Sentence discontinuous constituents and implicit learning limitations in Down syndrome

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Abstract

Children with Down syndrome experiment specific difficulties in morphosyntactical development. In particular, they demonstrate marked shortcomings in handling discontinuous constituents in sentences. It is suggested that these shortcomings stem from a conjugated deficit in some aspects of implicit procedural learning and relational semantics.Recommendations are made for rehabilitative intervention.

Keywords: syntactical development, grammatical morphology, semantical development, implicit procedural learning, artificial grammar.

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Syntax is the language subsystem responsible for organizing linguistic expression sequentially. Syntactical (or grammatical) morphology deals with the particular morphemes that can be added to the stem of some categories of words for encoding semantic features such as number, gender, time and aspect.

The particular difficulties of persons with Down syndrome (DS) in morphosyntax (a generic term for syntax and syntactical morphology) are well documented (Chapman, 1995; Miller, 1999; Rosenberg & Abbeduto, 1993; Rondal & Edwards, 1997; Rondal, 2009); Rondal & Guazzo, 2012). Overall they concern the understanding and production of discontinuous constituents in sentences: in particular, centrally embedded subordinated clauses and number agreement between grammatical subjects and verbs wherever the verb does not follow the grammatical subject immediately in the sentence. Major difficulties with reversible passives sentences can also be considered in the same category to the extent that they imply a mental reversal of the roles of semantical agent and patient with regard to corresponding actives. It has been suggested (e.g., Miller, 1999) that receptive morphosyntax is preserved in DS in contrast to production. This may be a kind of conceptual illusion, however. Language understanding in communicative context is facilitated lexically; that is, knowing the referential meaning of the words one can most often guess at the meaning of the entire sentence. Controlling for lexical knowledge, it can be demonstrated that typical persons with DS do not understand the morphosyntactic structures that they are not able to produce (Rondal & Edwards, 1997).

No convincing explanation has been proposed for the above shortcomings. At corresponding linguistic levels the language input directed by parents to their children with DS does not differ from parental language to typically developing (TD) children, neither in terms of morphosyntactic structures or contingent feedback upon children's production (Rondal, 1978; Rondal & Docquier, 2006). Given that parental speech to children is grammatical (Marcus, 1993) and adapted to the developmental levels of the children (Rondal, 1985, for a review), there is no reason to believe that grammatical difficulties in DS originate from poverty or maladaptation of the input. Reduced global cognitive ability does not supply a satisfactory explanation either.There is a loose correlation between severity of cognitive handicap and language development although the outcome may vary depending on the particular syndrome. Research shows, however, that intellectual disability is not automatically tied to grammatical underdevelopment. Several so-called language exceptional adolescents and adults with moderate or severe intellectual disability, including DS, have been found to exhibit normal-like productive and receptive grammatical abilities (Rondal, 1995). Cognitive ability within normal psychometric limits does not seem to be a requisite for advanced morphosyntactical development.

In what follows, I explore another explanatory path. Assuming that grammatical development in natural languages and natural conditions proceeds implicitly, i.e., without an intention to learn, a clear consciousness of the knowledge acquired, and depends on implicit procedural memory (Ullman, 2004), it may be interesting to have a look at the ability of children with DS in implicit learning.

Implicit Learning in Down Syndrome

Since Reber's (1967) pioneering work, typical experiments in implicit learning have involved learning a finite-state artificial grammar. An automaton produces visual sequences of items according to a set of transitional rules. In the learning phase, participants are requested to learn as many sequences as possible. They are not instructed that there are transitional rules between successive items. In the test phase, participants are told of the existence of transitional rules but the nature of these rules is not revealed. They are requested to classify new sequences in grammatical (those respecting the transitional rules) and nongrammatical ones. Results show that most participants are able to discriminate between sequences as if they had learned the transitional rules although they are not able to verbalize them.

