



## Theory & Research Bases of the *Sterling Edition*<sup>1</sup> Syntax Programs

*Simple Sentence Structure, LanguageLinks®: Syntax Assessment & Intervention, Prepositions!, Pronoun Perspective, and QuestionQuest®*

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How do children around the world, no matter what their native language, begin speaking in sentences at the same age? The uniformity and rapidity of first language acquisition is possible because human infants are born with a biologically endowed innate language faculty within the brain that drives the course of language development. Although this premise was doubted fifty years ago, today biologists and linguists alike accept it. Our human language faculty orchestrates and shapes the acquisition of language. Typically developing children need only the surrounding language input to acquire language. In contrast, children with language disorders will need more than exposure to language if they are to develop communication and reading competence. This monograph focuses on the theory and research bases of the programs in Laureate's *Sterling Edition Syntax Package*. Included in this package are research-based assessment and intervention programs to teach basic simple sentence syntax, prepositions, narrative perspective taking, and understanding of questions.

Neurotypically developing language learners are remarkably capable of exploiting language clues in their receptive language environment, and with little apparent effort are able to integrate this information into an ever-growing and increasingly nuanced framework of syntactic, semantic, and conceptual information (e.g., Booth, Waxman, & Huang, 2005; Gleitman, Cassidy, Nappa, et al., 2005; Hall & Waxman, 2004; Johnson & de Villiers, 2009; McDonald, 1997). This is even more remarkable considering that the process is based largely on information received through *incidental* exposure to language. Language acquisition also proceeds at an extraordinary pace, with most children already demonstrating knowledge of fundamental grammatical features as they enter the two-word stage of language development, and then going on to acquire fundamental syntactic competence by the age of six (e.g., Bohnacker, 1997; Brown, 1973; Engle, 1978; Fenson, Dale, Reznick, et al., 1994). Children with **language disorders**, however, clearly have an impaired ability to acquire language based solely on the input they receive from their receptive language environment. Clinical data show that, despite extensive incidental exposure to language, the majority of these children have a markedly

limited vocabulary and poor command of syntax, and are clearly in need of formal remediation. Moreover, clinically significant delays in the acquisition of language are *the* most prevalent developmental disorder seen in children. One rigorous epidemiological study involving more than 7,000 subjects estimated the overall prevalence of Specific Language Impairment (SLI; i.e., language impairment that cannot be attributed to other conditions such as hearing loss or other developmental disability) among 5-6 year old kindergartners at 7.4 percent (Tomblin, Records, Buckwalter, et al., 1997). This estimate is consistent with other work indicating that SLI affects between 6% and 8% of preschoolers, and a much higher percentage of children from disadvantaged backgrounds (Boyle, Gillham, & Smith, 1996; Leonard, 1998; Paul, 1996; Rescorla, Roberts, & Dahlsgaard, 1997). These estimates do not include the prevalence of children with language impairments (LI) that co-occur with other developmental disabilities. Such deficits are characteristic of Autism Spectrum Disorder (ASD), for example, with estimates published by the Centers for Disease Control and Prevention suggesting ASD rates in the United States averaging 1 in 110 and 1 in 70 among boys (Centers for Disease Control and

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Prevention, 2009). Research has found that verbal children with ASD, Down syndrome, and SLI have similar language profiles, characterized by delayed lexical and syntactic development (e.g. Geurts & Embrechts, 2008; Luyster et al., 2008; Tager-Flusberg, 2000; see Tager-Flusberg, Paul, & Lord, 2005), suggesting that similar language (albeit not communication) goals and treatment strategies would be appropriate for all these populations.

The high prevalence of childhood language disorders is unfortunate from an educational standpoint since impaired language frequently presages **academic difficulties**. Indeed, the Supporting Research section of the 2010 *Common Core State Standards for English Language Arts & Literacy* states:

*“Oral language development precedes and is the foundation for written language development; in other words, oral language is primary and written language builds on it. Children’s oral language competence is strongly predictive of their facility in learning to read and write: **listening and speaking vocabulary and even mastery of syntax set boundaries as to what children can read and understand no matter how well they can decode**”* (Common Core State Standards Initiative, June, 2010, emphasis added)

In this connection it is well established that preschoolers with **semantic-syntactic** language deficits are at much greater risk for reading disabilities during their school years, **with early syntactic ability seeming to be an especially important variable** (Bishop & Adams, 1990; Catts, 1993; Catts, Adolf, & Weismer, 2006; Scarborough, 2001). A meta-analysis by the National Early Literacy Panel (NELP; 2009) concluded that oral language was particularly related to later literacy achievement when this variable was defined in terms of *grammar* and *receptive language* (as opposed to, e.g., vocabulary knowledge). An epidemiologic study which examined the reading ability of second and fourth graders in a sample of more than 300 children who had been identified in kindergarten as having language impairments (Catts, Fey, Tomblin, & Zhang, 2002), found that as a group these children scored significantly below matched controls on word recognition and reading comprehension. In fact, about half of the children met criteria for having a reading disability in second (52.9%) and fourth grade (48.1%). Academic difficulties associated with language delays also tend to persist through the later school years (e.g., Dockrell, Lindsay, & Connelly, 2009; Kelso, Fletcher, & Lee, 2007). One study found that 40% of preschoolers with language impairments continued to have a significant impairment at follow-up some four to five years later,

and many had been held back a grade in school or were receiving special services for learning disabilities (Aram & Nation, 1980; Aram, Ekelman, and Nation, 1984).

### Enhancing Current Practice

Clinicians and researchers have long recognized that most children with LI regardless of etiology *need* training to develop linguistic competence, and this is a *prerequisite* to communicative competence (e.g., Shewan, 1975, p. 311). Current linguistic theory and research further emphasizes that language is acquired by listening, not speaking (Pinker, 1994, p.280). Despite this long established research-based explanation of language acquisition, most formal language intervention programs currently emphasize the use of language for social communication (e.g., McCauley & Fey, 2007) without stressing the importance of establishing a language knowledge base. That is, treatment emphasis is on the communication aspects of language with a focus on using language expressively. These programs feature goals that involve, for example: a) the use of language facilitation techniques such as open-ended questions, and the expansion of a child’s utterances during interactive communication; b) modeling and imitation in a functional language context; and c) conversational recasting using more advanced forms and language functions (Camarata & Nelson, 2007; Cirrin & Gillam, 2008; Cole, Maddox, & Lim, 2007; Hancock, Kaiser, & Delaney, 2002; Marulis & Neuman, 2010; Pepper & Weitzman, 2004; Ellis Weismer, 2000). This emphasis is valuable given that functional communication is so important to navigating one’s environment and basic quality of life. In terms of language development, however, this approach can be enhanced by providing technology-delivered receptive language intervention designed to support the development of syntax comprehension, that in turn would provide students with the means to communicate across a broader range of topics.

Laureate software can be used to supplement language intervention services in a manner that is cost-effective, easily implemented, and does not place an added burden on speech-language pathologists (SLPs) and special education professionals. The receptive emphasis is on the formal grammar component of language; the lexicon and syntax. This approach enables SLPs and special educators to focus on expressive language development in social contexts with the knowledge that their students are also getting the foundational receptive language training they need. In the following sections we review advances in linguistics that have dramatically increased our understanding of language *per se* and how linguistic competence is acquired, as well as ways in which language acquisition might more effectively be enhanced in children with language impairments. Also discussed is the use of applied behavioral analysis in the

design of effective instructional procedures for delivering a current linguistic theory and research based language intervention curriculum.

