Research in Developmental Disabilities 34 (2013) 3317–3331

Contents lists available at SciVerse ScienceDirect

Research in Developmental Disabilities

Aspects of grammar sensitive to procedural memory deficits in children with specific language impairment

Kuppuraj Sengottuvel *, Prema K.S. Rao

Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysore 570006, India

ARTICLE INFO

Article history:
Received 9 May 2013
Received in revised form 24 June 2013
Accepted 25 June 2013
Available online 31 July 2013

Keywords:
Procedural deficit
Sequencing problems
Language impairment
Adapted serial reaction time task
Inflectional operations

ABSTRACT

Procedural deficit hypothesis claims that language deficit in children with specific language impairment is affiliated to sequence learning problems. However, studies did not explore on aspects of grammar vulnerable to sequence learning deficits. The present study makes predictions for aspects of grammar that could be sensitive to procedural deficits based on core ideas of procedural deficit hypothesis. The hypothesis for the present study was that the grammatical operations that require greater sequencing abilities (such as inflectional operations) would be more affected in children with language impairment. Further, the influence of sequencing difficulties would be even greater in agglutinating inflectional languages. An adapted serial reaction time task for sequence learning measurements along with grammatical tasks on derivation, inflection, and sentence complexity were examined on typically developing and language impaired children. Results were in favor of procedural deficit hypothesis and its close relation to non-adjacent grammatical operations. The findings were discussed using procedural deficits, declarative compensatory mechanism, and statistical learning deficits.

Language is one of the most remarkable abilities of the human brain. Children who experience difficulties with language learning but have no other associated problems such as children with specific language impairment (SLI) play a vital role in providing evidence that can help delineate potential underlying dedicated cognitive processes for language. SLI is a relatively common developmental condition in which a child fails to develop language at the typical rate despite normal general intellectual abilities, adequate exposure to language, and in the absence of hearing impairment. Affected children have the greatest problems in learning word forms and the grammatical structure of language with acquisition of semantics and pragmatics relatively spared (Leonard, 1998). Theories proposed from various perspectives including neurolinguistics hypothesize that the dedicated cognitive process for grammar operation could be the procedural memory system. One such hypothesis is the procedural deficit hypothesis (Ullman & Pierpont, 2005) for grammar deficit in children with specific language impairment (SLI). The procedural deficit hypothesis is based on the declarative-procedural model by Ullman (2001) which enunciates a neurocognitive perspective of language processing. The declarative/procedural (DP) model proposes that temporal lobe circuits mediates lexical system that sub serves the associative memory of distributed (but structured) representations on which phonological, morphological and semantic mappings are acquired, stored, computed, and retrieved. On the other hand the fronto-basal ganglia circuits mediates the procedural memory system which sub serves mental rules of grammar in building the sequential and hierarchical structure of complex forms. Procedural memory in a broader sense is a non-declarative memory that underlies verbal and nonverbal unconscious sequence learning. Procedural

* Corresponding author. Tel.: +91 9742212172.
E-mail addresses: kodakcanon@yahoo.com (K. Sengottuvel), prema_rao@yahoo.com (Prema K.S. Rao).

0891-4222/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ridd.2013.06.036

memory was phylogenetically significant for motor learning of sequences which was adapted for verbal learning during language evolution (for detailed review see Christiansen, 1994; Kuppuraj & Prema, 2013b). For instance, sequencing abilities in verbal domain probably helps the system to predict the upcoming sequences in speech stream (Christiansen, 1994). The procedural deficit (PD) hypothesis based on the DP model predicts that grammar deficit in children with SLI is caused by poor procedural learning skill. The hypothesis was strengthened by data showing poor procedural memory performances in children with SLI (e.g., Lum, Conti-Ramsden, Page, & Ullman, 2012). Even though procedural memory deficits are reported in children with SLI, studies did not attempt to inquire on aspects of grammar which are more vulnerable to procedural memory deficits. The present study attempts to predict the aspects of grammar operations which could be more vulnerable to procedural memory deficits implicating ideas from statistical learning mechanism. The study compares grammatical profiles from children with SLI with predominant procedural learning deficits against the typically developing children with the objective to examine the grammar aspects (functional class morphemes such as inflection and derivation as well as sentence complexity) that are complemented the most by procedural memory system.

1. Grammar deficits in SLI

The linguistic competence of an individual depends on their ability to sequence content words from lexicon with the help of functional words/morphemes as per the rules of the native language. Children with SLI show deficits predominantly in the usage of functional class morphemes (Leonard, 1998; Rice & Wexler, 1996a; Schuele & Tolbert, 2001) where the content words (lexicon) usage appears near normal (e.g., Ullman & Pierpont, 2005). Cross linguistic investigations on SLI revealed that the language characteristics of a SLI child will depend on the language to which he/she is exposed to. For instance children with SLI who are exposed to language with obligatory noun, verb, and adjective inflections will use such inflections much more readily than children with SLI whose language permits bare stems and contain only small amount of inflections. Similarly, children with SLI whose language has considerable word order variation would show greater word order difficulties compared to children who are exposed to rigid word order language (Leonard, 2000). The language sensitive characteristics of SLI might be of interest to the present work as the language selected for present work is an agglutinative inflections rich south Indian Dravidian language (Kannada). Leonard (2000) states that children with SLI use fewer grammatical morphemes in obligatory contexts, and they often omit or substitute tense, agreement morphemes and other functional elements, such as auxiliaries, copula, and determiners.

1.1. Inflections in SLI

Inflections are a set of morphemes always suffixed to a root word to mark tense or agreement or number driven by underlying rule. Inflectional morphemes indicate relation between different words in a sentence and they could be suffixed with any word according to the rule. Knowledge of short and long distance relations (with in phrase, across phrase) in a sentence is compulsory for operation of these inflections. Examples are given from Kannada an agglutinative Dravidian language spoken in Karnataka state of southern India, because the present study uses Kannada language.

E.g. 1	*Short distance agreement (Inflections)*	*Long distance agreement*
Kannada	avanu –nakkida	ava**nu** -na:le- o:rinda- baru**thane**
English	*he - laughed*	*he –tomorrow- from his place- will come*
	/*nu*/ agree with /*da*/	/*nu* /agree with/*ne*/, /*na*:*le*/agree with/*tha*/
E.g. 2	Morphosyntax (in the realm of inflection)	
Kannada	manea**lli**- snehitaru -**idre**-kushia:gathe	
English	*at home- friends-if there- fun*	
	/*lli*/is locative case marker (inflected) which is related to/*idre*/which is conditional	

Example 1 shows that modification of a last word in a sentence could entirely depend on first word of the sentence (i.e., the agreement) in Kannada. The entities governing morphosyntax abilities are not independent from inflectional morphology. Wexler in his work on development of inflection in a biological based theory of language acquisition demonstrates the inseparability between verbal inflection (inflections on verbs called verbal inflections) and morphosyntax such as preposition, conditionals, and conjunctions of a sentence (see example 3 for inflection and morphosyntactic coexistence in Kannada). In the example 3 "*alli" (at)* is an inflectional locative case marker and "*idre" (if there)* is a morphosyntax element indicating condition, illustrating an inseparability of inflection and morphosyntax for proper surface structure of a sentence. Children with SLI fail to make agreements with tense, number, and gender in a sentence. Several studies have shown deficits in usage of inflectional morphology in children with SLI (Rice, Tomblin, Hoffman, Richman, & Marquis, 2004; Rice, Wexler, & Hershberger, 1998; Rice, Wexler, Marquis, & Hershberger, 2000).