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

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## Abstract

We will demonstrate a setup involving a communication board (for manual sign communication) and a drawing robot, which can communicate with each other via spoken language. The purpose is to help children with severe communication disabilities to learn language, language use and cooperation, in a playful and inspiring way. The communication board speaks and the robot is able to understand and talk back. This encourages the child to use the language and learn to cooperate to reach a common goal, which in this case is to get the robot to draw figures on a paper.

## 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 common acts.

Dialogue systems have also been used for second language learning; i.e., learning a new language for already language competent people. 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, having extensive difficulties with representational thinking and who therefore will have problems in learning linguistic communication. Our dialogue system will give an opportunity to explore spoken language – content as well as expression. Another target audience are children whose physical disabilities are very extensive, usually as a consequence of Cerebral Palsy (CP). The ablility 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.

### 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 Romski, 2002; Thunberg, 2007).

When it comes to children with autism, learning 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). Autistic persons 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.

## 2 TRIK: A talking and drawing robot

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

In our setup 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?"*.

### 2.1 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 language development to understand and learn basic linguistic principles.

As discussed in section 2.3 later, 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.

### 2.2 The robot and the communication board

The robot itself is built using LEGO Mindstorms NXT, a kind of technical lego which can be controlled and programmed via a computer. Apart from being cheap, this technology makes it easy to build a prototype and to modify it during the course of the project.

The communication board is a computer touchscreen. The computer 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.

### 2.3 Perfect speech recognition

Typically, the most error-prone component of a spoken dialogue system is speech recognition; i.e., the component responsible for correctly interpreting speech. An advantage of the TRIK setup is that we will, in a sense, have "perfect speech recognition", since we are cheating a bit. The (dialogue system connected to the) robot does not actually have to listen for the speech generated by the (computer connected to the) communication board; the information is instead transferred wirelessly.

### 2.4 The dialogue system

The dialogue system is implemented using the GoDiS dialogue manager (Larsson, 2002), which is designed to be easily adaptable to new domains, but is nevertheless able to handle a variety of simpler or more complex dialogues.

The grammars of the dialogue system are implemented in Grammatical Framework (GF) (Ranta, 2004), which makes it easy to quickly design the language interpretation and generation components of a dialogue system.

## 3 Evaluation

During April–June 2009, the system is evaluated by a small number of users with linguistic communication disorders. The users are children with a diagnose within the autism spectrum, or with Cerebral Palsy. The evalation process is designed as a case study with data being collected before and after interventions. The children are also video recorded when playing with the robot, to enable analysis of common interaction patterns.

Both before and after the two month trial period, the parents answer a survey about how they perceive their interaction with their children. They also estimate the communicative abilities of their children. During the trial period, the children are filmed while interacting with the robot. Furthermore, all interaction between the communication board and the robot will be logged by the system. The logs and videos will be analysed after the trial period using suitable methods.

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## References

Mikael Heimann and Tomas Tjus. 1997. *Datorer och barn med autism*. Natur och Kultur.

Staffan Larsson. 2002. *Issue-based Dialogue Management*. Ph.D. thesis, Department of Linguistics, University of Gothenburg.

Aarne Ranta. 2004. Grammatical Framework, a type-theoretical grammar formalism. *Journal of Functional Programming*, 14(2):145–189.

Rose Sevcik and Mary Ann Romski. 2002. The role of language comprehension in establishing early augmented conversations. In I. J. Reichle, D. Beukelman, and J. Light, editors, *Exemplary Practices for Beginning Communicators*, pages 453–475. Paul H. Brookes Publishing.

Gunilla Thunberg. 2007. *Using speech-generating devices at home: A study of children with autism spectrum disorders at different stages of communication development*. Ph.D. thesis, Department of Linguistics, University of Gothenburg.