LanguageLinks®: Syntax Assessment & Intervention and *Prepositions!* Background, Rationale, and Use In Instructional Programs

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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 incidental exposure to language structure if they are to develop adult competence in their native language. As clinicians we know that our main goal for children with language disorders is to help them achieve communication competence. Yet without language competence, or knowledge of vocabulary and syntax, children will never be fully competent communicators.

Problems acquiring the grammatical component of language are characteristic of a broad range of children with language impairments regardless of etiology. The *LanguageLinks®: Syntax Assessment & Intervention* and *Prepositions!* system is designed to assess and train the syntax forms these children need to become competent communicators. In designing and developing *LanguageLinks* and *Prepositions!*, our goal was to produce the best syntax assessment and intervention based on current linguistic theory and language acquisition research using evidence-based instructional strategies. Here we will review the theoretical and research bases of *LanguageLinks* and *Prepositions!*, present field-testing data demonstrating their effectiveness, and review their use in instructional programs.

In the mid-twentieth century, Noam Chomsky's generative grammar proposals triggered what many called a revolution in linguistic theory (Chomsky, 1955; 1957; Harris, 1993). Suddenly the focus of linguistic inquiry shifted from description to explanation. Chomsky proposed that a grammar of a language must not simply describe sentences - rather it must account for how sentences are created or generated, hence the term generative grammar. From the beginning, generative grammar has been concerned with not only adult knowledge of language but also how language is acquired. There is no longer any doubt that typically developing children acquire language primarily through exposure rather than direct teaching. How is this possible? Linguists explain that all human languages share a common underlying biologically endowed structure. While the lexicon or vocabulary of a language must be learned, the actual structure of language is based on universal principles. It has been over two decades since Chomsky introduced the *Principles and Parameters Theory*[1] (Chomsky, 1981) currently the dominant linguistic theory. In the *Principles and Parameters Theory*, biologically based linguistic universals guide the course of language acquisition (Chomsky, 2004). Without an innate capacity, or Universal Grammar, human beings would be unable to acquire and master a language. In the theory, Universal Grammar consists of a set of universal principles and a small set of parameters that are unique to human language.

[1] The Pisa Lectures given in 1979 were subsequently published in 1981 as *Lectures in Government and Binding* and for a brief period of time the theory was referred to as "Government-Binding Theory." Chomsky and others adopted the *Principles and Parameters* terminology as more accurately describing the theory.

The *Minimalist Program* (Chomsky 1995, 2002) represents the latest effort within the *Principles and Parameters Theory*. As its name suggests, the goal of the *Minimalist Program* is to reduce the complexity of linguistic theory and enhance its explanatory power (Chomsky, 1995; Abraham, Epstein, Thráinsson, & Zwart, 1996; for a recent overview of the *Minimalist Program* by Noam Chomsky see "An Interview on Minimalism," Chomsky, 2002). While some of the terminology we'll use in this chapter may be unfamiliar to those who have not studied linguistics, conceptually the *Minimalist* model is much simpler than its predecessors. For example, those who struggled trying to learn the phrase structure rules and the numerous transformational rules of earlier versions of generative grammar will be happy to learn they have been completely eliminated. The *Minimalist* model is a simpler, more elegant system of describing and explaining syntactic operations. Also gone from the *Minimalist Program* are the layers of Deep and Surface Structure that characterized earlier versions of generative grammar (Chomsky, 1965).

Universal Grammar Principles and Parameters

Children worldwide learning thousands of different languages do so in a very similar manner. First words emerge, word combinations occur, and syntax is mastered at about the same age regardless of language or culture. What exactly is the nature of the genetic endowment of a language faculty that enables children to acquire all languages on a very similar timetable? Linguists and biologists believe that the innate Universal Grammar humans are born with is composed of principles that are not dependent upon language input and only a small set of parameters that vary in a binary fashion across languages (Baker, 2001; Hornstein, Nunes, & Grohmann, 2005).

Universal principles unite all languages. They don't have to be learned because they are part of the genetically endowed language faculty and consequently are known without language experience. One important universal principle is the *Structure Dependence Principle* that all grammatical operations are structure-dependent. Regardless of language, all syntactic operations are sensitive to the grammatical structure of the sentences to which they apply. For example, in English we form a Yes/No Question by interrogative inversion:

> She is working at home. ---> Is she working at home?
> Children will love this game. ---> Will children love this game?

In forming a question from a statement, we don't simply move the second word to the front of the sentence as it may appear, rather the operation is structure dependent. In the case of a standard Yes/No Question we move the auxiliary (*is, are*) or modal (*will, might, should*) to in front of the Subject.

Unlike universal principles that require no language experience, parameters do require language input or primary linguistic data 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 account 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).

Important in the *Minimalist Program* is the concept of *Heads*. The *Head* of a phrase is the key word that determines the properties of the phrase. The *Headedness Principle* stipulates that every constituent must be headed…every phrase must have a *Head*. When two elements combine, one becomes the *Head*. Two parameters that determine word order in a language are associated with this principle. In terms of word order, English follows a pattern of Subject-Verb-Object (SVO). This order is determined by two different parameters. The *Head-Directionality Parameter* determines whether a Complement (Object) comes before or after the *Head* of the phrase. In English, Complements come after the *Head*. In English we say "*hit the ball*" where "*hit*" is the Verb *Head* and "*the ball*" is the Complement. The *Specifier-Head* or *Subject Side Parameter* determines whether Specifiers (Subjects) come before or after the *Head* of the phrase. English is a Specifier-First language in that Specifiers or Subjects come before their *Head*. For example, in English we say "*The boy hit the ball*" where "*The boy*" is the subject and the Verb "*hit*" is the *Head*. These two parameters and their settings determine word order in all languages.

