Spontaneous Language of Children With Specific Neurological Syndromes

Y. Levy
Psychology Department,
Hadassah-Hebrew University
Medical School
Jerusalem, Israel

A. Tennenbaum
The Jerusalem Institute for
Child and Family Development
Jerusalem, Israel

A. Ornoy
Hadamah-Hebrew University
Medical School
Jerusalem, Israel

This paper presents data concerning the early phases of language development in 8 children with congenital neurological syndromes (NS) who are cognitively impaired. The children are native speakers of Hebrew, and their verbal achievements assessed on normative tests are below their age level. The children's spontaneous speech was analyzed with respect to 13 different language variables known to be diagnostic of a child's developmental level. No differences were found between the children and their language-matched controls on 10 grammatical variables. The groups differed, however, in number of pragmatic errors, errors of word choice, and errors of gender marking on animate nouns. Profile analysis was done through the use of POSAC (partial order scalogram analysis by base coordinates; Shye, 1985; Shye, Elizur, & Hoffman, 1994). The analysis did not reveal differences between the children with NS and the controls.

These findings suggest the possibility of a mechanism that is functionally akin to brain plasticity. Such a mechanism will guarantee the preservation of basic linguistic skills in children with NS.

KEY WORDS: spontaneous productions, neurological syndromes, syntax, morphology, profile analysis

L anguage disorders in children are associated with a wide variety of etiologies including pre- and postnatal trauma, sensory loss, genetic syndromes, metabolic disorders, disease processes, and environmental deprivation. Attempts to demonstrate that genetically defined syndromes of mental retardation are associated with specific linguistic phenotypes from early on have usually had disappointing results. The within-group variability is often as great as, or greater than, the variability in genotypically different syndromes. Furthermore, although delay is typically present, with the extent varying with the syndrome, when basic linguistic functioning is achieved, the observed developmental course is generally similar to what is observed in typically developing children.

In the current work, naturalistic productions of 8 Hebrew speaking children with a variety of neurological deficits (NS) are analyzed. The children were cognitively impaired, and their verbal achievements, as assessed on normative tests, were below age level. The children's linguistic profiles were compared to those of typically developing, language-matched controls. We will investigate the claim that in the early linguistic phases there is similarity in grammatical development between children in these two groups. If indeed children with neurological deficits of various etiologies and typically developing children traverse the

same developmental path for language, it suggests an extraordinary robust phenomenon that has implications concerning the power of the brain to reorganize even in cases of diffused abnormality.

The study focuses on 13 variables known to be diagnostic of a child's linguistic level, as discussed below. The unique morphological complexity seen in Hebrew allows for a clearer delineation between formal and semantic aspects of language than is typically possible in a language like English.

Previous Research

Bishop (1988a) reviews a series of studies of children with anatomical injuries and concludes that they show a similar-to-normal course of acquisition in the early phases of language development. Thal et al. (1991) investigated 53 children, 10–44 months old, with a single unilateral brain injury to the right or to the left hemisphere, incurred before 6 months of age. The authors state that their expectation that there will be delays in grammatical development in children with left anterior lesions associated with a potential "developmental agrammatism" has not been supported by the data. In other words, with respect to grammar, the children were developing normally. Levy, Amir, and Shalev (1992) present a case study of a child with congenital left hemisphere (LH) infarct affecting the middle cerebral artery. The child's naturalistic productions were analyzed in comparison with MLU-matched controls. The findings show a similar-to- normal profile of grammatical development. Results were the same for children with various other anatomical malformations (Levy, 1996).

Feldman, Holland, and Keefe (1989) describe the language abilities of two pairs of twins in whom one twin sustained a brain injury to the LH around time of birth. Results show that the twins with the disabilities scored at or above the normal range on all formal tests, although they were somewhat lower on vocabulary and on the Expressive scale of the Sequenced Inventory of Communicative Development (developed by Hendrick, Prather, & Tobin, 1975). Levy (1997) studied the naturalistic productions of a pair of DZ twin boys. One of the children had a congenital LH brain injury, and the other twin was intact. Comparison between the two children showed that the child with the LH lesion, although delayed, followed a developmental course that was similar to the one followed by his healthy brother.

Studies of individuals with Down syndrome typically reveal language problems that are more serious than would be expected based on general cognitive functioning (Cardoso, Mervis, & Mervis, 1985; Sabsay & Kernan, 1993). MLU in children with Down syndrome was found to correlate highly with age, despite significant delays.

In the 1–3.5 range, MLU predicted grammatical complexity just as it does in typical children (Rondal, Ghiotto, Bredart, & Bachelet, 1988). Interestingly, studies of children with Down syndrome whose MLU did not exceed 3 have shown that, although delayed, their language does not differ from that of children with retardation of unknown etiologies. Nor in fact does it differ from the language of typically developing children of equivalent MLU (Owens & MacDonald, 1982; Pruess, Vadasy, & Fewell, 1987; Rondal, 1993; Tager-Flusberg, Calkins, Nolin, & Baumberger, 1990).

A common finding in individuals with fragile X syndrome (FX) concerns the production of deviant, repetitive language, which is distinct from the language of persons with either Down syndrome or Autism (Sudhalter, Cohen, Silverman, & Wolf-Schein, 1990). Hagerman and McBogg (1983) describe the language of FX males as "jocular, narrative, staccato and repetitive, with short bursts of three and four word phrases, often repetitive, abrupt and usually observational in content." However, the production of such deviant language did not correlate with the Index of Productive Syntax (Sudhalter, Scarborough, & Cohen, 1991). Furthermore, correlations between MLU and the Index of Productive Syntax derived from naturalistic conversations were similar to those observed in normal preschoolers. In other words, in individuals with FX too, MLU predicts syntactic complexity as it is revealed in naturalistic productions. Differences in strategies employed by individuals with FX syndrome during conversation did not correlate with the semantic-syntactic measures either (Ferrier, Bashir, Meryash, Johnson, & Wolff, 1991). Sudhalter et al. (1991) studied males with FX syndrome ranging in age from 5–36 years, in other words, a mixed group, mostly beyond the early phases of language acquisition. Their findings open up the possibility that, in the case of children with FX syndrome, language in the early phases will not differ from the pattern observed for other pathologies and in fact may be comparable to normal, language-matched controls.

Despite a growing interest in the unique cognitive profiles of individuals with William's syndrome (WS), not much is known about the early phases of language acquisition in these individuals. Recent studies suggest that the advantage of verbal over nonverbal competencies that is found in children and adults with WS (Bellugi, Bihrle, Neville, Jernigan, & Doherty, 1992; Bellugi, Marks, Bihrle, & Sabo, 1993) is far less marked in the early stages of language acquisition. Similar to children with other pathologies, children with WS show a significant delay in the onset of language (Bates, 1994; Capirci, Sabbadini, & Volterra, 1996). However, a case study of an Italian girl with WS (Capirci et al., 1996), followed between the ages 2;6 and 4;10, suggests that, although delayed, this child followed a normal course of

language acquisition, yet she did not seem to master certain aspects of formal grammar, and her production varied depending on context.

Summarizing, the picture that emerges from studies of basic language skills in children with different congenital pathologies affecting general IQ is that of similar-to-normal course of acquisition in the early stages, with phenotypic differences becoming more pronounced when aspects that are beyond the basic linguistic skills are considered.

Some Methodological Concerns

In many of the studies reported above, the procedures used for assessment involve familiar tests of production and comprehension. The advantage of this procedure is clear. The problem, however, is that most of these tests use a rather loose definition of language to describe patients' deficits or relative strength. Language is defined in far too broad terms, involving multiple levels of interactive skills. However, if the hope is to achieve a theoretical account of language disorders, separation of levels of analysis is mandatory.[1]

One way of delimiting the notion of language is to exclude from its definition knowledge that requires system-world relationships, where "world" means everything that is not internal to the language system. Examples of system-world constructs are the truth value of logical operations such as conjunctions and conditionals, presuppositions about the listener, factual knowledge, and propositional structure. Such a move would exclude from the definition of language—yet clearly, not from the actual act of communicative speaking—portions of pragmatics as well as knowledge of vocabulary. Still included in the definition of language would be problems concerning lexical properties of words, for example, gender or word classes, and reference, such as pronominalization and subject omission. The latter are language-specific and do not involve knowledge of the world.

