An Information Processing Perspective on Language Impairment in Children: Looking at Both Sides of the Coin

This article examines principles of information processing and the ways in which they can both facilitate and interfere with the language comprehension and production performance of children with language impairment. The clinical implications of these notions for assessment and intervention with children are discussed. Key words: language performance, processing constraints, processing facilitation

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EVERY DAY clinicians and special educators listen and talk to children with language impairment, engaging them in activities and interactions designed to foster their language development. We puzzle over the inconsistencies we observe in the children’s performance, their failure to generalize some language structures learned on the one hand, and unexpected rapid learning, on the other hand. Decades of research have confirmed that their language development is neither unusual nor idiosyncratic (Leonard, 1998), the pace and character of their day-to-day performance can seem unpredictable. At times, some language forms and content appear to be remarkably resistant to intervention, i.e., taking an inordinately long time to master, while others are learned with unexplained ease. This variability has intrigued clinicians and researchers for decades, especially in children with specific language impairment (SLI), children with persistent difficulty acquiring age appropriate language comprehension and/or production de-

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spite general cognitive abilities in the average range.

Lahey and Bloom (1994) suggested that some characteristics of the information processing system may produce the variability that we observe in children's language learning. They pointed to the effects of a limited capacity system when children try to learn language, with particular reference to working memory. Their arguments are compelling and well taken. We will examine some of these same issues, but expand our perspective by examining the ways in which language performance can be facilitated as well compromised. We will look at both sides of this coin: aspects of information processing that can bias or lead a child toward the discovery of language structures as well as those that can interfere with language performance.

Comprehending and producing language is one of man's most complex activities. Intimately tied to the mental processes that make up thinking, language is considered a primary interface between our thoughts and their expression (Groome, 1999). Both thought and language are served by an information processing system whose characteristics can influence the quality of our performance, the overt behavioral manifestations of a skill or ability in active use, in particular children's language. The information processing system, broadly defined, refers to the psychological processes involved in human cognition, including the processes and structures involved in attention, perception, memory, concept formation, problem solving, and information management (Groome, 1999). In this article, we focus on general characteristics of the system, the principles that seem to influence its operation across different psychological processes, and the ways in which they influence language performance. Instances of information processing structures and operations related more specifically to perception, memory, and attention are discussed in detail in other articles in this issue.

PRINCIPLES OF INFORMATION PROCESSING

Levels of processing

One of the more basic distinctions made about information processing is the idea that information can be processed on different levels. Information of any type can be handled by a wide range of processes, ranging from perception through abstract reasoning. Although this is a well-accepted idea, the notion that these processes may also reflect different levels of complexity and depth of processing (Groome, 1999) is not as familiar.

Cognitive psychologists refer to two basic levels of processing (LOP): the "bottom" and "top" levels (Groome, 1999). "Bottom" levels of processing are characterized by the perceptual analysis of input, are considered shallow processing, and thought to make few resource demands on the individual. In contrast, top levels of processing, are characterized by the use of cognitive processes, are thought to involve elaborate processing and make high demands on an individual's resources.

Evidence to support the psychological reality of processing depth for the different levels became apparent during a series of studies of explicit memory conducted by Craik and Tulvig (1975). They examined the nature and effects of different levels of processing (LOP) that were used as encoding strategies for memory performance. In
particular, they studied subjects’ memory for word lists when their encoding strategies emphasized the more perceptual or “bottom” LOP, e.g., strategies that focused on the sensory features of word. They compared their memory for these lists with their memory for lists with which they had used more concept-based strategies. They found evidence that information that was encoded for memory using perceptual cues was not remembered as well as similar information encoded with higher levels of analysis, such as semantic cues. These data confirmed that the different LOP resulted in differential encoding effects, i.e., the LOP principle, and that more shallow encoding resulted in a less memorable trace.

