The Role of Avatars in e-Government Interfaces

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Abstract. This paper investigates the use of avatars to communicate live message in e-government interfaces. A comparative study is presented that evaluates the contribution of multimodal metaphors (including avatars) to the usability of interfaces for e-government and user trust. The communication metaphors evaluated included text, earcons, recorded speech and avatars. The experimental platform used for the experiment involved two interface versions with a sample of 30 users. The results demonstrated that the use of multimodal metaphors in an e-government interface significantly contributes to enhancing the usability and increase trust of users to the e-government interface. A set of design guidelines, for the use of multimodal metaphors in e-government interfaces, was also produced.

Keywords: multimodal, e-government, interfaces, avatar, speech, earcons, trust.

1   Introduction

This research involves an empirical exploration to investigate usability aspects of e-government interfaces that incorporate a combination of multimodal metaphors. This study evaluates the contribution of these metaphors to usability, ease of communication and user trust. An e-government experimental platform, with two interface versions, was developed to serve as a basis for this investigation. The platform uses an input interface to send messages and an output interface to receive messages. Two groups of users were used to evaluate the results in terms of efficiency, effectiveness, user satisfaction and perception of trust.

2   Multimodal, Usability and Trust

Interfaces that communicate information to users using several communication channels often provide a more usable interaction. Rigas et al, suggest that the use of multimodal metaphors in interfaces aids the communication process [1, 2]. Also, the use of speech and non-speech in interface application helps users to make fewer mistakes and reduce the time taken to accomplish tasks [3]. Other studies also have

been carried out to test the use of multimodal metaphors in visual user interface and to evaluate and examine the effect of these metaphors on the usability of computer applications [4, 5].

Usability is one of the most important parameters in evaluating user interfaces [6] and software quality [7]. It is defined as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction" [8]. An effective e-government system requires the understanding of government websites and user expectations under the citizen-centric approach. It also requires identifying the barriers that might hinder these user interfaces to provide the desired services through the Internet [9]. An appropriate design can be used to improving the efficiency of governments, improve ease of interaction between government and public, facilitate economic development, reduce cost, and address expectations of users for service delivery [10, 11].

It is widely recognized in social sciences that trust is an important factor that mediates many aspects of human behavior [12, 13 and 14]. Definitions of trust vary but a widely accepted one is that it is "a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" [15]. Thus, a person who depends on someone else (the trustee) expects to reduce the likelihood or size of a negative outcome in some situation: when that dependence is misplaced, the expected value of the outcome is lower. The online environment does not allow the natural benefits of face-to-face communications and to directly observe the service provider's behavior, which happens to be an assurance mechanism on which people often base their perception. Based on trust, new service paradigms could emerge, developing passive citizen participation into active citizen participation in public service delivery [22]. As several parameters in online communication may decrease or increase the level of user trust, it is important to study and understand the way that user trust is influenced during online e-government interaction.

3 Aims and Objectives

The main aim of this research was to measure the impact of combining recorded natural speech, earcons and avatars on the usability of e-government interfaces by evaluate the extent to which the addition of these multimodal metaphors can affect the ability to communicate with users. The experiment measured and compared the efficiency, effectiveness, user satisfaction and associated user trust of a multimodal e-government interface and an equivalent text and graphics based interface. Two experimental platforms (a multimodal and a non-multimodal) were developed to deliver the same e-government functionality. The efficiency of the platforms was measured by recording the time users spent in completing the required tasks. The effectiveness was measured by calculating the percentage of tasks correctly completed by users. This measure was also used to assess the communication performance of users. User satisfaction was tested by rating different aspects of the platforms tested.

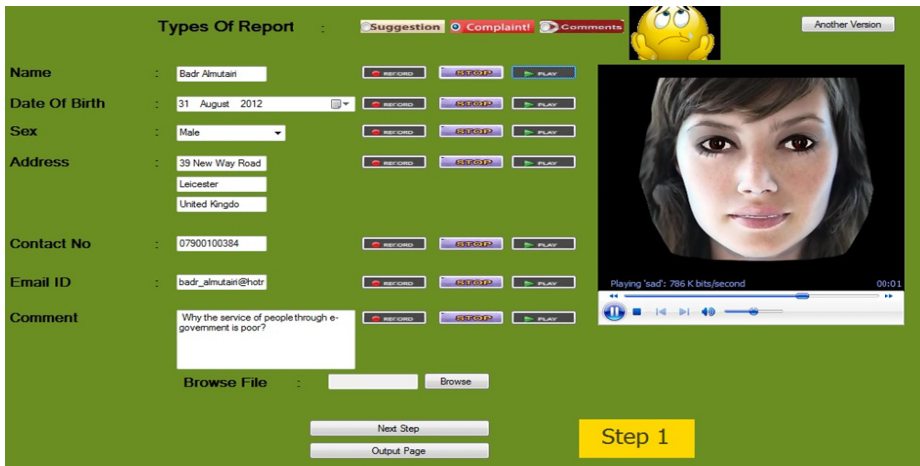**Fig. 1.** Multi-Modal e-government Platform (MMEGP) input interface

