Feel the Difference: A Guide with Attitude!

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Abstract. This paper describes a mobile context-aware 'intelligent affective guide with attitude' that guides visitors touring an outdoor attraction. Its behavior is regulated by a biologically inspired architecture of emotion, allowing it to adapt to the user's needs and feelings. In addition to giving an illusion of life, the guide emulates a real guide's behavior by presenting stories based on the user's interests, its own interests, its belief and its current memory activation. A brief description of the system focusing on the core element - the guide's emotional architecture - is given followed by findings from an evaluation with real users.

1 Introduction

In interaction with current virtual guides, users tend to lose interest rapidly due to lack of 'life' and unmet expectations of the character's intelligence. This problem must be solved in order to prolong interaction between the guide and user and make it more engaging and natural, thus increasing appreciation of heritage sites. Picard [1] argues that "a machine, even limited to text communication, will be a more effective communicator if given the ability to perceive and express emotions". They will have to have emotion-like mechanisms working in concert with their rule-based systems to be truly effective. Dautenhahn [2] added that the better computational agents meet our human cognitive and social needs, the more familiar and natural they are and the more effectively they can be used as tools. Hence, intelligence and emotions work in parallel to create an effective computer system.

2 The Affective Guide

The Affective Guide is an attempt to create a guide with personality and beliefs, to provide a more natural and engaging interaction during a tour visit, advancing the development of existing context-aware tourist guidance systems (eg. [3, 4, 5], etc.). It addresses the frustration that usually occurs in the interaction with an emotionless computerised system that does not react intelligently to a user's feelings. The Affective Guide is implemented on a PDA integrated with a text-to-speech system. The user's position is determined by a Global Positioning System

while the user's orientation is calculated based on previous and current location information. An ice-breaking session prior to a tour extracts information about the user's name and interests. This information is used to choose attractions that match the user's interests and plan the shortest route to them. The guide navigates the user to the chosen locations via directional instructions as well as via an animated directional arrow. Upon arrival, it notifies the user and starts the storytelling process. The system links electronic data to actual physical locations so that stories are related to what can be immediately seen. A server performs the processing and holds the guide's memories, both long-term and current memories and sends the results of processing to the PDA on demand through wireless communication.

2.1 The Emergent Emotion Model

The core element of this research is the emotional architecture of the guide which is biologically inspired, based on the 'PSI' model [6] where the interest lies in modelling the conditions for the emergence of emotions. This model bridges the gap between models that focus solely on physiological-level of emotions (eg. [7, 8, 9]) and those that concentrate on higher-appraisal level (eg. [10, 11]). Blumberg's [9] model is interesting but it was developed with only animals in mind. The Hap architecture in the Oz project [12] used the OCC model [10] and focused on building unique believable characters, as an artistic abstraction of reality, not biologically plausible behavior. On the other hand, we argue for successful linking between the lower-physiological and higher-cognitive systems to create a guide that possesses variable emotions, acts appropriately and effectively and appears an interesting and distinctive individual.