Hamman and Squire’s (1996, 1997) more recent work in verbal memory with normal and amnesic patients extended these findings with different types of verbal memory tasks. Their data confirmed that the LOP principle accounted for increased memory performance under semantic priming conditions as compared with perceptual priming. We often observe the LOP principle when children are asked to perform verbal memory tasks. When they associate information with other information that they already know, they are more likely to remember it than when they pay attention to the phonetic aspects of the target words.

In summary, there seems to be wide acceptance that there are different LOP within our systems and that they can have very different effects on the speed with which we process information. In fact, some researchers used these “top” and “bottom” levels as reference points in describing the different directions in which processing proceeds when we take in or manage information. They discuss whether processing begins at the “bottom” or perceptually-driven level and proceeds upward or whether it is more likely to begin at the “top” with cognitively drawn predictions and proceeds downward.

**Direction of processing**

When information is handled, its processing is thought to proceed in an orderly manner. For example, when a speaker wants to convey a thought by using a sentence, each word must be retrieved from the mental lexicon. In addition, the syntactic information needed to order the word in the sentence as well as the phonological and phonotactic information needed to produce the word must be accessed (Cutting & Ferrier, 1999). There is a great deal of evidence that lexical access seems to proceed from a predominantly semantic stage or level to a phonological one.

Cognitive psychologists often distinguish between two main approaches to processing input, based on the direction and level of processing that is engaged initially. These approaches are referred to as bottom-up processing and top-down processing. Bottom-up processing refers to processing in which sensory stimuli elicit a reaction to the information and processing begins at the lowest levels of perceptual analysis. Bottom-up processing is almost entirely initiated by the presence of a stimulus. An instance of this type of processing occurs when a child is first exposed to the task of letter identification as a part of the literacy experience. The child’s earliest encounters with specific letters usually results in the child in selectively attending to and analyzing the visual features of the letters. The results of this analysis are forwarded into working memory where some type of elaboration or strategic encoding, such as associating the analyzed
features with a letter name, is developed to help enter the information into more permanent memory stores to facilitate identification later (Gibson, 1979; Groome, 1999).

Although bottom-up processing has proven successful in explaining how we discriminate and identify relatively simple stimuli, it has been less effective in explaining how we perceive more complex stimuli (Groome, 1999). Modern cognitive psychologists acknowledge another direction of processing which handles instances of complex stimuli more easily, i.e., top-down processing. Top-down processing refers to the activation and use of stored schemas, linguistic knowledge and other world knowledge to drive processing by formulating guesses about what kind of information will be coming next. Once the prediction has been made, lower level processes are activated and the stimuli are analyzed perceptually for goodness-of-fit with the prediction. If the prediction is not confirmed and comprehension monitoring indicates that the analyzed stimuli “doesn’t make sense,” we usually return to the stimuli and re-analyze it to develop a more appropriate interpretation.

A great deal of research has focused on the issue of direction of processing in speech perception, word recognition, sentence parsing and discourse comprehension. Samuel’s studies (1999, 2001) on word recognition test questions about the direction of processing in word recognition. As he explains, “bottom-up” models of word recognition (Massaro, 1989; Norris, McQueen, & Cutler, 2000) suggest that the information processing system first recognizes phonetic distinctive features, e.g., voicing and the like. Then, the system identifies the phonemes containing those particular feature arrays. Lastly, it recognizes the word that is represented by the sequence of phonemes identified in the analysis. By contrast, “top-down” models of word recognition emphasize that our stored knowledge of words influences our ability to identify syllables and phonemes when we hear them spoken in a word (Connine & Clifton, 1987, Samuel, 1996). That is, the direction of processing proceeds from the “top” or word level knowledge to the “bottom” or perceptual level of analysis: “listeners hear speech sounds in accord with the representations of words stored in their mental lexicons” (p. 351, Samuel, 2001). Children learning language often make errors that result from their use of top-down processing when they are required to recognize unfamiliar words. For example, on his first Halloween, a preschooler was instructed by his mother to say “Trick or treat” as he visited each neighbor. He looked rather puzzled at her instructions, but was encouraged by her assurance that he would receive candy after he said the phrase to each neighbor. Early that evening, he dressed in his costume, took his Halloween sack and, shepherded by his father, went to the door of the first house on the block, knocked, and said expectantly “Chicken feet!”

