Phonetic and phonological aspects in relation to theory of mind and possible consequences for speech training in autism

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Abstract

Recent neuroscientific research concerning dysfunctional mirror neurons in autism spectrum disorders may contribute to the way we look at autism from a linguistic point of view. Can areas that overlap neurologically, according to neuroscientific research, be proven to be related in a cognitive linguistic way? This paper will discuss theoretical aspects concerning phonology – autism – mirror neurons.

Introduction

Kuhl et al (2005) write: *" Infant learning from exposure to language may be dependent on both an initial ability to discriminate phonetic units and an early interest in listening to speech".*
In this sense language and social abilities can be said to be related. The early stages of language development include the ability to percept segments in language, that takes place during early stages of perceptual development. There is an ongoing discussion about early precursors for language development. Phoneme recognition could be a so called precursor because it relates both to social development and language development. According to Kuhl (2005) there is a relation between early perceptual abilities and later language acquisition. This can be studied in autism, which is a disorder with a variety of symptoms related to both language and social development. Autism spectrum disorders (ASD) is characterized by difficulties with social interaction, absence of theory of mind, pragmatic and other language difficulties such as phonological impairment. The pragmatic difficulties may be secondary to other difficulties with theory of mind and language. Current research on the mirror neuron system link imitation to motor actions (Lacoboni, Dapretto 2006). Mirror neurons are related to action understanding and theory of mind. The Mirror Neuron System is also thought to be involved in hearing and is therefore directly connected to perception and production of speech. This conclusion may have learning aspects in that when we hear other persons speak or say different sounds we are stimulated to imitate these sounds in our production of speech. If it is the case that motor areas for speech – Brocas area – is activated during listening to sounds (motor theory for speech perception), mirror neurons could be influenced because of the cortical overlap with Brocas area. This could theoretically affect theory of mind, which may be be trained because of the plasticity of the human brain. Pickering/ Garrod (2007) claim that motorically related brain areas may be activated before perceptual prediction and perceptual actions. (This is the case in monkeys.) They claim that articulation is involved in language comprehension. Listening to sounds and language comprehension thus activate the speech production system.

In summary neuroscientific research has a large proportion of studies that conclude the existence of an overlap between Brocas area and the mirror neuron regions. This leads to questions whether there exists a linkage between mirror neurons – theory of mind – and language, for example phonological processing. Both lexical, grammatical and phonological information are processed within Brocas area according to several authors. This is of relevance for autism spectrum disorders, which is a disorder thought to have dysfunctional mirror neurons.

Relationship between phonology and autism

In an article by Wolk/Edwards (1993) the relationship between phonological difficulties and language delay is discussed. Four possible alternatives are given:

- Phonological limitations may restrict language development
- Limitations concerning general language development may restrict phonological development
- Phonological and other language difficulties may be independent of one another
- Phonological and language difficulties may share a common basis

If we analyse these statements further we may see that limitations in auditive perception, auditive processing and speech production may restrict syllable level, word level, phonological phrases or phonological utterances. Limitations on language development on the other hand, may restrict morphosyntactic structure, the phonological utterance and have an impact on lexical ability and word acquisition. Phonological and language difficulties may also share a common basis, together with other domains. Wolk/Edwards (1993) discuss that the most plausible explanation is an underlying neurolinguistic substrate for both phonology and language skills. This leads us back to the question whether theory of mind and language skills are linked in some way. We know that mirror neuron regions and Brocas area are linked anatomically in the human brain, but can we also prove that theory of mind and phonological skills are linked in a cognitive linguistic way? Researchers have in some previous research tried to examine the phonology of children with autism, who we know exhibit difficulties with theory of mind. In the last decades there are only a few articles concerning phonology and autism. Goldstein (2002) finds only one article (Koegel, ODell, Dunlap 1988) during a period of twenty years that focuses on speech production in autistic children. Koegel, ODell, Dunlap (1988) investigated the difference between reinforcing motor speech versus speech attempts. Reinforcing speech attempts (with motivation as an important aspect) was more effective than reinforcing motor speech.

One question that has been asked is: Do they develop phonology in the same way as other children? Wolk/Giesen, (2000) and Wolk/Edwards, (1993) found evidence for delayed (deviant) phonological development as well as unusual sounds in autistic children. Bishop (2004) found no indication of disproportionate difficulties in autistic people of normal ability. Tager-Flusberg (1990) found that autistic children seem to follow the same general path as Downs syndrome children in their study and normal children reported in the literature. Bartolucci et al (1976) discussed the matter of auditory input. Autistic subjects are suggested to be deficient in their ability to extract the components that structures auditory input. The study found that autistic subjects differ significantly from the mentally retarded in the phonemic substitutions which they make. Autistic subjects were also characterized by a high correlation between high frequency of phonological errors and low level of overall language development. The study also concluded that systematic investigations of the speech sound development of autistic children are absent in the literature. Bartolucci made an assumption that autistic children may generate phonemes by utilizing different strategies, which was weekly supported in the study. In that case the same end result at the phonological level could be reached by different processes. Rapin and Dunn (2003) found in their review article two subtypes in autistic children: one subtype concerning phonology and syntax and one subtype related to semantic difficulties and pragmatics. The authors of this article claim that there is a support that young autistic children are language disordered as well as autistic. Bortolini/Leonard, (2000) address the question of whether phonology is an area of special difficulties for these children or if phonology is impaired as a natural consequence of a more general limitation in language learning? Another aim was to investigate the centrality of phonology in the disorder in relation to morphosyntax. The authors of this article also discuss the impact of prosody on grammatical morphology in these children. This study revealed that the childrens phonological and grammatical morpheme limitations were separable to some degree.