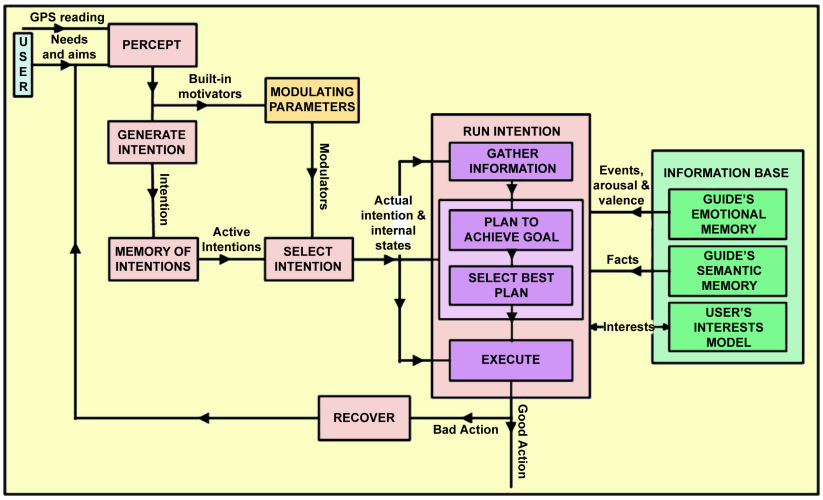

Fig. 1. The Emergent Emotion Model

Figure 1 illustrates the emotion model of the Affective Guide. The guide has two built-in motivators to maintain, *competence* and *certainty*. The *level of competence* refers to the guide's ability to cope with the user's differing perspective about an issue whereas the *level of certainty* is the degree of predictability of the user interests. The user's confirmation or not of the guide's prediction about their interest, contributes to its *level of certainty* while the degree to which the user agrees with its argument, contributes to its *level of competence*. These built-in motivator values will affect the modulator values, such as *arousal level, resolution level* and *selection threshold*. *Arousal level* is the guide's readiness to act while *resolution level* determines the carefulness of the guide's behavior. The *selection threshold* on the other hand, is the limit competing motives have to cross in order to become active. *Arousal level* is inversely related to *resolution level* while directly proportional to *selection threshold*. The interaction between the built-in motivators and the modulators produces wide variation of emotions and behaviors in the guide, expressed through a 2D animated talking head.

The guide continuously reads user inputs (feedback on the degree of interest in the story and degree of agreement to the guide's argument), together with system feedback (success or failure) and the GPS information. Then, it generates an intention and stores it in a memory of intentions together with the built-in motivators. More than one intention can be active at the same time and depending on the importance of the need and its *selection threshold* value, one of the active intentions is selected for execution. The execution of an intention will produce a success or failure feedback into the system and recovery will be performed as necessary. Basically, the guide has three possible intentions - update its belief about the user's interests; adjust the story presentation; or perform storytelling. In order to execute an intention, the guide decides whether to explore for more information, to design a plan using the available information or to run an existing plan depending on which intention is selected and its emotional state. A standard prompt is generated when there is no story to tell or the story for the current location has finished at which point the guide informs the user of the unavailability of any story. Planning is performed for storytelling and the extensiveness of planning depends on the guide's *resolution level*. In the case of updating its beliefs or story adjustment, the guide will explore the database for information so that appropriate changes to its beliefs and story topic may take place. By doing this, it adapts its behavior according to its internal states and the environmental circumstances.

For example, if the guide's prediction about the user's interests is correct (high certainty) and the user perspective is consistent with that of the guide (high competence), the guide may experience low to medium *arousal level* and *selection threshold* with a medium *resolution level*. In this case, the guide can master the situation. The guide will perform planning and provide an elaborated story on the current subject. On the other hand, if the guide's prediction about the user's interests is wrong (low certainty) and the user's perspective is in conflict with the guide's viewpoint (low competence), the *arousal level* of the

guide will be very high. It is reasonable to react quickly. In this situation, the guide tends to give a brief story without details.

2.2 Storytelling System

Results from our survey of human tour guides show that factors like role, interest, experience, the guides beliefs, the guides personality, type of tour and visitor group all affect the information presentation. Most guides tend to incorporate beliefs and past experiences whether his/her own or that of others while narrating a story since a life story is always more interesting than just bare facts. Hence, personality plays an important role in a tour guide. Furthermore, one of the most striking features of historical investigations is the coexistence of multiple interpretations of the same event, depending on the storyteller's perspective [13]. In accordance with these findings, the presentation of information from different perspectives by different guides is emphasized. Contrasting views and a distinct personality are achieved in the Affective Guide through emotional memories, a manifestation of the guide's past experiences.

The guide's long-term memory is made up of declarative memories, both semantic and emotional. Semantic memory contains facts, including location-related information and the user's profile. Emotional memory contains events that have emotional impact on the guide and holds the guide's beliefs. The emotional memory is tagged with 'arousal' and 'valence' [14] tags analogous to the *Emotional Tagging* concept [15], which recorded the guide's emotional states for an event. When interacting with the user, the guide reconstructs its own past, at the same time presenting facts about the site of attraction. The recollective experience of the guide is related to the evocation of previously experienced emotions through the activation of emotion tags. Hence, it re-experiences the emotions when a particular event happened, though there might be a slight variation due to the user's input. The guide takes the user's responses plus its own beliefs, interests and its current memory activation into consideration for story narration.

This research moves away from the concept of a guide that recites facts about places or events towards a guide that utilises improvisational story-telling techniques [16]. At every step, it decides what to tell dynamically. It selects a memory spot based on the above factors, that will lead to further extension of facts as well as emotional memory elements depending on its current *resolution level*. The retrieval of memory pieces continues until the combined memory pieces is large enough to generate a story. All these extension processes are performed by Jess[1]. For more information on the Affective Guide, please refer to [17].