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. In children with language disorders this does not happen with exposure to primary linguistic data alone. Understanding parameters and the receptive language experiences that "trigger" or "set" them can lead to intervention strategies that are more effective because they suggest the specific linguistic experiences that may optimize or correct the process of language acquisition on a fundamental (versus symptomatic) level. This 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; Roeper, 2007).

The Lexicon

In the *Minimalist* model, the lexicon (the mental dictionary of lexical items or words with their linguistic properties) has taken on a greater role in the grammar than it had in earlier generative grammar theory. Each representation of a word in the lexicon consists not only of 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.), inflectional behavior (e.g., how it is marked for number, person, and gender), and in the case of Verbs, syntactic Argument Structure (e.g., run requires only one argument, a subject "*The girl runs*"; kiss requires two arguments, a subject and an object "*The father kisses the baby*"; and *give* typically requires three arguments "*The girl gives the baby a toy*"). In other words, the *Minimalist Program* assumes that a complete lexical entry includes the specific roles a word can play in the structure of language and the appropriate form of that word in a given grammatical context. Unlike in past generative grammar theories, lexical entries enter the grammatical computational system or sentence forming process already marked with syntactic features (Abraham, Epstein, Thráinsson & Zwart, 1996; Chomsky, 1995).

Developing an early core lexicon is an important step in the acquisition of language. Most think of word learning as simply a process of linking a word's sound to meaning. The acquisition of word meaning, however, describes only part of what a child is learning even in the single-word stage of language development. Contemporary linguistic theory emphasizes that the child must also be learning the syntactic features of words in relation to the parameter settings of the language being acquired - the grammatical options that distinguish one language from another. Further, children are learning a great deal about the inflectional properties of the language they are acquiring. That includes such things as how a language marks number agreement of Subjects and Verbs (e.g. "*The boy_ run**s** / The boy**s** run_*") and how time is expressed (e.g. "*The boy **is** play**ing** / The boy play**ed***"). That such grammatical learning occurs during the 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 begin to produce forms such as Determiner "No" (e.g. "*No shoe*"), the progressive Verb marker *-ing* (e.g. "*running*"), and the Genitive or Possessive 's (e.g. "*the boy's ball*"). There is evidence that by this time a number of crucial parameters have already been set. Hirsh-Pasek, Golinkoff, et al. showed that when children as young as sixteen months (still in the one word stage) were presented with 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, they preferentially attended to the appropriate 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.

Within the *Principles and Parameters Theory*, the lexicon is divided into *Lexical Category* words (e.g., Nouns, Verbs, Adjectives) and *Functional Category* words and forms (e.g. Determiners, Tense, Complementizers) that serve essentially grammatical functions. Adger says that one way to think about *Functional Categories* "…is that they 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). The *Functional Category* includes Determiners, Tense (in earlier work called Inflection or INFL), and Complementizers:

> ***Determiners*** are associated with Nouns and are so-called because they specify (or determine) that to which a Noun expression refers. Determiners include, for example, articles (a, the), Prenominal Determiners (*this, that, these, those*) and Pronouns (*I, you, me, his, her*). A Determiner Phrase (DP) is headed by a Determiner.

Tense is associated with Verbs and refers to elements that inflect Verbs for tense and agreement. Tense includes, for example, the regular past tense *-ed*, infinitival *to*, auxiliary *be*, and third person singular *-s*. A Tense Phrase (TP) includes a Verb and its inflectional elements.

Complementizers include words such as *that, if*, and *whether* which serve to introduce and characterize complement clauses in several ways. Also included are various operations involved in the formation of questions (e.g. *Interrogative Reversals* and *Wh-Questions*).

Table 1 lists *Functional Category* examples of Determiners, Tense, and Complementizers. Even those not familiar with the current linguistic distinction between *Functional* and *Lexical Categories* will immediately recognize that the forms listed in Table 1 are especially problematic for students with language impairments and language-learning disabilities. The list also provides some explanation of grammatical errors. For example, children with language impairments sometimes persist in use of Accusative Case Pronouns in the Subject position which requires Nominative Case ("*Her*" vs. "*She*"). You'll note that Tense is responsible for checking Nominative Case. Children who are not correctly inflecting Verbs thus may use the default English Accusative Case in the Subject position saying, "*Him big.*" Once they are Tense marking (e.g. including Copular "*be*" in this case), they will begin to correctly use Nominative Case as in "*He is big.*" This has clinical implications in that work on Nominative Case should be preceded by work on one or more Tense elements.

If Nouns, Verbs, and Adjectives belong to the *Lexical Category* and Determiners, Tense, and Complementizers belong to the *Functional Category*, where do Prepositions fit in? Prepositions present a challenge to the simple notion of a *Lexical - Functional* dichotomy. On the one hand, Prepositions are typically regarded as a fourth *Lexical Category*. Consistent with this categorization is the observation that many Prepositions, as with *Lexical* items in general but not *Functional* items, have intrinsic semantic content that makes an important contribution to sentence meaning. In other ways, however, Prepositions have more in common with the *Functional Categories* and there is a growing tendency to regard them as such (e.g., Baker, 2003; Littlefield, 2005). There are numerous arguments for this view, just a few of which are mentioned here.

For example, unlike the *Lexical Categories*, which are always growing via the addition of new Nouns (computer, cell phone), Verbs (snowboarding, faxing) and Adjectives (groovy, spacey), Prepositions are more like a *Functional Category* in that they comprise a closed class; there are relatively few of them (roughly 50 in English, and far fewer in most other languages) and there is little or no tendency to coin new ones. Some have argued that this could to some extent be attributable to the limited set of relationships available to be encoded, but there certainly would seem to be room for coining at least a few new Prepositions now and then; particularly since many of them are currently used to indicate rather diverse relationships (e.g., *on the floor*, *on time; on topic; out of the house, out of time, out of kindness*).