Both top-down and bottom-up characterizations of information processing seem to have a very serial nature. It is important to remember that our environment is complex; it contains multiple contexts and functions for performance. As such, the same information handled in a top-down fashion in one context, may be handled in a bottom-up fashion in another. In addition, information is present on many levels and we seem to be able to perform more than one task at a time. Cognitive psychologists (Pashler, 1997)
have focused their attention on how we process complex information, questioning whether it proceeds in a cascade, parallel, or serial flow.

**Serial vs. parallel and interactive processing**

Recent advances in the neurosciences have offered powerful explanations of the ways in which the brain handles information. Many cognitive scientists have commandeered these explanations of the ways in which the brain works as a “hardware as software” (Bates & Carnevale, 1993) solution to questions about information processing.

A particularly powerful notion taken from models of how the brain works is that different levels in the cognitive system may operate simultaneously and in parallel with one another. In a parallel processing system, the results of partial analyses of information from a lower level, such as the perceptual level, may be fed upward to interact with cognitively-driven predictions about the identity of the information. This type of parallel and interactive processing can be observed in a sentence processing study conducted by Bates and her colleagues (Von Berger, Wulfeck, Bates, & Fink, 1996). Preschoolers were required to listen to typical and unusual sentences. They were asked to provide a designated signal at the end of each sentence. The unusual sentences contained semantic violations, such as, *She drank a glass of dog*. The children took longer to process the sentences that contained the semantic violations, suggesting that interactive processing was taking place. That is, the longer processing times may have reflected the cognitive dissonance created by their cognitively driven prediction that the glass might contain milk or another fluid and the result of their perceptual analysis that the final noun was an animal.

In contrast, serial models suggest that there are a number of serially driven, autonomous processes which are separate from one another, i.e., modules, and do not interact with one another. This allows parsimonious automatic processing. This model dissociates lexical and syntactic development, pointing to instances in which children are observed gaining automaticity or fluency with some types of processing, e.g., lexical access, while other types, such as syntactic processing or production, are developing. There is considerable debate over this issue, played out in the connectionist vs. modular models of the mind and language (Bates & Goodman, 1999; Elman, Bates, Johnson, & Karmiloff-Smith, 1997).

The idea that a system is capable of automatic behavior does seem to allow for a certain amount of efficiency. This idea is exemplified by the distinction between automatic vs. controlled processing.

**Automatic vs. controlled processing**

In 1977, Schneider and Shiffrin’s work emphasized the idea that we are capable of two types of processing or dual processing. These types include automatic and controlled processing. Automatic processing involves activities in which we do not have to allocate conscious attention to processing. It occurs so automatically that it takes conscious attention to interrupt or stop it. Processes often become automatic as a result of frequent practice, such as typing, reading, or driving a car. For example, when you see the message: DO NOT READ THIS SENTENCE, it is difficult for you to interrupt or stop your reading (Groome, 1999). Similarly, it is difficult to consciously stop comprehending...
language that you hear. Because this type of processing does not engage higher level conscious processing, it is thought to make few resource demands. On the other hand, automatic processing also can be responsible for action slips. For example, on a sleepy morning, you might make a turn to drive in the direction of the office, when you really needed to go in a different direction to buy gas for the car.

In contrast to automatic processing, controlled processing refers to cognitive activities that one performs consciously and intentionally, like balancing a checkbook or recounting a trip to the museum. This type of processing is thought to make considerable demands on cognitive resources. But, because we can perform some activities automatically, e.g., walking, we can also perform one or more additional activities simultaneously, e.g., carrying on a conversation.