Fig. 2. Avatar e-government Platform (AVEGP) input interface

4   Experimental Design and e-Government Platform

An e-government platform was developed for this empirical investigation. The platform provided two different interface versions. One version involved speaking avatars with human-like facial expressions and the other version had a combination of multimodal metaphors. Both interface versions of the experimental platform were designed to deliver the same information about software representation of a given message statement and each interface was divided into an input and output sections.

The software provided three message types (suggestion, complaint and comment) and included other explanations about specific requests. The message types were broadly divided into with easy, moderate, complex. This study also investigated recall and recognition tasks in addition to other user performance parameters (see Table 1).

Table 1. Dependent variables considered in the experiment

Variable Code	Variable	Measure
DV 1	Tasks messaging and question answering time	Efficiency
DV 2	Correctness of enter tasks and answers	Effectiveness
DV 3	User satisfaction	Satisfaction
DV 4	User trust	perception of trust

The data collection process was based on experimental observations and questionnaires. For each task, each user was required to complete nine message tasks and to answer six questions. The time spent to complete the message tasks and to answer each of the six questions was recorded to help measure the efficiency. However, in order to collect the data related to effectiveness, the correctness of users' answers was checked and the total number of successful users who completed the message tasks and answered questions was counted for each user. The pre-experimental part of the questionnaire was dedicated to gathering personal data about users such as age, gender and education. It also helped to obtain data related to users' prior experience in computers, Internet and e-government. Finally, the post-experimental part of the questionnaire was aimed at assessing the users' satisfaction with the e-government platform tested. Users' responses to this questionnaire were used to calculate the satisfaction score for each user in both the control and the experimental groups.

An is a computer-based character that has been utilized to virtually represent one party in an interactive context [16, 17] with the ability to communicate verbal and non-verbal information [18, 19]. Verbal communication refers to the use of speech and written messages whereas nonverbal communication can be attained by facial expressions [20]. In general, avatars can be classified as abstract, realistic and naturalistic. An avatar is a software or tool which can be used to allow users to speak about something through live message formats which can be used to give complaints, suggestions or comments. Use of the avatar is compared with video messages or recorded messages during this study. The efficiency and effectiveness of the messages can be determined by the time factor and by the number of mouse clicks as well as user satisfaction.

5   Results: Efficiency, Effectiveness and User Satisfaction

The time taken to perform tasks and answer the required questions was used as a measure of efficiency. This measure was considered for all tasks for the input interface and for the output interface (according to the question type, recall and recognition), message complexity, as well as for each task and for each of the users in

both groups. The control group spent a total of 34.3 minutes but note that the experimental group spends more time, 46.3 minutes, because they must enter both text and avatar video for each task. Figure 3 shows the mean values of the time taken by all users. The experimental group (see Figure 4) typically used less time to complete the tasks. It can be said the use of avatar video improved efficiency, as tasks took less time - unlike the other groups which took more time to listen and read the tasks in the output interface. The number of correctly entered messages was used as a measure of effectiveness. This measure was considered for all messages and all the questions, according to the question type (recall and recognition) and message complexity (easy, moderate and difficult) and message type (suggestion, complain and comment), as well as for each user in both control and experimental groups. Figure 5 shows the percentage of mouse clicks to enter messages for all tasks for the MMEGP and AVEGP. It can be noted that AVEGP users used less mouse clicks than MMEGP. The reason for this is the enhanced input interface used by users when using the new avatar tool. The mean number of mouse clicks for the MMEGP was (2667) more than that for the AVEGP (2243), for all messages. The t-test results revealed that the difference in mouse clicks between MMEGP and TOEGP was significant (t (23), MD=624, p< 0.05). As a result, the AVEGP users outperformed the users of the MMEGP Figures 6 and 7 show the users who send messages using text or avatar.