### **Linguistic Basis for Laureate's Syntax Intervention**

Linguistic, language acquisition, and language disorders research all highlight the importance of syntactic competence. Yet mastery of syntactic forms as manifested in proficient sentence comprehension and production is especially problematic for children with language impairments (including those with SLI, ASD, and intellectual disabilities), and this obviously impedes the development of both oral and written communicative competence. Given these circumstances, a central theme in language acquisition research concerns just how language is learned – what are the cues that children so efficiently exploit as they acquire language from their receptive language environment – and what are the best means to facilitate this process in children who are not acquiring language in a typical manner? Underscoring the biological underpinnings of these issues are observations concerning the emergence of language in neurotypically developing children, which is remarkably rapid and follows a very similar course in all human languages around the world. First words emerge, word combinations occur, and syntax is mastered at about the same ages regardless of language or culture. There are also striking commonalities across all human languages that extend to both language structure and the syntactic operations involved in using language to express human thought. Arising from these observations is the widely accepted biolinguistic view that the capacity for language is a species-specific endowment, and that language acquisition in human children is supported and guided by an innate language faculty, or **Universal Grammar** (Berwick & Chomsky, 2011; Hauser, Chomsky, & Fitch, 2002; Laka, 2009). Because Universal Grammar orchestrates language acquisition, neurotypically developing children need only *language exposure*, i.e., linguistic input, to acquire language – at least insofar as acquisition of the formal grammar component is concerned. The grammar of a language is composed of the lexicon (the “dictionary” of lexical items/words in the language) and the syntactic computational system that assembles lexical items into sentences. The relevance of this in the present context is that the ability to *use words* for communication in social settings is developed through communicative interaction, but acquisition of the *grammar of a language* is accomplished through *listening*; it is dependent upon receptive language input (Pinker, 1994; Radford, 1990; Wexler, 1998).

Noam Chomsky's *Principles and Parameters Theory* (Chomsky, 1981) and its refinement under the *Minimalist Program* (Chomsky, 1995, 2002, 2009) provides a

descriptive and explanatory framework for much of the current linguistic research concerning Universal Grammar. The guiding assertion is that Universal Grammar can be described as a fixed and invariant set of *Principles* that do not have to be learned because they are a part of our inherent biological endowment, and a small set of *Parameters* that vary in binary fashion across languages and are “set” by receptive exposure to a particular language. (e.g., Atkinson, 1992; Baker, 2001; Hornstein, Nunes, & Grohmann, 2005; Radford, 2004, 2009). The acquisition of language competence can be viewed as a matter of “setting” grammatical Parameters combined with the learning of the lexicon of a language both of which are dependent upon *exposure to appropriate receptive language input*.

**(a) Parameters.** Unlike universal Principles that require no language experience, Parameters do require language input for their setting. Since all Parameters have two possible settings, children must need language input to select the proper setting. A fixed set of Parameters accounts for most of the syntactic variations among human languages (Atkinson, 1992; Baker, 2001; Chomsky, 1981; Crain, 1991; Leonard & Loeb, 1988; Radford, 1990; Radford, 2004; Roeper & Williams, 1987; Wexler, 1998). Parameters determine such things as word order in a language and whether question words (e.g. Who, What, How) move to the front of a sentence (they do in English; they don't in Chinese).

There are two Parameters associated with determining the word order in a language. One Parameter is set to have the Object of a sentence come either before or after the Verb. The other determines whether the Subject comes before or after the Verb. In English, Subjects come before Verbs and Objects come after them yielding the canonical Subject-Verb-Object (SVO) word order. These word order Parameters are set very early. Neurotypically developing children have them set in the late one word stage. In pioneering research, Hirsh-Pasek, Golinkoff and their colleagues showed that when children as young as sixteen months (still in the one word stage) were presented with two television screens with one showing **Big Bird tickling Cookie Monster** and the other **Cookie Monster tickling Big Bird** and then were told, “*Oh look! Big Bird is tickling Cookie Monster!*” or vice versa, they preferentially attended to the appropriate matching visual stimulus (Hirsh-Pasek, Golinkoff, Fletcher, et al., 1985; Hirsh-Pasek & Golinkoff, 1996). This finding demonstrates that the two word order Parameters had already been set. The children already knew that English is a Subject-Verb-Object word order language!

**(b) The Lexicon.** Within the *Minimalist Program*, the lexicon has taken on a far more important role than in earlier generative grammar proposals. The representation

of a word in the lexicon includes not only phonological and semantic properties (i.e., sound and meaning), but also syntactic features such as *categorical membership* (e.g., whether it is a Noun or Verb), *inflectional behavior* (i.e., how the word may be marked for number, person, and gender), and in the case of Verbs, syntactic *argument structure* (e.g., *run* generally requires only one argument, a subject – “*The girl runs*”; *kiss* requires two, a subject and an object – “*The father kisses the baby*”; and *give* typically requires three – “*The girl gives the baby a toy.*”). In other words, a complete lexical entry is thought to include the specific roles a word can play in the structure of language and the appropriate form of that word in any given grammatical context. These properties of the lexicon are especially relevant here insofar as intervention is concerned: ***The lexicon is learned, which means we can use intervention strategies to teach lexical items and their grammatical properties to children with language disorders.***

In current linguistic theory the lexicon is divided into two divisions, the *Lexical* and *Functional Categories*. The Lexical Category includes the familiar Nouns, Verbs, and Adjectives; an *open class* in the sense that new words are frequently added; e.g., recent Nouns (*tweet, staycation*), Verbs (*twittering, blogging*), and Adjectives (*green-collar, spacey*; see Baker, 2003). In contrast, the Functional Category is a *closed class* of words and forms that serve essentially grammatical functions. Included in the Functional Category are:

**Determiners** – associated with Nouns and so-called because they specify (determine) that to which a Noun expression refers. *Determiners* include, for example: the articles “*a*” and “*the*”; Prenominal Determiners (e.g. *this, that, these, those*); Pronouns (e.g. *I, you, me, his, her*); and Anaphors or Reflexives (e.g. *myself, himself, themselves*).

**Tense** – associated with Verbs and includes elements that inflect Verbs for tense and agreement. *Tense* includes, for example, the Regular Past Tense “*-ed*” (*She painted the chairs*), Future Modal “*will*” (*He will run*), Infinitival “*to*” (*He likes to run*), Copular and Auxiliary “*be*” (*He is big. They are running*), Third Person Singular “*-s*” (*The boy runs*) and Negation (e.g., *is/is not* and *does/does not*).

**Complementizers** – associated with clauses and precede the subject in the clauses they introduce. In addition to words which mark complement clauses such as *that, if, and whether*, Complementizers play a central role in forming questions.

