Areas of Language Impairment in Autism

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Abstract: The amount of medical literature describing autism spectrum disorder has become a real challenge as the quantity of abstracts deposited in PubMed digital library is constantly growing. Because the major manifestation of autism spectrum disorder (ASD) is impairment in language acquisition and communication, we used primary key words “autism” and “language acquisition” to retrieve the relevant literature from PubMed digital library and annotated a collection of 274 abstracts (from December 2008 to 1976) using Knoxtator. The objective was to locate secondary key words which in combination with primary key words would enable one to make information retrieval on language development in autism more specific and focused. The discussion provides a brief description of some selected terms and compares language impairment in autism with normal language development.

Conclusion: By using the combination of key words one is able to effectively manage the information retrieval and make the research less time consuming.

Keywords: ASD, autism spectrum disorder, language, key words
Introduction
Autism is a developmental brain disorder that typically affects a person’s ability to communicate, engage in social interactions, and respond appropriately to the environment. Autism Spectrum Disorders (ASD), also known as Pervasive Developmental Disorders (PDDs), are defined as the disorders that cause severe and pervasive impairment in thinking, feeling, language, and the ability to relate to others. The reason of autism remains unknown. Many research articles in psychology, neuroscience, neuroimaging, and special education address the issue of language disorder in autism.1–3 The deficiency in communication and socializing is a key problem that speech therapists, psychologists and doctors try to resolve when working with autistic children.

Language disorders are conditions characterized by deficiencies of comprehension or expression of written and spoken forms of language.4 These include acquired and developmental disorders as well as may cover a very broad range from simple sound substitutions to impairment in speech and language use. Language acquisition is the process by which humans acquire their native or a second language. Delayed acquisition of language is a common characteristic in autistic children. Most autistic children have difficulty in effectively using language.5 The communication problems of autistic children vary.6 Some children may have rich vocabulary and relatively high intellectual and social development, and some may be unable to speak. The pronunciation in most cases is not a problem for autistic individuals, but the majority demonstrates no desire to make eye contact, and they have a poor attention span.7,8 These children are often unable to use gestures and can neither communicate nor pinpoint the object they want. Some autistic individuals speak in a high-pitched voice or use robot-like speech. Moreover, they are often unresponsive to the speech of others and may not respond to their own names. As a result, some are erroneously thought to have a hearing problem. Language and communication are the topics of major concern in autism; thus, the objective of this study was to identify secondary key words in addition to primary key words “autism” and “language acquisition” that would facilitate information search and retrieval in the domain of language development in autism. The study relied on an extensive collection of abstracts of articles indexed in PubMed digital library, a service of the United States National Library of Medicine that includes over 19 million citations from MEDLINE and other life science journals. The core subject is medicine, and PubMed covers fields related to medicine and biomedical science.9 Our automatic information retrieval strategy combined with expert manual annotation of 274 abstracts on language acquisition in autism delivered 30 secondary key words which were grouped into five domains (i.e. phonology, grammar, semantics, pragmatics and non verbal language). The grouping of the language terms in the referred domains provides a better knowledge organization and characterization of language impairment in autism.

Methods
Construction of corpus of PubMed abstracts on autism and language acquisition
Abstracts of journal articles that contain the primary key words “autism” and “language acquisition” were obtained from PubMed digital library.9 An initial search (Search #1) was conducted using the key word “autism” to gauge the total number of abstracts. Furthermore, the Medical Subject Heading (MeSH) annotation tag (mh) was used to filter abstracts annotated with the MeSH term autism (Search #2). Additional searches were conducted using the term “language acquisition” (Search #3) as well as the term “language acquisition” with the MeSH tag added at the end of the text (Search #4). The combination of Search #2 and Search #4 provided a reduced set of abstracts for examining areas of language impairment in autism (Fig. 1).