Also unlike *Lexical* items, Prepositions do not accept derivational affixes. Nouns, Verbs and Adjectives can move from one *Lexical* category to another by adding an appropriate derivational affix (e.g., *-ing, -ize, -able, -ish, -ity…*; *pressure – pressurize; book - bookish*), but Prepositions cannot; they are always Prepositions.

It can be seen, then, that Prepositions do not conform to all of the typical features of items in either the *Lexical* or *Functional Categories*. This has led some researchers to suggest that the category of Prepositions ought to be divided according to the relative proportion of a Preposition's lexical and functional features (Corver & van Riemsdijk, 2001; Littlefield, 2005). In this scheme one would classify semantically rich Prepositions as being *Lexical*, and other Prepositions that serve primarily syntactic roles as being *Functional*. Supporting the validity of this division is evidence from studies of the language of individuals with aphasia (e.g., Froud, 2001), as well as from analyses of children's first language acquisition (e.g., Littlefield, 2006).

Unlike in earlier versions of generative grammar, *Functional Category* forms as well as *Lexical Category* words can serve as the *Head* of a phrase. The concept of *Heads* is very important in linguistic theory. The universal *Headedness Principle* states that every syntactic structure is a projection of a *Head* word. Here again we see the importance of the lexicon in current thinking. In forming sentences, the lexicon is key. Those of us who serve children with language disorders should be very encouraged with this emphasis on the lexicon in current linguistic theory. The lexicon after all is learned. That means the learning of *Functional Category* lexical forms is a component of syntax mastery. By

Functional Categories	**Examples**
Determiners	
Articles	***a, the***
Prenominal Determiners	***this, that, these, those***
Locative Pronominals	***here, there***
Pronouns	
Nominative	***I, we, you, he, she, they, it***
Accusative	***me, us, you, him, her, them, it***
Pronominal Possessives	***my, your, our, his, her, their, its***
Independent Possessives	***mine, yours, ours, his, hers, theirs, its***
Anaphors (Reflexives)	***myself, yourself, ourselves, himself, herself, themselves***
Determiner '*no*'	He has ***no*** hair.
Genitive 's Inflection	Joe***'s*** house is blue.
Nonthematic '*of*'	Have a cup ***of*** tea.
Pronominal Quantifiers	***all, many, several, each, any, none***
	Joe has ***none. Many*** tried.
Tense	
Nominative Case Checking	He (Nominative Case Subject) ***is*** setting the table.
Tense & Aspect	
Regular Past "*-ed*"	Joe fix***ed*** the house.
Future Modal "*will*"	He ***will*** set the table.
Present Progressive (Aux. "*be*"+V+"*-ing*")	He ***is*** driv***ing*** the car.
Infinitival "*to*"	I want ***to*** set the table.
Auxiliary "*do/have*" (Affirmative)	She ***does, did, has, had*** set the table.
	They ***do, did, have, had*** set the table.
Modals (Affirmative)	I ***can, may, must*** set the table.
Negation	
Modal + Negative	Joe ***can't, won't, mustn't*** set the table.
Auxiliary "*do/have*" + Negative	She ***doesn't, didn't, hasn't, hadn't*** set the table.
	They ***do, did, have, had*** set the table.
Agreement	I/we/you/he/she/it/they...
Copula "*be*"	***...am, are, is, was, were*** hungry.
Auxiliary "*be*"	***...am, are, is, was, were*** skiing.
Third Person Singular	Joe fix***es*** the house.
Complementizers	
Complementizers	We know ***if, that, whether*** you are here.
Auxiliary Inversion	***Is*** Joe __ setting the table?
	Will, Can Joe __ set the table?
Wh-movement+NP+VP	***Which*** table ***will*** Joe __ set __?
	Who, what, where, when, why, how is Joe__V+"-ing"__?
Indirect Question	I wonder ***what*** Joe will do __.

Table 1. Functional Categories with Examples

emphasizing receptive mastery of *Functional Category* lexical forms we can facilitate syntax acquisition.

While many of a child's earliest multi-morpheme utterances may consist of bare Noun and Verb Phrases, *Functional Category* forms are apparent from the time typically developing children enter the two-word stage (Bohnacker, 1997; Brown, 1973; Engle, 1978; Spaulding, 1980). Indeed one clinical marker for children with language impairments is the absence or relative infrequency of *Functional Category* elements in their speech (Leonard, 1998; Trantham & Pedersen, 1976). As the *Functional Category* forms are acquired, the hierarchical nature of sentences emerges. While children in the early word combination stage may produce bare Noun and Verb Phrases, these do not exist in adult English. In sentences generated by competent language users, all Nouns combine or Merge with Determiners and become Determiner Phrases. This is true even if there is no overt Determiner in a phrase. Similarly, Verbs combine or Merge with Tense elements and become Tense Phrases. Hence, for example (functional elements in bold):

N V DP TP

Ball Roll comes to be replaced by ***The*** *ball* ***is*** *roll****ing***

This developmental step generally does not proceed smoothly for children with language disorders. In fact, one certain conclusion that can be drawn from the research is that *Functional Categories* are especially problematic for children with language disorders (e.g., Bedore & Leonard, 1998; Leonard 1995, 1998; Leonard et al., 2006; Rice, 1998; Rice, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998; Roeper & Seymour, 1994; Seymour, Roeper, & deVilliers, 2003; Wilson, 2000; Wilson & Pascoe, 1999).