A different methodological problem concerns the effect of the testing situation on children with retardation. A common alternative may be found in the study of naturalistic speech samples. This method has its problems too because natural conversations with young

children are context bound and often allow for rote memorized forms. Still, the usefulness of this method in describing the linguistic competence of children at the early phases of language acquisition has been demonstrated in countless studies. If one is testing basic linguistic skills, as we purport to do in the current work, this method seems preferable.

A Brief Description of the Structure of Hebrew and Related Acquisitional Facts

Hebrew

Hebrew has the characteristics of Semitic languages; that is, its words are composed of consonantal roots cast in vocalic word patterns. The roots are usually triconsonantal, and the patterns are in the form of vocalic infixes, prefixes, and suffixes. All verbs are analyzable into root + pattern. With respect to nouns, however, this generalization is only partial because some nouns do not have a recognizable root. There are seven verb patterns and about three dozen noun patterns. It is generally the case in Hebrew that the roots convey core meanings whereas the patterns are essentially derivational paradigms, which may partially introduce meaning modulations.

Although the formal paradigms of this derivational system are highly systematic, their semantics are only partially predictable from their forms. For example, the verb patterns may serve to express a set of predicate relations such as transitivity, reciprocity, reflexivity, passive, incohative, and causative. However, the same function may be expressed by more than one pattern, and the same pattern may serve to express more than one meaning or be "basic" for a given root (see examples below). As for nouns, it is often the case that derivational paradigms are strictly formal and do not convey meanings at all.

Hebrew has a rich inflectional morphology. Verbs in the past and future are inflected for tense, number, person, and gender. Present-tense verbs are not marked for person. The following are examples of verbs and nouns from the root *G-D-L* (Root consonants are in capitals; verbs are in third-person, msc, sg past tense; nouns are in sg form):

GaDaL "grew-intransitive (verb)"; *GiDeL* "grew-transitive (verb)"; *GuDaL* "was grown- passive (verb)"; *hiGDiL* "made bigger -active causative (verb)"; *huGDaL* "made bigger-passive causative (verb)." *GDiLa* "growing-up (noun)"; *GiDuL* "tumor; growth (noun)"; *GaDLut* "grandeur (noun)"; *haGDaLa* "enlargement (noun)"; *miGDaL* "tower (noun)."

Hebrew nouns are classified for gender, and this classification determines forms of agreement and of plural marking. Whereas in animate nouns gender marking

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[1]Consider, for example, the verbal parts of the WPPSI (Wechsler, 1967) and the WISC–R (Wechsler, 1974). Clearly the subtests of Information, Similarities, and Arithmetic involve much more than the knowledge of language. The Reynell (Reynell & Huntley, 1985), which is a test designed specifically for language, is problematic as well. For example, questions such as "Which pig is not outside the field?", which involve the logical operation of negation, are tapping other competencies as well as language. Even the TROG (Bishop, 1973), which is widely used to assess receptive syntax, has questions containing double negation such as "Which pencil is neither red nor long?" Clearly, understanding such statements is heavily dependent upon general cognitive functioning in addition to knowledge of complex syntax.

reflects the sex of the referent in the real world, in inanimate nouns gender is a mere classificatory system that systematically correlates with the noun's final syllable, determining plural ending and agreement. Agreement is required with respect to gender, number, and person, and it often results in vowel harmony among the final syllables of the agreeing elements. Subject-complement constructions that are without verbs, traditionally called "nominal clauses," are well formed in Hebrew. A direct object marker *et*, carrying no semantics, is obligatory for marking accusative objects.[2]

Acquisition

This section provides a background for the choice of variables that were investigated in the current work. It summarizes the known acquisitional facts in typically developing children with respect to the variables studied.

The acquisition of Hebrew morphology has been studied extensively in recent years. Berman (1985, 1994) investigated the development of verb morphology. She argues that early verb use is rote learned and, thus, item based. It is characterized by one verb form per root. Once the child begins to vary verb forms, there will be many more forms for each root, for roots will occur in different patterns and in different inflectional endings. The expectation is, therefore, that with development, there will be an increase in the proportion of verb forms to verb roots (Levy, 1997)

Hebrew speaking children start out with *semantically* unanalyzed forms of verbs, yet at the same period they can effectively control the necessary formal manipulations of the various root + pattern combinations. For quite some time children continue to use a rich variety of verb forms in morphosyntactically appropriate

contexts, not knowing that these formal manipulations may be systematically used to achieve modulations of meanings. It is only around age 4, a long time after they have been using most verb patterns productively, that children's errors indicate that they begin to appreciate the semantics of the system (Berman, 1985, 1994). For 2-year-old Hebrew speakers, the data show that, although unaware of the semantics of the derivations, they differentiate between the consonantal roots of words and the vocalic word patterns. It seems that the componential nature of Hebrew words is appreciated by Hebrew speakers at a very early stage in their linguistic development (Levy, 1988a).

Previous studies of the acquisition of gender in a variety of languages, including Hebrew, show that children master the formal-morphological parts of this system relatively early (Berman & Armon-Lotem, 1996; Levy, 1983; Mulford, 1985; Smoczynska, 1985). Thus, even under age 3, errors of linguistic gender on inanimate nouns, which mark gender morphologically, are infrequent. In cases of animate nouns in which linguistic gender is determined by the semantic notion of gender, errors are common, and learning is a more protracted process. These findings hold across all languages studied so far, among them Hebrew (Levy, 1983, 1988b)

In a cross-sectional survey of productive syntax in Israeli children ages 1;0–5;6, Dromi and Berman (1986) found an increase in the use of polyclause utterances and a decrease in the use of one-clause utterances, documented up to age 4. A decrease was observed in the production of verbless clauses as well, along with an increase in the use of clauses that have predicates. This is in line with the accepted view that an increase in the use of tensed-marked verbs where infinitives or present-tense verbs have been mistakenly used, is a mark of grammatical development (Berman, 1994; Sano & Hyams, 1994; Armon-Lotem, 1996). In a similar vein, Hebrew verbless clauses may be considered syntactically "simple" because they can be used even when knowledge of the syntax and semantics of argument structure is limited and there is little control over verb morphology.

Previous studies have shown that at or around MLU 3, children control agreement. Production of direct object marker *et* is likewise almost error free at this stage. This is the developmental phase during which children acquire crucial parts of the morphology and their errors become minimal (Berman, 1985; Levy, 1983, 1988a). However, errors of syntax and of meaning do not decrease at this stage. This seeming lack of improvement in syntax as well as in structural aspects of meaning may be due to growth in the child's linguistic repertoire. The latter is reflected in the use of longer sentences, more complex syntactic structures, as well as richer vocabulary, which the child may still not fully control (Levy, 1999).

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[2]Examples 1–4 illustrate agreement patterns in Hebrew, and 5–7 are examples of "nominal constructions" and use of the direct object *et*.

1. ha-yeled   nixnas   la-kit*a*   ha-xadash*a*
   the-boy   entered- SG/MSC to(def)-class/FEM   the-new/FEM
   "The boy entered the new class"

2. ha-yald*a*   nixnes*a*   la-kit-*ot*   ha- xadash-*ot*
   the-girl   entered-SG/FEM   to(def)-classes/FEM/PL the-new/FEM/PL
   "The girl entered the new classes"

3. ha-yelad*im* nixnesu   la-xadar*im*   ha-xadash*im*
   the-boys   entered-PL   to(def)-room/MSC/PL the-new/MSC/PL
   "The boys entered the new rooms"

4. ha-yelad*ot* nixnesu   la-xadar*im*   ha-xadash*im*
   the-girls   entered-PL   to(def)-rooms/MSC   the-new/PL/MSC
   "The girls entered the new rooms"

5. ha-yeled   xaxam
   the-child   clever
   "The child (is) clever"

6. ima   ba-bayt
   mother   in(def)-home
   "Mother (is) at home"

7. ima   ra'ata   et   ha-yeled
   mother   saw-PAST/FEM/SG (acc.marker)   the(def)-boy
   "Mother saw the boy"

The Study

Subjects and Controls

Eight children, 5 boys and 3 girls, with a variety of neurological syndromes (NS) were studied. Two of the children had fragile X syndrome (FX), 1 child had Sotos syndrome, 2 children had congenital hydrocephalus grade 4 with shunts, 1 child had a congenital LH infarct affecting the middle cerebral artery, 1 child had left hemiatrophy, and another had enlarged ventricles.