A questionnaire, based on the System Usability Scale (SUS) [21], with 10 statements was used to measure the attitudes of users after the experiment. Figure 8 shows the mean values of the satisfaction score. The users in the AVEGP appeared to be more satisfied than the users using the MMEGP. Figure 9 shows the chart of user agreement and disagreement with the trust statements for using the MMEGP and AVEGP experimental structures. AVEGP users typically responded positively to the five trust related statements. This shows broadly points that the multimodal approach increased in some way the user trust.
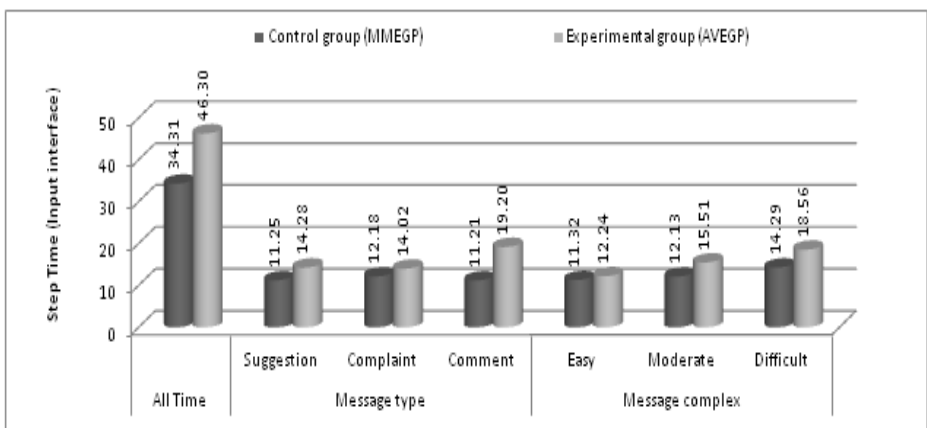

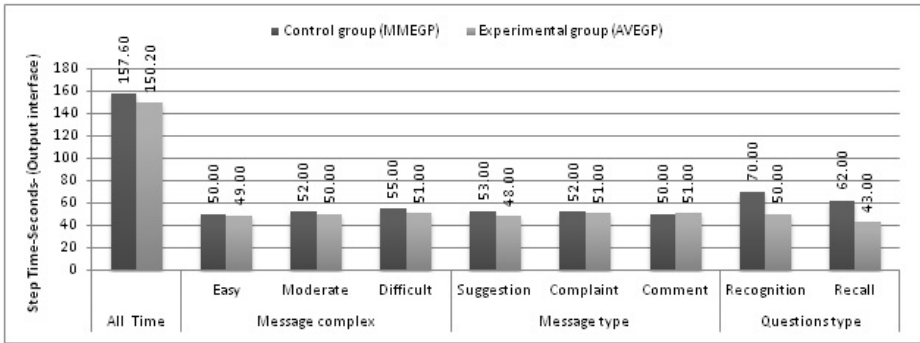**Fig. 3.** Mean values of time taken by users in both groups to enter all tasks (input interface)

Fig. 4. Mean values of time taken by users in both groups to enter all tasks (output interface)
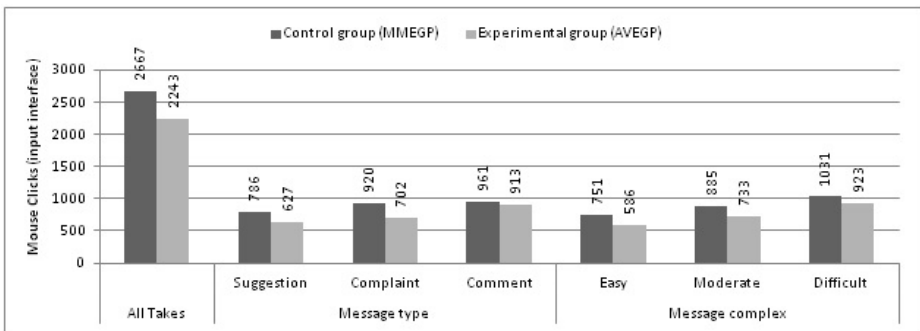