An experiment carried out by Witt (2011) illustrates how the above methodology can be adapted for use with children with intellectual disability. The finite-state automaton in Witt's experiments generated sequences of 3, 4 or 5 colored flags representing teams of small pandas in a computerized video game of cord drawing presented in sequences. Three series of colors were used: in one series, the sequential grammar allowed successive repetitions of adjacent colors (e.g., blue-yellow-yellow; blue-yellow-yellow -green; red-green-green-yellow-blue; and so on); in another series, the grammar allowed successive repetition of nonadjacent colors (e.g., blue-yellow-blue; red-green-yellow-red; blue-yellow-green-yellow-blue; and so on). A third series presented the colors in random serial order and served as a control condition. In the test phase, participants were informed that in the second day of the tournament, the organizers had forgotten to place the colors on the flags which, as a consequence, had remained white. The children were invited to set series of 3, 4, or 5 colors on corresponding cardboards, selecting the colors one by one from a random color display. The test phase was followed by a debriefing session in the form of a standardized questionnaire in which the children were asked whether they knew why they had been invited to play that particular game.

Reber (1993) has maintained that participants in implicit learning tasks unconsciously abstract the transitional rules involved in the sequences of stimuli. His interpretation has been largely abandoned in more recent contributions, however, although it cannot be completely disregarded particularly for shorter and simpler sequences. Perruchet and Vinter (2002) have suggested that participants in implicit learning of artificial grammar actually segment the input in sequences of chunks composed of items associated within the same attentional focus. The chunks serve to construct mental representations isomorphic to the percepts and these representations can reach consciousness.

Natural Morphosyntactical Development

Although, there are obvious differences between experimentally learning an artificial grammar and natural morphosyntactical acquisition, it is possible to transpose Perruchet and Vinter's (2002) model to the latter as a plausible attempt to contrast theoretical suggestions such as representational innatism or the idea that morphosyntactical development is possible only with the concourse of abstract grammatical notions genetically prefigured in their universal forms (Pinker, 1994).

The alternative theory (Perruchet & Poulin-Charonnat, 2015; Rondal, 2017) can be summarized as follows. As soon as the child has acquired a few words, s(he) can start extracting short sequences of nonanalyzed adjacent words from parental input. The extracts are significant portions of the input, pragmatically relevant, cognitively accessible, put in evidence at the beginning and/or the end of utterances, and frequently repeated. Associative forces activated by the presence of successive items within the same attentional focus favor the transformation of the percepts into mental representations isomorphic to the sequential structure of the input.

This model accounts reasonably well for the early stages of morphosyntactical development in TD children witness the numerous interactive corpus of parent-child interaction stored in the Childes world data base (MacWhinney, 1994). For the children with Down syndrome, it correctly predicts that simple and shorter sentences are readily understood and produced with correct word order, and that regular and irregular grammatical morphemes are used properly as long as they involve adjacent items (Rondal, 2009).

Continuing with development, however, hundreds hours of exposure to adult speech and thousands of possible extracts from this input, there is clearly a need for a reduction mechanism involving abstract entities. Also given that natural language cannot be assimilated to a register of ready-made utterances, the reduction mechanism has to have a generative character, i.e., an ability to generate a theoretically infinite number of utterances.

Relational semantics satisfies both requirements. By relational semantics, it is meant the meaning relationships holding between words in phrases, clauses or sentences (e.g., notions of agent, action, state, process, patient, location, quality, quantity, beneficiary, accompaniment, etc., and their intricate combinations in complex structures; see, for example, Chafe, 1973; Langacker, 1987; Van Valin, 1999). The idea is that through pairing with sequential extracts from parental input, these meaning relationships, already present in the semantic matrix of the utterances but unordered till then (by definition as they are universal and can be used in any language), become ordered linearly. They may then be used to reduce the huge number of input extracts into a workable system of relations dotted with generative power, i.e., able to serve as templates for producing an infinite number of organized sequences according to the grammatical requirements of the particular language. These meaning relationships are abstract notions but cognitively accessible and available from the beginning of development through the interface between cognition and semantics.

Relational Semantics and Discontinuous Constituents

Meaning relationships are useful for solving the problem of the grammatical dependencies between nonadjacent items and discontinuous constituents in sentences. Whereas the linear course of the phrase, clause or composite sentence is interrupted to include additional words or sequences of words, the semantic relations are maintained in short-term memory and function as a "cognitive splint" to more distant parts of the sentence. The following simple example illustrates the semantical mechanism that renders unnecessary the recourse to complex and cognitively little accessible hierarchical levels of sentence analysis as in traditional phrase structure grammars. In the sentence, *Beautiful Chloé wearing her blue-sky leather suit is riding the black stallion*, the first noun phrase is interrupted following the noun to embed a qualifying participial clause while the semantic relation agent-action-patient is kept in immediate memory and allows connecting the first noun phrase to the verbal phrase in the second part of the sentence.

