ABCD SW: Autistic Behavior & Computer-based Didactic Software

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ABSTRACT
In this demo we show an open source software (SW) program designed to facilitate the execution of Applied Behavior Analysis (ABA) intervention with low-functioning autistic children. The SW is based on Augmentative and Alternative Communication (AAC) and Discrete Trial Training (DTT). The SW automatically records data extractable from the session (times, success/error, etc.), while the tutor inserts subjective data such as type and level of prompt provided to a child, along with comments. The SW adapts the trial to the child's abilities (receptive/verbal) to make it accessible (comprehensible and operable). To offer the child a simple and accessible interaction environment, the tutor and child user interfaces are kept separate and offered on mobile devices. Using a laptop, the tutor sets the exercise that appears on the child's tablet. Synchronization between devices offers the tutor a real-time summary of actions performed by child, freeing up his/her cognitive resources needed to memorize this information and possibly favoring the decision-making process for the ABA intervention.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Graphical user interfaces (GUI)*. K.4.2 [**Social Issues**]: Handicapped persons/special needs.

General Terms
Algorithms, Design, Experimentation, Human Factors

Keywords
Autism, software, AAC, DTT, ABA, Web interface

1. INTRODUCTION
Mobile devices have opened up new frontiers in human-computer interaction. Not only are they ubiquitous and pervasive, but their user interfaces, especially touch screens, offer natural interaction and reliable and rapid feedback. Mobile devices are increasingly used for teaching subjects with learning and development disabilities, such as autistic children. Kientz et al. developed two systems: 1) Abaris, support teams executing Discrete Trial Training, building indices into videos of sessions and allowing easy data search; 2) CareLog, for collecting and analyzing behavioral data (Kientz et al., 2007). Recently a number of iPad and Android apps have been implemented for AAC and DTT but to our knowledge none utilizes a web-based distributed architecture. In the following we describe ABCD SW, an application to support teaching low-functioning autistic children. Section 2 describes the architecture, illustrating design choices as well as problems encountered in the pilot test and solutions. Conclusions and future work end the paper.

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2. THE ARCHITECTURE
ABCD SW is a Web application, coded in PHP, AJAX, and HTML5, which relies on the Drupal Content Management System (CMS) and an SQL database. The use of the Content Management System offers several advantages for data organization in terms of scalability and internationalization (native support for Multilanguage). Most of all, it permits managing application content independently from the code, by allowing end users to add/modify content in a user-friendly way. For drawing objects in the Web browser (images are dynamically inscribed in rectangles) the JavaScript Library Raphaël, which uses SVG (Scalable Vector Graphics), has been adopted.

The SW presents some adaptivity features for providing accessible content to autistic children, according to their user profiles (receptive or not, verbal or not): *words* are provided for presenting the discriminative stimulus to *non-receptive* children while *a choice between 3 words* is presented in an expressive trial to *non-verbal* subjects. Also, the most suitable reinforcements for each child can be selected when defining his/her profile.

2.1 The User Interfaces
According to classic ABA intervention, which requires the child to interact at an empty table under the tutor's supervision (to set up and coordinate the execution of trials of increasing difficulty), the application has been split into 2 independent parts that may run on different devices:

- A laptop is the tutor's environment; it drives the sequence of trials according to the child's performance, offers reinforcement after an independent successful trial, and records information from the trial (success/failure, type and percentage of prompts, behavior). An edit box allows one to insert comments about the trial, providing useful information for the next tutor.
- A touch screen tablet is used by the child 1) to execute the trials and 2) to look/play with visual reinforcements (i.e., a reward for the child when (s)he has worked well, to enhance the probability of repeating a good performance). While the

child is looking at the reinforcement, e.g. an animation, the tutor has time to insert information regarding the trial.

When the tutor inserts username and password and selects the child's nickname, a summary presents data on the entire DTT level performed by the child. After the tutor reads the recent information (each child has 3 or 4 tutors), (s)he is ready to start the session by pressing a push button that activates the tutor environment (Fig. 1).

