

FIRST WORDS, FIRST WORDS II, AND FIRST VERBS STERLING EDITIONS:

Theoretical, Research, and Clinical Background

Based on recent linguistic theory and research, Laureate's next generation *Sterling Editions™* make instructional delivery more individualized and more efficient than ever before. They feature *Optimized Intervention™* technology that tailors instructional delivery to each student's unique needs. The *Sterling Administration System* lets you easily build and maintain student files, individualized program settings, analyze performance data, and write reports. The first three *Sterling Editions* programs provide highly structured training of early developing nouns and verbs. Each program uses colorful pictures, encouraging speech, and language enriching animation to train 50 words in developmental order.

In the years since Laureate Learning Systems published the first versions of *First Words*, *First Words II*, and *First Verbs* (Wilson & Fox, 1982, 1985, 1985), advances in linguistic theory and child language research have greatly enriched our knowledge of early language acquisition. Much of this new knowledge supports the instructional approaches and content used in the earlier versions of our programs. But new research has also helped us to discover even more effective ways to give students the information they need to acquire language.

A Theoretical Foundation based on Linguistic Research

A recent milestone in the evolution of linguistic theory is the Principles and Parameters Model (Chomsky, 1981), which has provided the theoretical underpinnings for Laureate's new generation of language intervention programs published under the *Sterling Editions* banner. The model elaborates on observations (Greenberg, 1963), that there are underlying similarities among all human languages. It describes these commonalities in terms of a set of innately specified "universal principles" that define and constrain the structure of natural language. The acquisition of language is conceptualized as being based upon these universal principles, and involving the setting of syntactic "parameters" through exposure to timely and appropriate language input. The parameters are a small set of grammatical "options" that can account for most of the syntactic variations among human languages (Atkinson, 1992; Baker, 2001; Chomsky, 1981; Crain, 1991; Leonard & Loeb, 1988; Radford, 1990; Radford, 1997; Roeper & Williams, 1987).

The Principles and Parameters Model has become domi-

nant in the field of linguistics and provides a useful framework for language acquisition research, in part because the model has many heuristic implications. Of special interest here is the notion that the fundamental structure of language is already a part of our biological endowment. While the lexicon of a language must be learned, structure is based on universal principles. The acquisition of language competence can be viewed as a matter of "setting" grammatical parameters through exposure to appropriate receptive language input combined with the learning of a lexicon. Understanding parameters and the receptive language experiences that "trigger" or "set" them can lead to intervention strategies that are more effective because they specify the specific linguistic experiences that may optimize or correct the process of language acquisition on a fundamental (versus symptomatic) level. Put another way, the model suggests that the most successful language intervention should emphasize linguistic input that is likely to interact with innate factors that shape language acquisition, and is likely to "set" the grammatical parameters of the child's native language (Atkinson, 1992; Hyams, 1986; Lightfoot, 1991; Roeper & Williams, 1987).

Consider, for example, a parameter called the "Head Directionality" parameter. This determines whether the Head of a phrase comes at the beginning or end of the phrase. A related parameter is the "Subject Side" parameter (also known as the Specifier-Head parameter), which determines whether a subject noun phrase appears first or last in a clause. In English these parameters are set to Head-first and Specifier-first at a very early age, yielding the canonical Subject-Verb-Object word order in English. In fact, by the time typically developing children enter the two-word stage, it



appears these parameters are already set as evidenced by their use of appropriate word order (Lightfoot, 1991; Radford, 1990; 1997). This means these parameters are set during the one-word stage.

For children with language disorders, the *Sterling Edition* programs have been designed to provide highly structured stimulus and reinforcement language that we believe can help in triggering the correct setting of these parameters as children are acquiring their first words. If a child is still having difficulty with Subject-Verb-Object word order after completing *First Words* and *First Verbs Sterling Editions* (indicating that the Head Directionality and Subject Side parameters may not be set), we have developed another program called *Simple Sentence Structure* that is designed specifically to help trigger these parameter settings.

Another parameter that has been much studied in children over the past thirty years is the Null Subject parameter. This determines whether a language allows one to drop the subject of a phrase. English and French require an overt subject, whereas Italian and Spanish do not. The Null Subject parameter is thought to be triggered in English by receptive exposure to sentences such as “It is raining” or “It is snowing,” where the “It” has no semantic content and is present simply because English requires an overt subject. With this in mind we intentionally chose to include the verbs “rain” and “snow” in *First Verbs Sterling Edition* so that students would be exposed to these potentially important sentence types.

Accepting that there are certain fundamental principles of human language that are fixed and hold true across all languages, Baker (2001) has suggested that the number of parameters necessary to produce the immense diversity in the surface structure of human languages is quite small. He also has proposed that parameters are arranged hierarchically in the sense that some parameter settings affect others by either restricting their potential or rendering them irrelevant (for a very accessible overview see Mark Baker’s *The Atoms of Language*, 2001).