2.3 Prototype System

A prototype version of the Affective Guide has been developed. The 'Los Alamos' site of the Manhattan Project[2] was chosen as the narrative domain, where the

[1] http://herzberg.ca.sandia.gov/jess/
[2] http://www.lanl.gov/

buildings are mapped onto Heriot-Watt Edinburgh campus buildings. The Manhattan Project was chosen because it contained many characters with different personalities and ideologies that can be used as Affective Guides. All stories are related to the 'Making of the atomic bomb'.

2.4 Example Stories

Some examples of the stories generated by the guide with different *resolution level* is provided below:

Presentation by an emotional guide's with low *resolution level*:
The Japanese bombing targets were chosen to be places the bombing would most adversely affect the will of the Japanese people to continue the war and military in nature. The targets were places that have not been previously damaged by air raids to enable accurate assessment of the effects of the bomb.

Presentation by an emotional guide's with medium *resolution level*:
The Japanese bombing targets were chosen to be places the bombing would most adversely affect the will of the Japanese people to continue the war and military in nature. It seemed brutal to be talking about burning homes. But we were engaged in a life and death struggle for national survival, and we were therefore justified in taking any action that will save the lives of American soldiers and sailors. We must strike hard with everything we have at the spot where it will do the most damage to the enemy. The targets were places that have not been previously damaged by air raids to enable accurate assessment of the effects of the bomb.

Presentation by an emotional guide's with high *resolution level*:
The Japanese bombing targets were chosen to be places the bombing would most adversely affect the will of the Japanese people to continue the war and military in nature. It seemed brutal to be talking about burning homes. But we were engaged in a life and death struggle for national survival, and we were therefore justified in taking any action that will save the lives of American soldiers and sailors. We must strike hard with everything we have at the spot where it will do the most damage to the enemy. The targets were places that have not been previously damaged by air raids to enable accurate assessment of the effects of the bomb. The scientists became extremely active trying to stop the military use of the bomb over a city, urging a harmless demonstration instead. My own position was that the atom bomb is no worse than the fire raids which our B 29s were doing daily in Japan and anything to end the war quickly was the thing to do.

3 Evaluating the Affective Guide

The main aim of the evaluation is to measure the effect of the inclusion of emotions and attitudes on users' tour experiences. Three versions of the Affective Guide were tested - emotional, non-emotional and random emotions. The

emotional version consists of a guide that expresses emotions through facial animation and reflects its attitude by including its perspective and experiences in the narration. Mulken *et al.* [19] found that the mere presence of an interface character makes interaction more entertaining and improves the interaction experience. In order to prevent a biasing representation effect, a guide agent also presents in the non-emotional version. The non-emotional guide has a neutral emotional state, achieved by fixing the values of the modulating parameters. Its processing and internal state are not affected by the user feedback and it does not present any perspective related stories. Additionally, in order to verify that it is not the facial expressions of the guide alone that causes the guide to be perceived as more interesting, a variation of the non-emotional version is included where the guide generates random facial expressions, but presents no perspective information. Hence, the three versions for the guide are:

- Guide A: The guide shows emotions and attitude
- Guide B: The guide shows neither emotions nor attitude (the control group)
- Guide C: The guide shows emotions but no attitude (the placebo group)

Furthermore, we would like to determine if the emotional guide is better able to foster learning in the user. Are the users more motivated to learn about the subject when the presentation is make by the emotional guide? Does the emotional guide embody a higher level of intelligence that prolongs the participant's attention? Does the inclusion of perspective and life experience make the stories more interesting? The goal is to verify if the emotional guide is able to create a greater long term memory effect in the user compared to the non-emotional guide.

In the experiments, the participants were asked to interact with the Affective Guide. Prior to the tour, the participants were required to answer some general questions about their previous experiences with mobile technologies and guided tours as well as their interest in the topic of presentation. The participants were not told the purpose of the experiments, hence, they can not predict and will not be affected by any prior assumptions about the guide's behavior. The participants were provided with instructions for use as well as background information about the Manhattan Project and were told that they would be tested on their knowledge about the Los Alamos site after the tour.