Generating Sentences

Linguists working in the *Minimalist Program* have made tremendous progress in advancing our understanding of language and its acquisition. In this section we will discuss how linguists describe the generation of sentences. This linguistic view may seem far removed from our subjective experience of producing language but in fact it provides new insights into the production and comprehension of sentences in all languages. The model provides direction to scientists working on the biology of language. For example, neuropsychologists have shown that the distinctions between the neural circuitry used to produce Nouns and Verbs demonstrates that lexical entries code for grammatical properties as well as semantic information (Caramazza & Shapiro, 2004). Additionally, studies of adults with Broca's aphasia have revealed very specific syntactic deficits as a result of brain lesions. These deficits are adequately described in terms of aspects of syntactic formulation and comprehension of sentences within the *Minimalist Program* (Grodzinsky, 2004).

In earlier generative grammar theory, Phrase Structure and Transformational Rules were the mechanisms proposed for sentence generation. In the *Minimalist Program* the Computational system of human language (CH_L) generates sentences from a lexical array in a principled economical fashion.

Two necessary components in sentence generation and comprehension are the lexicon and the syntactic computational system. The first step in generating a sentence is to get the words from the lexicon that will make up the sentence. Linguists say that we first make a copy of each lexical item that will be used in the sentence from the lexicon and indicate how many times each will be used. In the sentence "*He is hitting the ball*" the lexical array or numeration would be:

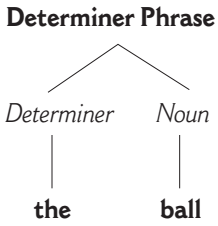
the_1 he_1 is_1 $hitting_1$ $ball_1$

Once a lexical numeration has been copied from the lexicon, the syntactic computational system combines words using two operations:

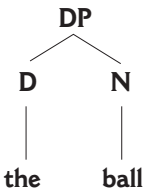
Merge combines elements in a binary fashion
Move copies and then repositions words and/or phrases

Using these operations, the computational system builds sentence structures that can be interpreted for sound and meaning. Unlike in earlier versions of generative grammar where sentences were built from the top down, within

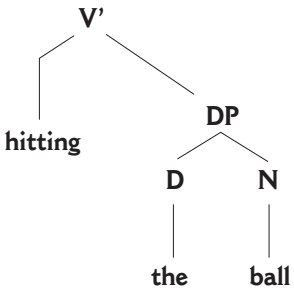
the *Minimalist* model sentences are built from the bottom up. To generate the sentence "*He is hitting the ball*" the computational system would first Merge "*ball*" with "*the*." When two elements are combined, one becomes the *Head* that dominates the structure. For example, when "*ball*" combines or Merges with "*the*" to form the phrase "*the ball,*" the *Head* is the Determiner "*the*." When a Noun Merges with a Determiner the *Functional Category* Determiner becomes the *Head*. The phrase has the following structure:



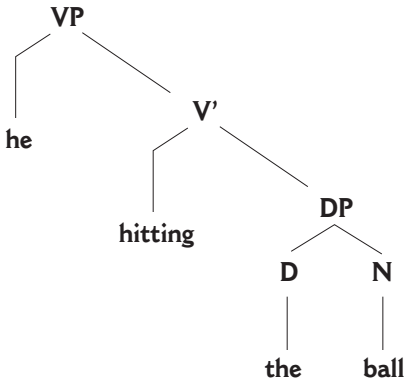
This is commonly diagramed with abbreviations for Determiner, Noun, and Phrase:



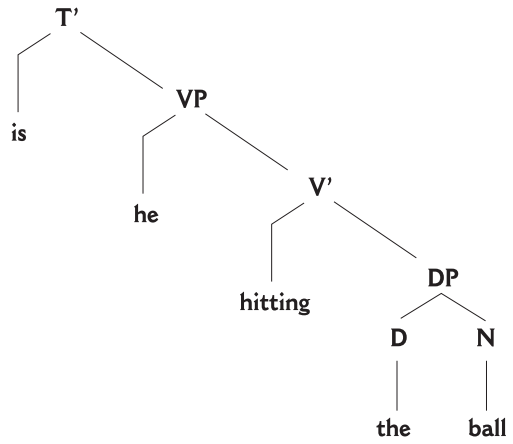
With the Merge of "*the*" with "*ball,*" we now have a Determiner Phrase (DP) whose Head is "*the*." The next step would be to Merge the DP "*the ball*" which is the Complement with the Verb "*hitting*" to form:



Then the Subject or Specifier "*he*" would be Merged with "*hitting the ball*" to form the Verb Phrase:

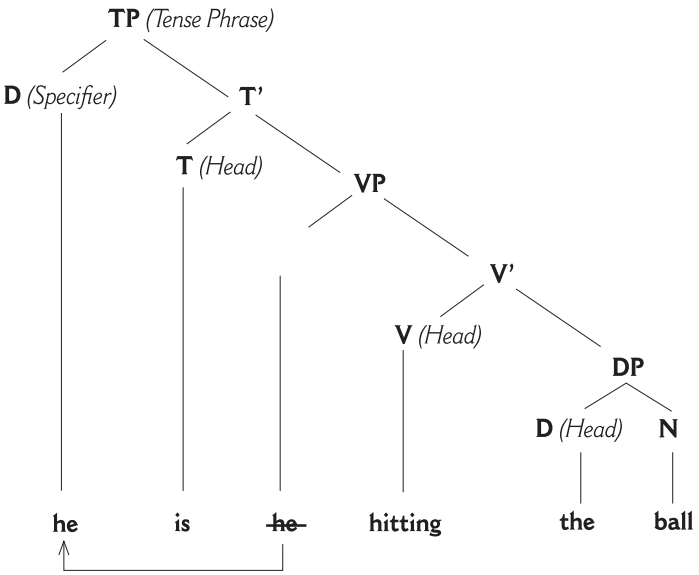


"*He*" starts out in the Specifier position of the Verb Phrase (VP) where the Verb assigns it the Thematic Role of Agent. Although "*he*" starts in the Specifier of the Verb Phrase, it will later be Copied and Moved into the Specifier position of the Tense Phrase. The next step would be to Merge the VP with auxiliary "*is*," the Tense element in the sentence.