Fig. 1. Tutor environment

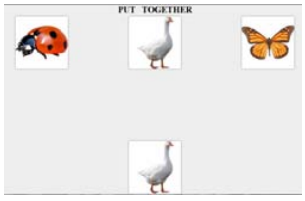

Fig. 2. Child environment: non-receptive subject

2.2 Synchronization between Devices/UIs

An early version of the SW was tested with a large touch screen placed horizontally to simulate a table. However, some problems were detected in terms of touch screen sensitivity, related to the large screen size, with the possibility of loss of the dragged object. This fact has a negative impact on the performance of children with poor fine motor skills. Since it is very important for an autistic subject to have rapid and unambiguous feedback, we investigated a new solution. Specifically, tablet devices (iPad and Android) showed more reliable interaction with dragging and touch actions, with the additional advantage of being ubiquitous devices that can be used without cables (children may unplug cables). The use of a tablet as an extended monitor led to new problems, especially considering that usually the VGA/HDMI/DVI ports of the device may be only a video input and not video output. The solution was to consider the devices involved as autonomous and independent, and make full use of their Internet connectivity. For this, a communication modality between the terminals was created using the database as common channel. Each event from the tutor's or the child's device is saved on the channel, and the two terminals are synchronized every second with new data (if present in the database). This has been implemented with multiple Ajax calls to the server. An alternative is the use of HTML 5 sockets, but at the moment this still does not seem to be sufficiently stable.

In Fig. 1 the tutor has set the program 'Matching image-image', level 'MT' (Mass Trail), on the article 'Butterfly' in the 'Animals' category. Once the trial is activated (pressing the Level button), the Child environment is set up according to this trial and the child profile. The tutor laptop overlaps another UI for evaluating the trial and activating reinforcements. This UI provides the shortcuts corresponding to specific information about the trial (see columns *Code* and *Value* in Fig. 3): the level of prompt provided (0, 20, 50, 80, 100%), the child's behavior (error, non-collaboration, self-stimulation), whether there was a tutor error, commands to activate a reinforcement on the child user interface, or an interface reset (if random selection was not suitable for the child). The last three rows provide the tutor with a summary of the child's performance.

If two devices are not available, by deselecting the check box in the lower right part of the Tutor interface (AB©Dsynch), a new tab panel is opened in the browser for the child's environment.

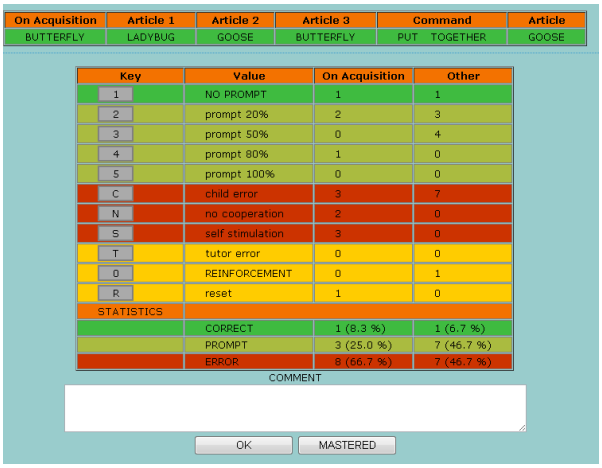

Fig. 3. The tutor control panel

3. CONCLUSIONS

In this demo we show a software program for teaching low-functioning autistic children by implementing basic ABA programs. Compared to previous work based on AAC and DTT, the novel aspect is related to the distributed web-based architecture that enables the use of the SW anywhere, anytime and on different devices. The possibility of controlling the flow of the trials and obtaining in real time an overview of the child's performance would improve the efficiency and effectiveness of the intervention. Adapting the child's environment to his/her abilities allows delivery of accessible content. We are testing and improving the software by means of an ongoing test (ending in June 2012) with 7 children. The proposed architecture also presents interesting potential for use in fields where synchronization can enhance interaction between different subjects.

4. ACKNOWLEDGMENTS

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5. REFERENCES

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