

TRIK: A Talking and Drawing Robot for Children with Communication Disabilities

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1 Introduction

1.1 Dialogue systems

Most existing dialogue systems are meant to be used by competent language users without physical or cognitive language disabilities; either they are supposed to be spoken to (e.g., phone based systems), or one has to be able to type the utterances (e.g., the interactive agents that can be found on the web). The few dialogue systems which are developed with disabled people in mind are targeted at persons with physical disabilities, who need help in performing daily activities.

Dialogue systems have also been used for second language learning; i.e., learning a new language for already language competent people. Two examples are the artificial agent "Ville: The Virtual Language Tutor" (Beskow et al., 2004), and "SCILL: Spoken Conversational Interface for Language Learning", a system for practicing Mandarin Chinese (Seneff et al., 2004).

However, we are not aware of any examples where a dialogue system has been used for improving first language learning.

1.2 Target audience

Our intended target group are children with severe communication disabilities, who needs help to learn and practice linguistic communication. One example can be children with autism spectrum disorders (ASD), having extensive difficulties with representational thinking and who therefore will have problems in learning linguistic communication. Many children with autism are furthermore hindered in their speech development by the fact that they also have motor disabilities, most often in the form of dyspraxia. Our dialogue system will give an opportunity to explore spoken language - content as well as expression.

Another target audience which we believe will benefit from our system are children whose physical disabilities are very extensive, usually as a consequence of Cerebral Palsy (CP). The ability to control a robot gives a fantastic opportunity to play, draw and express oneself in spoken language, which otherwise would be very difficult or even impossible to do.

1.3 Language development

To be able to learn a language one must have practice in using it, especially in interplay with other language competent people. For the communication to be as natural as possible, all participants should use the same language. For that reason there is a point in being able to express oneself in spoken language, even if one does not have the physical or cognitive ability. If one usually expresses oneself by pointing at a communication board, it is thus important that the board can express in words what is meant by the pointing act. This is even more important when learning a language, and its expressions and conventions (Sevcik and Ronski, 2002; Thunberg, 2007).

When it comes to children with ASD, learning sometimes appears to be simpler in

cooperation with a technical product (e.g., a computer), since the interaction in that case is not as complex as with another human (Heimann and Tjus, 1997). Individuals with ASD have difficulties in coordinating impressions from several different senses and different focuses of attention. When one is expected to listen to, look at and interpret a number of small signals, all at the same time, such as facial expressions and gazes, human communication can become very difficult.

All children need repetition to learn things. Children with disabilities often need even more repetition in their language learning. Adapted techniques, and in this case the speech-controlled drawing robot, can offer the required repetition as an exciting complement to human communication.

2 Project description

Our basic idea is to use a dialogue system to support language development for children with severe communicative disabilities. There are already communication boards connected to speech synthesis in the form of communication software on computers. The main values that this project add to existing systems are that:

- the child can explore language on her own and in stimulating cooperation with the robot;
- it can be relieving and stimulating at the same time, with a common focus on the dialogue together with a robot;
- the child is offered an exciting, creative and fun activity.

By being able to use a picture- or symbol-based communication board the children are given an exciting opportunity to explore language; to play and in the same time learn to use a method for augmentative and alternative communication.

2.1 A talking communication board and a talking robot

In our goal scenario the child has a communication board which can talk; i.e., when the child points at some symbols they are translated to an utterance which the board expresses via speech synthesis, and in grammatically correct Swedish. This is recognized by a robot which can move around on a paper and draw at the same time. The robot executes the commands that was expressed by the communication board; e.g., if the child points at the symbol for "draw a figure", and the symbol with a flower, the utterance might be "draw a flower, please", which the robot then performs.

The dialogue system comes into play when the robot is given too little information. E.g., if the child only points at the symbol for "draw a figure", the robot does not get enough information. This is noticed by the dialogue system and the robot asks a follow-up question, such as "what figure do you want me to draw?".

2.2 Pedagogical advantages

By having the communication board and the robot talking to each other there is a possibility for users in an early stage of communication development to understand and learn basic linguistic principles. For the linguistically more advanced child the robot offers the possibility of understanding basic properties of dialogue such as turn-taking, asking and answering questions, the importance of providing sufficient information, and cooperating to achieve a shared goal. In addition, the child learns to plan its actions in order to achieve a goal; e.g., getting the robot to draw a flower.

The setup works without the robot and the communication board actually listening to

each others' speech - instead, they communicate wirelessly. However, there is an important pedagogical point in having them (apparently) communicate using spoken language: It provides the child with an experience of participating in a spoken dialogue, even though the child does not speak.

2.3 Components of the system

The final TRIK setup consists of the following components:

- a simple LEGO robot which can turn and move in all directions, and has a pen that can be lifted and lowered;
- a touch-screen which functions as a communication board with symbols;
- a computer with a dialogue system and speech synthesis, which is physically attached to the communication board and communicates wirelessly with the robot.

The computer will seem like it is a part of the communication board, but it also controls the robot, both movements and speech. Every utterance by the robot will be executed by the speech synthesizer, and then sent to the robot via radio.

3 Evaluation and conclusion

The system was evaluated during April-June 2009 on three children aged between 5 and 8 and with communication disorders: one with ASD and two with Cerebral Palsy. The evaluation was designed as a case study with data being collected before and after intervention. The children were video recorded when playing with the robot, to enable analysis of common interaction patterns. The children used the robot during sessions of 15-30 minutes under a period of two months.

With only 7-8 test sessions per child it is difficult to draw any definite conclusions. Our general impression is that the children found the robot fascinating, and that they gradually learned how to use it during the test period. However, the interface needs to be individualized more to better match the specific disorders and development levels.

As a conclusion we believe that the TRIK project is very promising, and we are working on improving the robot and the evaluation procedures.

4 References

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