Now we'll need to Move "*he*" into the Tense Specifier position. We have to do this in order to have the Nominative Case feature checked by the Tense element. You recall it is the Tense element that checks for Nominative Case. Unlike many other languages, Case in English is only overtly marked on Pronouns.

A simplified diagram[2] of the sentence "*He is hitting the ball*" follows:



The syntactic structures generated by Merge and Move must be interpreted into sound and meaning[3]. The syntactic component interfaces with the external sound or Articulatory-Perceptual system via Phonetic Form. It interfaces with the external meaning or Conceptual-Intentional system via Logical Form. An important characteristic of these syntactic structures then is that the Phonetic Form structure can contain only the sound information necessary to decode/encode a sentence and the Logical Form (LF) representation can contain only semantic information. This is

[2] The vP shell structure is not shown.

[3] Structures generated are sent to the interfaces in phases rather than waiting until the sentence is complete.

because our cognitive system can only interpret meaningful information in a Logical Form (LF). You'll recall that in the *Minimalist* model lexical items enter the numeration used by the syntactic computational system with all their grammatical features. Some of these features are interpretable at the Conceptual-Intentional system interface and some are not. To provide an example, consider the sentence…*"He is big."* The pronoun *"he"* has the following features: 3rd Person, Masculine, Singular, Nominative Case. The first three features are interpretable to the Conceptional-Intentional system [+interpretable]. They have meaning. The last feature Nominative Case is uninterpretable [-interpretable]. It does not have meaning. *"Him is big"* means the same thing. Since the LF-representation can contain only semantically interpretable features the [-interpretable] Nominative Case feature must somehow be removed or made invisible before reaching the interface. In the *Minimalist* model this is done by having [-interpretable] features checked by [+interpretable] features with which they must agree. In case of *"he,"* the Nominative Case [-interpretable] feature will be checked (or made invisible at LF) by the Tense [+interpretable] feature of *"is."* Now let's look at *"is"* (Copular *"be"*) which is Present Tense [+interpretable] and Singular [-interpretable]. Singular marking is meaningful on the Subject but redundant on the verbal element so it must check against the Subject's number [+interpretable] to be removed or made invisible at LF.

The *Minimalist Program* is still in its infancy but the insights into language and language acquisition it has provided have inspired the development of new approaches to language intervention. In the next section we'll discuss the instructional research bases for *LanguageLinks* and *Prepositions!*

Instructional Research

Linguistic theory should guide the choice of content in any language intervention plan, but how to deliver that content should be driven by what we have learned from research into the effectiveness of various instructional methods. While pragmatic competence in social situations revolves around expressive use of language, research has shown that language (vocabulary and syntax) is acquired through listening, not speaking. Language input provides the data necessary to trigger parameter setting and lexical learning. 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)

Critically then, receptive language training whether it be in the realm of vocabulary or syntax should play a central role in any intervention plan for children with language impairments regardless of etiology. While the ultimate goal may be to develop communicative competence, that goal cannot be reached without first establishing language competence. Studies have validated the receptive approach to developing language competence. Research has shown that receptive procedures are in fact more effective than expressive imitation procedures in language intervention and can produce gains in production as well as comprehension (Courtright & Courtright, 1976; 1979; Zimmerman & Pike, 1972; Zimmerman & Rosenthal, 1974).

The well-established learning principles of behavioral analysis (Holland & Skinner, 1961) provide a foundation for instructional design in all of Laureate's language assessment and intervention programs including *LanguageLinks* and *Prepositions!*

The programs also use principles of explicit or discrete trial instruction which uses carefully controlled instruction and stimulus presentation. Over the past thirty years, research has demonstrated that explicit instruction is effective in teaching a variety of language skills (Justice et. al., 2003; Maurice, Green, & Luce, 1996; Wilson, 1977). Laureate's language intervention programs include several kinds of instructional support in training. When pretrial instruction is included, the target picture is presented and the target 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 a variety of visual and auditory attention focusing techniques such as an animated character or arrow appearing above the correct response target.

In addition, two kinds of instructional feedback are used in the programs. Even after CCR has been faded, it is still provided following an incorrect response or if no response is made. This always occurs in the earliest vocabulary training programs and is gradually faded as the student advances in syntax. 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, 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., Finn, Futernick, & MacEachern, 2005; Gale, Crofford & Gillam, 1999; Gillam, Crofford, Gale, & Hoffman, 2001; Gillam, Frome Loeb, Hoffman, et al., 2008; Miller, 1993).

The use of computer-based language intervention software offers many advantages to clinicians, educators, parents, and administrators. Software programs can provide the highly structured interactions needed to illustrate the formal aspects of language. Additionally, computers provide a cost-efficient delivery system for individualized language intervention. Children can use language intervention software in classrooms and homes and thereby receive individualized services beyond those delivered by a speech-language pathologist. Most importantly, research has shown that language intervention software works. Significantly improved language development and communication 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 can make language gains comparable to those seen during individual language therapy with a speech-language pathologist (Gale, Crofford, & Gillam, 1999; Gillam, Frome Loeb, Hoffman, et al., 2008; Gillam & Loeb, 2005; 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 Spectrum Disorders 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).

Applying Theory and Research

To acquire a language, children must be exposed to primary linguistic data or language input. Based on this input, they must learn the lexicon, set parameters, and become competent users of the computational system to generate sentences. Children with language disorders can experience difficulties in any or all of these linguistic components. As discussed earlier, receptive training is best suited to developing a lexicon, setting parameters, and establishing syntactic competence. Receptive language intervention should be an essential component in all programs for children with language disorders until they have mastered grammar. For busy clinicians and educators, finding time to provide evidence-based receptive language intervention is difficult. That's where software can help.