The Minimalist Program is the most recent effort in Chomsky’s (1993, 1995) long-standing generative grammar research. Its goal is a further reduction in the complexity of linguistic theory, perhaps to the extent that a unifying explanatory theory of language can be proposed. One key feature of the Minimalist Program is a strong “lexicalist approach.” That is, the model specifies that each “lexical entry” (the cognitive representation of a word) includes not only phonological and semantic properties (sound and meaning), but also syntactic features such as categorial membership (i.e., whether it is a noun, verb, determiner, etc.) and inflectional behavior (e.g., how it is marked for number, person, and gender). In other words, the Minimalist Program assumes that a complete lexical entry includes knowledge

of the specific roles a word can play in the structure of language, and knowledge of the appropriate form of a word in a given grammatical context. As such, and to the extent that it’s lexical entry is complete, a word can emerge from the lexicon and enter the computational system already in a fully inflected state (Abraham, Epstein, Thráinsson & Zwart, 1996; Epstein, Thráinsson & Zwart, 1996).

Given that the lexical features of a language must be learned, and considering that lexical knowledge under current linguistic theory is more complex than previously thought, a reexamination of how we go about teaching vocabulary is in order. Our traditional approaches need to be reevaluated in light of the expanded conception of a lexical entry, and ought to include strategies that we could not have been aware of in the past.

Applying Linguistic Research

In many ways, of course, contemporary research confirms the wisdom of strategies that clinicians have long used based on their observations and intuition. For example, the Principles and Parameters Model, the Minimalist Program, and observations from child language research all stress the importance of appropriate receptive language input. Hence, like the original *First Words*, *First Words II*, and *First Verbs*, the *Sterling Edition* programs provide explicit and systematic receptive language training. To promote basic semantic vocabulary development, illustrations depicting each word are presented together with the spoken word. This strengthens the association between the lexical representation of a word and the perceptual-cognitive properties the word is intended to reference.

Semantic learning alone, however, describes only part of what a child is acquiring during early lexical development. We’ve seen that there also must be learning about the parameters of the language being acquired – the grammatical options that distinguish one language from another. That such learning typically occurs during the early single-word stage is evidenced by the rapid progression of syntactic competence: Typically, at about 12 months a child will begin to produce isolated words with no evidence of grammatical marking. Within another six months or so, however, the child will also begin to produce simple inflections such as the noun plural marker *-s* and the progressive verb ending *-ing*. At the same time there is evidence that these children already comprehend the significance of word order.

Perhaps the best evidence of this is provided by the pioneering work of Hirsh-Pasek, Golinkoff, Fletcher, et al. (1985), who developed the preferential looking task enabling the testing of very young children. In their research, when children as young as sixteen months were presented with two televisions showing *Big Bird* tickling *Cookie Monster* and vice versa, and then were told, “Oh look! *Big Bird* is tickling

Cookie Monster!” or vice versa, the children preferentially attended to the visual stimulus that corresponded to the structure of the spoken sentence (Hirsh-Pasek, et al., 1985). In other words, they were sensitive to the word order differences and their significance, indicating that the word order parameters were already set. We’ve also noted that children’s early two-word utterances typically reflect the canonical word order of the child’s language, providing additional evidence that the word-order parameters have been set appropriately (Lightfoot, 1991; Radford, 1990; 1997; Wexler, 1994). By a year later, the child will have acquired most of the basic grammatical forms of a language.

Clearly, then, during even the earliest stages of language acquisition, children are learning not only the meaning of words but also grammatical features of the lexicon and the syntactic structure of their language. In contemporary linguistic theory, the lexicon itself is thought to consist of content words, i.e., the *lexical categories* (e.g., noun, verb, adjective) and non-content elements that serve essentially grammatical functions, i.e., the *functional categories*. The latter include *Determiners* (the D-system), *Inflection* (the I-system), and *Complementizers* (the C-system).

- The D-system is associated with nouns and is so-called because it specifies (or determines) that to which a noun expression refers. Determiners include, for example, articles (*a, the*), pronominal determiners (*this, that, these, those*), pronouns, and anaphors (*himself, herself*). A determiner heads a Determiner Phrase (DP).
- The I-system is associated with verbs and refers to elements that inflect verbs for tense and agreement. The I-system includes, for example, the regular past tense *-ed*, infinitival *to*, auxiliary “*be*,” and third person singular *-s*. An Inflectional Phrase (IP) includes a verb and its inflectional elements.
- The C-system comprises words such as *that, if, and whether* that serve to introduce and characterize complement clauses in several ways, and various operations involved in the formation of questions.