Discussion and further work

We have now seen that there are very few articles about phonology and autism. Three articles (Bishop, 2004; Wolk/Edwards, 1993; Wolk/Giesen, 2000) used phonetic inventory/ process analysis as a linguistic method.

Generative phonology is not generally referred to, but may be the ground for much of the research implicitly. Distinctive features are referred to by Bartolucci et al (1976) and Koegel, ODell and Dunlap (1988), who use the distinctive feature analysis in their research. Wolk/Giesen use natural segment classes. Concerning phonological development in autistic children, some researchers have found delayed pattern in autistic children similar to mentally retarded children (Bartolucci/Pierce, 1977; Tager-Flusberg et al 1990). Wolk/Giesen, (2000) and Wolk/Edwards (1993) found delayed/ deviant development in autistic children concerning phonology. Only one article investigates perceptual abilites in autistic children – the article by Bartolucci/Pierce (1977). Bortolini/Leonard (2000) examined the relationship between structural constraints and use of grammatical morphology in SLI (=specific language impairment). No studies of this kind exist concerning children with autistic disorder. Mostly segmental levels are investigated in the literature. Tager-Flusberg, (1990) however, investigated morphological structures in a speech corpus and Bortolini/Leonard examined morphology in relation to constraints. The two subtypes found by Rapin & Dunn (2003), need to be examined more. If it is true that there are different subtypes: one semantic – pragmatic and one phonological – syntactic this must be taken into consideration when it comes to treatment of autistic children. There are several possible questions to ask concerning this subject. How are different language modules related? How is phonology related to word acquisition? How is language and joint attention related? Can imitative ability as a motor event improve by listening to sounds?

From my literature study I conclude the following:

Listening to sounds may influence cortical brain areas and affect linguistic prediction – phonological awareness and speech production in children with for example SLI/autism. If motor areas for speech – the so called Brocas area is activated according to motor theory for speech perception, mirror neurons could be influenced because of the overlap between Brocas area and theory of mind. This could theoretically affect theory of mind in autism because of the brain´s plasticity. The knowledge of mirror neurons can be summarized as "knowing how" to perform an action. This would be of importance for children with autism, who lack functional mirror neurons.

For my future empirical study I will hypothesize that children with autism will improve their speech and language by perceptual speech therapy. I will assume that cortical brain areas will be influenced by listening to sounds and that motor areas for speech may also be affected according to the motor theory for speech perception. This will also be in accordance with development of theory of mind because of the overlap of brain regions (Brocas area and mirror neuron regions).

My general hypothesis is:

1. Children with autism will improve their phonological ability and maybe their general speaking ability in that prevalence of certain target phonemes composed of distinctive features will improve by training with auditive stimuli.

Specific hypotheses:

2. Phonological (or semantic) errors will be reduced by perceptual speech therapy.
3. Secondary effects will be seen on words in different categories, that will increase, such as prevalence of nouns, verbs etc.
4. Syllable constructions will be affected.
5. Mean length of utterance – MLU will increase after therapy.
6. Complexity of syntactic structure will be affected.

Subjects: Subjects are autistic children, that are diagnosed with autism. The plan is to involve high-functioning autistic children with an IQ above 70, in the study. Preferably the group of subjects is as homogenous as possible. The children must have normal vision and hearing and preferably be about 6 years of age at therapy start. If possible only boys will be enrolled in the study to rule out gender as a variable. The children must have difficulties with language form and communication.

The plan is to try these hypotheses with a single subject design across behaviours. In a single-subject design the same individual´s performance is measured repeatedly and you may according to Hegde (1994) get a better result than with pre/posttests. With this design you do not present results in form of averages and subjects are not selected randomly. Focus will be on distinctive features in order to get a better possibility to analyze patterns in the children´s speech than with phonetic/phonemic inventories. This study may involve types of distinctive features; place features, laryngeal features and manner features. When the first feature is treated, the two remaining features still remain in baseline and so on.

Measures will be taken on prevalence of target phonemes. A qualitative analysis of semantic/phonological errors, word production per se, prevalence of words in different categories, syllable constructions will be made. Complexity of syntactic structure will then be performed together with MLU. Correlations between non-linguistic mental age and number of phonological errors in perception and production tasks will also be looked upon together with correlations between perception and production, IQ-level and language, language ability related to level of autism and age in relation to other variables such as language ability and treatment results. Further questions are: Is there a correlation between syntactic level and number of phonemes? How is lexical ability related to phoneme complexity? How is syntactic level and MLU related? This also needs to be found out in the study.

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