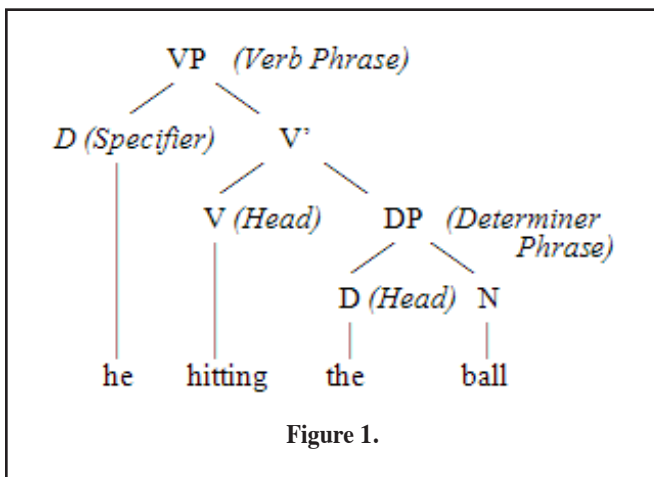
Traditionally, Prepositions were considered to be among the Lexical Categories. More recently, linguists have presented arguments for including Prepositions among the Functional Categories (Baker, 2003; Moro, 2008). Like the

other members of that group, Prepositions are a closed class of words. While languages freely add Nouns, Verbs, and Adjectives to the lexicon, this is not the case with the Functional Categories. Regardless of category, early syntax intervention should include training on Prepositions. The earliest forms to emerge are Determiners, Tense, and some Prepositions while Complementizers emerge somewhat later. *Importantly, these Functional Category forms are a part of the lexicon, are learned, and therefore can be taught.*

**(c) Importance of Functional Categories.** The acquisition of Functional Category forms is essential to the comprehension and production of sentences. Indeed, hierarchical sentence structure emerges as the Functional Category forms are acquired. Typically, these forms first emerge as children enter the two-word stage of language development (18-24 months; Bohnacker, 1997; Brown, 1973; Engle, 1978; Fenson, et al., 1994). Children at this early stage will, for example, begin to use possessive’s (e.g., *Daddy’s hat*), and produce forms such as Determiner *No* (e.g., *No shoe*). As such, we know that very young language learners are processing Functional Category information to at least some extent starting at a very early age. At this stage children may still produce an expression using bare Nouns and Verbs such as “*Ball rolling*,” but bare items do not occur in adult English. Instead, an adult would include the Determiner “*the*” and the Tense element “*is*” and say, “*The ball is rolling.*” In sentences generated by competent language users, Nouns *Merge* (i.e., combine) with Determiners to become Determiner Phrases (DP). Similarly, Verbs *Merge* with Tense elements to become Tense Phrases (TP). This step is critical because the information provided by the Functional Categories serves to “*erect a syntactic skeleton above lexical category forms which serves to hold together the various syntactic relations that take place in the phrase.*” (Adger, 2003, p. 165). Unfortunately, Functional Category forms are especially problematic for children with language disorders. In fact, a clinical marker for children with LI is the inaccurate or infrequent use of Functional Category forms (e.g., Bedore & Leonard, 1998; Leonard, 1998; Rice, 1998; Rice, Wexler, & Hershberger, 1998; Roeper & Seymour, 1994; also Trantham & Pedersen, 1976; Wilson & Pascoe, 1999). Rice (1998), for example, documented the use of Tense forms in 5-year-olds with LI and age-matched controls. Only one of 37 children with impairments used obligatory Tense forms more than 60% of the time, whereas all but one of the 45 children in the control group used these forms with 75% or greater accuracy. Given the critical role of Functional Category forms in language learning and the fact that these are a particular area of weakness in children with LI, it seems clear that *Functional Category training ought to be included in language intervention plans.* Next we’ll look at

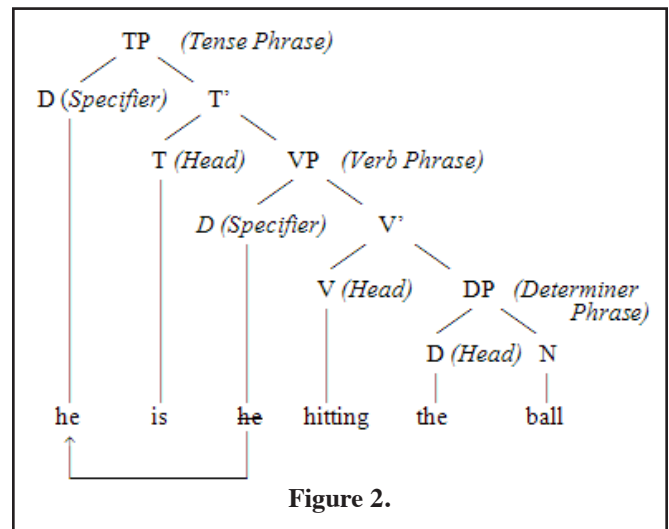
a linguist's view of sentence formation, which will assist readers in appreciating why the Functional Category forms should be a critical focus area.

**(d) The Syntactic Computational System.** In the *Minimalist Program*, the innate Computational System of Human Language ( $C_{HL}$ ; Chomsky, 1995) serves to generate sentences. The  $C_{HL}$  does so by combining Lexical and Functional Category items into hierarchical sentence structures in keeping with the *Principles* of Universal Grammar and the *Parameters* of the language being spoken. Two operations are involved: *Merge* combines elements by bringing new components into the structure, and for this reason has more recently been referred to as *External Merge*. The second operation, *Move*, repositions components within the structure and hence is more recently referred to as *Internal Merge* (Chomsky, 2002; 2009; Radford, 2009). Here we consider generation of the simple sentence "He is hitting the ball." The first step is to Merge "the" and "ball." When two forms Merge, one becomes the *Head* of the resulting phrase or hierarchical structure. When Functional Category forms Merge with Lexical forms, the Functional form becomes the *Head* of the phrase. Thus, Merging "the" and "ball" yields the Determiner Phrase (DP) "the ball." Next, the Determiner Phrase "the ball" Merges with the Verb "hitting" and becomes the *Complement* (Object) of the Verb. The Verb assigns this Object its semantic role of recipient of the action. The third step is to Merge the phrase "hitting the ball" with the *Specifier* (Subject) "he." Although this Pronoun will move later, it enters the computation here, where the Verb assigns the semantic role of Agent to its Subject.



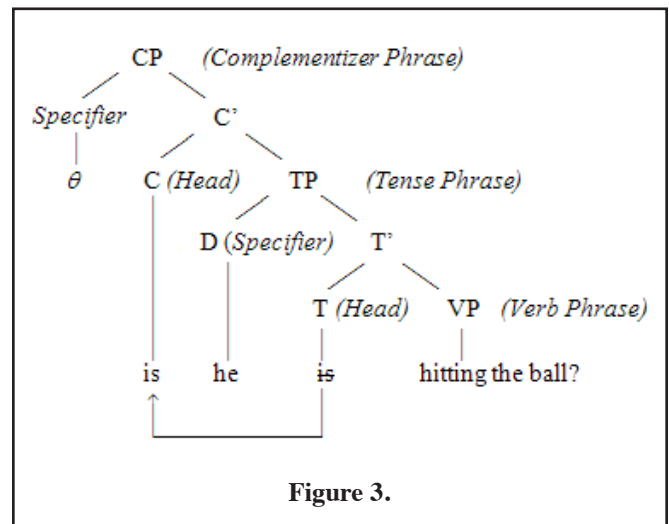
**Figure 1** illustrates the hierarchical structure built in these first three steps in the construction of this sentence. Already, the important role of Functional Category forms is apparent – they erect the *structure* of sentences. Without these forms one only has strings of words.