In typically developing children, Determiners, Tense, and Prepositions begin appearing in the early two-word stage. Once a child with a language disorder has entered into the two-word stage, targeted training on *Functional Category* forms and Prepositions should be provided. Learning Determiner, Tense, and Preposition forms is an important step in the mastery of syntax. Children with language disorders must not only learn these forms, they must be systematically exposed to sentences which include them. The *LanguageLinks: Syntax Assessment & Intervention* and *Prepositions!* programs[4] are designed to help children with syntactic deficits achieve language competence. These are the first comprehensive syntax intervention programs to be based on current linguistic theory, instructional research, and have field test data to support their use. In Table 2, you'll find a listing of Levels 1-6 included in *LanguageLinks*. The grammatical forms are trained in developmental order. 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

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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.[5]

In addition to Determiners and Tense forms, Prepositions play an important role in early syntax development. Learning Prepositions is an essential step in language mastery. Prepositions often make an essential contribution to sentence meaning by signifying relative temporal and spatial relationships of many kinds, as well as relations involving cause, purpose, manner, means, viewpoints, and much more. Fundamentally, Prepositions serve to indicate a relationship between elements in a sentence, with one of these elements being the Prepositional Complement or Object (Quirk et al., 1985). This being the case, it is necessary that Prepositions have a Complement. Thus, an important step in syntax acquisition involves learning Prepositions and their use with Complements in prepositional phrases. *Prepositions!* was designed to teach ten spatial Prepositions *(in, on, under, in front of, in back of, next to, above, below, behind,* and *between*) and their use in sentences, a necessary step in the mastery of syntax and toward school success.

Spatial or locative Prepositions are especially important in early language development. Semantically, these are used to express concepts of location or position. As such, 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* (Brown, 1973).

LanguageLinks (Determiner and Tense Forms)

***LanguageLinks* Level 1 Modules**	**Examples**
1. Gender with Genitive 's	Girl's Noun/Boy's Noun
2. Regular Noun Singular/Plural	Noun/Nouns (Singular/Plural)
3. Determiner 'No'	With/With No
4. Accusative 1st & 2nd Person Singular	Me/You
5. Noun/Verb Agreement Copular 'Be'	Is/Are
6. Nominative 3rd Person Gender	He/She

***LanguageLinks* Level 2 Modules**	**Examples**
1. Negation	Is/Is Not
2. Nominative 3rd Person Number/Gender	He/She/They
3. Accusative 3rd Person Number/Gender	Him/Her/Them
4. Locative Pronominals	Here/There
5. Auxiliary 'Be'/Regular Past -ed	Is Verb+(-ing)/Verb+(-ed)
6. Prenominal Determiners Singular	This/That

***LanguageLinks* Level 3 Modules**	**Examples**
1. Prenominal Determiners Plural	These/Those
2. Pronominal Possessive 1st & 2nd Person Singular	My/Your
3. Accusative 1st Person Singular/Plural	Me/Us
4. Nominative 1st & 2nd Person Singular	I/You
5. Noun/Verb Agreement Auxiliary 'Be'	Is Verb+(-ing)/Are Verb+(-ing)
6. Nominative 1st Person Singular/Plural	I/We

***LanguageLinks* Level 4 Modules**	**Examples**
1. Negation	Does/Does Not
2. Accusative 1st Person Plural & 2nd Person	Us/You
3. Pronominal Possessive 1st Person Singular/Plural	My/Our
4. Nominative 1st Person Plural & 2nd Person	We/You
5. Pronominal Possessive 1st Plural & 2nd Person	Our/Your
6. Noun/Verb Agreement 3rd Person Singular/Plural	Has/Have

***LanguageLinks* Level 5 Modules**	**Examples**
1. Pronominal Possessive 3rd Person Number/Gender	His/Her/Their
2. Future Modal Will/Auxiliary 'Be'/Regular Past -ed	Will Verb/Is V+(-ing)/V+(-ed)
3. Independent Possessive 1st & 2nd Person Singular	Mine/Yours

[5] Throughout the development of *LanguageLinks* and *Prepositions!*, we have worked closely with our consultants Jill de Villiers, Smith College, and Tom Roeper, University of Massachusetts.

4. Independent Possessive 1st Singular/Plural	Mine/Ours
5. Independent Possessive 1st & 2nd Person Plural	Ours/Yours
6. Noun/Verb Agreement 3rd Person Singular/Plural	Noun Verbs/Nouns Verb (Agr)

***LanguageLinks* Level 6 Modules**	**Examples**
1. Independent Possessive 3rd Person Number/Gender	His/Hers/Theirs
2. Anaphors Singular Masculine	Himself/Other DP
3. Anaphors Singular Feminine	Herself/Other DP
4. Anaphors Plural	Themselves/Other DP
5. Genitive 's	Boy Noun/Boy's Noun
6. Present Passive	Is Verb+(-ed) By (Passive)

Table 2. LanguageLinks: Syntax Assessment & Intervention Levels and Modules

Many spatial Prepositions consist of a single word (*in, on*) and are classified as Simple, while others consist of a two- or three-word sequence (*next to, in front of*) and are classified as Complex. The earliest Prepositions to be acquired are simple ones. However, other simple Prepositions develop after children have learned some complex forms. For example "*behind*" develops later than "*in back of*" (Stemach & Williams, 1988). The six Modules in *Prepositions!* train 10 essential Prepositions in a variety of contexts. Like all the other *Sterling Edition* language intervention programs, *LanguageLinks* and *Prepositions!* both use an expert *Optimized Intervention*® system to automatically deliver both assessment and intervention based on student responses.