Fig. 5. The mean number of mouse clicks performed by users in both groups to enter messages for all the tasks for the input interface
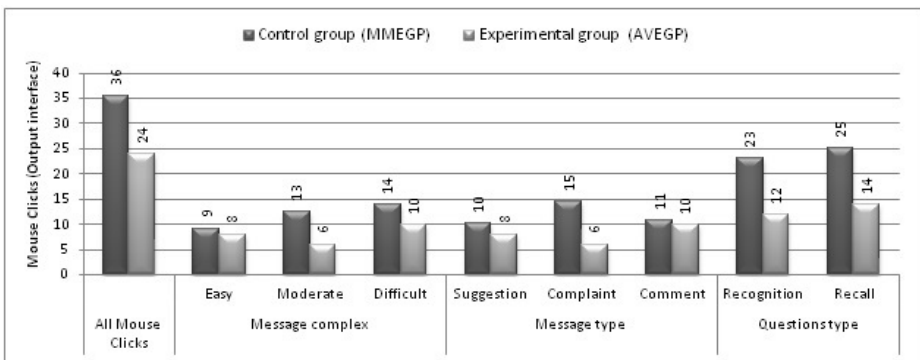

Fig. 6. The mean number of mouse clicks by users in both groups to enter message for all the tasks in the output interface
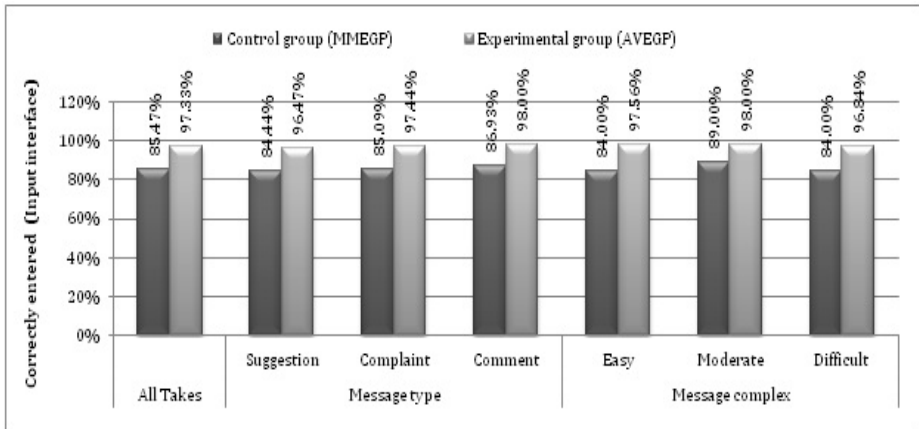
Fig. 7. Percentage of correctly completed tasks

