

COMPUTER BASED SUPPORT FOR LEARNING FACIAL EXPRESSIONS

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ABSTRACT

Current computer based approaches to teaching autistic people facial expressions typically provide pictures of such expressions, and either multiple choice tests or facial 'dictionaries'. Such approaches appear to be neither fun nor engaging. This paper reports on the findings of an experiment to compare a conventional computer based approach to support learning facial expressions to a novel approach in which users learn facial expressions through interacting with virtual pets. The experiment showed that the conventional approach was most effective in terms of teaching the most facial expressions over the shortest period of time. However, the novel approach was judged to be more fun to use even though it required more time and effort. In addition this paper outlines an initial set of suggestions for developing graphic user interfaces for autistic people.

Keywords

User interface design, computer based learning, autism, experimental evaluation

1. INTRODUCTION

Autism is a spectrum of disorders, ranging from low functioning autism, where the person cannot speak and has little understanding of the environment around them, to high functioning autism and Asperger's Syndrome [1], where the person can speak and has average to above average intelligence. All the disorders along the spectrum share the same triad of impairments in social understanding, social communication, and imagination *e.g.* being able to imagine the result of their actions [7]. People with Asperger's Syndrome are on the higher functioning end of the autistic spectrum; they often find it very difficult to recognise facial expressions or to know what feelings are behind them. This difficulty is one of the key factors

contributing to their problems with social relationships as they do not always understand how other people are feeling which can lead to misunderstandings, being easily tricked, or appearing cold and uncaring. It is suggested that a system which can help them to recognise facial expressions and understand the emotions behind them could potentially increase their success in maintaining social relationships.

1.1 Teaching Facial Expressions

Several computer based approaches to teaching autistic people facial expressions are available *e.g.* Responsive face [6], and Gaining face [2]. Typically these approaches provide some explanations of expressions, envisage short periods of use, provide some simple game play and scenario comprehension, and are often quite 'dry' to use. For example, Gaining face is very much like a visual dictionary of facial expressions. A particular emotion can be selected from a list, and the corresponding facial expression is displayed along with explanations of the key parts of the expression. Expressions can be compared, and there is a quiz which tests the user's ability to recognise expressions through a multiple choice test.

1. NOVEL APPROACH TO TEACHING FACIAL EXPRESSIONS

This paper explores a novel approach to teaching facial expressions which is more fun and engaging than conventional approaches. In order to achieve this, typical characteristics of autistic people were taken into account for both the conceptual and interface design (an initial set of user interface guidelines are suggested later in this paper).

Characteristics of autistic people used to inform the conceptual design are their tendency to enjoy collecting things and interacting with experiences which have constrained rules and expectations (so making outcomes of actions easier to predict) [3]. These were reflected in informal surveys of autistic people which indicated that virtual pets, and in particular, a site known as Neopets [5] is highly popular and widely used. Virtual pets must be fed and played with, and to achieve this items may be bought from shops using virtual money earned by playing games. Moreover, different pets can be collected, and the virtual world usually has a simple set of rules governing activities.

The novel approach to teaching facial expressions takes virtual pets as its design concept; virtual pets convey facial expressions through interaction with various items. As

autistic people often have difficulties identifying with or bonding with other people, pets were designed which have similar themes to autistic people's interests as identified through the informal interviews: a cat, a train, and a robot. In addition, one of users' aims in the virtual world is to 'collect' the facial expressions conveyed by the virtual pets. Once collected, they are added to a special collection encyclopedia which can be browsed through.

1. INTERFACE DESIGN

Two programs which teach facial expressions were developed to be experimentally compared. One program reflected the conventional approach to computer based teaching of facial expressions (referred to as the Encyclopedia approach). The second program was based on virtual pets (referred to as Utisma). Both of the programs are online JSP web sites.

1.1 Common Elements

Both programs included a test consisting of 20 multiple choice questions, where a random picture was displayed and the user decided which expression was being displayed as illustrated in figure 1.