Development of list of language terms and domains
The corpus of abstracts obtained from PubMed using a combination search of primary key words “autism” and “language acquisition” was manually examined and annotated by a Language Expert (N.K.) for secondary key words in areas of language impairment in autism. The annotation tool used was Knowtator plug-in of the Protégé Knowledge Representation System.10 The advantage of using Knowtator is that one can download the abstracts as separate texts and select the appropriate information from the context. Some other linguistic
tools, for example simple concordance program, enables one to analyze many abstracts for word/term frequency but it takes all the abstracts as one text and the word/term in question has to be known to the researcher. Thus, the rationale for using Knowtator was to find the key words based on the context and expert knowledge. The annotator read all the abstracts and decided which terms were used to describe language impairment in ASD. The further retrieval of annotated terms was done automatically with the help of algorithm.

The definition of language domains was completed by grouping and describing the retrieved terms and listing subsequent impairments associated with each term. The retrieved secondary key terms were further described as to their relationship to autism and the associated impairments. All the terms represent the result of “top-down” approach where the general information is known but the detailed features are unclear. We refer to the collection of abstracts as general information and specific terms as detailed features and therefore, for the definition of the secondary key words “top-down” approach was necessary.

**Results and Discussion**

**Normal language development and impaired language development in autism**

Normal language development usually follows a predictable sequence. Although there is a great variation in the age at which children reach given milestones (Fig. 2), certain characteristic features of normal language development still apply to different age groups. For example, children are cooing at six months, babbling at nine months and producing one-word utterances around 12 months of age. Normal speech is usually developed by 4–5 years of age. In autism, the cause of speech and language problems is unknown; however, many experts believe that the difficulties are caused by a variety of conditions that occur either before, during, or after birth and affect normal brain development. Some autistic children may be unable to speak; whereas others acquire rich vocabularies and discuss topics of interest in great depth. In ASD, speech and language develop to some degree, but not to a normal level. The significance of retrieving the terms characteristic of language impairment in autism and grouping them into domains is that these terms can be used in combination with the primary key words “autism” and “language acquisition” for further investigation of language development in autism. Therefore, the secondary words generated by our search aid in making this retrieval process more focused and efficient.

**Language terms and domains in corpus of PubMed abstracts on autism and language acquisition**

The PubMed literature database contains over 11,000 citations that have the MeSH term “autism”
(as of December, 2008). In addition, the search with term “language acquisition” including the MeSH term tag retrieved over 9,000 citations. A combination of these searches retrieved about 300 abstracts from which 16 had only headings without the abstract and thus only 274 were manually annotated using Knowtator. A total of 30 language terms were identified and categorized into five language domains: phonology, grammar, semantics, pragmatics and non-verbal language. This grouping into domains was necessary to demonstrate the aspects of language affected in autism. Although some of the retrieved terms are used in the same manner in general language, these terms are interpreted from the point of impairment and thus the accent is made on the explanation of these terms in the context of autism. For example, echolalia is not common to normal language as the aspect of pragmatics. However, in the context of autism, we classified this term as a characteristic of the pragmatics domain. Table 1 presents the language domains and subsequent impairments that appear in the medical literature on autism.

**Phonology**

Phonology refers to the sound patterns of a language; that is, the sounds that make up a language and the rules governing their combination. Phonology is the area of language least likely to be impaired in people with autism. However, some preliminary studies with magnetic resonance imaging have shown that children with autism process sounds a split second slower than typically developing children. Their response was delayed by about 20 milliseconds compared to controls. Some people with autism are also extremely sensitive to normal sounds. They encode new information through contrastive stress in multiword phrases or through lexicalization in single-word phrases and consistently produce repetitions of previously encoded information whereas the encoding of a new action or state is relatively infrequent in autism. Autistic children show

