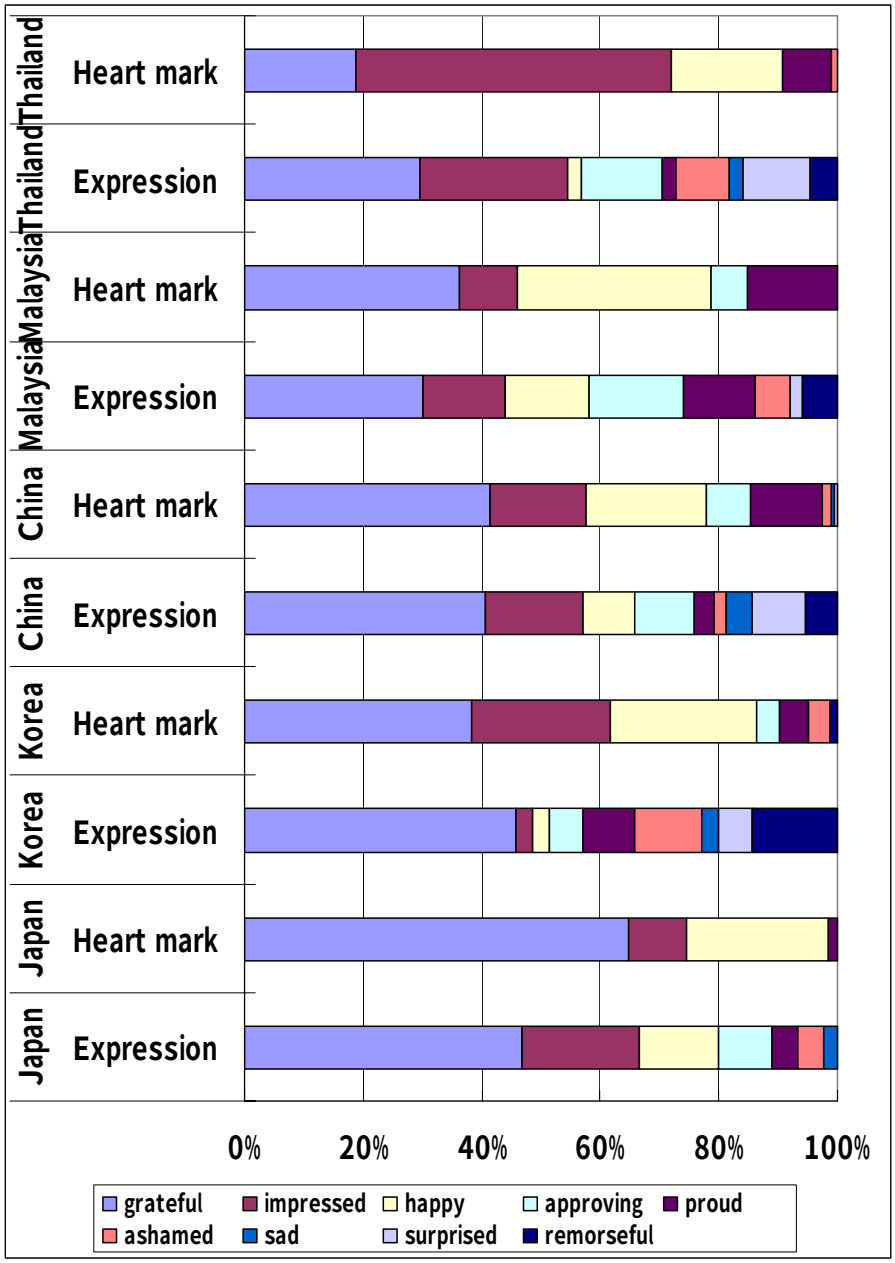


Figure 6-6: Detail answers to the “grateful” expression (comparison of answers to the design that used facial expression only and with a heart mark)

Analysis of the design that uses facial expression with a gesture mark, and facial expression with gesture

Lastly, we analyze the answers to the avatar design that uses facial expression with a gesture mark, and facial expression with gesture, by using the “impressed” expression. As can be seen in Figure 6-2, the “impressed” expression has one of the lowest matching rates among positive expressions. Figure 6-7 shows the design examples used to express “impressed” expression, and Figure 6-8 and Figure 6-9 shows the detailed answers to the “impressed” expression by country.

There are two designs used to express “impressed” expression. The first used facial expression with a gesture (“clapping hands” gesture) to express “impressed”, and the latter used facial expression with a gesture mark (exclamation mark “!”) as shown in Figure 6-7. Figure 6-8 shows the detailed answers to the design that used facial expression with a clapping hand gesture, and Figure 6-9 shows the detailed answers to the design that used facial expression with “!”.

The detailed answer of Japan shows the highest matching rate, about 80% (percentage of answers that answered “impressed”) among the five countries. While in other countries, detailed answers vary according to the design used to express “impressed”. Especially in China, the “impressed” expression with clapping hands gesture is interpreted as “approving” more often as “impressed”. In Thailand, the “impressed” expression with a “!” mark is interpreted as “grateful” rather than “impressed”.

Figure 6-7: Example of the designs for “impressed” facial expression

Note: Right: with “clapping hands” gesture, Left: with “!” mark)

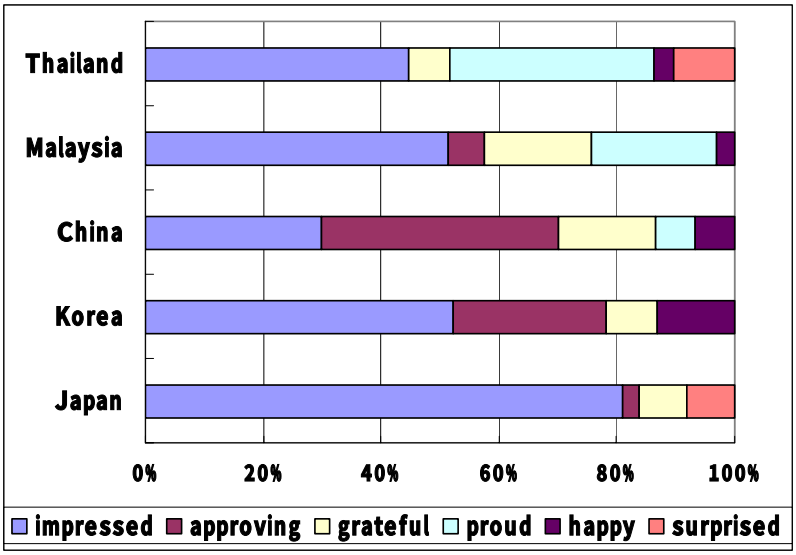


Figure 6-8: Detail answers to “Impressed” expression with a clapping gesture shown by country