Table 1 presents the diagnosed syndromes, ages, MLU, and number of analyzable utterances for each child (excluding imitations and repetitions). The scores achieved by the children on the various assessment batteries reveal mild to moderate retardation. The Appendix gives the children's detailed medical histories, with further information concerning their general cognitive functioning.

The children and their families were monolingual. They lived at home, and their parents had at least high school education. The children have been under the medical supervision of the second and the third authors from birth. They have various physical handicaps characteristic of their respective syndromes. The children's speech was clear and intelligible, and none had hearing impairment. Their MLU ranged from 2.2–2.9, ages 3;3–6;10. Thus, criteria for inclusion in the study involved the following: the children came from middle class, educated families and were raised at home in a normal family environment. They were not severely retarded and had achieved basic communicative linguistic skills. The children were considered by their physicians and educators as representative of their respective syndromes. It should be noted that these four congenital conditions—chromosomal (FX), metabolic (Sotos), developmental (Hydrocephalus), and anatomical (infarct; hemiatrophy)—are representative of the most common *diagnosed* congenital causes of retardation in children.

Eight typically developing children, 5 boys and 3 girls, ages 2;0–2;4, with no reported health problems, matched on sex and SES with the subjects of the study, served as controls. The groups were matched on two language measures: MLU and distribution of short and long utterances. The latter has been introduced in previous studies as a way of circumventing familiar problems with central measures such as MLU (Levy et al., 1992).

Method

The children were recorded in their homes, 2–3 times with no more than 2 weeks interval between sessions. Prior to data collection, the experimenter, a female master's student in psychology, familiarized herself with the child during one or more visits to his/her home. Each session lasted for 1 hour during which the experimenter talked and played with the child, often in the presence of other members of the child's family. The experimenter was instructed to interact with the child in a natural way, focusing on activities that will encourage conversation such as joint play or joint personal

Table 1. Characterization of the subjects.*

Child	Syndrome	IQ	MLU	Age	Total utterances
A	FX	**GCI = 48 verbal = 23	2.2	4;8	383
Mi	Sotos	GCI = 50 verbal = 24	2.5	6;10	376
M	Hydroc	GCI = 63 verbal = 35	2.5	3;3	587
B	FX	IQ = 70 verbal = 70	2.9	3;5	365
E	Hydroc	Leiter = 58	2.8	3;5	739
Av	LHInfarct	Leiter = 60	2.3	4;4	530
T	Left Hemiatroph	IQ = 69 verbal = 75	2.8	3;6	536
S	EnlargV	Bayley = 74	2.4	3;6	533

*A, Mi, and M were tested on the McCarthy (1972). B and T were tested on the Stanford-Binet (1960). E and Av were tested on the Leiter (1969), and S was tested on the Bayley (1969). See the Appendix for more details.
**Note that verbal scores for the McCarthy (1972) have a mean of 50 (*SD* = 10), and the GCI has a mean of 100 (*SD* = 15).

activities, yet specific manipulations were not attempted. Although the investigator indeed was very attentive to the child, she did not explicitly correct the child, and there were no specific instructions with respect to her behavior. These naturalistic speech samples were audio-recorded and later transcribed by the person who collected the data.

Coding

MLU was calculated according to the system devised by Dromi and Berman (1982) and revised by Levy (1995). This system takes account of the fact that Hebrew is a richly inflected language and thus morphological units smaller than words are counted. Child utterances were coded according to the CHILDES system (MacWhinney, 1995), supplemented by a special coding system for Hebrew texts (Levy, 1995). Excluded from the coding were imitations, repetitions, game-like utterances, and idiosyncrasies. Files were coded by two separate investigators who did not participate in data collection. Coding was checked and rechecked several times, and disagreements were settled by discussion. Between-coders agreement was .94. Utterances for which agreement could not be reached were excluded from the final analysis.

Coding referred to correct usage as well as to errors and concerned all aspects of morphology, syntax, lexical choices, and pragmatics. The coding of grammatical errors is problematic because of the nonstandard use that may be found in colloquial speech and the central role that extralinguistic context plays in the interpetation of utterances within discourse. Based on the level of education of the children's parents, which was comparable to that of the researchers who did the coding, the coders' standard of colloquial speech was adopted as the baseline for coding decisions.

Errors in children's productions were divided into three main categories: syntactical, morphological, and meaning based. The syntactic category includes diverse syntactic phenomena such as use of subordinate constructions and the relevant functors, agreement, use of direct object marker, use of prepositions, and ungrammatical subject omission.[3] With respect to morphology, we coded use of diverse verb derivations, use of tenses, and all other verb and noun inflections. The coding of

morphological errors included errors of form involving root consonants, word patterns, and inflections. Only cases in which it was clear that the error concerned formal features were coded as morphological.

Problems of meaning relate to lexical, semantic, and pragmatic aspects. The following are considered as tapping lexical-semantic problems: errors in word choice, use of incompatible terms, and problems of reference. For example, utterances in which the child uses a negative term and immediately contradicts it by using a positive term that reverses the meaning of the statment or instances in which reference cannot be determined from what was actually said are coded as meaning problems. Errors of gender marking on animate nouns, inappropriate marking of tense, person, and number, and lack of definite marker when definiteness is required are likewise counted among the meaning errors. Errors of tense, number, person, and gender were coded as meaning errors whenever the focus was neither on agreement nor on problems of morphological form, but on the correct marking of the semantic concept. Cases in which a decision could not be reached as to whether the error is best viewed as morphological or as a meaning error were discarded.

Meaning errors include pragmatic infelicity. These are cases in which the child's words or construction was such that, had the *general context* been different, that same word or construction would have been appropriate. Discourse exchanges in which the child does not respond to the investigator's questions and changes the topic inapproppriately and exchanges in which the child's response indicates lack of understanding of the requirements of the conversation are likewise coded as pragmatically inappropriate.[4]

Variables

The study focuses on 13 variables known to be diagnostic of a child's linguistic level. Three of the variables—correct syntactic agreement (*agr*), correct use of direct

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[3]With respect to subject omission, Hebrew is "mixed." Omission of NP subject is typically grammatical in the first and second persons in the future and past tense. It is ungrammatical in third persons and in the present tense. Subject omission is likewise ungrammatical in "verbless clauses" because those are typically in the present tense. However, subject omission in the third persons and in the present tense may be acceptable, given certain discourse contexts. (Vainikka & Levy, 1999). Consequently, errors of subject omission in the third person and in the present tense may be of two types: omissions that are ungrammatical and thus constitute a syntactic error and omissions that, had the immediate context been different, would have been acceptable. The latter cases are counted among the pragmatic errors.

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[4]The following are examples of pragmatically inappropriate uses:

Ch: ve-ima   ve-aba   yiknu   lanu
     and-mom   and-dad   will buy-pl.3rd   to-us
     "And mom and dad will buy us"
Res: ma?
     "what?"

Omission of the direct object of the verb *yiknu* results in a grammatical, yet, referentially opaque sentence.