**Figure 2. Normal language development vs. language development in autism.**

<table>
<thead>
<tr>
<th>Normal language development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooing occurs around 6 months</td>
</tr>
<tr>
<td>Babbling occurs around 9 months</td>
</tr>
<tr>
<td>One-word utterances develop around 12 months</td>
</tr>
<tr>
<td>Telegraphic speech develops about the age of 2</td>
</tr>
<tr>
<td>Normal speech develops by about 4-5 years of age</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Impaired language development in autism</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 6 months, no eye contact during interaction, no cooing, no smiling when parents smile and no response to peek-a-boo game</td>
</tr>
<tr>
<td>At 12 months, no attempts to speak, no pointing, waiving or grasping, no response when name is called, indifference to others, fixation on a single object which impedes further acquisition of abstract concepts and new vocabulary</td>
</tr>
<tr>
<td>At 24 months, does not initiate two-word phrases and demonstrates additional loss of word or developmental skill</td>
</tr>
</tbody>
</table>

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Normal language developement

| Cooing occurs around 6 months |
| Babbling occurs around 9 months |
| One-word utterances develop around 12 months |
| Telegraphic speech develops about the age of 2 |
| Normal speech develops by about 4-5 years of age |
Language impairment in autism

Table 1. Five domains of language terms with characteristic impairments in each.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Characteristic impairments</th>
<th>Number of terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phonology</td>
<td>Articulation; Phoneme; Pitch; Sound; Syllable</td>
<td>5</td>
</tr>
<tr>
<td>Grammar</td>
<td>Pronoun; Sentence; Syntax</td>
<td>3</td>
</tr>
<tr>
<td>Semantics</td>
<td>Cohesion; Lexicalization; Object naming; Phrase; Receptive vocabulary; Vocabulary; Word</td>
<td>7</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>Attention; Behavior; Communication; Comprehension; Echolalia; Encoding; Imitation; Joint attention; Play; Regression; Request; Response; Speech; Utterance</td>
<td>14</td>
</tr>
<tr>
<td>Non-verbal language</td>
<td>Gesture</td>
<td>1</td>
</tr>
</tbody>
</table>

a higher capacity in memorizing picture-pitch associations and in detecting pitch changes in melodies than their normal counterparts. Moreover, some individuals with autism known as musical savants possess absolute pitch. It is argued that this superiority may be due to an abnormally high sensitivity to fine-grained pitch differences in sounds.

Grammar

Grammar is severely impaired in children with autistic developmental disorder. Interpreting reflexives and using short and long passive verbs of both action and psychological associations is extremely difficult for autistic children. The inability to process the syntactic relationship between the reflexive and its antecedent is expressed by poor interpretation of reflexive but not personal pronouns, whereas poor performance on passives shows the inability to interpret syntactic chains.

Pronoun reversal, which occurs when individuals confuse first and second person pronouns in speech, is a characteristic of language impairment in autism. Autistic individuals are significantly less likely to apply the pronoun “me” in a visual perspective-taking task and are less likely to employ the pronoun “you”. A high percentage of autistic children are reported to have current difficulties with personal pronouns in their everyday life. The deficiency in the ability to determine the speaker’s intention without explicit cues and impairment in the comprehension of syntactic structures makes the acquisition of new verbs difficult for autistic children. It has been reported that the function of processing implicit syntactic relationships is significantly dependent on the hippocampus. Autism has been postulated to be a developmental syndrome related to hippocampal dysfunction.

Semantics

Semantics is an aspect of language that relates to understanding the meanings of words, phrases and sentences and using words appropriately when we speak. Autistic children have difficulties with semantic processing of words, especially abstract words like ‘curious’ or ‘vague’, words that relate to feelings and emotions such as ‘embarrassed’ and ‘anxious’, and words that refer to status (for instance ‘expert’ or ‘authority’) or degree. They have difficulty with idioms, sayings and slang expressions, often taking them literally or interpreting them incorrectly. Odd speech, as manifested by at least two of the following six criteria is one of diagnostic criteria, for Asperger’s disorder: 1. abnormalities in inflection, 2. talks too much, 3. talks too little, 4. lack of cohesion to conversation, 5. idiosyncratic use of words, 6. repetitive patterns of speech.