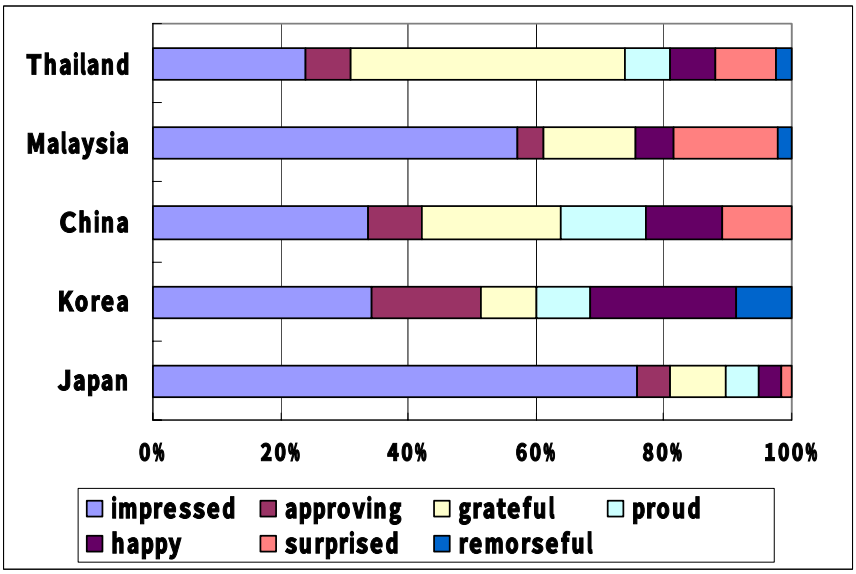


Figure 6-9: Detail answers to “Impressed” expression with “!” shown by country

6.4. Discussion

The results shows the avatar facial expressions designed using the Japanese comic drawing techniques have higher recognition accuracy within Japanese subjects than the subjects in other countries within Asia. Thus this is another indication that the in-group advantage within the same country, which is found in human facial expressions, is also applicable to avatar expressions, when compared to the answers among the five Asian countries. We again found results that support the decoding rule, that negative expressions are more accurately recognized than positive ones in human facial expression, in avatar expressions.

Next analyses were made using different avatar expressions designs in the four facial expressions that had the lowest recognition accuracy. There are three different designs used in the experiment, namely, 1) facial expression only (i.e., “proud” expression), 2) facial expression with a gesture mark (i.e., a heart mark in the “grateful” expression, an exclamation mark in the “impressed” expression), 3) facial expression with a gesture (i.e., a clapping hand gesture in the “impressed” expression).

The results showed that Japan’s recognition accuracy is the highest in all the three designs (facial expression only, facial expression with a gesture mark, and facial expression with a gesture) among the five Asian countries, and using a gesture mark increases the recognition accuracy compared to the one to the designs that use facial expression only. While other countries than Japan, using a gesture mark decreases the recognition accuracy compared to the one to the design that use facial expression only. Thus using a gesture mark does not necessarily improve the recognition accuracy in other countries than the expresser country. Using a gesture with facial expression caused varied answers in other countries than Japan. Thus avatar expression designs with gesture do not lead to a better interpretation either.

The reason for decreased recognition accuracy of gesture marks and gestures in other countries may result in the unique comic culture in Japan. The comic culture has been developed in relative isolation in Japan

[McLoud00], has grown in a different way than other countries, by creating new drawing techniques, i.e., slashing gestural line style to express motion and dynamics, collages of faces and symbolic expressionistic effects, word-picture linkage, and iconic characters instead of caricatures) [McLoud93]. Example of such unique Japanese iconic expressions are “frames to express anger”, and “balloon from a nostril to express sleeping”. The avatar designs used in the experiment were designed by three Japanese designers to limit the expressers from one country, thus have unique comic drawing styles that is interpreted accurately only by Japanese, and lead to various interpretations from other countries. Further study should be done to evaluate avatars designed by artists of other cultures, e.g., European or American.

6.4.1. Summary

This chapter analyzed the design features that would lead to misinterpretation of avatars’ facial expression. The goal of this experiment is: 1) to investigate cultural differences in avatar expression evaluation and apply findings from Psychological study in human facial expression recognition within Asian countries, 2) to identify design features that cause cultural differences in avatar facial expression interpretation.

The results confirmed that 1) there are cultural differences in interpreting avatars’ facial expressions among Asian countries, and the Psychological theory that suggests physical proximity affects facial expression recognition accuracy is also applicable to avatar facial expressions, 2) use of gestures and gesture marks may sometimes cause counter-effects in recognizing avatar facial expression. Using gesture and gesture marks increase the recognition accuracy of the expresser’s country, while other countries’ recognition accuracy was not increased when compared to the one to the designs that uses facial expression only. Thus we have to be careful in adding a gesture or mark when designing avatars and avatar facial expression.

Chapter 7. Conclusions

7.1. Contributions

This study aimed to verify the effects of using lifelike characters on the interface, and whether the appearance of characters is universally appropriate. With respect to the above research issues, this thesis verified the effects of using lifelike avatars in the following communication domains.

1) The effects of using lifelike characters on an agent-human interface

In order to study the effects of lifelike characters with a face and facial expressions in the interface, a series of experiments was conducted to compare subjects' responses to and evaluation of different faces and facial expressions. The experimental results obtained demonstrate that: 1) personified agents help users engage in a task, and are well suited for an entertainment domain; 2) people's impressions of a face in a task are different from ones of the face in isolation. Perceived intelligence of a face is determined not by the agent's appearance but by its competence; 3) there is a dichotomy between user groups which have opposite opinions about personification. Thus, agent-based interfaces should be flexible to support the diversity of users' preferences and the nature of tasks.

2) The effects of using lifelike characters on a network communication tool

Next evaluation of the effects of using lifelike characters and facial expressions was made using a P2P communication tool. The tool features various character templates and facial expressions to enable users to express their emotions as avatars. The tool has been used by more than 380,000 users since its launch in 1998. The user study shows that featuring characters and facial expressions realized a new communication media where expressing one's emotions is the main purpose for communication. The reasons are; 1) More than 75% of the communications are aimed for expressing one's emotion by using the facial expressions provided. The frequency of using facial expressions did not decline during the research period. These indicate characters and facial expressions are used not as means to complement verbal information such as emotions but as an expressive communication media. 2) More than 80% of the users answered the reason for using the tool is that they can change the characters and facial expressions. 3) Use of the tool did not affect the frequency of email communication. This means the tool was used for different purposes from emails. The emotionally expressive communication tool with lifelike characters has also proved it's sustainability as it has maintained many users at home and communities as well as offices for seven years.

3) The effects of using lifelike characters on intercultural communications

Next evaluation was made by using lifelike characters for intercultural communication. The experiment was conducted as a series of discussions on a multilingual BBS with avatars between China and Japan. The results show the existence of avatars improved user experiences and interactions among participants and build enthusiasm toward participation and friendliness in intercultural communications. However, some characters and facial expressions used in the experiment were interpreted completely differently and used for different purposes between Chinese and Japanese participants. As avatars are widely used for international business communications as well as daily casual ones via instant messengers, this finding rises an important research questions, i.e., what is an appropriate character

representation for intercultural communication, what kind of character traits are suitable for intercultural representation, what kind of facial expressions are universally understood and interpreted, and so on.

4) Cross-cultural analysis of interpretations of avatars' facial expressions

This section aims to elucidate the following two issues: 1) Identifying cultural differences in interpreting avatars' facial expressions. This is done by applying psychological findings on cultural differences in human facial expression recognition to the case of avatar expressions. 2) Identifying design features that cause cultural differences in avatar facial expression interpretation. An open web experiment was conducted to gather users' interpretations of various avatar facial expressions from eight countries within Asia, North and South America, and Europe. The results confirmed that 1) there are cultural differences in interpreting avatars' facial expressions among the participating countries, and the psychological theory that suggests physical proximity affects facial expression recognition accuracy is also applicable to avatar facial expressions. Japan had the highest recognition accuracy for avatar expressions designed by Japanese designers, followed by Korea. 2) There are wide differences among cultures in interpreting positive expressions, while negative expressions had higher recognition accuracy regardless of culture. 3) Use of gestures and gesture marks designed by one culture sometimes causes misunderstanding by other cultures.