Radford (1997) and other child language experts suggest that children’s earliest utterances may consist of bare noun and verb phrases. As the functional categories are acquired, however, nouns merge with determiners and become DPs. Verbs merge with inflectional elements and become IPs. Hence, for example (functional elements in bold):

N	V		DP	IP
Ball	Roll	comes to be replaced by	The ball	is rolling

This developmental step generally does not proceed smoothly for children with language disorders, however. In

fact, one certain conclusion that can be drawn from the research is that functional categories are a fundamental locus of problems for children with language disorders (e.g., Bedore & Leonard, 1998; Leonard 1995, 1998; Rice, 1998; Rice, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998; Roeper & Seymour, 1994; Wilson & Pascoe, 1999; Wilson, 2000). One report (Rice, 1998), for example, described the use of tense-marking morphemes in 5-year-olds with language impairments and age-matched controls. Only one of 37 children with impairments used obligatory tense-marking morphemes more than 60% of the time, whereas *all but one* of the 45 children in the control group used these morphemes with 75% or greater accuracy. In our own research, we extended this work with a focus on singular and plural Auxiliary *be*, regular past tense *-ed*, third person singular *-s*, and negation with *do*-support in children 4;0 to 5;11. Over the course of two studies, every one of 33 children with identified language impairments made multiple errors using these constructions and failed to meet test criterion. In contrast, all but six of 127 children thought to be developing typically did meet criterion. Of the six, one failed due to a dialectical variation. The others were referred for further testing and at least three were subsequently diagnosed as language impaired (Wilson & Pascoe, 1999; Wilson, 2000).

Taking all this into account, early language intervention intended to develop the lexicon should not merely focus on teaching the phonological and semantic features of the lexical categories such as nouns and verbs. Rather, intervention also ought to place considerable emphasis on illustrating the use of the functional categories in association with those nouns and verbs in various syntactic settings. Without this input, children with language impairments will have an inordinate difficulty in establishing a rich and complete lexicon. In practical terms this means that nouns, for example, ought to be presented in singular and plural forms in conjunction with appropriate determiners. Verbs ought to be inflected appropriately and presented in ways that illustrate their morphological variety in an assortment of common syntactic settings. In doing so, structured receptive input illustrating the functional categories is provided, and the acquisition of a more complete lexical entry for each word becomes possible.

The design of our new *First Words, First Words II*, and *First Verbs Sterling Editions* software embraces this notion in several ways. First, during instruction and feedback, words being trained are always presented in the context of full sentences. Second, the sentences employed are designed to provide systematic receptive language input illustrating functional elements associated with the lexical category of the word being trained:

- In the case of nouns, these include D-system features such as the use of articles (*a, the*) before and after reference is established, and the proper use of pronominal determiners in singular and plural contexts (*This/These*). Use of the plural marker *-s* and Copular “*be*” Agreement (*Is, Are*) are also demonstrated.
- In the case of verbs, training includes systematic receptive language input illustrating the argument structure(s) associated with each verb, and during the instructional introduction, the substitution of proper nouns with third person nominative pronouns (*he, she, they, it*), highlighting the I-System assignment of nominative case.
- Furthermore, once a student has moved past the basic training levels, each word is associated with a unique reinforcement animation that provides additional examples of the word in full sentences. Nouns are presented in additional sentences that illustrate D-system constructions; i.e., the noun is merged with a determiner to form a DP. Included are sentences featuring articles, pronouns, the genitive ‘s inflection, and DPs that include one or more adjectives.

In the case of verbs, these sentences provide receptive language input illustrating the I-system; i.e., several morphological forms of the verb (e.g., past tense, simple present, third person singular, and with future modal *will*) in complete sentences. All this during engaging reinforcement animation, at a point when one would expect the student’s attention might be engaged most fully.

Instructional Strategies based on Child Language and Clinical Research

Receptive Language Training

The instructional approach used in *First Words*, *First Words II*, and *First Verbs Sterling Editions* emphasizes the importance of initial receptive training. At a fundamental level this approach is comparable to the storybook picture naming that parents use with their infants. The parent calls the infant’s attention to an object or action, and then repeats the word associated with the stimulus. Parents tend to name a whole object rather than its parts (Ninio, 1980), consistent with the word learning biases of young language learners. Parents also tend to repeat a target word consistently, but vary the sentence containing the word. Moreover, parents tend to initiate such language learning interactions long before an infant is capable of producing the word, but will often test for comprehension by asking the child to point to the associated stimulus.