Ch: tavi   li   kola
     bring-3rd, fem.sg   me   Coke
     "get me coke"
Res: aval ein li, mictaeret
     "but I don't have, sorry"
Ch: shvi, shvi, ani adom
     sit-fem.sg, sit-fem.sg, I red"
     "sit down, sit down, I (am) red"

The verbless clause "ani adom – I red" is grammatical but contextually inappropriate in this exchange.

object marker (*et*), and errors in gender marking on inanimate nouns (*gi*) require linguistic knowledge that is inherently formal. A decrease in the use of Hebrew verbless clauses (*hc*), proportion of verb roots to verb forms (*roots:vf*), use of past tense verbs (*past*), percentage of complex sentences (*coj+rel*), and distribution of errors of morphology (*mor*) and of syntax (*syn*), although reflecting structural knowledge, are not completely divorced of semantic-pragmatic knowledge. Pragmatic errors (*prg*) and errors of word choice (*wc*) involve mostly semantic-pragmatic knowledge, whereas errors in marking gender on animate nouns (*ga*) involve morphological form as well as the semantic notion of gender. Percent of meaning errors (*mean*) subsumes *prg*, *wc*, and *ga* as well as other types of meaning errors. *Coj+rel*, *agr*, and *et* are counted among the syntactic errors, and *gi* is considered an error of morphology. Thus, *partial* dependencies exist between some of the variables.

Although some of the features listed above are universal, others are specific to Hebrew. For example, production of subordinate and coordinate clauses, increased use of predicates, increased use of tensed-marked verbs, and control of morphology, specifically, gender marking on nouns in languages with rich morphologies of which Hebrew is one, are among the defining characteristics of language development cross-linguistically. Measures such as proportion of verb roots to verb forms, use of verbless clauses as well as use of direct object marker *et* are specific to Hebrew.

Percent of the different error types—*mor*, *syn*, *mean*—are calculated out of the total number of errors committed by the child. Percent of verbless (*hc*) and complex (*coj+rel*) clauses are calculated out of the total number of coded utterances for each child. Percent of use of direct object marker (*et*) and of agreement (*agr*) are calculated relative to obligatory contexts of usage. That is, *et* is calculated relative to the number of utterances in which there were direct objects, and agreement is calculated relative to instances of noun- (or pronoun-) verb combinations.[5] Errors of gender on animate (*ga*) and inanimate (*gi*) nouns are calculated out of the total number of errors of morphology, although in the case of *ga* semantics is involved as well. Percent of past tense (*past*) is calculated out of the total number of verbs used by the child. *Root:vf* is the proportion of verb roots to *different* verb forms. Because of the compositional nature of Hebrew words verbs that share the same consonantal root may vary in their derivational pattern as well as in their inflectional form. Errors of word-choice (*wc*) and errors of pragmatics (*prg*) are calculated out of the total number of errors of meaning committed by the

child. Note that although the three major error type—*mor*, *syn*, and *mean*—are calculated relative to the total number of errors committed by the child, specific errors within each category are calculated relative to the total number of errors in their respective category.

Analysis

Distribution Around the Mean

The mean and standard deviation (*SD*) of the control group provide measures of the performance and the variance seen in that group. A child with NS is considered similar to the controls with respect to a given variable if his/her achievements are within 1 *SD* from the normal mean. (See Conti-Ramsden, 1998, and Johnson and Carey, 1998, for a similar approach to the comparison between children with disorders and their normal controls). Note that this criterion is rather stringent; by definition, for each variable, there will be normally developing children as well who will be below or above 1 *SD* from the mean.

Given the variance seen in the control group, it is hypothesized that for a given variable, if the children with NS do not differ from the control group, then no more than 2 children should be within 1 *SD* from the mean of the controls. Variables in which more than 2 children were below or above 1 *SD* from the normal mean suggest a difference between the groups.

Profile Analysis

Profile analysis was done through the use of POSAC (Partial Order Scalogram Analysis by base Coordinates; Shye, 1985; Shye, Elizur, & Hoffman, 1994). Multiple scaling by POSAC is a technique for measuring individuals with respect to a multivariate attribute. When we observe a sample of subjects on some variable (or test item) we can produce a data matrix where each column represents a variable and each row represents a subject. The data in each row is the subject's profile. If the items all have a common range (i.e., they are similarly ordered with respect to the measured attribute) we can define order relations between profiles. Given two different profiles, one profile is said to be greater than another only if it is strictly greater than the other in at least one score. Otherwise the two profiles are incomparable. The two dimensional POSAC is concerned with the following question: Given a set A′ of observed profiles with *n* items, can we assign two scores (that is, a point in a Cartesian coordinate plane) to each profile in A′, such that for any two observed profiles, their observed relation "greater than" and "incomparable to" would be represented correctly by their corresponding two coordinate scores? When the two scales are found, the profiles can be mapped onto a bidimensional Cartesian coordinate

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[5]In Hebrew, adjectives and certain prepositions and verbs agree with the head noun; however, there were no such instances in the children's productions.

plane. POSAC has the following advantages over other nonparametric analyses: All variables are simultaneously considered. Variables are not represented by other more "central" variables and there are no weights given. Each variable is equally important in the analysis. Combination of variables, whether linear or other, is not attempted. POSAC is the only existing technique in which all of these properties co-exist.

Once the two-dimensional map has been plotted, the goal of the researcher would be to find an interpretation for the scales such that the original meaning of the common range will be retained. The interpretation of these scales can be helped by observing the role of specific variables in the organization of the plotted space. POSAC may be used for a discriminant analysis as well. That is, one can observe the extent to which a certain variable divides the profiles into groups. In our case, the external variable of interest is the group a child belongs to—whether she is a child with NS or one of the controls. Another external variable is MLU—does MLU divide the POSAC space such that children with high MLU have higher profiles than children with low MLU?

Two profiles were created for each child: a general profile and a grammatical profile. Because analysis by POSAC sets a limit on the number of variables that can enter a single profile, nine variables were chosen out of the 13 measured in order to create a general profile for each child. The selected variables were the ones with respect to which the developmental predictions in the language acquisition literature are the clearest. The variables were the following: distribution of errors of morphology, syntax and meaning; percent of relative and conjoined clauses, percent of past tense verbs, errors in gender marking on inanimate nouns, errors in gender marking on animate nouns, correct usage of direct object marker, and percent of pragmatic errors. Each of the observed variables was given three possible ranges, coded as high, middle, and low, according to the distributions around the mean seen in the typically developing group. Children's performance was coded as low, middle, or high on each of the variables. A profile was composed for each child, and a POSAC space diagram was plotted.

The grammatical profile was created through the exclusion of three meaning-laden variables from the general profile: percent of meaning errors, errors in marking gender on animate nouns, and pragmatic errors. Thus, six variables constitute a child's grammatical profile: distribution of errors of morphology and syntax, percent of relative and conjoined clauses, percent of past tense verbs, errors in gender marking on inanimate nouns, and correct usage of direct object marker. A POSAC space diagram was plotted for the grammatical profile.

Findings
Distribution Around the Mean

Table 2 presents percents of errors and of correct usage of the children with NS on the 13 linguistic variables along with their performance relative to the typically developing children.

Errors and correct usage are presented for each child individually. If the child's performance in a given variable is within 1 *SD* of the mean seen in the typically developing group it is marked as ^ ; it is marked – if it is below 1 *SD* and + if it is above 1 *SD*. Note that –/+ are always in the same direction. Thus, if a child has more instances of correct usage it will be marked as +, whereas if he/she is making fewer errors than the expected normal amount, it will be marked + as well. These data served to calculate Figures 1 and 2 as well.

The first three rows in both tables—*syn, mor,* and *mean* mark the distribution of the different error types: errors of morphology, syntax, and meaning. The fourth and fifth rows check the percent of verbless clauses *hc* and of complex clauses *coj+rel*. Row 6 marks use of the direct object marker *et*. Row 7 *gi,* marks errors of gender in inanimate nouns. Usage of past tense is marked as *past,* followed by the proportion of verb roots to verb forms, marked as *root:vf.* Errors of agreement are coded as *agr* on Row 10. *Ga* marks errors of gender on animate nouns; *wc* marks errors of word choice and *prg* marks pragmatic errors.

Recall that when no more than two children scored within one *SD* from the typically developing children the groups' performance was considered comparable. When more than two subjects scored below or above one *SD* of the controls, the groups were considered different. As can be seen from Table 2, in the first nine variables the children with the NS score at or around the mean achieved by the controls. Although the children with NS make fewer errors in *agr* than the controls, it can be seen from the mean and the *SD* that both groups are close to ceiling. The children with NS differ from the controls with respect to errors of word choice (*wc*), errors of gender marking on animate nouns (*ga*) and pragmatic errors (*prg*).