The conclusion is that lifelike characters have positive effects in the following issues:

1) Personification of software agents improves user experience without causing users' misassumption that the agents would have higher intelligence that they actual have at least in entertainment domain, which has been argued by former studies.
2) Avatars improve the quality of interaction in human-human communication by enhancing sentiment communications which main

focus in to express users' emotions, and providing improved user experience in intercultural communications.

However, this research showed that we should be careful designing the appearance of lifelike characters in the following issues:

1) People's opinion about personification causes opposite appreciation to the appearance of the lifelike characters.
2) There are cultural differences in interpreting characters' facial expressions. Physical proximity affects facial expression recognition accuracy.

7.2. Future Directions

Personified agents and avatars are frequently used in computer applications and network communications. This study adopted the entertainment application to verify the effects of lifelike characters, but we need further investigation in other application domains, i.e., educational applications and business applications.

Avatars used in the cross-cultural comparison of interpretation were drawn by Japanese designers in this study to limit the expresser from one country. In the future study, avatars drawn by other countries, such as the United States, France, and Germany should be used and evaluated. In doing so, the avatar design guideline suggested in this study would be more universal. We referred to psychological findings to investigate the reason for the cultural differences in avatar expression interpretation in this study. However, studies in other areas, i.e., art culture, comic study, and field study on the number of characters on public signboards may give other implications to the cultural differences in appraising avatars.

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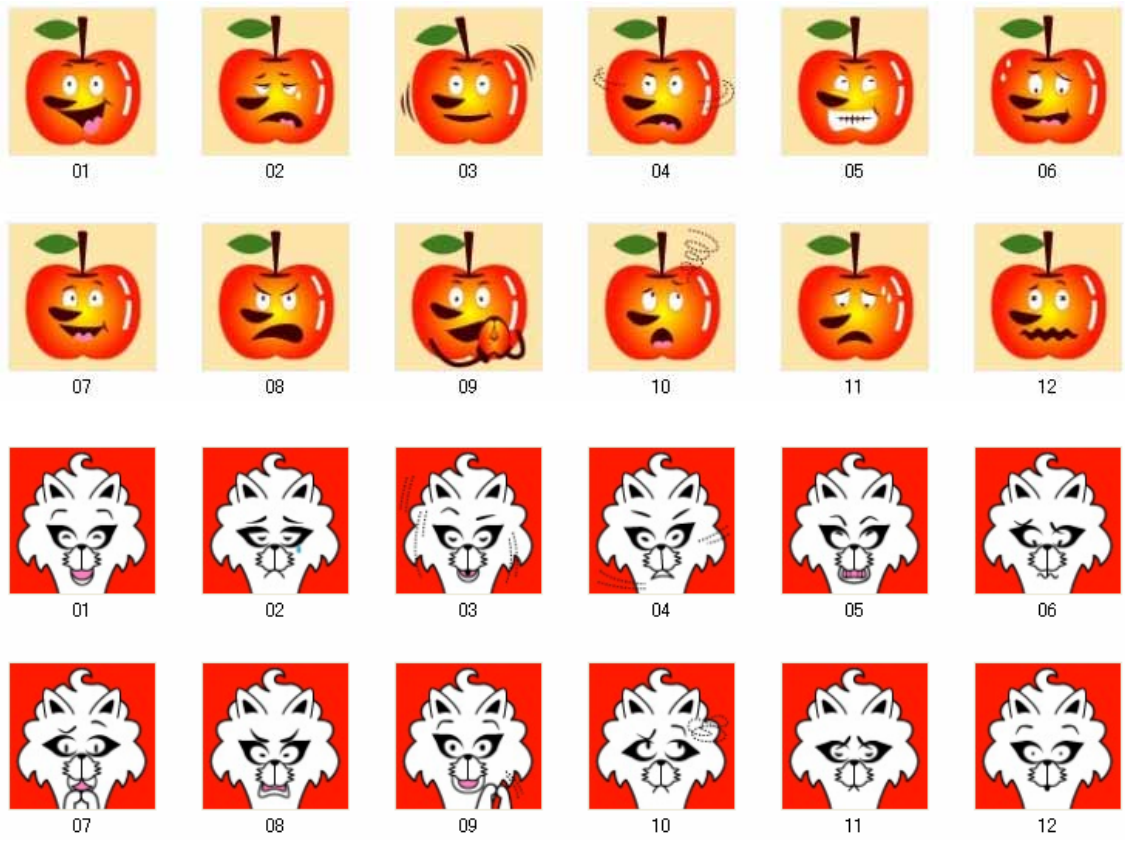
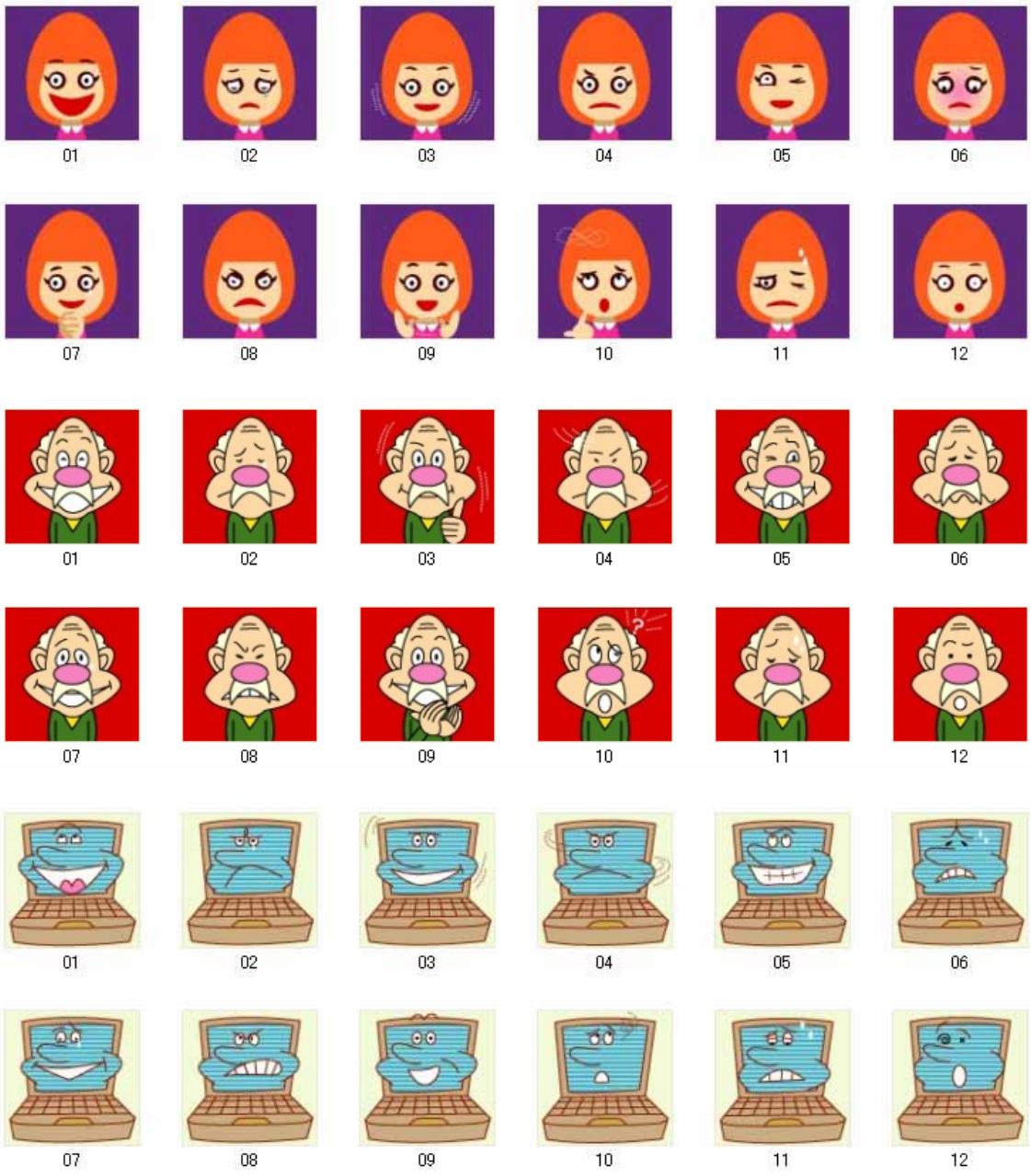
Appendix

40 character designs with 12 facial expressions used in the experiment in Chapter 5.