The next two steps in the generation of this simple sentence are shown in **Figure 2**. The fourth step is to Merge the Verb Phrase "he hitting the ball" with the Tense element "is", which occupies the Head position of the Tense Phrase (TP). Finally, the Pronoun "he" must be copied and Moved from the Specifier (Subject) position of the Verb Phrase to the Specifier position of the Tense Phrase (also in Figure 2). Movement never takes place unless it is necessary or motivated by a linguistic requirement. Here, "he" moves into the Specifier position of the Tense Phrase because it is in this position that the Tense element ensures that the Subject is in Nominative Case. Note that when an element is copied and moved, it is only pronounced in its relocated position.



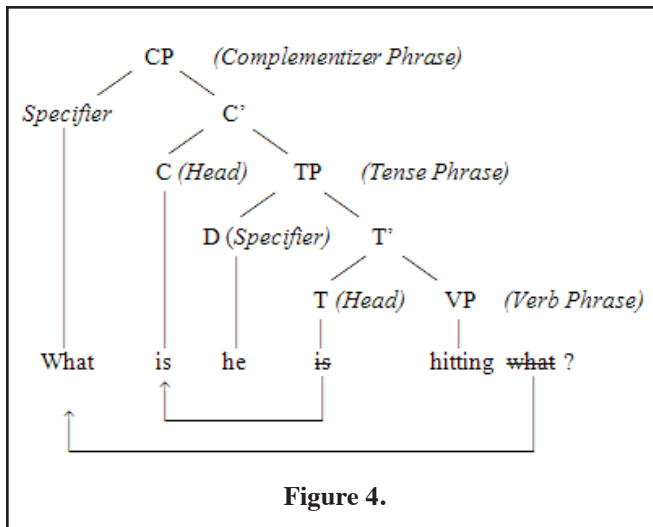
**Figure 2.**

The structure in Figure 2 shows that simple sentences can be generated using only the Functional Category forms of Determiner and Tense. But the production of more complex sentences generally requires a Complementizer Phrase (CP). Questions, for example, can only be generated with a Complementizer Phrase.



**Figure 3.**

In **Figure 3**, our simple sentence “*He is hitting the ball*” has been converted into the *Yes/No-Question* “*Is he hitting the ball?*” To do this, the Tense Phrase has been Merged with a Complementizer Phrase and the Tense Head “*is*” has moved into the Head position of the Complementizer Phrase (i.e., auxiliary inversion). Note that in *Yes/No-Questions* the Specifier position in the Complementizer Phrase is empty and is marked as null (0).



In **Figure 4** our sentence is changed into a *Wh-Question* asking what was hit. The unknown item is initially represented by the *Wh-Element* “*What*” in the Verb Object position at the end of the sentence, but this is then moved to the Specifier position of the Complementizer Phrase at the front of the sentence to produce the sentence “*What is he hitting?*” This form of *Wh-Question* is referred to as an Object question as it concerns the Object of the Verb. This is in contrast to a Subject question like “*Who is hitting the ball?*” Clinical examples of errors with *Yes/No-* and *Wh-Questions* are common, and many investigators have documented problems in children with LI related to movement and auxiliary inversion (e.g., Ebbels & van der Lely, 2001; Leonard, 1995; Leonard, Eyer, Bedore & Grela, 1997; Marinis & van der Lely, 2007; Rice, Hoffman, & Wexler, 2009; Roeper & Seymour, 1994; van der Lely & Battel, 2003).

More detailed discussion of the syntactic computational system is beyond the scope of this narrative, but reviewing these steps in building sentences illustrates the critical role played by Functional Category forms. Children who are struggling with these forms will be at a clear disadvantage when attempting to produce or comprehend even simple phrases, and will certainly be at a loss when striving to comprehend syntactically rich, recursive, hierarchically structured spoken and written language. Moreover, these are precisely the kind of receptive language deficits that research suggests cannot

be addressed effectively in social communication contexts (e.g., Law, Garrett & Nye, 2004), and are associated with later academic disabilities (e.g., NELP, 2009). What seems clear is that Functional Category forms and their associated structures should be a focus of intervention. **Functional Category forms are learned, and what is learned can be taught.** With proven instructional strategies we can teach Functional Category forms to children with language disorders to help them master syntax and become more effective students.

#### **(d) Applying Linguistics to Language Treatment.**

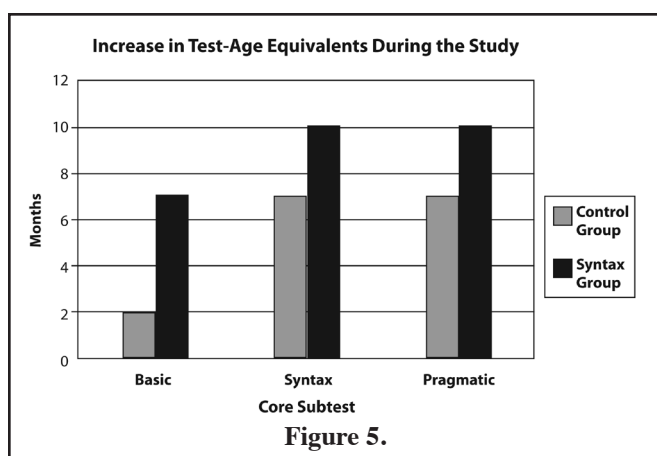
Considering the foregoing in relation to treatment strategies has been an ongoing focus of Laureate Learning Systems’ research and development efforts since the company was founded in 1982. A fundamental assumption guiding these efforts and supported by an extensive body of literature is that children with language disorders must be exposed to systematically-organized primary linguistic data to acquire their native language. Receptive language exposure is required to develop a lexicon and establish syntactic competence. In the case of children with language disorders, who by definition are not acquiring language based on incidental language exposure, an intuitive prescription for intervention involves repeated exposure to salient, highly structured language input in the context of proven instructional strategies. Evidence of the effectiveness of this approach is reviewed next.

### **The Efficacy of Receptive Syntax Intervention**

Since recognizing the potential clinical value of the computer in the early 1980s, Laureate has established a long history of developing research-based language intervention programs, obtaining feedback from educators and clinicians using the programs for treatment in schools, and making improvements on that basis. Laureate also routinely tests *prototype* software in authentic educational settings with the intended target populations, providing a means to optimize instructional approaches and instructional materials as well as yielding anecdotal evidence of efficacy. Efficacy research using *published* Laureate programs has also been undertaken and has yielded very positive results (Gale, Crofford, & Gillam, 1999; Gillam, Crofford, Gale, & Hoffman, 2001; Gillam, Loeb, & Friel-Patti, 2001; Gillam, Loeb, Hoffman, et al., 2008; Marler, Champlin, & Gillam, 2001; Miller & Felton, 2001; Wilson, 1996; and research reviewed next).