A consideration of Table 2 reveals that the differences seen between the groups are distributed among different children. This is particularly clear in the first nine variables where differences are, in general, rather minimal. Thus, the only children who differ from the controls on two variables are M and Av; all the others are either similar to the controls or different on just one variable. Notice, that M is worse than the controls in *gi,* which is coded as a morphological error. It comes as no surprise that she is below normal on *mor* as well. As for Av, he does not use many past tense verbs that could

Table 2. Performance of children with NS on 13 linguistic variables and their status relative to the mean performance (±*SD*) of typically-developing controls.

Variables	Controls mean % (*SD*)	Subjects With NS							
		A	Mi	M	B	E	Av	T	S
Syn	29.5	^	^	^	^	^	^	^	^
	SD = 9.56	24	20	20	37	25	23	39	25
Mor	13.6	^	^	–	^	^	^	^	^
	SD = 8.64	7	19	24	8	15	17	15	14
Mean	58.2	^	^	^	^	^	^	^	^
	SD = 11.2	69	60	56	55	59	60	47	61
Hc	12.3	–	^	^	^	^	^	^	–
	SD = 6.8	23.4	12	18.8	15	5.4	13	16.2	33.2
coj+rel	5.5	^	^	^	^	^	^	+	^
	SD = 4.9	1.4	3.1	2.3	7.6	2.1	3.7	14	3.4
Et	93.4	^	^	^	^	^	^	^	^
	SD = 12.2	100	100	92.3	85.7	90	86.7	100	85.7
Gi	3.1	^	^	–	^	^	^	^	^
	SD = 2.3	4.7	0	5.6	0	0	0	2	3.6
Past	21.4	^	^	^	^	–	–	^	^
	SD = 7.65	19	17	20	21	11	8	21	38
root:vf	1:1.55	^	^	^	+	^	–	^	^
	SD = 0.27	1:1.5	1:1.8	1:1.8	1:2	1:1.8	1:1	1:1.8	1:1.5
Agr	91.5	+	+	^	+	+	+	^	–
	SD = 4.04	100	100	88.2	100	100	100	93	82.4
Ga	10.6	–	^	^	^	+	^	–	–
	SD = 5.4	28.6	10	5.6	6.7	0.8	15.4	21.6	17.8
Wc	3.7	+	^	^	–	+	^	^	^
	SD = 1.2	1.5	3.4	3.7	7.4	1.2	3.5	2.6	4.5
Prg	8.9	–	–	–	–	^	+	+	^
	SD = 3.1	24	16	13	17.2	8.5	4	3.3	8.2

^ = within one *SD* from the mean. – = below one *SD* from the mean. + = above one *SD* from the mean

syn = percent of syntactic errors. mor = percent of errors of morphology. mean = percent of meaning errors. hc = percent of verbless clauses. coj+rel = percent of complex clauses. et = percent correct use of direct object marker. gi = percent of errors of gender in inanimate nouns. past = percent of past tense verbs. root:vf = proportion of verb roots to verb forms. agr = percent of correct agreement. ga = percent of errors of gender in animate nouns. wc = percent of errors of word choice. prg = percent of errors of pragmatics.

have affected the ratio *root:vf.* This correlation, however, is not always critical as can be seen in E, who does not do well with past tense forms but his ratio of *root:vf* is similar to that of the controls. In other words, growth in verb forms in the case of E results from increase in use of forms other than past tense.

Profile Analysis

Figure 1 presents a POSAC diagram of the linguistic profiles of the controls (C) and of the children with the neurological syndromes (NS). The bi-dimensional mapping in space seen in Figure 1 is very good (Correp coefficient representing the proportion of profiles in which scaled order was preserved was .88). Although the axes are not *determined* by any single variable, the distribution of the profiles along the two coordinate scales in Figure 1 is highly correlated with percent of past tense verbs (*past*) and by errors in gender in inanimate nouns (*gi*). Note that the axes represent general aspects of the content world rather than any individual variable. By saying that the meaning of the two coordinate scales is determined by certain variables we are *not* saying that the axes can be thus labeled because the analysis is done post hoc and is based on the distribution of the profiles in the multidimensional space. A single variable that is the best predictor of the partial

Figure 1. General POSAC space diagram for children with neurological syndromes (NS) and for the controls (C).
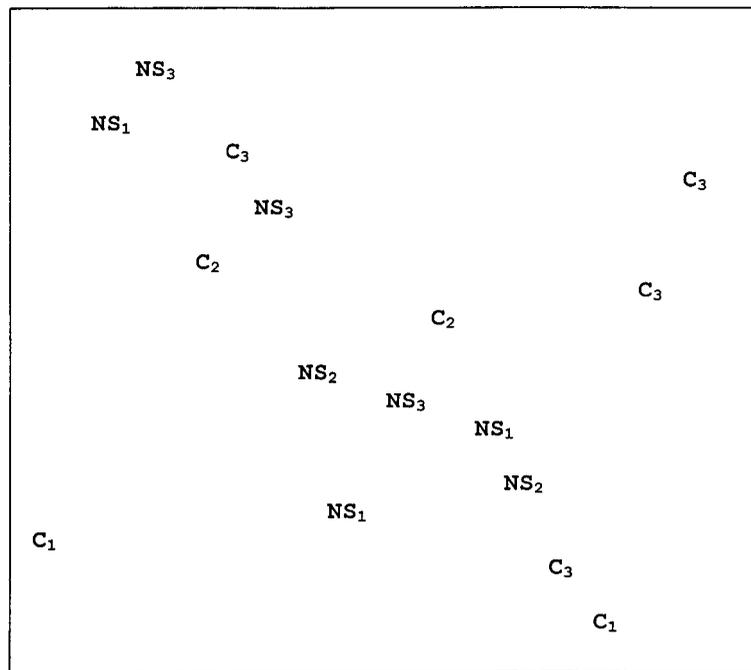
*Numbers indicate the child's MLU level.

order among the profiles is complex clauses (*coj+rel*).

Recall that the external variable of interest, that is, the variable that could divide the space in a relevant way, is the group a child belongs to. As can be seen in Figure 1, the space *does not* divide in any natural way between the two groups. In other words, one cannot draw a line that will have children with NS on one side and the controls on the other. Rather, the profiles of the children with NS and those of the controls are similarly distributed in the plotted space. Another relevant external variable is MLU. The figures in brackets appearing in Figure 1, mark each profile as either 1—low MLU (2.2–2.4), 2—middle MLU (2.4–2.7), or 3—high MLU (2.7–2.9). Although profiles that are high on the axes tend to have high MLU (3) and profiles that are low on the axes tend to have low MLU (1), this external variable does not divide the space in any natural way either.

Figure 2 is a plot of a POSAC space that is exclusively grammatical. Recall that the grammatical profiles include only six of the nine variables that make up the general profile, excluding pragmatic errors, errors of gender on animate nouns, and meaning errors. Similar to Figure 1, the bidimensional mapping in space seen in Figure 2 is very good (Correp coefficient was .82). The meaning of the two coordinate scales remains unchanged. It is determined by percent of past tense verbs (*past*) and by errors in gender in inanimate nouns (*gi*).

A single variable that is the best predictor of the partial order among the profiles is, once again, the amount of complex clauses (*coj+rel*).

As can be seen in Figure 2, the grammatical diagram is not divided between the two groups in any natural way. In this case too, the profiles of the children with NS are not separated in the POSAC space from the profiles of the controls. MLU seems to organize the space only in the sense that the profiles with very low MLU were indeed low on both axes. The difference between middle and high values of MLU does not seem to organize the space in any systematic way.

In sum, neither Figure 1 nor Figure 2 show a spatial separation between the profiles of children with NS and the controls. In both groups, number of errors in gender marking on inanimate nouns and use of past-tense verbs are good predictors of a child's linguistic level, though the best *single* predictor of a child's linguistic profile is number of complex clauses.