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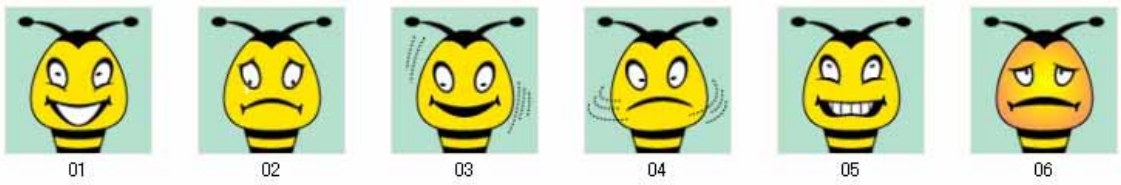
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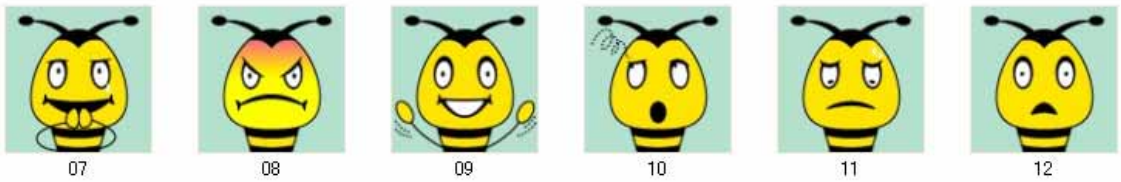
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