Field research using Laureate’s more recently developed syntax programs has also yielded encouraging results. The first such study (Finn, Futernick, & MacEachern, 2005) was conducted in the Medford MA public schools using *prototype* software for what would become the *LanguageLinks*<sup>®</sup>: *Syntax Assessment &*

*Intervention series* (Wilson & Fox, 2007) and *Prepositions!* (Wilson & Fox, 2007). Subjects were 22 children ages 3;0 to 4;10 who were classified as having impaired language and were receiving language services. Etiologies were diverse and included SLI, ASD, and intellectual disabilities. Language status was evaluated before training using the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999). Standard scores on the core tests (Basic Concepts, Syntax Construction, Pragmatic Judgment) for subjects' age levels were determined and Core Composite (CC) standard scores were calculated. Subjects were matched based on age and CC score, and randomly assigned to one of two groups. Those in the experimental group were assigned to use software designed to train items in the Functional Categories of Determiner, Tense, and Prepositions. Those in the control group were assigned to use vocabulary training software. Teachers were asked to use the appropriate software with each subject for approximately 10 minutes per day, several times per week when possible, for 12 weeks. After the 12 weeks, subjects were again evaluated using the CASL. Since all subjects were receiving language intervention services from the school, it was not surprising that most children had improved CC standard scores at the end of the study ( $p < 0.001$ ). More to the point, however, the CC standard scores of children in the experimental group increased by more than twice that of children in the control group, an average of  $9.91 \pm 2.2$  versus  $4.18 \pm 2.0$  points. This interaction (Treatment x Trials) did not reach conventional levels of statistical significance but nearly did so ( $p = 0.067$ ). **Figure 5** shows that in terms of Test-Age Equivalents, advances in the functional language of children using the Functional Category software averaged 8.7 months across the three core subtests, while those using the control software averaged 5.3 months.



Contributing to the overall improvement in CC standard scores were increases in standard scores on each of the core subtests as shown in **Table 1**.

	Basic	Syntax	Pragmatic	Composite
Control Group	$1.8 \pm 2.2$	$6.6 \pm 2.5$	$6.5 \pm 2.5$	$4.2 \pm 2.0$
Syntax Group	$6.6 \pm 2.4$	$11.7 \pm 2.9$	$7.6 \pm 3.2$	$9.9 \pm 2.2$

Table 1. Standard Score Increase

The outcome of the Medford study is noteworthy because the intervention was conducted *entirely under naturalistic conditions* with the aim of maximizing validity. It is also promising that such results were seen despite the relatively brief duration of intervention, clinically diverse subjects, and fidelity issues associated with variations in computer use and progress through the curriculum. While a replication that addresses these limitations is desirable, the results plainly support the view that language intervention software designed to train Functional Category forms can make an independent contribution to the success of language intervention in authentic educational settings.

In 2008 a field study was conducted using Functional Category software from the completed *LanguageLinks* series at Clarke School for Hearing and Speech in Northampton MA (Merchant, de Villiers, & Smith, 2008). Subjects were ten oral deaf students ages 5 to 7 years who had language delays attributed to impoverished receptive language exposure. The children were pre-tested on vocabulary using the Expressive One-Word Picture Vocabulary Test (EOWPVT; Gardner, 1990) and on expressive morphosyntax using a portion of the Diagnostic Evaluation of Language Variation (DELV; Seymour, Roeper, & de Villiers, 2003, 2005). Pre-test scores were used to divide the students into two groups balanced by language ability. One group then used the Functional Category (syntax) training software and the second group used software that trained vocabulary. After 10 weeks all subjects were re-tested with the EOWPVT and the DELV. The groups then traded software programs and received training for another 10 weeks, after which they were again tested. As such, all of the children received training with both the syntax and the vocabulary software, but in a counterbalanced order. Children's scores on the DELV expressive morphosyntax test were significantly improved at the completion of the study ( $p < .03$ ). More importantly, however, comparisons of pre-, mid-, and post-training scores on the DELV revealed that improvements in expressive morphosyntax *were* significant when children had been in syntax training but *not* when they had been in vocabulary training. **Figure 6** shows the morphosyntax score increases and **Figure 7** shows the vocabulary score increases. Clearly, syntax training *per se* was associated with significant improvements

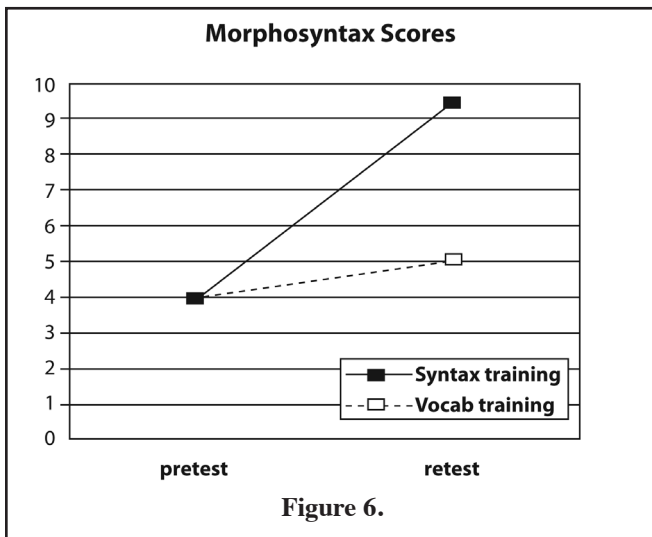


Figure 6.

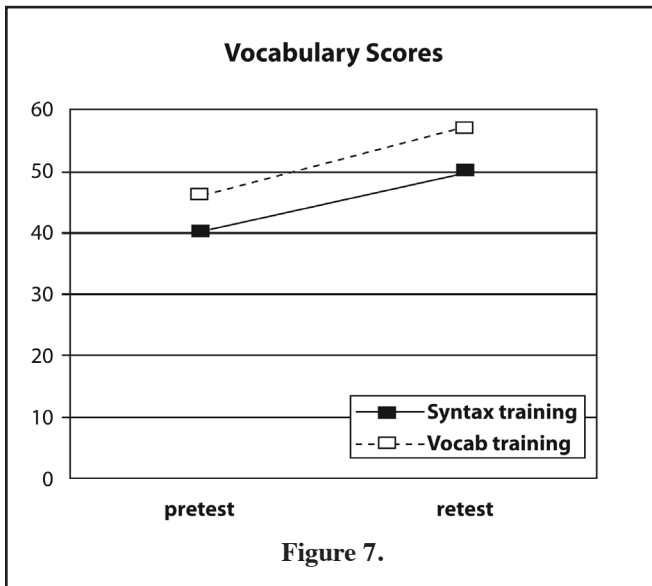


Figure 7.

in expressive morphosyntax, underscoring the fact that Functional Category items are *learned* and therefore can be *trained*. It is also notable and encouraging that, while *receptive* syntax training was provided, the measured gains were in *expressive* syntax.

A similar field study using software from Laureate's *LanguageLinks* series was the subject of a Ph.D. dissertation by J.E. Cannon (2010) at Georgia State University. Cannon's subjects were 26 Deaf/Hard of Hearing (DHH) children 5-12 years old who attended a day school for the deaf. Cannon was especially interested in the comprehension of written language, noting that the severe morphosyntactic deficits commonly seen in DHH children are associated with impaired reading comprehension as well. Presenting the training sentences both aurally and visually as text on the computer screen, Cannon found that daily use of *LanguageLinks* for 10 minutes/day over 9 weeks, was

associated with significant improvements ( $p < .024$ ) in the children's scores on the DELV expressive morphosyntax assessment. Moreover, based on hierarchical linear modeling growth curve analyses, it was determined that the acquisition of written morphosyntax was significantly accelerated as a consequence of regular use of *LanguageLinks* ( $p < .001$ ). This was measured not only by scores from the test component of the software, but also by a separate analysis of performance using a subset of items from the *Comprehension of Written Grammar* (CWG; Easterbrooks, 2010). The CWG items assessed students' ability to comprehend 15 grammatical structures as measured using a task that involved matching pictures to written sentences. Significant improvements on the CWG as detected by the growth curve analysis were presented as evidence that morphosyntactic knowledge acquired during the receptive language intervention also generalized to the comprehension of *written* language. An article based on Cannon's dissertation was recently published (Cannon, Easterbrooks, Gagné, & Beal-Alvarez, 2011).