Naming words as a teaching technique falls into the category referred to as modeling. This involves naming a picture and asking the child to respond receptively. Model-

ing strategies have been found to be an effective means of language instruction for children with language disorders (Courtright & Courtright 1976; Gale, Crifford, & Gillam, 1999; Kushner & Winitz 1977; Wilson 1977). There is less support for the efficacy of strategies involving imitation. In fact, at the end of one study the authors concluded that not only is imitation training unnecessary, it actually can interfere with learning to understand and produce language responses. They suggested that the preferred method of instruction would be to first concentrate on comprehension using receptive training (Ruder, Hermann, & Schiefelbusch, 1977).

Research has shown that children with language impairments benefit from receptive language training. In fact, there is evidence that young children with SLI can learn new nouns as readily as others when provided with structured receptive input and additional repetition (Dollaghan, 1987; Leonard, 1981; Rice, Oetting, Marquis, et al., 1994). It is not surprising, therefore, that many language intervention programs have stressed the importance of first providing receptive training (Miller 1977; Miller & Yoder 1972, 1974; Bricker & Bricker 1974; Wilson 1972, 1976, 1977, 1996).

That receptive training is effective in language intervention is expected given that typically developing children acquire language not through talking but by listening. Language input provides the data necessary to learn the lexicon and trigger parameter setting. Pinker (1994) stated this succinctly when he wrote;

“It is not surprising that grammar development does not depend on overt practice, because actually saying something aloud, as opposed to listening to what other people say, does not provide the child with information about the language he or she is trying to learn.”

(Pinker 1994, p. 280)

Laureate’s *Sterling Edition* programs continue the efficacious tradition of receptive language training. *First Words* and *First Words II* use modeling to introduce 100 early-developing nouns. Each noun is represented by two salient illustrations and two carefully chosen photographs that depict prototypical examples of the whole named object. Each noun is repeated consistently, but with varying carrier phrases as each stimulus is presented. *First Verbs* uses modeling to introduce 50 early developing verbs. Verb instruction is provided both before and after displaying salient animations that isolate the relevant verb action. Each verb is also repeated in the final position to facilitate acquisition.

A variety of research studies indicate that it is appropriate to initiate lexical training using pictures such as those in the *Sterling Edition* programs. There is no need, for example, to first introduce words using objects as examples. One

study comparing acquisition using objects for one set of words and photographs for another found that there was basically no difference in the children's responses to the two forms (Daehler, Perlmutter, & Myers 1976). Performance with both sets of stimuli was equivalent. In subsequent testing the investigators found that the children were equally able to transfer learning acquired using either stimulus set to new forms and new exemplars. Clearly it seems that modality transfer is not a problem.

Moreover, comparable evidence has been obtained in studies using much younger subjects. Rose (1977) found that six-month olds could visually differentiate 3-dimensional stimuli from their 2-dimensional representations and could transfer this information across these stimuli. Pictures have even been regarded as a preferred means for vocabulary teaching (Ninio & Bruner, 1978). The abstract nature of the pictorial stimulus may assist the child in forming the proper distancing relation that permits him/her to apply a referential label.

Taken together, these and other studies suggest that formal language instruction using pictures is appropriate without prior training with objects. This is not to suggest, of course, that training with *Sterling Edition* programs cannot be combined with informal training using objects. There is evidence to suggest that children may perform better when objects are used as exemplars rather than pictures because the objects have a higher interest value (Daehler, Lonardo, & Bukato, 1979), not because there is a true comprehension differential. Certainly, when objects are more attractive than their corresponding pictures, it would be expected that a child is more likely to respond to the objects.

An added feature of the *Sterling Edition* programs is their innovative animated reinforcement routines. As noted earlier, these word-specific post-trial reinforcement animations feature the just-trained noun or verb in various syntactic contexts with an assortment of grammatical forms. As such, these routines contribute to receptive language training, even though their overt purpose is to motivate responding. The use of animation as a consequent event to motivate responding is based on a large body of research showing that children will emit responses to achieve a change in visual stimulation. In fact, even infants as young as 3 months will activate mobiles to achieve visual reward (Fagen, 1980; Fagen & Rovee, 1976; Mast, Fagan & Rovee-Collier, 1980). An additional prospect is that many educators who use *Sterling Edition* programs with their students will find these reinforcement animations amusing.

Instructional Approach

Training with *First Words*, *First Words II*, and *First Verbs* *Sterling Editions* includes several kinds of instructional support: When pretrial Instruction is included, the target

picture is presented and the target word is spoken before the student is asked to respond. Cueing to the Correct Response (CCR) is also provided on lower training levels. This consists of an arrow or animated character that appears above the correct response target. In addition, two kinds of instructional feedback are used in the *Sterling Editions*. Cueing to the Correct Response (CCR) is always provided after the first incorrect response or if no response is made. Again, this consists of an arrow or animated character that appears above the correct response target. In addition, the target picture flashes three times as the question is repeated. The student is then given a second chance to respond. The second kind of feedback is Knowledge of the Correct Response (KCR). In KCR, the learner 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 all cases, then, at the end of each trial the learner receives informational feedback indicating the correct response.