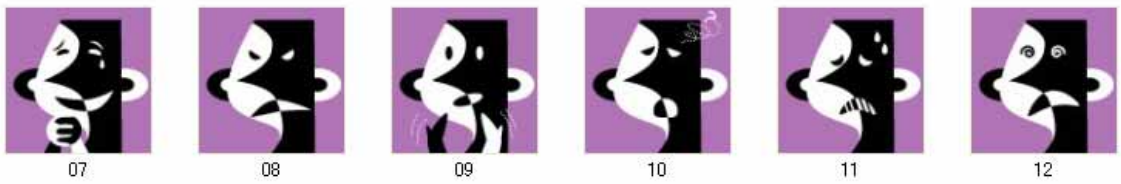
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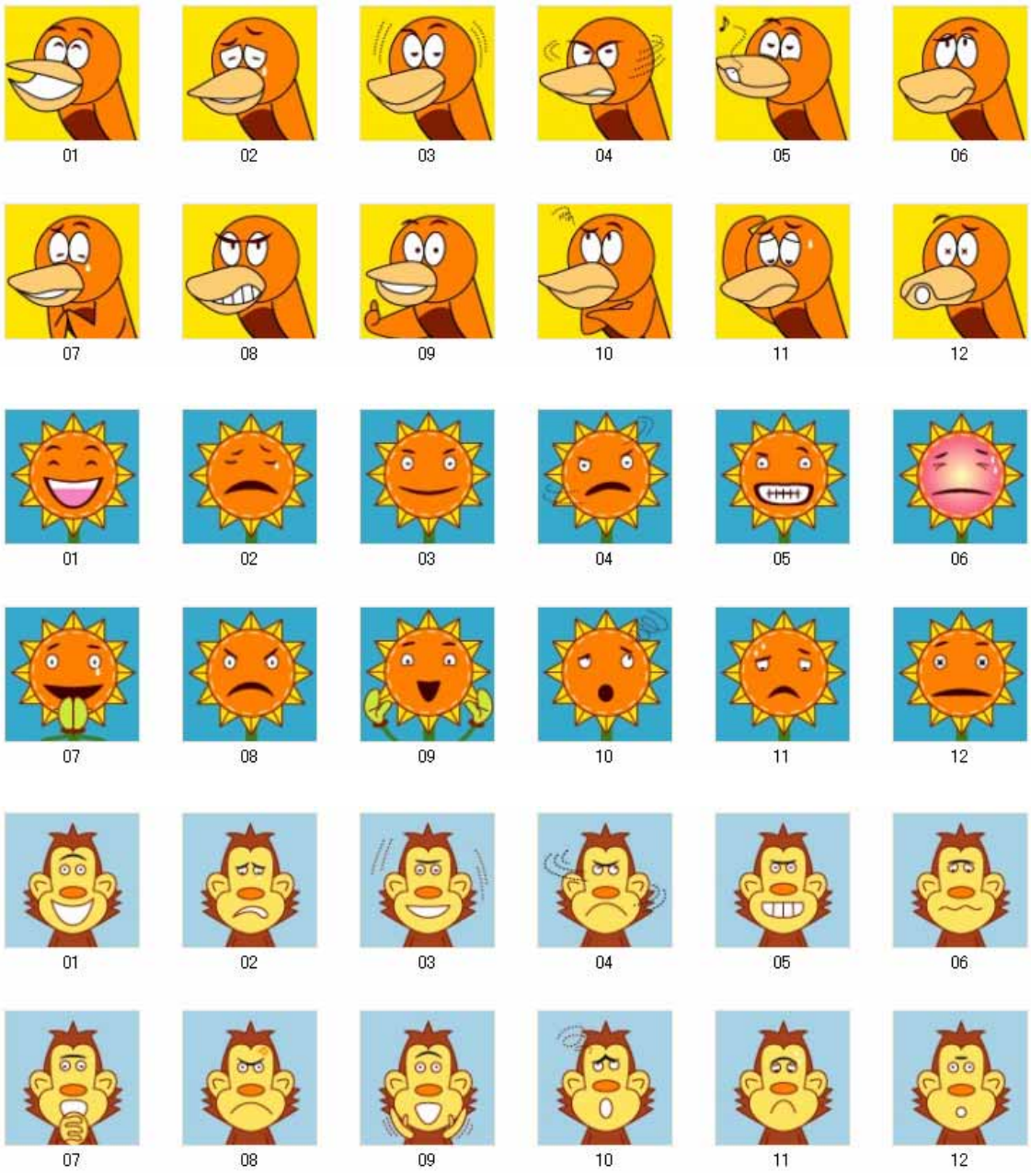
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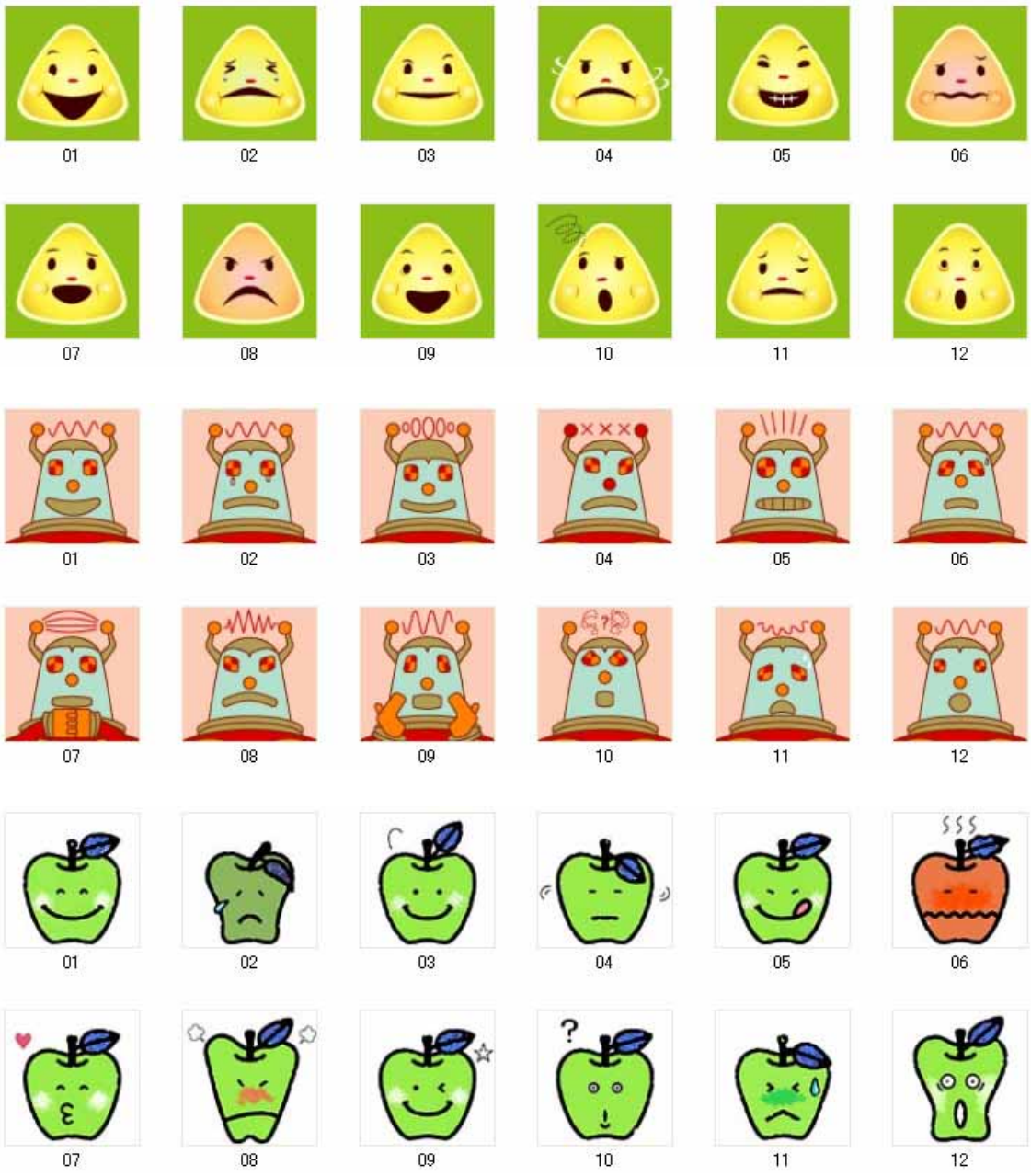