Another study was conducted by Smith, Pereira, Ravina, et al. (2011) at Clarke School for Hearing and Speech that used software from Laureate's recently released *QuestionQuest*® series (Wilson & Fox, 2010), which trains Functional Category items associated with questions in the Complementizer category. Subjects were 14 children ages 5;4 to 8;4 years; most with cochlear implants. Subjects used the software for 30 minutes/day, usually 3 times per week, for 8 weeks. They were tested using two versions of a *Wh-Question* elicited production test based on the DELV; one version before the intervention and a second version after (counterbalanced). They were also tested on 17 untrained morphosyntax production items (e.g., tense markers, copula) from the DELV Screening Test. At post-test there was no significant change in performance on the untrained morphosyntax test ( $p=0.4$ ). As can be seen in **Figure 8**, scores more than doubled, however,

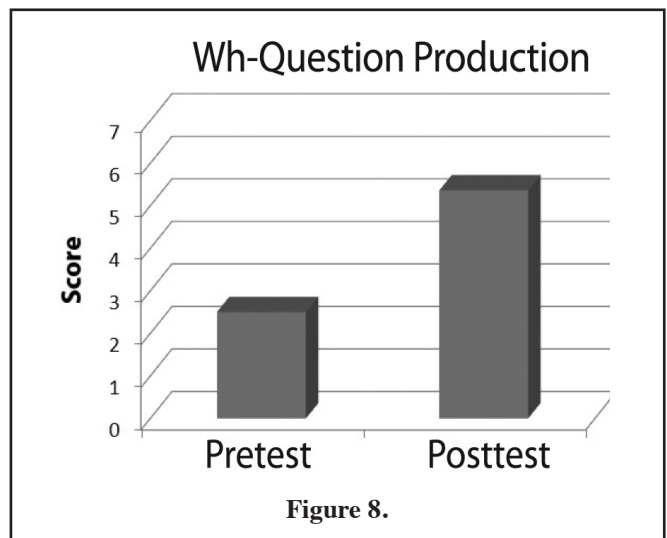


Figure 8.

on the *Wh-Question* elicited production test, a difference that was highly significant ( $p=0.003$ ). The authors noted that improvements in elicited production were evident in students across a range of initial ability. Some who initially did not produce *Wh-Questions* did so after training; others with initially limited production expanded their repertoire.

To summarize, receptive language intervention strategies targeting Functional Category items, as in the research reviewed above, can be a highly effective way to develop critical syntax skills. Language intervention in schools, however, commonly emphasizes the use of language in social communication contexts. This is an important component of language intervention, yet it is not likely to be very efficient in promoting morphosyntactic skills that are essential for adequate comprehension of spoken and written language. A focus on language for communication to the exclusion of comprehension training is a weakness in current approaches that can be remedied by the addition of a software-delivered receptive syntax training component to *supplement* current practices, while at the same time being easy to administer and cost-effective in requiring little professional supervision.

### **A Role for Computers**

Computer-based language intervention strategies can be used to advantage to supplement the services provided by SLPs and special educators. Computer-based intervention has a long record of fundamental efficacy (e.g., Steiner & Larson, 1991; Wilson & Fox, 1983). Moreover, research has shown that children with diagnosed language impairments can make language gains comparable to those seen during individual language therapy with an SLP, using language intervention software *with non-professional assistance* (e.g., Gillam & Loeb, 2005; Schery & O'Connor, 1995). For children with social-pragmatic difficulties as well as language impairment, the demands of dyadic communication can make it difficult to focus on acquiring language forms and structures (e.g., Moore & Calvert, 2000). Yet many of these children tend to interact exceedingly well with computers. Well designed software can provide a salient focus of attention and a highly structured receptive language learning context with predictable operant contingencies, and with less interpersonal pressure than during direct instruction by a human tutor. There also is a broad consensus that language intervention, regardless of specific procedures, is far more effective when the intervention is engaging, appropriately challenging, requires active participation, and provides a legitimate reason for engaging in communicative behavior (McPheeters & Meyer, 1992; Mire & Chisholm, 1990; Spiegel, 1983; Warren, 1993; Weismer, 1988). Those who have had occasion to witness children working with properly designed educational software agree that

computer-based instructional programs are well suited to meet these criteria (e.g., Howard, 1986; Steiner & Larson, 1991; Wilson & Fox, 1983; 1986).

### **Instructional Strategies**

The manner in which curricular content is trained ought to be driven by what has been learned from research examining the effectiveness of specific instructional methods. Laureate's syntax intervention programs provide **receptive language training**. The curriculum is trained using discrete or **explicit trial instruction**. Many years ago research established that *receptive* language training procedures can be more effective than expressive imitation procedures, and produce gains in language production as well as comprehension (Courtright & Courtright, 1976, 1979; Zimmerman & Pike, 1972; Zimmerman & Rosenthal, 1974). This is not surprising since, while pragmatic competence involves the expressive *use* of language, language *per se* (vocabulary and syntax) is *acquired* through listening, not speaking. Other research, including our own, has shown that *explicit trial instruction*, featuring carefully controlled antecedent instruction and training stimulus presentations, is an empirically validated evidence-based methodology for treating children with disabilities, and is an effective means to teach a variety of language skills (Justice et. al., 2003; Maurice, Green, & Luce, 1996; Simpson, 2005; Wilson, 1977). The well-established learning principles of **behavioral analysis** and **errorless learning** (Holland & Skinner, 1961; Terrace, 1963) have long provided a foundation for the instructional design of Laureate's language software. Several kinds of **instructional support** are available during training in Laureate's syntax programs. Instructional support is faded or maintained as needed to sustain correct responding at levels sufficient to be challenging but not frustrating. After a trial, **instructional feedback** is always provided. Providing Knowledge of the Correct Response (KCR) assures that the student is always told the correct answer, either as part of the reinforcement sequence following a correct response, or as informational feedback following an incorrect response. In our research, we have found that even training using feedback alone for instruction was effective (Wilson & Fox, 1983). There have been other demonstrations of the effectiveness of these procedures as well, across a range of computer administered instructional programs (Gilman, 1969; Tait, Hartley, & Anderson, 1973; Wilson & Fox, 1981).

### **A Role for Expert Systems**

Properly delivering a pedagogically complex and appropriately individualized curriculum can be challenging for school personnel who do not have specialized training, and yet this is critical since even the most effective curriculum

may accomplish little if not used in an appropriate manner. In addressing this problem, an advantage of using software is the ability to use curricular control systems based on expert system methodology to guide the selection of activities, presentation of material, and level of instructional support, such that the content and focus of instruction is continually adjusted based on a student's performance and emerging capabilities. Considerations such as these (complex training requirements and limited professional resources) prompted the National Aeronautics and Space Administration (NASA) to develop Intelligent Computer-Aided Training (ICAT) systems to train space shuttle astronauts (NASA, 1991; Way, 1993). NASA subsequently sought to find uses for ICAT technology in other fields, and during that process met with special educators from the Center for Special Education Technology and the Council for Exceptional Children (CEC). This group identified the language problems of children with disabilities as a critical problem in special education that might productively be addressed using ICAT technology, and to this end, asked Laureate to enter into a technology transfer agreement with NASA's Software Technology Branch. These events initiated our work on the development of ICAT systems for language intervention. We have now developed several generations of increasingly advanced ICAT systems, which we call *Optimized Intervention*<sup>®</sup> technology.