6   Discussion

The results obtained have been used to compare the two interface versions in terms of efficiency, effectiveness, user satisfaction and user trust. The study also focused on the factors that can affect the role of multimodal interaction metaphors, such as the message type (suggestion, complaint, comment) the message complexity level (easy, moderate and difficult) and the question type (recall and recognition).   On the whole, it was expected that users of the AVEGP would be more satisfied than the users of the MMEGP. Consistent with this assumption, the multimodal presentation of the message content in the AVEGP was shown to be significantly more satisfactory than the speech based interface in the MMEGP. It seems that the avatar approach was interesting and attractive to users in the experimental group, as they expressed a more positive attitude towards the video-visual communication of the message content. Although both of the e-government interfaces tested were easy to use, neither was confusing or nervous. The results obtained did not demonstrate a remarkable difference between both groups of users regarding these satisfaction features (see Q1 to Q6 in Figure 8).   However, a larger difference was observed for statements relating to communication (see Q7 to Q10 in Figure 9). These results derived from two independent groups and users within those two groups and were not exposed to both interfaces. However, users in the experimental group might have had prior experience to typical government interfaces and this may have served as a comparison point. Users in the experimental group thought that their communication was improved and aided by the multimodal metaphors. It was easier for users to identify the information communicated by the avatar. This result on its own is not conclusive; as it is based on subjective rating of users and the typical mean difference is not large enough (even when a statistical significance for the overall satisfaction results was reached). This experiment data suggests that using multimodal approach might
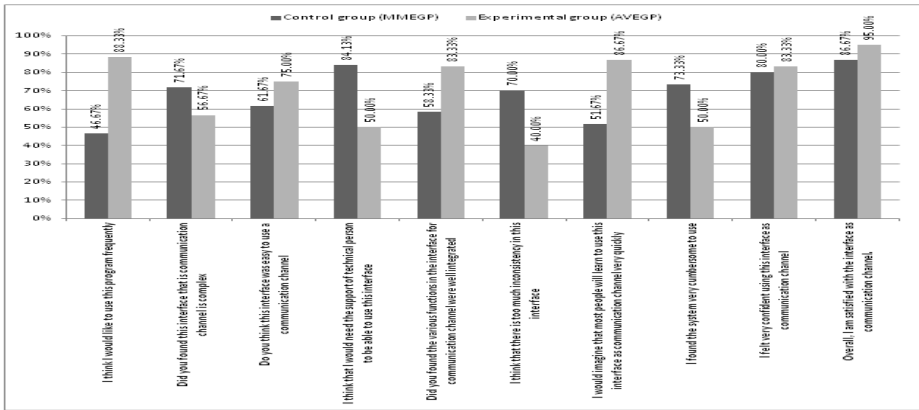
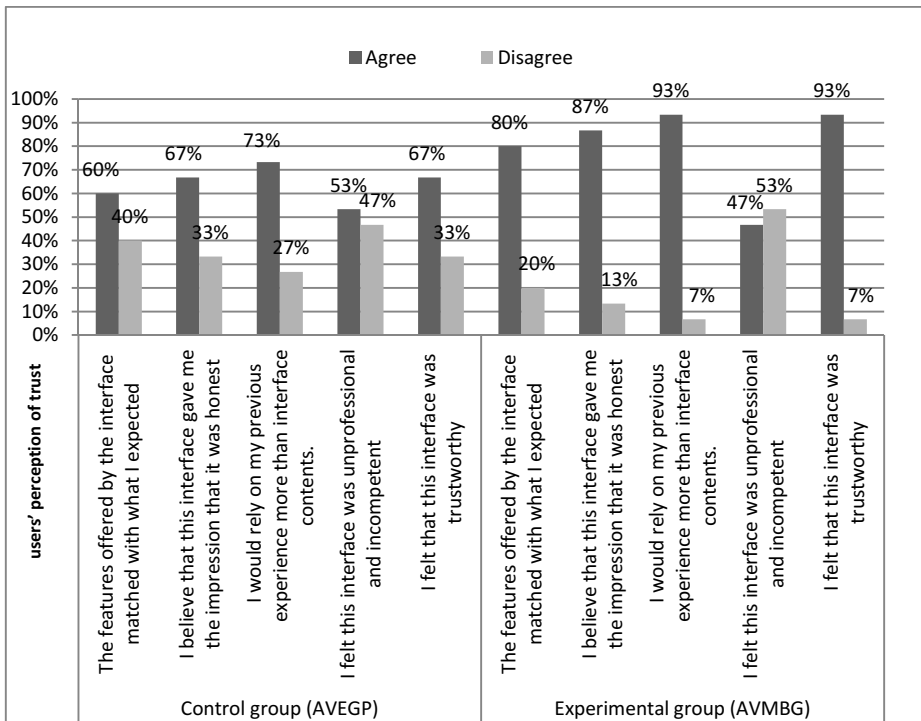**Fig. 8.** Percentages of user satisfaction results

Fig. 9. Percentage of user views for each trust statement

increase user trust. Users in the experimental group demonstrated a positive attitude towards the avatar. It can therefore be extrapolated that the multimodal aided e-government interface is more likely to result in an agreeable and satisfying experience for the user. This experience is linked with the ability to complete message tasks correctly and quickly. In summary, this experimental study suggests the importance of

the multimodal interaction metaphors to enhance user messaging (communication) performance and the usability of e-government interfaces in terms of efficiency, effectiveness, user satisfaction and user trust.

7   Conclusion

The results obtained from this experiment confirm that multimodal metaphors do in fact help to improve the usability of e-government interfaces, and reduce the time needed for users to respond to messages and, allow users to undertake activities more accurately, and make use of the interface more pleasing and satisfactory and more trustworthy. In other words, we conclude that the new multimodal metaphors tested can contribute greatly to improving the performance of users' communication and ease of use of e-government interfaces in terms of effectiveness and a percentage of 14% compared to the other group in input interface and 30% in the output interface, efficiency a percentage of 24% compared to the other group in input interface and 4% in the output interface and user satisfaction a percentage of 9% compared to the other group. It is therefore proposed to include multimodal metaphors in e-government interfaces and these needs to be taken in mind when designing such interfaces. The e-government interface is gaining the popularity among the providers of e-government services. Its importance from the users' point of view has become the main concern for e-government service providers. This is why this paper has focused on investigating the usability which is an important factor for the improvement of e-government interfaces for the provision of high quality government services.

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