Summary and Discussion

This paper presented linguistic profiles of 8 children with different congenital neurological conditions (NS) resulting in borderline to moderate retardation. The profiles were based on analyses of samples of

Figure 2. Grammatical POSAC space diagram for children with neurological syndromes (NS) and for controls (C).
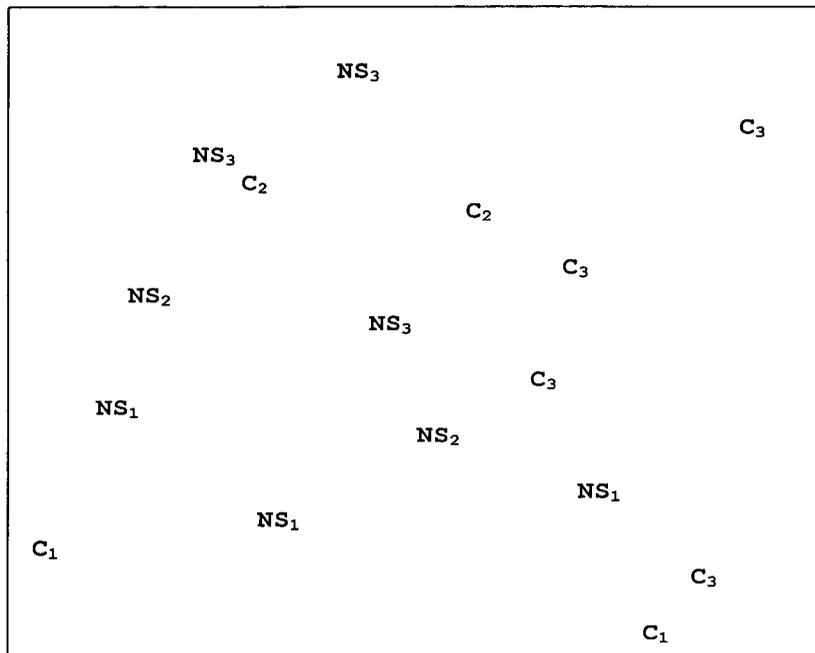
*Numbers indicate the child's MLU level.

naturalistic conversations with the children. The purpose of the analysis was to bring out similarities and differences in the linguistic profiles of the children with NS relative to typically developing children. Given the nature of the group, we chose to present individual profiles and avoided averaging over children. The conclusions from the current study offer testable hypotheses for further research with children of similar neurological and cognitive profiles.

Thirteen different linguistic variables—some inherently formal and relating to specific properties of Hebrew and others involving grammatical as well as semantico-pragmatic distinctions—were considered. The developmental literature makes specific predictions with respect to most of these variables. The picture that emerges for typical development is the following. Similar to other languages, increased use of tensed verbs in Hebrew indicates that functional categories have developed. Proportion of verb root to verb forms, a typically Semitic feature, is another measure of growth in verb morphology. Decrease in the use of verbless clauses that are a common grammatical construction in Hebrew, along with increase in the use of complex clauses signal improved syntax. In richly inflected languages, of which Hebrew is one, inflectional morphology as well as parts of derivational morphology are acquired relatively early. One way in which this development can be appreciated

is in the fact that errors of morphology are typically fewer than either errors of syntax or of meaning, even with MLU under 3. A further indication of the facility with which morphology is acquired concerns gender marking on inanimate nouns. This is a formal morphological marker, acquired prior to or around MLU 3. Agreement is a syntactic operation that children master at this developmental level, and the Hebrew direct object marker *et* is another formal device that children typically acquire at that time.

Before considering the profiles of the children with NS, let us point out the great variability that is seen in the typically developing children. Although the control group is small, it is rather homogenous in terms of the children's language level as measured in MLU and in proportion of long and short utterances, their SES, their family and educational histories, and the complete lack of health problems. Nevertheless, the observed variability is great, while still preserving the expected developmental course.

Do the children with NS present a different developmental picture than the one described here? The children's performance on nine variables was within one *SD* of the performance seen in the controls. In a 10th variable, that of errors of agreement, differences were minute because both groups were close to ceiling. Thus, there were 10 variables—mostly features that can be

referred to as grammatical—on which the groups' performance was similar, and three variables—all related to semantic-pragmatic aspects—on which the groups differed. One has to bear in mind, however, the inherent difficulty in separating semantic and formal features in the production of morphologically complex forms.

Notice that with respect to some of these variables, most clearly with respect to the variables that are formal and carry no semantics such as gender in inanimate nouns (*gi*), agreement (*agr*), and use of direct object marker (*et*), one can easily hypothesize alternative routes to development. For example, it is logically possible, as well as developmentally plausible, that formal grammatical features such as those conveyed through the morphology will be acquired late by children and, consequently, agreement or marking gender on inanimate nouns will constitute a complex developmental problem (Levy, 1988b). The data concerning normal development do not go this way. Yet, those could still be the routes that cognitively impaired children would follow. The findings of the present study suggest that this is not the case. Rather, with respect to structure-dependent features, both groups seem to follow a similar developmental course.

On the other hand, half of the children with NS fail to reach the expected level in pragmatics (*prg*), and 3 out of 8 did worse than the controls on gender distinctions in animate nouns (*ga*) that presuppose knowledge of the cognitive notion of gender. Note that although coding pragmatic errors is in general more problematic than coding formal linguistic aspects, this difficulty may be more severely felt in the coding of the language of children with retardation and may have affected the findings with respect to pragmatic errors. Surprisingly, children with NS err *less* than the controls on word choices. This finding does not necessarily mean that lexical knowledge is a strength in this group! Rather, the small number of errors of word choice may be a reflection of an over-used, impoverished vocabulary, rather than a sign of advanced lexical knowledge. We leave this hypothesis open for further research.

A similar picture to the one seen in Table 3 is reflected in the POSAC multidimensional space diagrams. The diagrams do not reveal differences among the profiles that correlate with group membership, nor, in fact, with MLU. The lack of correlation with MLU, however, is not surprising given the limited range that was probed.

Summarizing, the current findings suggest that *at the basic level*, the clinically observed language disorders seen in children with neurological deficits cannot be explained in reference to disorders of grammar because, at this phase, grammatical development, although delayed, does not differ from the observed pattern in typically-developing children. Thus, language development at the basic level is seen as an extraordinary robust phenomenon across normal children and children with retardation.

The current findings support previous research on the early phases of language development in children with disabilities. It suggests that there may be a phenomenon here that is functionally akin to the recovery patterns that are attributed to brain plasticity. Brain plasticity refers to the capacity of the brain to diminish the impacts of lesions through structural functional changes (cf. Bach, 1990). The clinical manifestations of neuronal plasticity are observed especially after prenatal, neonatal or childhood cerebral damage. Because specific functional deficits often occur after injury to certain neuro-anatomical locations, it has been tempting to suggest that within the brain, structure equals function (Boyeson, Jones, & Harmon, 1994). In the last few years there has been a shift toward conceptualizing cerebral cortex functions as basic processes under continual modification from feedback and lateral interactions, with emphasis on the role of brain plasticity in adaptive behavior (Altman, 1987).

With respect to language, however, researchers have not agreed on a functional interpretation of the plasticity thesis. The common understanding has been that it refers to the final outcome, namely, to the level of linguistic competence that children with focal lesions can eventually reach (But see Dennis, 1980; Dennis & Kohn, 1975; Woods, 1983, and the critique offered in Bishop, 1988b). A different way of interpreting plasticity may be in relation to the normalcy or pathology in the developmental course traversed by these children (Levy et al. 1992).

Recent work on developmental brain plasticity continues to focus on focal brain injuries as the clinical arena in which plasticity may be observed (e.g. Chugani, Muller and Chugani, 1996). We suggest that the uniformity in language development seen among children with a variety of non-focal neurological damage, and its similarity to typical development calls for the postulation of a mechanism that achieves outcomes that are similar to what is brought about through plasticity.