### **Applying Theory & Research.**

For children who are in the late one word or early word combination stage, the introduction of training materials designed to appropriately trigger the two word order Parameters that yield the Subject-Verb-Object canonical word order in English sentences is important. The *Minimalist* model suggests that the acquisition of syntactic competence can be viewed as a matter of "setting" grammatical parameters through exposure to appropriate receptive language input. In terms of word order, English follows a pattern of Subject-Verb-Object (SVO). You will recall that this order is determined by two different Parameters. One Parameter determines whether the Complement (Object) comes before or after the Head (Verb). The other determines whether Specifiers (Subjects) come before or after the Head (Verb). These two Parameters and their settings determine word order in all languages. Clinically we all have encountered children who produce "mixed up" sentence order and encounter difficulty interpreting reversible sentences. Linguistic theory provides us an explanation for their difficulties. The word order Parameters have not been set to their appropriate English values.

**Simple Sentence Structure** (Wilson & Fox, 2003) was designed to provide what are believed to be salient

"triggering" data for setting the Subject-Verb Object canonical word order of English. The program systematically takes the student through contrasting Verbs, contrasting Objects (Complements) contrasting Subjects (Specifiers), and finally to a set of reversible sentences (e.g., *The girl is splashing the boy/The boy is splashing the girl*). In a clinical study using an intervention strategy based on *Simple Sentence Structure*, a reversible sentence receptive strategy was effective in increasing the production of SVO constructions (Loeb & Armstrong, 2001).

An important next step towards mastering syntax is learning Determiner and Tense forms and the associated syntactic structures. Complementing this should be instruction in Prepositions and the phrases associated with them. In typically developing children Determiners, Tense, and Prepositions begin appearing in the early two-word stage.

**LanguageLinks<sup>®</sup>: Syntax Assessment & Intervention** (Wilson & Fox, 2007) is a software system that covers a broad range of Determiner and Tense forms in six developmentally ordered levels. *LanguageLinks* provides an evidence-based practice approach to helping children with syntactic deficits achieve language competence. It was the first comprehensive syntax intervention system to be based on current linguistic theory, instructional research, and have field test data to support its use. Each of the Levels in *LanguageLinks* contains six Modules which train either two or three grammatically contrasting Determiner or Tense forms per Module. The *LanguageLinks* system will take children with language impairments from the early two-word development stage (typically developing children are in this stage from 18-24 months of age) through the mastery of a broad range of syntactic forms in the Determiner and Tense categories. In typically developing children this takes place by four or four and half years of age. Children with language disorders may need to work on these Functional Category forms throughout their elementary school years.

**Prepositions!** (Wilson & Fox, 2007) trains 10 important Prepositions and can be introduced at the same time a student is working on *LanguageLinks*. Spatial or locative Prepositions are especially important in early syntax development. They are used to express concepts of location or position. Knowledge of spatial Prepositions is critical to commenting on the position of objects in the environment. These Prepositions enter the lexicon early in the word combination stage. The Prepositions "in" and "on" are typically cited as the two earliest developing spatial Prepositions. They were among the 14 grammatical morphemes studied in Brown's classic 1973 book *A First Language: The Early Stages*.

A final product that addresses Determiners is **Pronoun Perspective** (Wilson & Fox, 2008). First and Second Person Pronouns (e.g. *Me/You, My/Your, Mine/Yours*) are

especially difficult for many children with LI. *LanguageLinks* has 8 Modules that address 1<sup>st</sup> and 2<sup>nd</sup> Person Pronouns, presenting them in a context where the character on the screen is always the 1<sup>st</sup> Person and the student is always the 2<sup>nd</sup> Person. **Figure 9** shows a “You” trial from the *Me/You* Module in *LanguageLinks*. On the Beginning and Intermediate training levels this trial would be preceded by an animated sequence in which the character would point out the skates “...for you.” In this sequence the skates actually move from the bench on the right to the bench in the foreground making the “You” very salient.



Figure 9 “You” Trial from *LanguageLinks*.  
Character’s voice: “Find the skates for you.”

This is the first step in developing 1<sup>st</sup> and 2<sup>nd</sup> Person understanding. The second step is learning how to take a narrative perspective on 1<sup>st</sup> and 2<sup>nd</sup> Person references. This is critical for comprehending “Who said what to whom” in stories and text. In *Pronoun Perspective*, both the 1<sup>st</sup> and 2<sup>nd</sup> Person characters are on screen and students take the role of the observer. This requires an understanding that the speaker is the 1<sup>st</sup> Person and the listener the 2<sup>nd</sup> Person. **Figure 10** shows a “Me” trial from the *Me/You* Module in *Pronoun Perspective*. Since this is a “Me” trial, the animated instruction on the Beginning and Intermediate levels would show the boy on the right saying “The dog is kissing me.”



Figure 10 “Me” Trial from *Pronoun Perspective*.  
Narrator’s voice: Who says... “The dog is kissing me.”

When we developed *Pronoun Perspective*, we thought it would be primarily useful for students with ASD, but in prototype testing at a local kindergarten we found that many students including those from low income backgrounds had difficulty with this narrative perspective. According to the Title I supervisor, the students having difficulties with this narrative perspective on 1<sup>st</sup> and 2<sup>nd</sup> Person Pronouns were also having difficulties understanding stories. This underscores the importance of Functional Category comprehension to reading.

Once students have mastered a core group of Determiner, Tense, and Prepositions forms, they are ready for the recently released **QuestionQuest**<sup>®</sup> (Wilson & Fox, 2010) series which provides training on Complementizers with a focus on *Wh-* and *Yes/No-Questions*. Children who are learning to understand and respond to questions need to learn many semantic (meaning) and syntactic (structure) subtleties. For example, we all have encountered children who when asked questions like “What kind of ice cream do you want?” answer “Yes” indicating they have failed to discriminate between a *Yes/No-* and a *Wh-Question*. Children must also learn the various semantic meanings of *Wh-Questions* such as the *How* question “How will he open the lock?” most likely requires an instrument answer “...with a key” while “How is she dancing?” requires a manner response “...on her toes.” Note that in typical conversational contexts, the ellipsis response “...on her toes” is expected rather than a full sentence response of “She is dancing on her toes, that’s how she is dancing.” In contrast to queries where either an instrument or manner response is expected, the response to “How is he cleaning the floor?” depends on the pragmatic context as it could be answered with the instrument response “...with a sponge” or a manner response “...on his hands and knees.” Children must also learn that when more than one

person is involved in an activity, a question such as “Who is washing the car?” requires an obligatory exhaustive response where all the participants are named. Similarly, when a scene is described as “Everybody is reading something and sitting somewhere.” The response to “Who is eating what where?” requires a pairing of all the actors with what they are eating and where they are sitting. Children with language disorders benefit from systematic instruction to learn to comprehend these various aspects of questions.

*Simple Sentence Structure, LanguageLinks, Prepositions!, Pronoun Perspective, and QuestionQuest* are all *Sterling Edition* programs. Laureate’s *Sterling Edition* language intervention programs each feature an *Optimized Intervention*® expert system uniquely designed to deliver the curriculum and the *Sterling Administration System* that makes data collection and management easy.