In our own research we have found that, in training using only feedback as an instructional component, both KCR and CCR were 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), including Laureate's language development software (e.g., Gale, Crifford, & Gillam, 1999; Miller, 1993).

Vocabulary Selection

Language acquisition research also has provided a general description of the ages at which children can be expected to comprehend and produce various lexical items. We turned to these typical developmental sequences for guidance in determining the content of the original *First Words*, *First Words II*, and *First Verbs*. Since that time more information has become available, prompting us to both revise and expand the original curriculum for the *Sterling Editions*. The words included in the curriculum are acquired by typically developing children in the age range from about nine to twenty-four months, and as such are among the earliest comprehended and produced by children (Benedict 1979; Carroll & White 1973; Fenson, Dale, Reznick, et al., 1994; Gruendel 1977; Leopold 1947; Nelson 1973).

In sequencing the words in developmental order for *Optimized Intervention*, we relied heavily on data collected by Fenson and his colleagues (1994), who studied the typical course of language development in 1,803 children ranging in age from 8 to 30 months. We also exercised clinical judgment, giving special consideration to the fact that children using the *Sterling Edition* programs would usually be older than those included in the Fenson research. An

additional consideration was the degree to which words could be represented saliently and unambiguously using illustrations. This did not pose a problem for basic category nouns, but we did have to rule out a few early developing verbs because depicting them clearly was problematic. We did not, for example, attempt to depict verbs such as *want* and *see*. Other verbs (e.g. *go*, *stop*) were eliminated after field-testing showed that many children could not readily identify illustrations meant to represent them.

As a rule, referential nouns are thought to be the first words understood by the infant, followed by actions and attributes (MacNamara 1972; see below). Following this progression, a child using *Sterling Edition* programs would normally begin with *First Words Sterling Edition*, which trains fifty nouns using two illustrations and two photographs for each noun. *First Verbs Sterling Edition*, which trains fifty early developing verbs, can be introduced once the establishment of a core noun vocabulary is underway. *First Words II* can be introduced once the nouns in *First Words* are mastered.

Learning First Words: Differences between Nouns and Verbs

Most young children grasp the notion that words can symbolize objects and people (i.e., referential nouns), and come to use these words without difficulty. Verbs, however, clearly pose a greater challenge. In research ranging from the earliest diary studies to contemporary normative analyses, a constant finding is that English speaking children tend to produce nouns long before verbs (Benedict 1979; Fenson, et al., 1994; Greenfield & Smith 1976; MacNamara 1972; Nelson 1973). In fact, among the first 50 spoken words identified in Fenson's (1994) extensive normative study there were no verbs at all. This is not to say that children do not comprehend verbs as early as they do nouns; there is evidence that they do (Goldin-Meadow, Seligman, & Gelman, 1976; Smith, 1985; Goldfield, 2000). Verbs comprised 14 percent of the first 50 comprehended words identified by Fenson and colleagues. Still, it is clear that children acquire new verbs more slowly than other lexical categories, make more errors during verb acquisition, and produce only a fraction of the verbs that they apparently comprehend (Benedict 1979; Gentner, 1982; Goldin-Meadow, Seligman, & Gelman, 1976; Greenfield & Smith 1976; Nelson 1973).

These observations have been taken to suggest that the process of verb acquisition challenges even the most competent language learners. Reasons offered to explain why verb acquisition poses such a challenge derive largely from several basic features that generally distinguish verbs in the lexicon.

Gentner (1982, 2001) has suggested that, in acquiring a lexicon, the child must map linguistic information onto perceptual-cognitive information about the world. The child's task, in other words, is to match word meanings to

perceptual-cognitive reality. Nouns are acquired first because referential nouns refer to perceptually salient entities, whereas verbs are perceptually less constrained. In all languages, concrete objects are labeled in a more or less similar manner. In contrast, the manner in which verbs map onto perceptual-cognitive reality is more arbitrary, as evidenced by variations in the ways experiences are partitioned and represented across languages. Gentner (1982) provided the following illustration using two closely related Indo-European languages, English and Spanish:

The bottle floated into the cave.
La botella entro en la cueva, flotando.

She pointed out that in English the manner of motion (floating) is conflated into the verb, while in Spanish it is the direction of motion relative to the cave that is incorporated into the verb. In both languages, however, the bottle and the cave are labeled in a similar manner. Languages appear to make coherent references to objects because of the nature of the perceptual world, thus providing nouns with a perceptual saliency not shared by verbs.