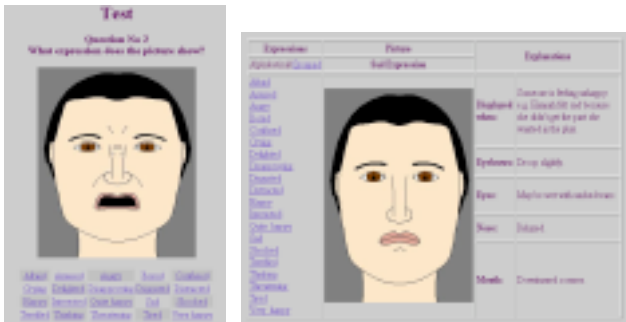


Figure 1: Facial Tests Figure 2: Facial Explanation

1.1 Encyclopedia Approach

The Encyclopedia program consisted of two sections reflecting the conventional approach to computer based teaching of facial expressions: Explanations as illustrated in figure 2, and Comparisons as illustrated in figure 3. In the Explanations section an expression could be chosen from a list, and a picture of the expression was shown with explanations. In the Comparisons section two expressions could be chosen from lists, and pictures of the expressions were shown side by side with explanations.

1.1 Utisma Approach

The Utisma program consisted of a virtual world inhabited by virtual pets called Petacs as illustrated in figure 4. Users could adopt the Petacs and interact with them in their virtual home by giving the Petac items which could be purchased in virtual shops. When given an item, the Petac responded to it by saying something and changing its facial expression. In order to reinforce the learning experience in a fun way, a version of the classic card game GoFish was created in the virtual world in which normal playing cards were replaced with facial expression cards. In keeping with conventional tests, the user needed to repeatedly correctly

identify the expressions on the cards, but the game play aspect was intended to encourage engagement with the program and hopefully the subject matter at hand. A Collection Encyclopedia was also provided which displayed the facial expressions that the Petac had collected. This approach was intended to encourage users to interact and play with the world in order to collect facial expressions and learn them. The Utisma Comparisons section was similar to the Comparisons section in the Encyclopedia program. However, as with the Collection Encyclopedia section, only collected expressions were displayed.

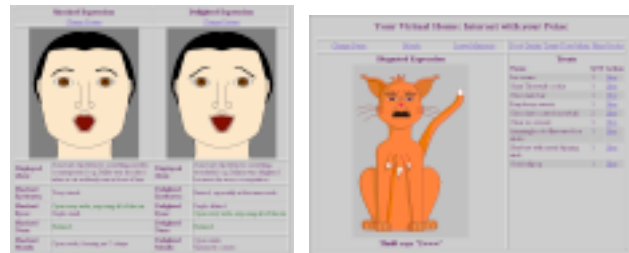


Figure 3: Facial Comparisons Figure 4: A Petac

1. EXPERIMENT

The aim of the experiment was to determine which program design (Utisma or Encyclopedia) best helps autistic people to recognise facial expressions whilst being fun to use.

1.1 Hypotheses

The null hypothesis was that there is no difference in the ability to teach facial expressions to autistic people between the Utisma and Encyclopedia programs, where greatest ability is measured as greatest increase in test results in the shortest amount of time. The directional alternative hypothesis was that the Utisma program provides the greatest ability to teach facial expressions to autistic people.

A secondary question was whether the Utisma program is more fun to use than the Encyclopedia program.

1.1 Variables

The independent variable was the type of program used; either the Utisma or the Encyclopedia program.

Dependent variables were: the difference between number of facial expressions recognised before and after the experiment; time spent using the facial expression parts of the program (thus removing the amount of time spent 'playing' with pets *etc.*); Likert scale ratings of enjoyment of use.

1.1 Method

A multiple choice test entailing matching 20 facial expressions to descriptions, was sat both before and after using the program. Participants could also test themselves during the experiment. The difference in score between the first and last test was recorded. Due to the logistics of the experiment it was not possible to re-test participants some period of time after the experiment (*e.g.* four weeks). After using the period of testing, each participant filled out a

questionnaire. Answers to the questionnaires were examined to determine how enjoyable the programs were considered.