### **Optimized Intervention**®

The *Optimized Intervention* system in Laureate’s *Sterling Edition* software is the culmination of research and development efforts which have been supported by Small Business Innovation Research (SBIR) grants from the National Institutes of Health, National Institute on Deafness and Other Communication Disorders (NIDCD), and the National Institute on Child Health and Human Development (NICHD). The system uses artificial intelligence methodology to select appropriate training material and to adjust instructional support in relation to emerging skills and competencies, resulting in highly individualized and efficient language instruction. Each *Sterling Edition* language intervention program has an *Optimized Intervention* uniquely designed to test and train the curricular targets. Words, concepts, and forms are arranged in developmental order for testing and training. All the programs begin by probe testing in developmental order to ascertain the appropriate place to begin training. Once training begins, *Optimized Intervention* determines what material a student needs to work on and how much instructional support the student may require to make progress. As a training session proceeds, the training material and degree of support are adjusted continually based on the student’s performance. As powerful as *Optimized Intervention* is, it couldn’t be easier to use:

- Enter or choose the student’s name
- Select the program
- Press GO

Once the student has achieved mastery over the material being trained, *Optimized Intervention* continues to probe and introduce new stimuli until the student has achieved mastery over the entire curriculum for that program.

### **The Sterling Administration System**

The *Sterling Administration System* manages all aspects of student performance from automatic data collection to reporting. Student data collection, analysis, and reporting are necessary to ensure accountability. In addition to the attention we have paid to instructional integrity in the *Sterling Edition* programs, through the *Sterling Administration System* we provide tools for making data collection, analysis, and reporting easy. The *Sterling Administration System* carefully tracks all variables related to a student’s progress through the curriculum and stores that information in the Student File. The Report Writer has been designed to access this Student File and extract meaningful information to include in student reports and other documentation. All *Sterling Edition* programs come with multiple built-in reports.

In addition to built-in reports, *Sterling Edition* programs provide several hundred labeled data items that can be used to customize the built-in reports or to create entirely new custom templates that can be applied across students. For example, you could create a *LanguageLinks* report to send home to parents that showed what forms a student had mastered and what they could encourage in production. You can then simply apply the report to any student using the program. You can also export student data into spreadsheets for graphing and statistical analysis. The *Sterling Administration System* makes this easy. With the *Sterling Administration System* and *Optimized Intervention*, the *Sterling Edition* programs promise to deliver more effective and efficient assessment and intervention while at the same time providing the data clinicians, special educators, teachers, and administrators need for accountability.

### **Using Laureate’s Syntax Programs**

While Laureate programs can be used in a number of different contexts and for different purposes, we generally follow a three pronged approach for students who are on Individualized Education Plans (IEPs) starting with 1) use of Laureate’s receptive software in their classrooms on a regular basis. The *Optimized Intervention* expert system in each of the programs ensures that students will receive individualized instruction that is responsive to their unique needs. If an SLP is seeing a student for a half an hour twice a week, just 15 minutes of classroom use of Laureate syntax software four days a week means a doubling of individualized language intervention services being delivered. As students master forms SLPs can begin to introduce 2) structured expressive use of these forms in therapy. Then as students gain confidence in using forms in structured settings 3) the use of these forms and structures in natural communication

settings can be supported and encouraged. For students who are English language learners (ELL) we recommend use of the software in the classroom to supplement the language instruction they are already receiving. Depending upon the student, one-on-one intervention may not be necessary but s/he certainly should receive support in the expressive forms s/he has learned in a small group setting. ELL students will also need classroom communication supports. Similarly, students receiving services through a Response to Intervention (RTI) model will typically not need one-on-one tutorial expressive intervention with stimuli from the software. They will benefit from small group instruction designed to elicit receptively mastered forms and structures. As with ELL students they should also be provided with communication supports to effectively use language for communication and reading comprehension.

**1. Classroom Use of the Programs to Establish Receptive Mastery.** *Simple Sentence Structure* can be introduced in the late one word stage as soon as a core Noun and Verb vocabulary (+/- 150 words) has been established. It can also be used after students are combining words if they are evidencing difficulty with word order. The program is also excellent for ELLs whose native language does not follow an SVO pattern. Once children enter the two-word stage emphasis should be placed on receptively training Determiner, Tense, and Preposition Functional Category forms. *LanguageLinks®: Syntax Assessment & Intervention* and its companion program *Prepositions!* provide training on these critical Functional Category forms. Laureate’s free *Syntax Tests* program can be used to assess students’ knowledge of the Determiner, Tense, and Preposition forms trained in these programs. The Full Test takes about 30 minutes while the Screening Test takes about 15 minutes. Both assessments are delivered automatically and do not have to be completed in one session. A variety of built-in reports are available. These reports not only give the results of testing, but also tell you which levels of *LanguageLinks* the student needs and whether *Prepositions!* is needed as well. As students begin mastering the 1<sup>st</sup> and 2<sup>nd</sup> Person Pronouns in *LanguageLinks*, you can introduce them to *Pronoun Perspective* which provides practice comprehending pronouns from a narrative perspective. It develops a 3<sup>rd</sup> Person perspective and improves social communication knowledge ensuring that students understand “*Who said what to whom.*” After students have mastered most of the Modules in these programs, *QuestionQuest* can be introduced. Students who are learning to understand and respond to questions need to learn many semantic (meaning) and syntactic (structure) subtleties. Mastery of later developing forms such as *Yes/No-* and *Wh-Questions* is especially problematic for children with LI as well as English language

learners. With the *QuestionQuest* curriculum students learn to answer who, what, with what, where, how, and why questions. They learn to answer exhaustively as well as to discriminate between *Yes/No-* and *Wh-Questions*.

**2. Structured Expressive Use of Mastered Forms and Structures.** The stimuli used in the software can also be used to encourage use of the forms and structures as the student masters them in receptive training. By using the same familiar stimuli as used to train comprehension, students on IEPs are better able to see the relationship between understanding and expression. This is especially true with questions where students can better see the continuities among understanding, answering, and asking questions. Modeling can be used as it was in comprehension training. Prompts and text cues can provide additional response support. Here’s a screen shot from *QuestionQuest*:



Using this image model “*Who is eating an apple?...the officer. The officer is eating an apple.*” Point to the officer and ask, “*Who is eating an apple?*” Accept responses of either the whole sentence or “*...the officer*” which is the grammatically correct ellipsis response favored by competent language users. Note that the Determiner (definite article *the*) must be present. Responses without the Determiner “*the*” should be correctly modeled.

For many students on IEPs, structured group sessions can take the place of one-on-one instructional dyads. This is certainly the case for ELL students and those receiving services through a RTI model.

**3. Facilitate Use of Sentences for Communication in Social Settings.** Once students have demonstrated their ability to use Functional Category forms and structures in an instructional dyad or small group, they should be encouraged to use their new capabilities in social settings at home, school, and in the community. Most students will

need scaffolding to assist them in this important step.

In the late one word stage begin syntax training by ensuring that students have the word order Parameters set to English SVO. Once a student enters the word combination stage, start receptively training Determiner, Tense, and Preposition forms and their associated structures. Students can use the software in their classrooms to master these Functional Category forms necessary for sentence comprehension and production. Once students are well on their way mastering earlier developing forms, introduce Complementizers in *Yes/No-* and *Wh-Questions*. As forms and structures are receptively mastered, introduce structured expressive use. Structured expressive small group instruction can be useful for all students. Once receptive and expressive competence has been established, your students are ready to use their sentence structures in communication settings.

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