Given the small sample in the current study, we cautiously offer the following hypothesis for further research: In cases of diffuse damage, learning is guided by functionally determined priorities that guarantee the preservation of basic levels of performance in critical domains. Thus, although the necessary reorganization is not always possible, when the nature of the neurological deficit is such that it does not impede the development of basic linguistic competencies, the latter will be achieved following a normal acquisitional course. The often-observed delay in development may be the cost of the required reorganization. Let us stress that this

conclusion is not meant to deny existing differences among children with different syndromes. Although similarities indeed characterize children's core linguistic knowledge at the early developmental phases, phenotypic differences may still be seen either in peripheral linguistic phenomena that may be observable even at the early phases or, and this is more likely, in later developmental phases, where the limitations inherent in specific syndromes may show up.

Acknowledgments

References

Altman, J. (1987). Cerebral cortex: A quiet revolution in thinking. *Nature*, *328*(6131), 572–573.

Armon-Lotem, S. (1996). A parametric approach to functional heads and the acquisition of Hebrew. Unpublished doctoral dissertation, Tel-Aviv University, Tel-Aviv, Israel.

Bach, R. P. (1990). Brain plasticity as a basis for recovery of function in humans. *Neuropsychologia*, *28*, 547–554.

Bates, E. (1994). *Building bridges across disciplines: Cognition to gene*. Address presented to the Sixth International Professional Conference of the William's Syndrome Association, San Diego, CA, July 26–28.

Bayley, N. (1969). *Bayley Scales of Infant Development*. New York: The Psychological Corporation.

Bellugi, U., Bihrle, A., Neville, H., Jernigan, T., & Doherty, S. (1992). Language, cognition, and brain organization in neuro-developmental disorders. In M. Gunnar & C. Nelson (Eds.), *Developmental behavioral neuroscience* (pp. 201–232). Hillsdale, NJ: Lawrence Erlbaum.

Bellugi, U., Marks, S., Bihrle, A., & Sabo, H. (1993). Dissociations between language and cognitive functions in Williams Syndrome. In D. Bishop & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 132–149). Hillsdale, NJ: Lawrence Erlbaum.

Berman, R. A. (1985). The acquisition of Hebrew. In D. I. Slobin (Ed.), *The Cross-linguistic study of language acquisition* (pp. 255–372). Hillsdale, NJ: Lawrence Erlbaum.

Berman, R. A. (1994). Developmental perspectives on transitivity: A confluence of cues. In Y. Levy (Ed.), *Other children, other languages* (pp. 189–242). Hillsdale, NJ: Lawrence Erlbaum.

Berman, R. A., & Armon-Lotem, S. (1996). How grammatical are early verbs? *Les Annales Litteraires de l'Universite de Besancon, 25*–31.

Bishop, D. V. M. (1973). *Test for Reception of Grammar (TROG)*. Department of Psychology, University of Manchester.

Bishop, D. V. M. (1988a). Language development after focal brain damage. In D. V. M. Bishop & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 203–219). Hillsdale, NJ: Lawrence Erlbaum.

Bishop, D.V. M. (1988b). Can the right hemisphere mediate language as well as the left? A critical review of recent research. *Cognitive Neuropsychology, 5*(3), 353–367.

Boyeson, M. G., Jones, J. L., & Harmon, R. L. (1994). Sparing of motor function after cortical injury: A new perspective on underlying mechanisms. *Archives Neurology, 51,* 405–414.

Capirci, O., Sabbadini, L. & Volterra, V. (1996). Language development in William's syndrome: A case study. *Cognitive Neuropsychology,* 1017–1039.

Cardoso, M. C., Mervis, C. B., & Mervis, C. A. (1985). Early vocabulary acquisition by children with Down syndrome. *American Journal of Mental Deficiency, 90,* 177–184.

Chugani, H. T., Muller, R. A., & Chugani, D. C. (1996). Functional brain reorganization in children. *Brain Development, 18,* 347–356.

Conti-Ramsden, G. (1998). What is the nature of specific language impairment? Is SLI really specific? In A. Baker, M. Beers, G. Bol, J. de Jong, & G. Leemans (Eds.), Child language disorders in a cross-linguistic perspective (pp. 47–64). *ASCLD, 6,* Universiteit van Amsterdam, No. 71.

Dennis, M. (1980). Capacity and strategy for syntactic comprehension after left and right hemidecortication. *Brain and Language, 7,* 153–169.

Dennis, M., & Kohn, B. (1975). Comprehension of syntax in infantile hemiplegics after cerebral hemidecortication: Left hemisphere superiority. *Brain and Language, 2,* 472–482.

Dromi, E., & Berman, R. A. (1982). A morphemic measure of early language development: Data from modern Hebrew. *Journal of Child Language, 9,* 403–424.

Dromi, E., & Berman, R. A. (1986). Language-general and language-specific in developing syntax. *Journal of Child Language, 14,* 371–387.

Feldman, H. M., Holland, A. L., & Keefe, K. (1989). Language abilities after left hemisphere brain injury: A case study of twins. *Topics in Early Childhood Special Education, 9,* 32–47.

Ferrier, L. J., Bashir, A. S., Meryash, D. L., Johnson, J., & Wolff, P. (1991). Conversational skills of individuals with fragile X syndrome: A comparison with autism and Down syndrome. *Developmental Medicine and Child Neurology, 33,* 766–788.

Hagerman, R. J., & McBogg, P. M. (1983). *The fragile X syndrome*. Dillon, CO: Spectra.

Hendrick, D. L., Prather, E. M., & Tobin, A. R. (1975). *Sequenced Inventory of Communicative Development.* Seattle: University of Washington Press.

Johnson, S. C., & Carey, S. (1998). Knowledge enrichment and conceptual change in folkbiology: Evidence from Williams Syndrome. *Cognitive Psychology, 37*(2), 156–200.

Leiter, R. (1969). *Leiter International Performance Scale.* Chicago, IL: C. H. Stoelting Company.

Levy, Y. (1983). It's frogs all the way down. *Cognition, 15,* 75–93.

Levy, Y. (1988a). The nature of early language: Evidence from the development of Hebrew morphology. In Y. Levy, I. M. Schlesinger, & M. D. S. Braine (Eds.), *Strategies and Processes in Language Acquisition* (pp. 73–98) Hillsdale, NJ: Lawrence Erlbaum.

Levy, Y. (1988b). On the early learning of formal grammatical systems: Evidence from studies of the acquisition of gender and countability. *Journal of Child Language, 15*, 179–187.

Levy, Y. (1995). Coding manual for Hebrew texts-Revised. *Publications in Developmental Psychology, 2*. Levin Institute, The Hebrew University, Jerusalem.

Levy, Y. (1996). On the early development of morphology and syntax in two children with congenital brain pathologies. *Journal of Reproductive and Infant Research, 14*, 255–270. Special issue on longitudinal studies.

Levy, Y. (1997). The development of morphology and syntax in a pair of DZ twin boys. *European Journal of Disorders of Communication, 32*, 165–190.

Levy, Y. (1999). Early metalinguistic competence: Data from children's conversational repairs. *Developmental Psychology, 35*(3), 822–834.

Levy, Y., Amir, N., & Shalev, R. (1992). Language development in a child with a congenital LH lesion. *Cognitive Neuropsychology, 9*, 1–32.

McCarthy, D. (1972). *McCarthy Scales of Children Abilities*. New York: Psychological Corporation.

MacWhinney, B. (1995). *The CHILDES Project*. Hillsdale, NJ: Lawrence Erlbaum.

Mulford, R. (1985). Comprehension of Icelandic pronouns gender: Semantic vs. formal factors. *Journal of Child Language, 12*, 443–454.

Owens, R. E., & MacDonalds, J. D. (1982). Communicative uses of the early speech of nondelayed and Down syndrome children. *American Journal of Mental Deficiency, 86*, 503–509.

Pruess, J. B., Vadasy, P. F., & Fewell, R. R. (1987). Language development in children with Down syndrome: An overview of current research. *Education and Training in Mental Retardation, 22*, 44–55.

Reynell, J., & Huntley, M. (1985). *Reynell Developmental Language Scales*. Windsor, UK: NFER-Nelson.

Rondal, J. A. (1993). Down syndrome. In D. Bishop & K. Mogford (Eds.), *Language development in exceptional circumstances* (pp. 165–176). Hillsdale, NJ: Lawrence Erlbaum.