Participants were asked to use the program for a minimum of 15 minutes everyday for 2 weeks. Each participant used only one program which was enforced during the log-in procedure. Test questions were generated in a random order to eliminate learning of answers by their position in the test sequence.

1.1 Participants

Volunteer participants were recruited by advertising on the National Autistic Society website [4] and in various online autism groups. 37 people volunteered to use the programs. 18 people were assigned to use the Encyclopedia program and 19 people were assigned to use Utisma. 11 of the Encyclopedia people were under 20, and 12 of the Utisma people were under 20.

1. RESULTS

Many people did not take the final test after the 2 week period of testing. However, 12 Utisma and 10 Encyclopedia participants did at least take tests whilst using the program during the testing period. Therefore the difference in score is calculated between the first and highest scores. Time spent reflects the time spent using the facial expression parts of the programs until the highest score in tests was achieved as detailed in table 1.

Utisma			Encyclopedia		
Score Diff.	Time (s)	Under 20	Score Diff.	Time (s)	Under 20
14	24001		5	3043	
1	758	√	10	4039	
3	920	√	15	8949	√
5	4291		9	5035	√
2	2750	√	3	1456	√
6	4550	√	2	688	
9	9613	√	3	1372	√
4	6365		2	812	√
4	2936		4	1323	√
7	11876		1	1240	√
13	12826	√			
1	879	√			

Table 1: Experiment results

The results indicated that difference in score/ time (s) was not normally distributed. Therefore a Mann Whitney U-test was used. It was found that participants using the Encyclopedia program were able to significantly increase their score between tests quicker than those using the Utisma program ($U = 17$; $z = 29$; $p = 0.05$). Thus, the Encyclopedia program appears to be more effective in teaching facial expressions than the Utisma program, where effectiveness is measured as greatest increase in score over shortest amount of time.

There was no significant difference between the increase in scores over time of the under 20s using the two programs, suggesting that both programs were equally effective at teaching facial expressions to under 20s ($U = 12$; $z = 8$; $p = 0.05$). Whereas over 20s using the Encyclopedia program had a significantly greater increase in score over time than over 20s using the Utisma program ($U = 0$; $z = 0$; $p = 0.05$). Therefore, it is proposed that the Encyclopedia program was the most effective program at teaching facial expressions to over 20s.

Analysis of the questionnaires indicates that the Utisma program was thought to be on average 'quite a lot of fun to use' (average 4 on a 'usage' scale: 0 = didn't use it; 1 = not fun at all; 2 = slightly fun; 3 = somewhat fun; 4 = quite a lot of fun; 5 = lots of fun) whereas the Encyclopedia program was thought to be 'not fun at all' to use (average 1 on same scale). In contrast, participants felt the programs were both equally as helpful in teaching them to recognise facial expressions in real life (rather than in the tests) (average 2 on a scale: 1 = not at all; 2 = slightly; 3 = somewhat; 4 = quite a lot; 5 = very much).

1. DISCUSSION

One reason for the difference in effectiveness between Utisma and the Encyclopedia program may be the amount of effort required to collect expressions in Utisma. This was achieved by giving Petacs an item so that it responds with the required expression. Although thought to be fun by the majority of the participants, this process of collecting expressions does take time whereas expressions are instantly available in the Encyclopedia program. 2 out of 12 of the participants using the Utisma program did manage to score full marks in the test so illustrating that the program was able to teach expressions. There was also no significance between the increase of scores over time between the under 20s using both programs, suggesting that the Utisma program was equally as effective in this age group as the Encyclopedia program.

When asked whether participants would want to use the program again, Utisma participants unanimously said that they would want to (10 of 10 participants), whereas Encyclopedia participants did not (0 of 9). This seems to suggest that even though it takes longer to increase their score with the Utisma program, participants do not mind which may be because they enjoyed using the program. Moreover, a great many comments given referred to liking the Petacs, one participant even saying he would miss his Petac. These results and comments seem to suggest that the distinctive and imaginative approach of Utisma was widely enjoyed, and judged a success by the testers. Such enjoyment of Utisma with its reliance on imagination helps to illustrate that the lack of 'imagination' exhibited by autistic people is in the area of predicting outcomes rather than creativity (*cf.* [7]) *i.e.* the user must be able to appreciate the fact that they are supposed to be adopting and interacting with pets in an imaginary, virtual world.