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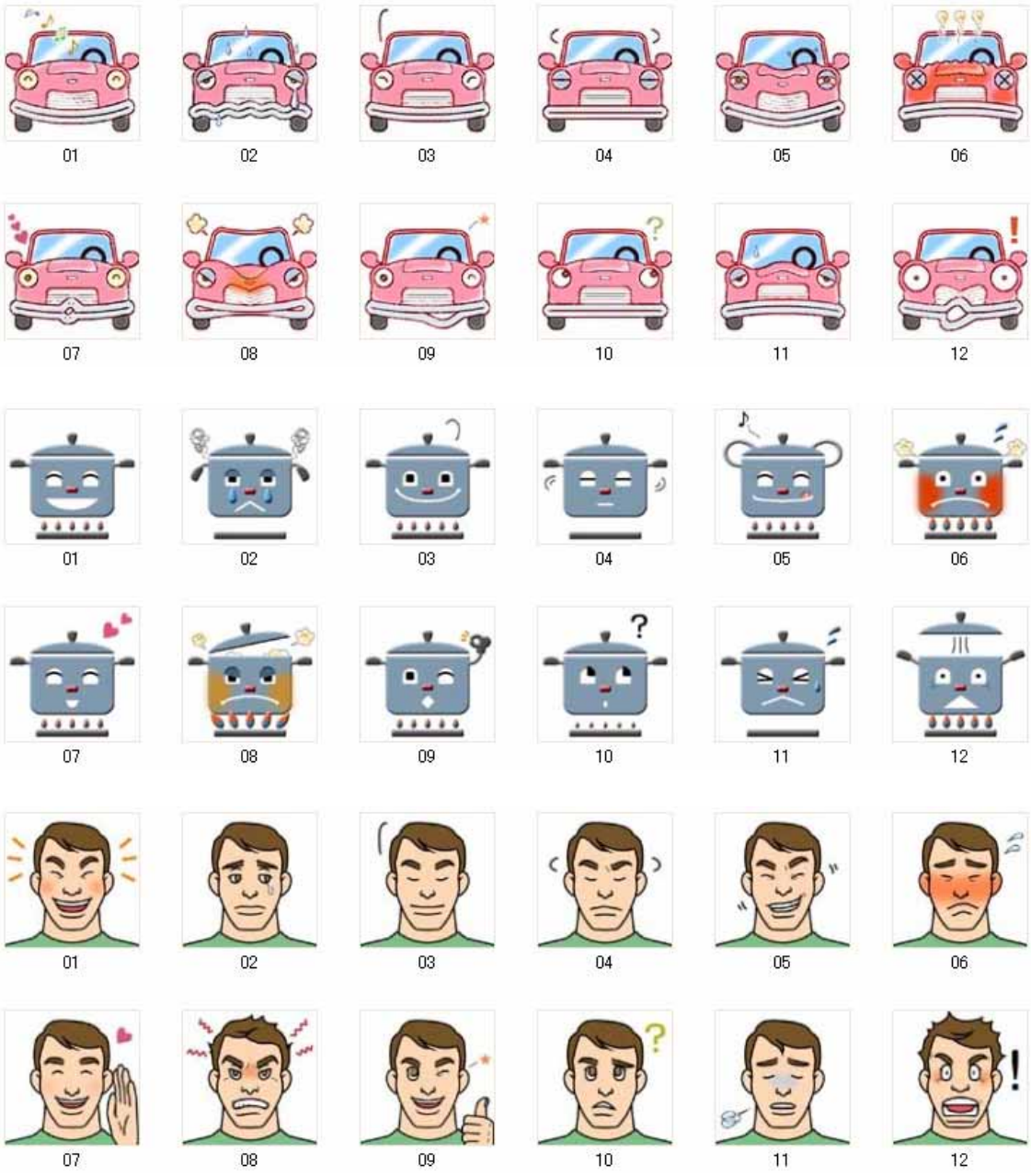
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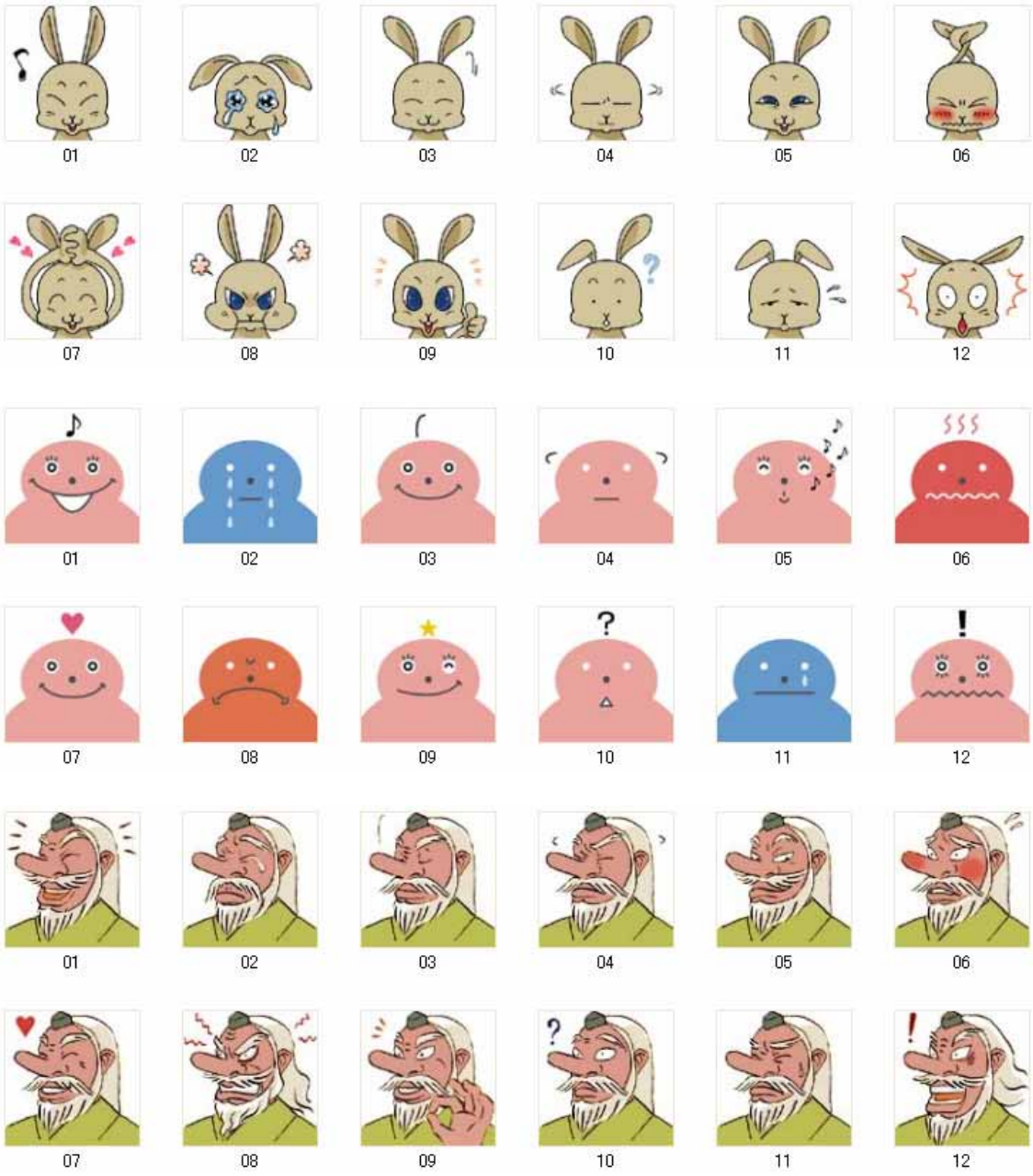
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