During language acquisition, young verb learners are faced with puzzling out the partitioning and conflating scheme in the language they're trying to learn. This is all the more challenging considering the amount of semantic information that may be encoded within and contribute to the meaning of a particular verb (e.g., implications of causation, change of state, manner or result, direction or location of action, etc.). An additional challenge to learning verbs, then, would seem to involve the refinement of semantic representations and the acquisition of semantically more precise terms.

Another feature of verbs that may contribute to the challenge of acquisition is that verbs are necessarily associated with syntactic functions (e.g., a syntactic frame) and thematic roles (e.g., agent, patient) (Pinker, 1989). In acquiring a lexical entry for the verb *kiss*, for example, a child must learn how to construct a phrase containing the required number and arrangement of arguments (the intransitive, transitive, or ditransitive "argument structure" of the verb). They also must understand the thematic roles required by the semantic features of the verb (e.g., an animate being to perform the action, and some sort of recipient of the action; Dowty, 1991; Pinker, 1989). Finally, they must know how to assign the thematic roles to the argument structure of the verb. These accomplishments are, of course, beyond the abilities of young children in the single-word stage who must instead rely on their audience to intuit, for example, whether their pronouncing the verb *kiss* is intended to describe an event or initiate one.

On the other hand, during typical development the ini-

tial challenge of acquiring the argument structures and thematic roles associated with early verbs produces a body of knowledge that becomes a valuable asset to verb learning. With experience, recurrent regularities among the interrelationships between verbs, syntax, and semantics can be exploited by children in order to more accurately guess at the possible meanings of novel verbs (Gleitman, 1990; Levin, 1994; Naigles & Kako, 1993; Naigles & Hoff-Ginsberg, 1998; Pinker, 1989). “Canonical linking rules” describe regularities in the ways that various thematic roles and syntactic functions can be linked (Pinker, 1989; van der Lely, 1994). The links are bi-directional such that children who understand the semantic meaning of a verb can use that information to construct an appropriate syntactic framework (“forward linking,” from semantics to syntax), and those who hear a novel verb in a familiar syntactic context can use that context to deduce a great deal about the meaning of the verb (“reverse linking,” from syntax to semantics). Such linking is facilitated further by the fact that verbs that share certain aspects of meaning also tend to have common syntactic features (Gropen et al., 1991a, 1991b; Levin, 1994). The development and use of canonical linking rules may account, at least in part, for the acceleration in verb learning which coincides with the emergence of early word combinations and an improved ability to develop tentative semantic interpretations of words (Dollaghan, 1987; Rice, Oetting, Marquis, et al., 1994).

A final feature of verbs that appears to present a special challenge during acquisition derives from the complexity of verb inflection (I-system) (Gentner, 1982; Rice, 1994; Rice, Wexler, & Cleave, 1995). Not only must children learn a verb’s semantic meaning, argument structure, and the thematic roles it assigns, they also must learn how to mark the verb for tense, person, and number in a variety of grammatical contexts. We noted earlier that the grammatical morphemes associated with the I-system seem to be especially problematic for children with language impairments (Eyer & Leonard, 1995; Loeb & Leonard, 1991; Rice, 1998; Wilson, 2000). The assignment of case and its marking in the English pronominal system also causes problems for these children. Yet since the subjective or nominative case is assigned by verb inflection, the I-system plays a critical role in this area as well.

Vocabulary Acquisition by Children with Language Disorders

Despite differences in the learning of nouns and verbs, typically developing children acquire items in both of these lexical categories at an accelerating pace throughout the first three years of life. Even very young children appear to have the ability to very quickly infer the meaning of a new word and can acquire new words in naturalistic contexts with very

few exposures. This ability has been referred to as “fast mapping” or “quick incidental learning” (Rice, Buhr, & Nemeth, 1990; Tomasello & Kruger, 1992).

Unfortunately, children with language disorders do not learn new words as readily as their typically developing peers, and research has shown that these children may be quite limited in their ability to “fast map” or take advantage of quick incidental learning contexts (Rice, Buhr, & Nemeth, 1990; Rice, Buhr, & Oetting, 1992; Rice, Oetting, Marquis, et al., 1994). Another important finding in this research, however, is that increasing the number of exposures to new words does in fact assist children with language impairments in acquiring those words (Rice, Oetting, Marquis, et al., 1994). These results confirm what clinicians have long known, that children with language impairments need many more repetitions to master materials than do typically developing children.