Optimized Intervention®

The *Optimized Intervention* system efficiently tests then enters training at an appropriate level. It was originally inspired by methodology developed by the Software Technology Branch of the National Aeronautics and Space Administration (NASA) 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 to 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. Critical to this extended endeavor was the support of the National Institutes of Health, including Small Business Innovation Research (SBIR) awards from the National Institute on Deafness and Other Communication Disorders (NIDCD) and the National Institute on Child Health and Human Development (NICHD).[6]

The *Optimized Intervention* system in Laureate's *Sterling Edition* software is the culmination of these research and 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. Each *Sterling Edition* language intervention program has an *Optimized Intervention* uniquely designed to test and train the curricular targets. Words, concepts, and syntactic 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.

In *LanguageLinks* and *Prepositions!* the *Optimized Intervention* activity begins with a Probe Test to determine where to begin training. Probe testing on a form ends after the third error. Testing continues for all 10 stimuli for a form if the student makes two or fewer errors. Even if a student achieves a score of 80% or higher on a form, it still goes into

[6] Small Business Innovation Research Grant Numbers 1R43 DC02709-01, 2R44 HD35255-02, 1R43 DC02601-01A1, 2R44 DC02601-02, 1R43 DC04487-01, 2R44 DC04487-02, and 1R43 HD33333-01A1 from the National Institute on Deafness and and Other Communication Disorders (NIDCD) and the National Institute on Child Health and Human Development (NICHD).

training if the other form(s) in the Module have failed. Since the forms in a Module present a grammatical contrast, we believe it is important for students to be exposed to all the contrasting forms. Students must be able to discriminate the contrasts in any form family.

Optimized Intervention training continues until a student has demonstrated mastery over all forms in a Module. If the student continues to fail to reach Criterion for a given form or forms in a Module, training on that Module is postponed. Training is resumed after the student has gone through the other Modules on a Level in the case of *LanguageLinks* or the remaining Modules in the program for *Prepositions!*.

The power of the *Optimized Intervention* system combined with its ease of use means that speech-language pathologists and other professionals can prescribe the use of *Sterling Edition* programs in classrooms and homes, thereby increasing the amount of individualized language intervention services provided. *Optimized Intervention* assures that the program content is being delivered in a sound progression and manner. The extensive data collection and reporting capabilities of the programs ensure that the prescribing professional can review in detail a student's performance within and across sessions. Increasing the amount of individualized language services provided means that students will meet their goals more quickly. While increasing services by providing one on one professional treatment on a daily basis is usually prohibitively expensive, that is not the case with computer delivered services. With *LanguageLinks* and *Prepositions!*, services can be delivered on a daily basis to all students who could benefit from the training the system provides. It can provide the intensive receptive language intervention needed to establish language competence freeing the professional to work on other important goals.

Field Testing Research on *LanguageLinks* and *Prepositions!*

In 2005, a study was conducted in the Medford Massachusetts Public Schools Early Education Program using Modules from what would become *LanguageLinks* and *Prepositions!* (Finn, Futernick, & MacEachern, 2005). Current linguistic theory and research highlights the importance of syntactic competence but mastery of syntax is especially problematic for children with language impairments. Given the syntax deficits students with language impairments have, it was hypothesized that the use of syntax intervention software designed to train *Functional Category* Determiner and Tense forms as well as Prepositions would result in greater increases in language scores than use of software designed for vocabulary and concept building.

In the Medford study, subjects were 22 preschool children (5 females, 17 males) with initial ages of 3;0 to 4;10 (Mean=4;0). They had been classified as having language impairments prior to enrollment. Subjects were from five classes led by three different teachers. All classrooms included typically developing peers in addition to the children on IEPs. In one classroom, the only special education students were those with an Autism diagnosis. The other classrooms had a mixture of children with Specific Language Impairments, Pervasive Developmental Disorders, and Developmental Disorders. All were receiving speech-language pathology services as part of their program.

The language status of each subject was evaluated 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, CC score, and classroom, and then randomly assigned to the experimental or control group.

Classroom computers were set up to run the software. Subjects in the experimental group used the prototype *LanguageLinks* and *Prepositions!* syntax intervention system. Those in the control group used other Laureate programs designed to train vocabulary and categorization. Teachers were asked to use the appropriate software with each subject for approximately 15 minutes per day, several times per week if possible. Children's interest level and attention span were to be taken into account, however, and no child was to be compelled to participate. Software use continued for 12 weeks. After this, subjects were once again evaluated using the CASL.

Children's CC standard scores before and after software use were analyzed using a two-way (Group x Trials) mixed design analysis of variance. All but two children had improved CC standard scores at the end of the 12-week study. Overall gains in scores averaged 7.045 $\pm$ 1.58 points (X-bar $\pm$ SEM). This increase was significant ($F(1,20)=22.6$,

p<0.001). The interaction between treatment group (Syntax vs. Control) and trials (Pre- and Post-testing) closely approached significance (Group x Trials, F(1,20)=3.73, p=0.067). The CC standard scores of children in the experimental group increased by an average of 9.91 ± 2.2 over the 12 weeks. The scores of children in the control group increased by an average of 4.18 ± 2.0.

Contributing to the overall improvement in CC standard scores were increases in standard scores on each of the Lexical/Semantic (Basic), Syntactic, and Pragmatic core subtests. In post hoc analyses, overall increases in Syntax and Pragmatic but not Basic standard scores were found to be significant (p<.01). On each subtest, score increases were larger among children using the syntax software (Table 3).

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

Table 3. Increases in CASL subtest standard scores and CC standard scores of children in each treatment group (mean ± SEM).

Considered in terms of Test-Age Equivalents, advances in the functional language of children using the control software averaged 5.3 months across the three core subtests, while advances of those using the syntax software averaged 8.7 months (Figure 3).