Some autistic children exhibit echolalia, which is the repetition of words, signs, phrases or sentences spoken by other people. Some children use this as a communication device. That is, the adult says “do you want a car?” and the child might say “want a car” to mean yes. A child may repeat the same phrase over and over again as a means of regulating their own behaviour. They learn to talk by memorizing words and phrases while being unable to use these same words freely. Also, they repeat phrases out of context, especially phrases heard on TV. Late emergence of spoken words is an early sign of ASD, but most children with these disorders acquire at least some spoken language, with approximately 80% producing more than five words.

Pragmatics

Achieving proficiency in pragmatic knowledge—the ability to understand and use basic speech—is impaired in autism. High functioning autistic children acquire some pragmatic skills on an elementary
level, and they learn to answer questions in yes/no or one word responses. The definition of pragmatics skills includes being able to participate in a conversation by taking turns with the other speaker, reacting appropriately to the other person’s body language and mood as well as their words, the ability to maintain a topic or change topics appropriately, the ability to maintain appropriate eye-contact during a conversation and the ability to distinguish how to talk and behave formally with some individuals and informally with others.29

There are various stereotypical behaviors which are commonly seen among people with autism. Some of the most common are ‘body-rocking’, hand and limb ‘flapping’, ‘head-banging’ and ‘spinning’. These behaviors can be used to express different psycho-emotional states and may be engaged in at various times: when agitated, when aroused or active, when happy, when excited, when angry and even when simply comfortable and relaxed.30

The communication problems of autism vary depending upon the intellectual and social development of the individual. Some may be unable to speak, whereas others may have rich vocabularies and are able to talk about topics of interest in great depth. The majority of autistic individuals have little difficulty with pronunciation though most have problems effectively using language. Despite common areas of language impairment, children and adults who have an autism spectrum disorder will differ from one another in the comprehension of the spoken messages of others and in their response to the strategies applied to facilitate the communication process.

Deficiencies in the development of joint attention skills are a hallmark of children with ASD. However, the range of the development of joint attention in autism is very broad and some autistic children have tendencies to display better abilities than others. Also, it is suggested that children with autism who display more intact joint attention skills exhibit better outcomes with respect to the development of cognitive, language, and symbolic play skills. The normal development of children is characterized by complex and diverse behavior such as play.31 The play of autistic children can be impaired in all stages of development. Their play behavior is often limited to simple manipulation, the quality of their play is lower than that of non-autistic children of comparable mental age, and spontaneous, symbolic play is usually absent or impaired.32 Although children with autism show limitations in spontaneous play, this is not attributable to a complete inability to play but may be the result of lack of experience or behavioral regression manifested in the level of play. When regression occurs, autism appears to be the cause. Approximately 30% of autistic children have regression of both language and behavior which happens usually prior to the age of 2.33 Developmental regression can be overcome by promoting early play. The children with ASD usually need to be taught the ability to request objects during learning and play.34,35 Therefore, children with these disorders are most always recommended for speech therapy36–38 that involves teaching the correct pronunciation of words, non-verbal communication, speech pragmatics, turn taking in conversation, and the development of skills used to understand abstract concepts.

Non-verbal language
By the age of 18–24 months children later diagnosed with autism show unique communication profile with core deficits in deictic gestures.39 It has been reported that children with autism have significantly impaired motor coordination skills and also generalized impairment in gestural performance.40 Therefore, the early development of the use of non-verbal language can be beneficial for individuals with autism. Non-verbal language can decrease the typically expressed negative behaviors such as tantrums, anxiety, self-injury, and aggression and increase social interaction and supports the development of cognitive structures necessary for speech and communication.

Conclusions
The areas of language impairment found in autism are grammar, pragmatics, semantics, phonology and non-verbal language. Retrieval and categorization of secondary key words based on PubMed corpus of abstracts enables one to use the combination of primary and secondary key words for more efficient and focused information search. Structured presentation of secondary key words enhances the knowledge organization of the domain of language impairment in autism. Information related to the topics in language impairment in autism may be of major concern of doctors, specialists, speech therapists, parents and all the people surrounding autistic children. Further work
may include identification of specific terms pertaining to different aspects of autism based on word frequency in corpus and development of ontology of autism.

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Disclosures
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