Children with language impairments also have greater difficulty with the acquisition of verbs as compared to nouns, just as typically developing children do. Indeed, verb acquisition seems to pose a formidable challenge for a significant number of these children. Recent research has examined in some detail the acquisition of verbs by children with specific language impairments (SLI). Among many observations are the following:

First, as noted above children with SLI appear more limited in their ability to acquire new verbs under conditions that reliably produce new verb learning in other children (Rice, Buhr, & Nemeth, 1990; Rice, Oetting, Marquis, et al., 1994; Watkins & Rice, 1991).

Second, children with SLI tend to rely heavily on a relatively restricted set of verbs, most of which encode only fundamental semantic distinctions and thus may be used to convey a broad range of meanings (Rice & Bode, 1993; Watkins, Rice, & Moltz, 1993). Not surprisingly, this reliance is associated with frequent errors involving the substitution of verbs that are semantically inappropriate.

Third, children with SLI seem less able to exploit regularities between syntax and semantics that provide important cues when attempting to deduce the meaning of a new verb; a process called syntactic bootstrapping (or reverse linking) (Gleitman, 1990; Gropen, Pinker, Hollander, et al., 1989; Gropen, Pinker, Hollander, & Goldberg, 1991a, 1991b; Kelly, 1998; Levin, 1994; Naigles, 1990; Pinker, 1989; van der Lely, 1994). In one experiment, children with SLI were exposed to a novel verb within a sentence and asked to make up or guess a plausible meaning for the verb and act it out with puppets (e.g., “*The girl voozes the boy*”). Unlike children in a control group, those with SLI struggled. They could act out an event that accommodated the argument structure of the verb (transitive), but the assignment of thematic roles was often inappropriate (van der Lely, 1994).

This finding is remarkable in view of the presumably important and pervasive role of syntactic bootstrapping in deducing the meaning of new verbs (Gleitman, 1990; Gropen et al., 1991a; Naigles & Hoff-Ginsberg, 1998; Naigles & Kako, 1993; Pinker, 1989). A reduced ability to exploit such syntactic cues would certainly impair language development, and from a clinical standpoint this appears to be an important deficit to target for remediation.

Fourth, children with SLI typically use more uninflected verb forms and have tremendous difficulty with verb morphology. This is perhaps not surprising given that these children also have difficulties with subject case marking, word order, and word classes (Clahsen, 1989; Hansson & Nettlebladt, 1995; Loeb & Leonard, 1991; Rice, 1994; Rice, Wexler, & Cleave, 1995; Watkins, 1994; Wilson & Pascoe, 1999; Wilson, 2000), which suggests inadequate comprehension of the syntactic and semantic features that are fundamental to the derivation of verb inflection; elements of the I-system.

For children with language impairments, providing focused, structured and repetitive exposure to new words will go a long way in facilitating acquisition and assuring the development of a base lexicon. In the case of verbs, the contexts in which verbs are presented and the use of appropriate inflection also are important instructional elements that contribute to acquisition. In either case, however, the use of software for this purpose is ideal. Highly structured examples can be provided repeatedly in a consistent manner with as little or as much instructional support as the child needs to respond successfully.

Using Computers in Language Intervention

The use of computer-based language intervention software offers many advantages to clinicians, educators, parents, and administrators. These programs are wonderfully suited to providing the highly structured interactions needed to illustrate the formal aspects of language. They also provide a structured conversational context for peer-to-peer and student-adult dialogue. Additionally they provide a cost-efficient delivery system for individualized language intervention. And happily, almost all children seem to enjoy using computers!

Most importantly, research has shown that language intervention software works. Significantly improved language development and communications skills have been documented when regular use of language intervention software was added to the ongoing curriculum in special education classrooms. Moreover, using language intervention software with non-professional adult assistance, children with special needs in the early stages of language acquisition can make language gains comparable to those seen during individual language therapy with a speech-language pathologist (Gale,

Crifford, & Gillam, 1999; Howard, 1986; Schery & O'Connor, 1995; Steiner & Larson, 1991; Wilson & Fox, 1983; 1986). One investigation even demonstrated that three to six year old children with autism were more attentive and motivated when using a computer and actually learned and retained more vocabulary than they did during one-on-one instruction with a teacher (Moore & Calvert, 2000).

Optimizing Language Intervention, Record Keeping, and Report Writing

In developing the *Sterling Edition* programs, an important consideration was that the quality of computer-based language intervention has traditionally depended to a considerable extent on the ability of an educator to carefully track the performance of each student, select and properly utilize programs that teach appropriate content, and to gauge the timing of intervention emphasis in relation to emerging skills. Further, these decisions have had to be based entirely on clinical judgments and perceptions of what will challenge but not frustrate each child. Such evaluations can be difficult under any circumstances, and especially so for those who must manage a large number of students with diverse language skills. These decisions are critical, however, since even the most effective software can be expected to accomplish little if not used in an appropriate manner.