It is interesting to note that the Utisma participants found the Collection Encyclopedia and Comparisons sections 'quite a lot of fun' to use (average 4 on the previous usage

scale), whereas those using the Encyclopedia program on average found them not fun at all to use (average 1 and 2 respectively on the same scale). Moreover, participants spent less time in these sections in Utisma than in the Encyclopedia program. These results may be because the Utisma program offered cute Petac pictures to look at as well as just human pictures. Also, expressions needed to be collected in Utisma, which made it into a game and drew on the popular autistic interest of collecting things. Moreover, Utisma gave a sense of achievement when more expressions appeared. This illustrates the importance of combining people's interests with their teaching tools in order to make something seem more fun to them.

Given the results and the nature of the program it is suggested that approaches such as virtual pets would be more appropriate for under 20s, and in particular 10-15 year olds. It is rare to find a program for the general public (particularly those aimed at under 20s), which are purely factual and have no fun elements to them whereas currently existing programs for autistic people are usually factual programs.

2. SUGGESTIONS FOR USER INTERFACE DESIGN

The Encyclopedia and Utisma programs required careful user interface design taking into account the characteristics of the target users. There were many positive comments about the layout and colour schemes of both programs. People commented that it was straightforward, didn't hurt their eyes, and made it quick and easy to navigate around. This section outlines lessons learnt which could be used in the design of future programs aimed at autistic people.

2.1 Use of Colour

Due to some types of visual hypersensitivity, some shades and combinations can hurt autistic eyes. There is little current literature on the subject of 'safe' or 'unsafe' colours to use in interface designs, so autistic people were informally interviewed as part of the design process. A grey background with dark writing was used in the design as it reduces the contrast between the background and the writing. Initially black writing was tried, but this made the user interface seem very drab and uninteresting in testing so dark purple writing was used instead. This had the combined advantages of not hurting autistic eyes and being interesting and appealing to look at.

2.2 Use of Layout

Due to visual processing difficulties, some autistic people have trouble finding their way around interfaces if they are cluttered, have too much information on them at once, or are not well ordered or logical to use. Moreover, a sense of sameness throughout the interface should be promoted since autistic people dislike change. The user interface was designed with simple and consistent layouts to reflect this.

2.3 Use of Movement

No animations were used in the designs as some types of visual hypersensitivity mean that things which flash, move

across the screen, spin *etc.* can either hurt, distress, or cause intense distraction to the autistic person. Comments from participants indicate that a program can be made to be fun and interesting even when bright colours and animated images are not used.

In contrast, some autistic people are hyposensitive to visual stimuli meaning that they love and actively seek visual stimulation such as bright colours. To address this difficult balance between hypo- and hyper-sensitivity, one Petac was made to be brighter than the others.

2.4 Special Interests

Autistic people often have obsessive interests which they pursue to the point of thinking of nothing else. Embracing these interests could help keep their attention and encourage them to learn. As mentioned previously, the Utisma user interface conceptually embraced such characteristics through the use of pets, virtual worlds, and the theme of collecting items. Such details tailored the virtual world into a place where autistic people could feel they are liked, appreciated and belong, which is important to a population of people who often feel like they do not belong or are unable to fit in the human social world [7].

3. CONCLUSIONS

This paper presented a comparison of two approaches to teaching autistic people facial expressions. It was found that the conventional approach was quickest at teaching the greatest number of facial expressions in the shortest amount of time. However, the novel approach was enjoyed more, and more likely to be used in the future. A set of suggested features to take into account when developing user interfaces for autistic people were proposed which gave a view on both conceptual and interface design.

Future work needs to more rigorously evaluate the computer based learning techniques such as those outlined here, especially with respect to the levels of engagement with the subject matter and the propensity to continue using such tools. Moreover, design guidelines need to be developed to provide adequate guidance for future interface development.

4. REFERENCES

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