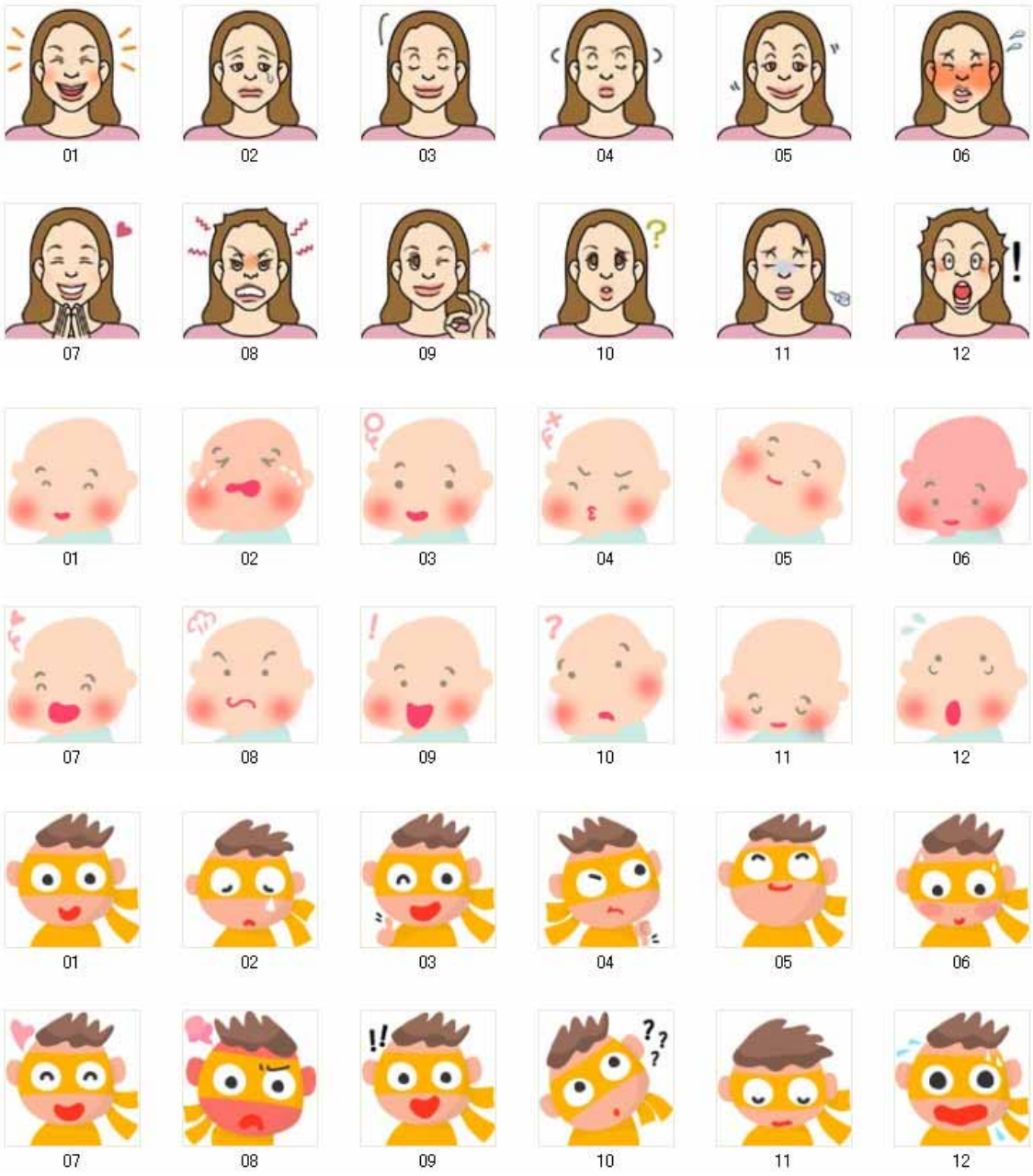
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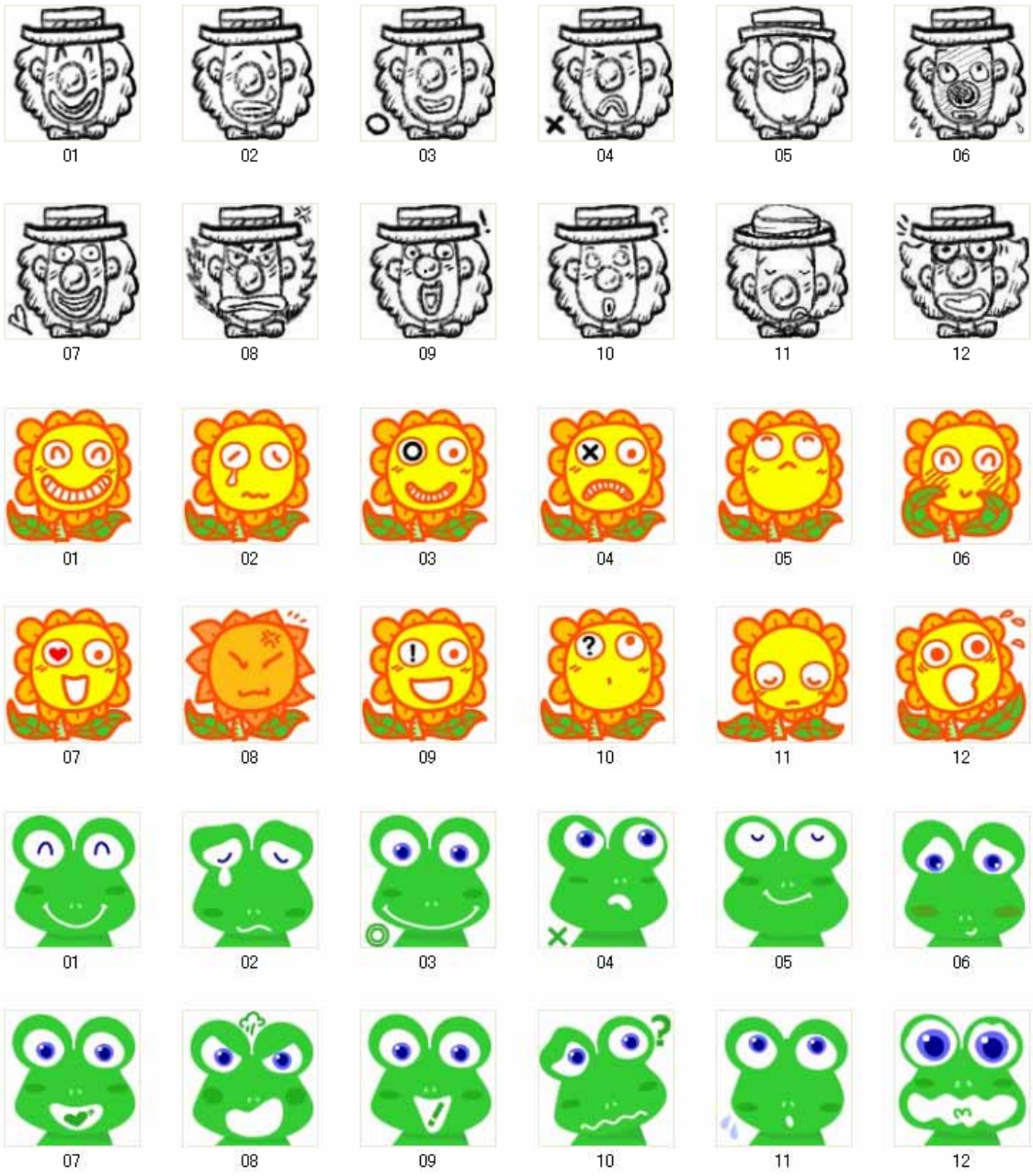
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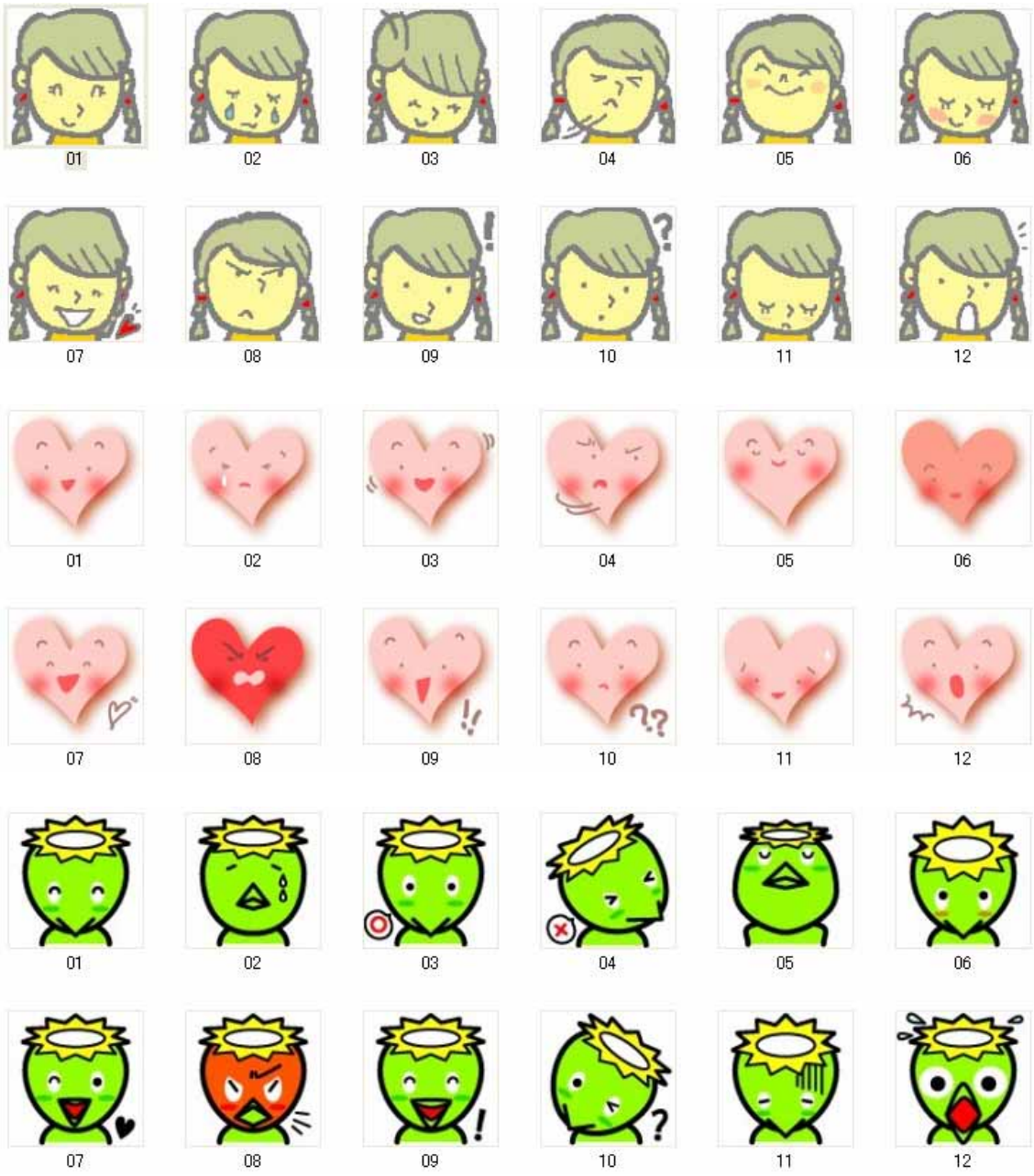