I suggest that the syntax-semantics connection is the place where children with DS exhibit a particular weakness accounting for their difficulties with sentence discontinuous constituents. At corresponding mental ages with TD peers, children with DS do access basic semantical relations. However, they are limited in combining elementary semantical relations into more complex, extended, and/or conjugated ones (Rondal & Edwards, 1997; Rondal, 2009). In the example given above, one needs to keep in mind the relationship between the agent (*Chloé*) and the action-patient (*is riding the black stallion*) while dealing with the embedded clause that corresponds itself to a semantical relation agent-action-patient (*wearing her blue-sky leather suit*) with the agent being nonexpressed as this is the same as in the main clause.

A similar situation holds for the grammatical subject-verb number agreement wherever the verb does not follow the subject immediately, as in the example: *Choé and another lady that I do not know are both riding white horses*.

Witt's (2011) research, already mentioned and conducted with children with mild to moderate intellectual disability including Down syndrome (chronological ages between 9 and 10 years; mental ages - MA - 5 to 6 years) and MA-matched TD children), is revealing. Results show that children with intellectual disability are indeed able to learn sequential relations in an artificial grammar task. However, in contrast to their MA-matched TD peers, they are sensitive only to adjacent repetitions of pairs of items and do not encode mentally positional information. This is what would be expected from the indications above regarding the morphosyntactical limitations in children with Down syndrome. Or, the other way around, given these children's lack of sensitivity to nonadjacent items and positional regularities in sequences, one could predict their difficulties with sentence discontinuous constituents. Only immediately linearly following items and perceptually more prominent characteristics of the sequences are attended to, dealt with, and stored in procedural memory. Meaning relations do not combine the way they should in order to sustain morphosyntactical treatment beyond a few successive items. These shortcomings prevent the construction of appropriate mental representations of the structure of sentences with discontinuous constituents. Research needs to clarify whether the bulk of the problem is with perception, attention, or memory, or all of these cognitive components.

In some respects, the lack of understanding of and producing complete reversible passive sentences in persons with DS is related to the preceding considerations. The passive structure can be illustrated with the following sentence: *The Ferrari (car) is followed by the McLaren*. It has the same referential meaning as the corresponding active: *The McLaren (car) follows the Ferrari*. The difference is that, for emphatic purpose or because the Ferrari car is old information (i.e., can be considered by the speaker as easily retrievable given the communicative context or the fact that the Ferrari car has already been mentioned), it is placed at the beginning of the sentence. This type of passive is reversible in the sense that its reversal makes also a plausible sentence (e.g., *The Mclaren is followed by the Ferrari*). Complete reversible passives are relatively rare in natural languages because they involve additional lexical-grammatical complexities in order to mark the sentences as passive (i.e., use of the auxiliary verb *to be*, past-participle on the main verb, and agentive preposition introducing the agent noun phrase) and because they can be substituted by corresponding and formally simpler active ones. Truncated (e.g., *A medicine was prescribed*) and nonreversible passives (e.g., *A medicine was* *prescribed by the physician*) are easier to deal with as lexical meaning suggests sentence meaning.

The problem in understanding and producing complete reversible passives is double. One has to deal correctly with the particular grammatical morphology of the sentence (auxiliary and past participle) and the agentive preposition. Only sentences with action verbs can be formulated at the passive voice. One must also realize that from the same global referential meaning two corresponding semantical relations can be linearized: agent-action-patient and patient-action-agent but that only the second one is relevant in the passive formulation. Persons with DS, although able to learn basic semantical roles, as said, have difficulties in dealing with the reversal of semantical relations commanding the morphological and lexical marking of passive sentences.

Assuming that pending additional research the above theoretical and interpretive suggestions could be substantiated further, the prospect for rehabilitative intervention is clear if not necessarily easy to carry out. One must pay more attention to the way children with DS attend to, perceive, and mentally represent successive parts in longer sentences. Understanding and producing combined semantical relations underlying formally more complex sentences should be placed higher on the rehabilitation agenda. One would need disposing of computer programs specifically designed for people with DS and allowing visualizing on screen the relationships between sentence discontinuous constituents (coupling words and nonverbal representations for those uneasy with reading), taking advantage of the fact that visual cognition is better preserved in DS than auditory one.

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