Modelling infant language acquisition from parent-child interaction: Identifying, testing, and simulating components and consequences of speech and gestures

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Project summary

This project aims to model infant language development from an interactional perspective during the first 3 years of life by identifying, testing, and simulating some of the fundamental processes involved in early language acquisition. A range of components that can be summarised by speech and gestures have an impact on language development, which is in turn measureable by milestones such as productive vocabulary size and interaction competence. The project team consists of a unique constellation of researchers with their individual linguistic, clinical, and technical background on language acquisition that is united at the site of one potent laboratory. They go beyond descriptive and experimental results on interactional language development by readily testing their results in computational models in order to build a model of infant language acquisition that truly incorporates the multitude of aspects embedded within parent-child interaction.

Introduction

One of the major questions in language acquisition research addresses the origin of language in infants. Theories about the infant being born with an innate capacity to learn language, for example in form of a Language Acquisition Device (Chomsky, 1965), have for some time been challenged by an emergent view that focuses on general processing skills and memory systems instead of a specific language module. Up to recently there has been no possibility to address this question directly through research. One reason has been our lack of understanding of the central components involved in language acquisition. Another reason has been technological difficulties in infant research. Now we have reached a point at which we are aware of the central components of language development, and we have developed experimental advances in which we can use these components to address the underlying question of infant language acquisition.

When language is defined as a complex and sophisticated communication system that emerges in interaction between two or more agents, the components that this emergent process relies on are *signal nature*, *agent prerequisites*, and *the characteristics of interaction*. *Signal nature* describes the acoustic, optic, and tactile information which can either be seen as information input towards an agent or information output from an agent. *Prerequisites of the agents* are constraints and resources within sensory processing, memory storage, motor skills, and previous experience. The infrastructure on which this acquisition process relies is *interaction* between parent and infant. This interaction consists of vocal channels, non-vocal behaviour such as facial expressions, eye contact, hand gestures, and body movements. Mastery of language is the result of the complex interplay of all these components: signal nature, agent prerequisites, and characteristics of interaction.

Through a combination of multidisciplinary research tools the current project is able to combine behavioural sciences, neurology, mathematics, physics, and cognitive science within the area of linguistic research. Only in combining these approaches there is the potential of being able to build a model describing infant language acquisition with respect to its multifaceted complexity and its embeddedness in the surrounding language environment. Furthermore, building such a model creates the possibility to address the fundamental question: is it possible to learn a language without a Language Acquisition Device? Finding the answer to this question would be a breakthrough in child language research, and is now within reach.

Project aim and research questions

The project aims to build a comprehensive model of language acquisition from an interactional perspective. This is achieved in three theoretically separate, but practically interwoven steps, (1) to identify single components of complex interaction patterns both with regard to vocal and non-vocal factors, such as speech input/output, eye-gaze, hand gestures, bodily movements, and the timing of these components in relation to one another; (2) to relate these components to each other and to objectively measurable language outcomes, such as vocabulary size, ability to tune in and out of turn-taking, and language comprehension at age two and three; (3) to test the validity of the results by simulating the acquisition process – with its different components – in computational modelling.

1. **Identifying components of parent-child interaction**

   Which vocal and non-vocal components such as for example voice pitch, intonation, pauses, facial expression, eye movement, and hand gestures can be identified as essential in parent-child interaction with children from 3 months to 3 years?

2. **Testing isolated components and their effects on language acquisition**

   Which components have what kind of consequences during experimentally manipulated interaction and in computational simulations? What are the long-term consequences of naturally occurring component differences on language acquisition measures such as vocabulary size?

3. **Simulating aspects of interaction and language acquisition**

   Can combinations of components in simulation approach the complexity observed in real-life interaction situations? How can an artificial system learn language similar to an infant? How does a viable model of language acquisition from an interactional perspective look like?