Then, the guide takes each participant around Heriot-Watt University campus which is the pretended Los Alamos site. The participants can choose one of the three areas - 'Science', 'Military' or 'Social' as their interest for the guide's narration. To prevent distraction, the participant is allowed to carry the PDA and laptop and go on the tour on their own. The participants were requested to listen to at least three stories at each location. During the tour, the participants have to rate the degree of interest of the stories as well as how much they agree with the guide's argument after each storytelling cycle. This step was performed by all participants, including those interacting with the non-emotional and random emotions guide. For these two groups, the participants' input will not affect the processing of the guide in any way, but act as a control that

gives the participants an impression that the guide is reacting to their feedback. Upon completion of the tour, each participant was asked to answer two sets of questionaires.

3.1 Questionaires

In the experiments, the independent variable (IV) is the Affective Guide's emotions and attitude (absence or presence). We defined as the dependent variables (DVs), the guide's storytelling performance, the guide's facial expressiveness, the guide's character and the participants' tour experience. The DVs are measured using 7-point, Likert scale using Questionaire A. Rating of 1 indicates the worst or a negative answer while 7 indicates the best or a positive answer. Five questions assessed the guide's storytelling performance (Q1: intelligence, Q2: believability, Q3: emotional content, Q4: interest relation, Q5: stories adjustment), five questions assessed the guide's facial expressiveness (Q6: intelligence, Q7: believability, Q8: naturalness, Q9: emotional reaction, Q10: appropriateness), two questions assessed the guide's character (Q11: personality, Q12: resemblance to real guide) and four questions assessed the participant's experience (Q13: interestingness, Q14: meaningfulness, Q15: engagement, Q16: overall experience).

Questionaire B was generated after the tour to test recall level. It contains multiple choices questions based on what the participants have listened to during the tour. Subjects could take as long as necessary to complete the test. Each correct answer for the multiple choices questions will be awarded one point. Participants were also asked to indicate whether they find the information overloading, so as to avoid that the subjects' answer to the retention questionaire will be confounded by lack of interest and information overload.

3.2 Results

A total of 30 participants took part in the experiment, 10 participants for each guide. A one-way Multivariate Analyses of Variance (MANOVA) was performed to examine the effect of the different guides on linear combination of the DVs altogether. ANOVAs with Bonferroni adjustment (overall $\alpha < 0.05$) were employed for follow-up analyses on those dependent variables that showed significance in the omnibus F-test. The Bonferroni tests are reported by giving the mean differences in the dependent variables between any two groups with A, B and C representing the observed means for Guide A, Guide B and Guide C respectively.

The MANOVA was significant with Wilks' lambda=0.011, F=3.463, P=0.005. and partial η^2=0.895. The overall F-test indicated significant difference in intelligence of storytelling (F(2, 27)=4.192, P<0.05), believability of storytelling (F(2, 27)=3.498, P<0.05), stories adjustment (F(2, 27)=4.314, P<0.025), naturalness of facial expressions (F(2, 27)=4.776, P<0.025), emotional rating of facial expressions (F(2, 27)=8.830, P<0.025) and overall tour experience (F(2, 27)=4.500, P<0.025). Differences in interestingness of stories (F(2, 27)=3.054, P=0.064) missed the statistical significance at α=0.05. Figure 2 compares the

participants' rating for Guide A, B and C. The mean (standard deviation) for the DVs are shown in Table 1.

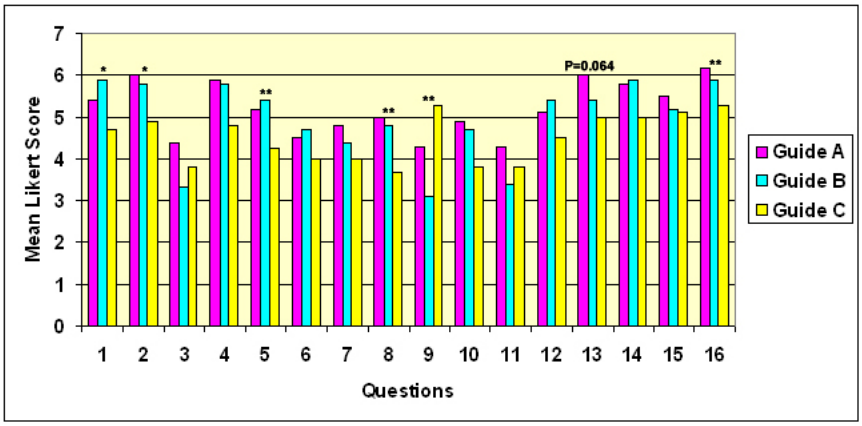

Fig. 2. Significant differences between Guide A, B and C (* P<0.05, ** P<0.025)