Rondal, J. A., Ghiotto, M., Bredart, S., & Bachelet, J. F. (1988). Mean length of utterance in children with Down syndrome. *American Journal of Mental Retardation, 93*, 64–66.

Sabsay, S., & Kernan, K. T. (1993). On the nature of language impairment in Down syndrome. *Topics in Language Disorders, 13*(3), 20–35.

Sano, T., & Hyams, N. (1994). Agreement, finiteness and the development of null arguments. *NELS (NorthEastern Linguistics Symposium), 24*, 543–555.

Shye, S. (1985). *Multiple scaling: The theory and application of partial order scalogram analysis.* Amsterdam: North Holland.

Shye, S., Elizur, D., & Hoffman, M. (1994). *Introduction to facet theory: Content design and intrinsic data analysis in behavioral research.* London: Sage.

Smoczynska, M. (1985). Acquisition of Polish. In D. I. Slobin (Ed.), *The Cross-linguistic study of language acquisition* (Vol. 1, pp. 595–686). Hillsdale, NJ: Lawrence Erlbaum.

Sudhalter, V., Cohen, I. L., Silverman, W., & Wolf-Schein, E. G. (1990). Conversational analysis of males with fragile X, Down syndrome and autism. *American Journal on Mental Retardation, 94*(4), 431–441.

Sudhalter, V., Scarborough, H. S., & Cohen, I. (1991). Syntactic delays and pragmatic deviance in the language of fragile X males. *American Journal of MedGenetics, 38*, 493–497.

Tager-Flusberg, H., Calkins, S., Nolin, T., & Baumberger, T. (1990). A longitudinal study of language acquisition in autistic and Down syndrome children. *Journal of Autism and Developmental Disorders, 20*(1), 1–21.

Terman, L. M., & Merrill, M. A. (1960). *Stanford-Binet Intelligence Scale.* Chicago, IL: Riverside Publishing Company.

Thal, D. J., Marchman, V., Stiles, J., Aram, D., Trauner, D., Nass, R., & Bates, E. (1991). Early lexical development in children with focal brain injury. *Brain and Language, 40,* 491–527.

Vainikka, A., & Levy, Y. (1999). Empty subjects in Hebrew and Finnish. *Natural Language and Linguistic Theory, 17*, 613–671.

Wechsler, D. (1967). *Wechsler Preschool and Primary Intelligence Scale.* New York: Psychological Corporation.

Wechsler, D. (1974). *Wechsler Intelligence Scale for Children* (Rev. Ed.). New York: Psychological Coporation.

Woods, B. T. (1983). Is the left hemisphere specialized for language at birth? *Trends in the Neurosciences, 6*, 115–117.

Contact author: Yonata Levy, Psychology Department, The Hebrew University, Jerusalem, Israel 91905. Email: msyonata@mscc.huji.ac.il

Appendix. Medical histories of the children with NS.

A — A, a boy, was delivered by Cesarean Section, following normal pregnancy, with a birth weight of 3,040 g. A has a brother who was diagnosed with fragile X syndrome. At 1 year of age, developmental motor delay, hypotonia, and psychomotor delay were noticed. Genetic tests corroborated the diagnosis of fragile X. At the age of 2;9, a more pronounced psychomotor delay was noticed. The child was still hypotonic, and his attention span was very short. At the age of 4;8, his GCI on the McCarthy Scale (McCarthy, 1972) was 48; verbal = 23; perceptual = 22; quantitative = 23; memory = 22.

Mi — Mi, a boy, was born after 36 weeks of normal pregnancy, in a normal delivery, with a birth weight of 2,750 g. Mi's height was 51 cm and head circumference was 38 cm. The anterior fontanella was open 7 × 9 cm; there was dolicocephaly, a mildly coarse face, with hyperthelorism and antimongolian slant. His hands and feet were very large. EEG and CT were performed, both with normal results. At the age of 4 months, the child had developmental motor delay and hypotonia, with a head circumference of 44.5 cm (97%), height 84 cm. (50%), and weight 5,500 g (53%). At 13 months of age the child's head circumference was 51 cm (97%), height 84 cm (97%), weight 12 kg (97%), anterior fontanella 2 × 2 cm. Mi had a high forehead, micrognathia, large feet and hands, hypotonia, delayed psychomotor development. A special delay was noticed in language. Sotos syndrome was diagnosed. At the age of 6;10 Mi is moderately retarded with a GCI of less than 50 on the McCarthy Scale (McCarthy, 1972). His verbal score = 24; quantitative = 21; performance = under 22.

M — M, a girl, was born in a normal delivery following 31 weeks of normal pregnancy. A few days after she was born, an IVH grade 4 was diagnosed with hydrocephaly. At 1 month a VP shunt was performed. From the age of 2 years, a general psychomotor delay was observed, with very short attention span. At the age of 4;5 GCI on the McCarthy Scale (McCarthy, 1972) was 63. Verbal = 35; performance-perceptual = 27; quantitative = below 22, and memory = 33.

B — B, a girl, was delivered normally after a normal pregnancy, with a birth weight of 2,640 g. At the age of 5 months she stopped gaining weight, and a motor delay was observed. At the age of 15 months, B was diagnosed as having a mild developmental delay, hypotonia, and FTT. At the age of 34 months, B was small for her age, psychomotor development was slow, and attention span was very short. A genetic test corroborated the diagnosis of fragile X. At the age of 40 months, B scored 70 on the Stanford-Binet (Terman & Merrill, 1960) in both performance and verbal tasks. Attention span was still very short.

E — E, a boy, was delivered after 27 weeks of pregnancy by Cesarean section due to early contractions and abnormal position of the fetus. His birth weight was 1,120 g. After delivery, the child suffered from HMD, ROP Stage II–III, and IVH Stage IV with hydrocephaly. A VP shunt was performed with improvement in his general functioning. CT showed an enlarged left ventricle. The diagnosis of a Spastic Quadriplegia was made at the age of 7 months. At the age of 41 months, E's Bayley score (Bayley, 1969) was 27 months on the perceptual and visuo-spatial tasks and 36 months on the verbal tasks. IQ score as measured by Leiter (Leiter, 1969) was 58.

Av — Av, a boy, was born normally following a normal pregnancy. Early milestones were considered normal. At the age of 5 months he was diagnosed as having a right spastic hemiplegia. CT disclosed a wedge-shaped hypodense area in the area distribution of the MCA. Av never had a seizure or a syncopal event. Av spoke single words at 16 months and had about 30 word at 24 months. He started to combine 2–3 words at 3 years. At 40 months his Leiter (Leiter, 1969) score was 60.

T — T, a girl, was delivered by Cesarean section, following a normal pregnancy. Her birth weight was 2,400 g and APGAR was 7. Her initial motor development was normal, but at 4 months, a right hemiparesis was noted. EEG showed a relative paucity of electrical activity over the left hemisphere. CT showed a left hemiatrophy and a large porencephalic area in the left parietal lobe. First words appeared at 15 months and two-word combinations at 20 months. At 30 months T's Bayley score (Bayley, 1969) was 68, with a language score indicating 5 months delay.

At the age of 42 months, T developed complex partial seizures. Her EEG at that time showed a sharp wave focus in the left temporal area and treatment with Tegretol (Carbamazepine) was introduced. T has considerable attentional problems. Her full scale IQ is 69, verbal 75 and performance 67 (Terman & Merrill, 1960).

S — S, a boy, was born after a normal pregnancy. His birth followed an intrauterine manipulation performed under anesthesia. His birth weight was 1,800 g and APGAR was 1. S. spent his first 5 weeks of life in an NICU because of low weight, but suffered no particular complications. His initial motor development was considered normal and only at 9 months was a spastic right hemiparesis noted. CT scan showed a moderate enlargement of the ventricles. S began uttering first words at 14 months. However, language development following the first few words was very slow and at times seemed to have come to a halt. Utterances of 2 and 3 words did not appear until S was 36 months. At 30 months his Bayley score (Bayley, 1969) was 74, with a particularly low language score, indicating 6 months delay.