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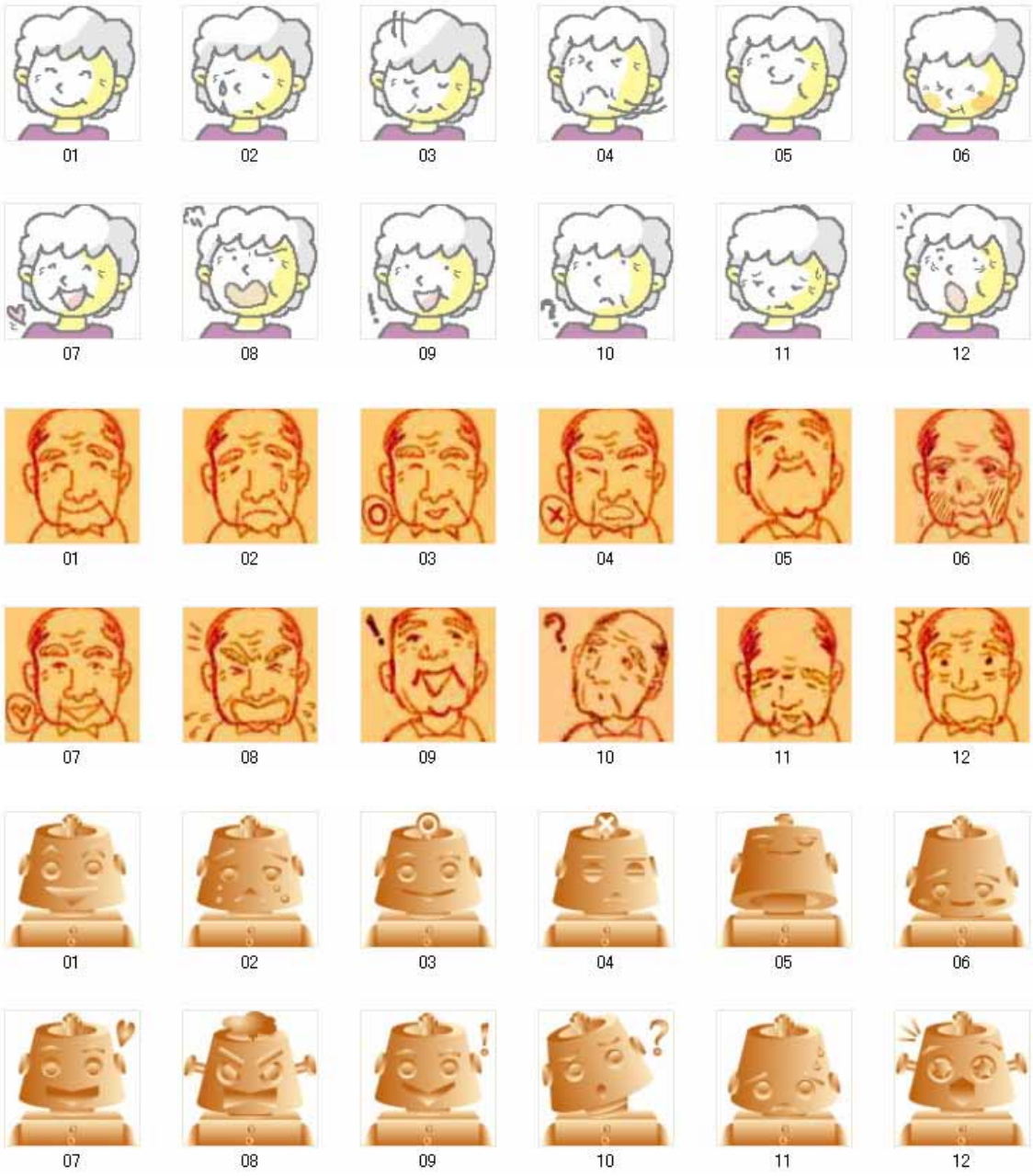
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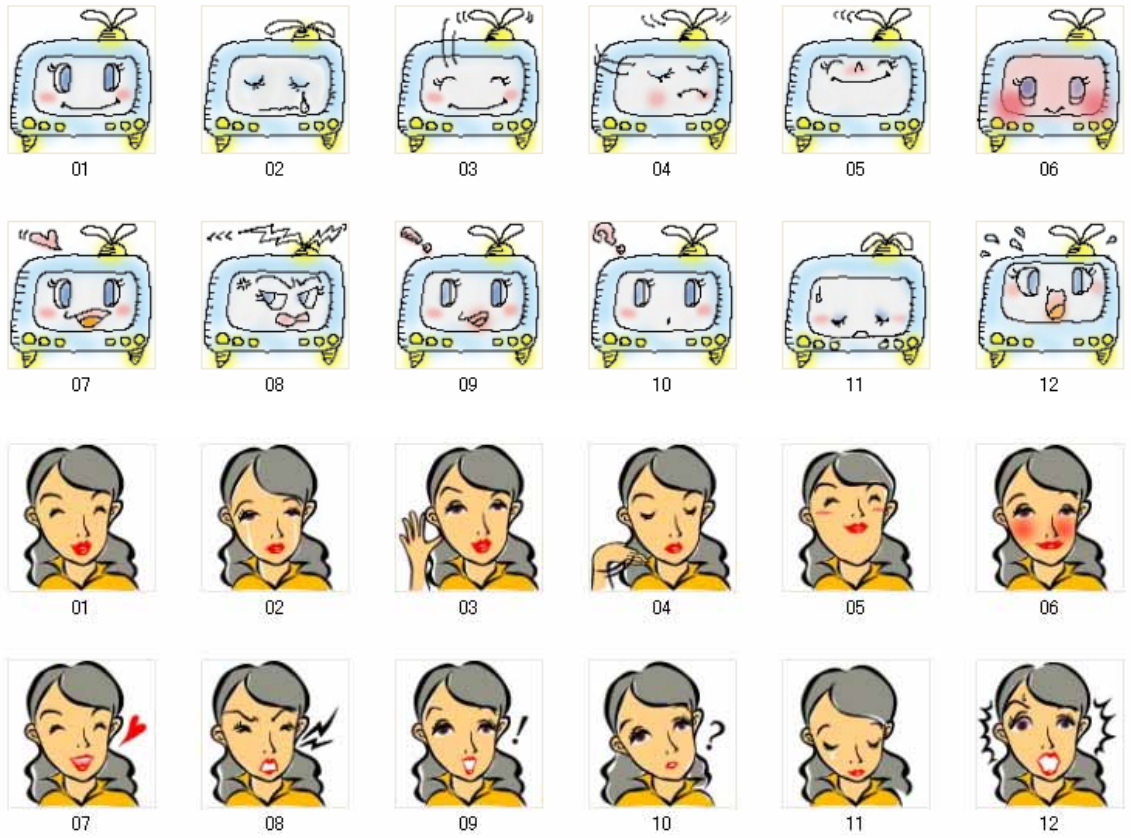
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