DV	Guide A (n=10)	Guide B (n=10)	Guide C (n=10)
Q1:intelligence	5.40 (.699)	5.90 (.876)	4.70 (1.160)
Q2:believability	6.00 (.667)	5.80 (.632)	4.90 (1.449)
Q5:stories adjustment	5.20 (1.135)	5.40 (.843)	4.25 (.791)
Q8:naturalness	5.00 (1.054)	4.80 (.919)	3.70 (1.059)
Q9:emotional reaction	4.30 (1.160)	3.10 (1.101)	5.30 (1.252)
Q13:interestingness	6.00 (.816)	5.40 (.699)	5.00 (1.155)
Q16:overall experience	6.20 (.632)	5.90 (.568)	5.30 (.823)

Table 1. Mean and standard deviation for significant DVs for male participants only

In the Bonferroni test, Guide A is perceived as more emotional than Guide B (A-B=1.20, P=0.090), but missed statistical significance. No other significant effect was detected for Guide A and Guide B. For comparison between Guide A and Guide C, participants observed Guide A's facial expressions to be more natural than Guide C's (A-C=1.30, P<0.025). Participants found Guide A's discourse more believable (A-C=1.10, P=0.059) and the stories better adjusted than Guide C's (A-C=0.95, P=0.094). Stories presented by Guide A were also found to be more interesting than those presented by Guide C (A-C=1.00, P=0.062). Although these tests missed statistical significance, overall, participants who interact with Guide A had a significantly better experience than those who interacted with Guide C (A-C=0.90, P<0.025). Comparing Guide B

and Guide C, the participants found Guide B's discourse more intelligent (B-C=1.20, P<0.025) and its capability in adjusting the story is significantly better than Guide C's (B-C=1.15, P<0.05). In terms of facial expressions, Guide B is more natural (B-C=1.10, P=0.066) than Guide C whereas Guide C is significantly more emotional than Guide B (C-B=2.20, P<0.025). Guide B and Guide C do not differ in terms of participant's experience. As for the recall test, no significant difference is observed. The average mark for Guide A is 54.46, Guide B is 50.49 and Guide C is 51.89.

3.3 Discussion

The results show that in terms of facial expressions (Q9), a random emotions guide is perceived as the most emotional, followed by a guide with normal emotions and lastly the non-emotional guide. The average rating for the emotional guide is slightly more than 4 on the Likert scale, which reflects that the guide is expressing emotions at the right level, not too much or too little. The random emotions guide's rating on the other hand is above neutral, more than 5, while the non-emotional guide's rating falls below neutral, slightly above 3. The facial expressions in the random emotions guide can change quite drastically, hence is the most emotional.

Comparison between the emotional guide and the guide with random emotions showed that the emotional guide is perceived as more natural (Q8) than the random emotions guide. The participants who interacted with the random emotions guide questioned the believability of the stories (Q2) it presented according to their feedback. They believed the emotional guide's discourse more than the random emotions guide. This could be due to the fact that the inclusion of attitude in the guide causes its stories to be more realistic and absorbing. Furthermore, the emotional guide was given a higher rating on its ability in adjusting the stories (Q5) based on their interests.

Comparing the non-emotional guide and the random emotions guide, the participants rated the non-emotional guide facial expressions as more natural (Q8) than the random emotions guide. They also perceived the non-emotional guide discourse as more intelligent (Q1) than those presented by the random emotions guide. Since most of the participants selected 'Science' and 'Military' compared to 'Social' as their interest in these two groups, this might explain why they perceived the non-emotional guide as more natural and intelligent than the random emotions guide as scientists and military personnel are usually quite serious. As for the participants perceptions on the guide's ability to adjust stories (Q5) in these two groups, it could be solely an influence of the questionaire. The participants might not have any cue whether the guide is adjusting the stories or not but because they were being asked to rate on how well the guide is adjusting the stories based on their feedback, they interpreted that the guide must have done so.