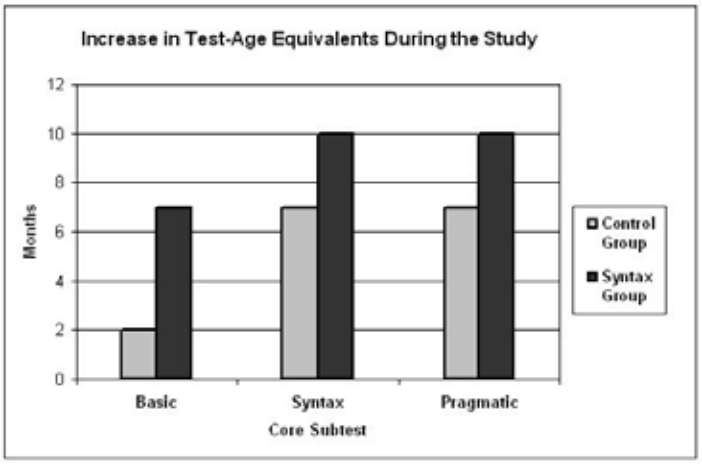

Figure 1. Change in Test-Age Equivalents of subtest raw scores pre- versus post-intervention.

While the effectiveness of using language intervention software has been demonstrated previously, those experiments have often involved impracticably intensive intervention schedules. The outcome of the Medford study using the prototype *LanguageLinks* and *Prepositions!* software is noteworthy because the intervention was conducted under entirely naturalistic conditions with the aim of maximizing validity. This demonstrates that syntax assessment and intervention software can provide effective intensified language intervention services in the classroom.

Who Can Benefit From Using *LanguageLinks* and *Prepositions!*

A wide range of children can benefit from using these new syntax assessment and intervention programs designed to improve communication abilities. *LanguageLinks* and *Prepositions!* cover Determiner, Tense, and Preposition forms that start to emerge when typically developing children enter the two-word stage. Thus the programs are appropriate for use with children as soon as they begin combining words. Children can use the programs until they have mastered all the forms covered. In typically developing children this would be around four years of age. In the case of children with language impairments this could take well into the elementary school years. Regardless of etiology, children with language impairments have problems mastering grammatical forms. Therefore, *LanguageLinks* and *Prepositions!* are

appropriate for children with Autism Spectrum Disorders (ASD), Developmental Disabilities (DD), Specific Language Impairment (SLI), and Hearing Impairments among others. They are also appropriate for use with pre-school and elementary age English language learners (ELL).

Use in Instructional Programs

LanguageLinks and *Prepositions!* were designed to be used in classroom, home, and therapy settings. Like all of Laureate's *Sterling Edition* language intervention programs, they feature an *Optimized Intervention* activity. Most parents and professionals will use this activity to provide intensive individualized intervention. Speech-language pathologists in schools can prescribe classroom use of the program knowing it will be easy to train teacher's assistants or teachers in the use of the software. Once the professional has entered the identifying information on a student for report purposes as well as chosen the appropriate settings (e.g. response time, standard session length, interface) anyone can start the student on the program. No training is needed, as the person only has to choose the student's name and program then press "GO."

When individualized language intervention can be delivered on a daily basis, students benefit because syntax mastery provides a foundation for improved communication. Parents, administrators, speech-language pathologists, and other professionals will be pleased with the outcome.

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Six Levels, 36 Modules in All

Level I Modules

The first level introduces the Possessive "s," trains regular Noun plurals, Determiner "No," Pronouns, and Copular "Be."

1. Girl's Noun/Boy's Noun
2. Noun/Nouns (Sing/Pl)
3. With/With No
4. Me/You
5. Is/Are
6. He/She

Sample Command: "Find the skates for you."

LanguageLinks: Level 1 (Mac/Win CD)

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Level 2 Modules

The next level in the progression trains 3rd Person Pronouns, location Determiners, Negation as well as Present Progressive and regular Past Tense Verb forms.

1. Is/Is Not
2. He/She/They
3. Him/Her/Them
4. Here/There
5. Is Verb+(-ing)/Verb+(-ed)
6. This/That

Sample Command: "Who says...Here is our snowman."

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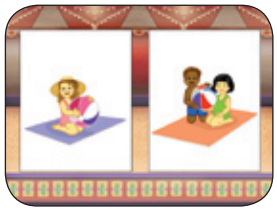
Level 3 Modules

The third level continues with plural Determiners, Pronouns, and Noun/Verb Agreement using Present Progressive Verb forms.

1. These/Those
2. My/Your
3. Me/Us
4. I/You
5. Is Verb+(-ing)/Are Verb+(-ing)
6. I/We



Sample Command: "Who says...We have a ball."

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Level 4 Modules

The fourth level trains more Pronoun forms, Negation, and Noun/Verb Agreement.

1. Does/Does Not
2. Us/You
3. My/Our
4. We/You
5. Our/Your
6. Has/Have

Sample Command: "Find...The boys do not have pumpkins."

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Level 5 Modules

The fifth level in the series trains additional Pronouns, Future Modal "Will," and 3rd Person Noun/Verb Agreement.

1. His/Her/Their
2. Will Verb/Is Verb+(-ing)/ Verb+(-ed)
3. Mine/Yours
4. Mine/Ours
5. Ours/Yours
6. Noun /Verb Agreement

Sample Command: "Find...The peanuts sweep."

LanguageLinks: Level 5 (Mac/Win CD)

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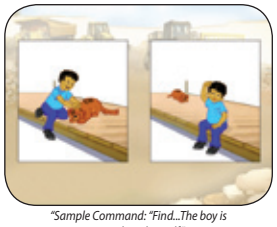
Level 6 Modules

The final level trains regular and reflexive Pronouns, Possessive "s," and Present Passive.

1. His/Hers/Theirs
2. Himself/Other DP *
3. Herself/Other DP *
4. Themselves/Other DP*
5. Boy Noun/Boy's Noun
6. Is Verb+(-ed) By



"Sample Command: "Find...The boy is scratching himself."

**Determiner Phrase*

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