With these concerns in mind, the *Sterling Edition* development team turned to an examination of computer assisted training paradigms to see if there were ways to lift some of this burden from the shoulders of educators. The fruits of these efforts are *Optimized Intervention* and the *Sterling Administration System*.

Optimized Intervention™

A highly valuable component of the *Sterling Edition* software is an *Optimized Intervention* system, originally inspired by methodology developed by the Software Technology Branch of National Aeronautics and Space Administration at the Johnson Space Center (Way, 1993). This group had developed software to train space shuttle astronauts that incorporated many useful features. In particular, the software was able to codify the knowledge and skills of professionals in such a way that these assets could be used to present customized lesson content, evaluate progress during a lesson, and revise the curriculum based on individual patterns of strengths and weaknesses.

In the 1990's, representatives from NASA and a panel of special educators from the Center for Special Education Technology and the Council for Exceptional Children, identified the emerging language problems of children with disabilities as a critical problem in special education that might productively be addressed using NASA's methodology. Subsequently, Laureate Learning Systems was invited to

enter into a technology transfer agreement with NASA. Since that time, Laureate has developed and field-tested a long series of language intervention systems designed specifically to guide students through language development curricula while adapting the emphasis and timing of activities in relation to the changing language capabilities of individual children. Critical to this extended endeavor was the support of the National Institutes of Health, including Small Business Innovation Research (SBIR) awards IR43 DC02709-01, 2R44 HD35255-02, IR43 DC02601-01A1, and 2R44 DC02601-02.

The *Optimized Intervention* system in Laureate's *Sterling Edition* software is the culmination of these development efforts. 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. The system also features extensive data collection and reporting capabilities, thereby greatly simplifying the process of tracking student progress and generating reports detailing areas of strength and weakness.

A useful analogy when thinking about the *Optimized Intervention* system is a clinical session. At the outset the clinician determines what material a student needs to work on and how much instructional support the student may require to make progress. As the session proceeds, the training material and degree of support are adjusted continually based on the student's performance. This is precisely what the *Optimized Intervention* system does. A speech-language pathologist or special educator using *Optimized Intervention* knows that an aide working with the child has only to choose the child's name, the program, and click on GO.

The Report Writer

As noted above, *Sterling Edition* programs carefully track all variables related to a student's progress through the curriculum, and store that information in the Student File. Laureate's Report Writer has been designed to access the Student Log and extract meaningful information to include in student reports and other documentation. The Report Writer eases the paper work burden of meeting the requirements for documentation both for assessment and evaluation of progress.

Included in the Report Writer are several hundred "Data Items" – essentially, segments of code designed to extract and report specific pieces of information from the Student Log. A Data Item may, for example, query the Student Log and count the number of correct responses in an activity with a particular level of instructional support, or the number of responses outside of the response area. Student reports comprise collections of Data Items; a typical report includes a few biographical items, some program and

interface items, and various student performance items. To simplify matters, collections of Data Items have been gathered and arranged into predefined report templates that can be selected in the Report Writer. All one needs to do, then, is to first select a session or a range of sessions to include in a report, and then select a predefined report format. This will produce an attractive document detailing program use, the material presented, and cumulative outcomes. The report can then be saved in the student's file, printed out, and/or exported to a word processor.

It is also possible to add additional Data Items to a standard report or to choose a novel assortment to include in a custom report for specialized purposes.

One of the predefined report formats included in the Report Writer is a "spreadsheet" template. This essentially provides access to the "raw" data in the Student Log, formatted in a manner designed to facilitate spreadsheet analyses and graphing. Biographical and program data are included in the header, and then trial-by-trial data for each session are included as delimited text.

Laureate is proud to release the first three programs in our new *Sterling Editions* series. *First Words*, *First Words II*, and *First Verbs Sterling Editions* will soon be joined by *Simple Sentence Structure Sterling Edition* followed by multiple modules dedicated to training syntax. These new modules are based on recent developments in linguistic theory, language acquisition research, and studies of children with language disorders. You can look forward to be able to provide extensive training in the myriad of Determiner-System and Inflection-System forms that are especially problematic for children with language disorders. In the modules that will cover D-System forms we have not only included Nominative, Accusative, and Possessive third person pronouns (*He/She/They*, *Him/Her/Them*, *His/Her/Their*, *His/Hers/Theirs*), but also first and second person singulars and plurals (*I/You*, *I/We*, *Us/You*, *Our/Your*, *Ours/Yours*), anaphors (*Himself/Herself/Themselves*), determiner "no", genitive 's (*boy's ball*), and pronominal determiners. The I-System forms covered include Future Modal Will, Present Progressive, Regular Past Tense, Third Person Noun-Verb Agreement (*The boy runs*), Negation, and Copular "be" (*The boy(s) is/are big*).

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