Degree of emotional content in the stories (Q3) recorded no significant difference. This may be due to the fact that the topic is a serious one, though from the graph in Figure 2 we can see that the stories presented by the emotional

guide were given a higher emotional rating. Besides that, changes in voice tone are important for emotional detection, and the text-to-speech system lacks this. Next, the participants found the stories highly related to their chosen interest (Q4) resulting in no significant difference between the groups. This could be due to the fact that all the spots of attraction were chosen based on the participants selected interest during the start of the tour, leading to a high relation between stories and interests.

The result showing insignificant differences for the intelligence of the guide's appearance (Q6), maybe a judgment based on first impressions rather than interaction behavior. Furthermore, in this experiment, facial expression changes are the same for all guides except in the intensity of changes, leading to equivalent degrees of believability (Q7) and appropriateness (Q10) for the guide's facial expressions. The personality (Q11) comparison between the guides did not differ significantly but observing Figure 2 again, the emotional guide's participants expressed higher ability in identifying the guide's personality. The inclusion of attitude might have made the guide character's more distinctive. The emotional guide is being described as interesting, helpful, funny, friendly, hardworking, opinionated towards others, enthusiastic, happy, accurate, patriotic, loyal, sociable, outspoken, confident, cautious, reactive, patient, open-minded, straighforward and frank. In contrast, the non-emotional guide is being described as calm, intelligent, informative, serious, friendly, confident, trustworthy, giving, sad and knowledgeable. Participants described the random emotions guide as sad, unenthusiastic, proud, susceptible, expressive, bitter, sad, angry, unbiased, flat, observant, intelligent, sharp, shrewd and not friendly.

Overall, no significant difference was detected for the guide's degree of resemblance to the real guide (Q12). One reason that the reported differences between guides did not achieve significance may have been due to the granularity of the rating scale employed in the experiment. Each guide is rated as highly analogous to its real counterpart with an average rating of about 5. Using a 7 point Likert scale meant that there was proportionally little room to express any further improvements. The participants judged the guide's attributes for resemblance based on the guide's knowledge about the subject, information presentation and the navigation instructions. Notwithstanding, participants who interacted with the emotional guide commented on the guide's emotional responses and ability to present stories and anecdotal information rather than just facts as analogous to the real guide.

In terms of tour experience, the test showed significant differences for interestingness of stories (Q13) and tour experience (Q16). The participants who interacted with the emotional guide found the stories more interesting and had a better overall tour experience than those who interacted with the random emotions guide. From the figure, it can also be observed that the emotional guide has a higher rating for Q13, Q15 and Q16, followed by the non-emotional guide and finally the random emotions guide. Those who interacted with the emotional guide liked the sense of having a companion that is capable of tailoring the stories to their interests. Regarding insignificance in meaningfulness of tour (Q14),

most participants reported an overload of information because they lost track of the guide's discourse easily. Most of them had problems keeping up with the guide's discourse due to the less-than-natural and high speed voice generated by the text-to-speech system.

As for the recall test, no significant difference is observed. The guide's voice would be the obvious cause. Many of the participants are non-native English speakers which complicate the comprehension of information further. The Scottish cold winter is another factor which reduced the participants' concentration level as many of them pointed out. The availability of multiple choices would have also allowed the participants to guess on the answer when they were unsure. Additionally, the number of questions that each participants have to answer varies depending on the amount of stories they listened to. As a result, performance may also varies with participants that answered fewer questions scoring better than those that got more questions.

4 Conclusion and Future Work

This paper provides evidence that an affective guide with personality can improve tour experience. It proves that it is not the addition of facial expression alone that makes an interaction more interesting, but the intelligence and attitude of the guide. Although the differences between the emotional and non-emotional guide is not significant enough, the graphs reflect a better rating for the emotional guide in terms of participants' experiences. The participants may simply not notice an improved performance in the emotional guide to a significant enough degree due to the short interaction time. As in human social interaction, it takes time to know an individual personally. In this study the effects have been represented in a limited fashion due to the number of participants tested. Furthermore, the between-subjects design and the adjustment of alpha level in the post-hoc test make it relatively difficult to get significant differences, but there is no obviously preferable alternative. It is very possible that other effects could be found if subjects are asked to interact with the agent for a longer term. In order to improve the reliability of the test, a larger group of subject is required and the technical problems with the current technologies have to be solved. It would be desirable to replace the text-to-speech system with one that can generate a more natural and emotional voice.

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