We see clear instances of automatic vs. controlled processing in the language performance of adults who have sustained aphasia. It is often the case that clinicians note whether these patients have retained any “automatic” speech, such as the ability to count, recite the days of the week, use familiar, well-learned phrases and even swear words. They compare this with their ability to produce intentionally formulated utterances. Similarly, when we look at some of the literature on children’s language learning styles, we see reference made to some children who rely more on the production of well-learned formulae or cliches to communicate or to bootstrap themselves into more analyzed language. Using formulaic language to bootstrap oneself into more analyzed language is another instance of looking at the other side of the coin, a facilitatory side (see Bates, Bretherton, & Snyder, 1988, for a summary of this research). On the other hand, reference is also made to other children who are more explicit in assembling the language they produce (Bates, Bretherton, & Snyder, 1988). That’s early work suggests that many children who are late talkers show evidence of a more formulaic style of language (Thal & Toabis, 1992).

Whether or not different components of information processing make large or minimal demands on cognitive resources is a key issue in language performance. The concern about the demands made by different types as well as the different levels of information processing centers around our awareness that we have systems with clear limitations.

**Limited capacity system**

**Resource allocation, postponement, and bottlenecks**

In the mid-seventies, cognitive scientists became acutely aware of the ways in which human performance was limited. In recent years, researchers studying children with specific language impairment (SLI) have appealed to these ideas to explain the ways in which capacity limitations accounted for impaired language performance. In particular, Lahey and Bloom (1994), Ellis Weismer (1996), and others have looked at this side of the information processing coin.

Research on performance conducted by Norman and Bobrow (1975), Kahnemann (1973), and others indicated that the human information processing system might best be described as a limited capacity system. Capacity is a term that is used to refer to the perceptual and cognitive abilities that determine the amount of information that an individual can process and/or integrate during any given period of time. Capacity differ-
ences are thought to be responsible for individual differences, e.g., the different language processing skills of a child with SLI as compared with a linguistically gifted child (Bishop, 1992). Resources is a term referring to the amount of effort or cognitive abilities that an individual actually has available to devote to any task at any one point in time. That is, an individual may have the capacity to drive a car and talk to a passenger at the same time. Circumstances, however, may necessitate that the driver devote a good share of typically available resources to some other important activity, e.g., negotiating around a traffic accident on the highway. This will limit the driver’s ability to continue to talk to the person in the passenger seat. These concepts apply to all aspects of human performance, including language performance.

Research indicates that human performance, especially language performance, can be limited by the data available to the individual, the resource demands of tasks, and the capacity that the individual brings to the task (Norman & Bobrow, 1975; Just & Carpenter, 1992). Data refers to the information that is available to the individual to perform the task. Without sufficient information, there may be no way to perform a particular task. For example, a child with SLI undergoing a bout of otitis media may have sustained a mild conductive hearing loss and have difficulty hearing her teacher in the classroom. She may be able to hear her teacher intermittently, when the classroom noise levels are low or when he is talking to her at her desk. The combination of the conductive loss and the presence of classroom noise can mask her ability to hear the message at times. In this example, the child’s performance is data-limited. In this case, it does not matter how many resources are available or can be made available, performance will not improve because there is insufficient data. When, however, the noise level diminishes or the child moves closer to the teacher, the child can again understand the teacher because the combined masking effects of the conductive hearing loss and the noise are no longer be present and the data are once again available.

On the other hand, performance can be compromised by availability of resources. If there are not sufficient resources available at a specific point in time, if they are allocated to other tasks occurring concurrently, e.g., walking and talking, there may be no way to complete the task. Slobin’s (1985) operating principles of language development make clear reference to this notion. The results of his cross-linguistic studies of children’s language development indicated that children usually try to use new structural forms, e.g., a bound morpheme, with familiar words. When they used new markers with new words, they were less successful. The newly learned form made it necessary for the child to devote extra resources because it was not yet a well established structure that could be used with a high degree of automaticity. When the child used the new form with an unfamiliar word or word string, its execution demanded many of the available resources, leaving few resources to complete the task. This is an instance of resource-limited processing.

A child’s capacity limitations can influence and limit the resources that the child has available to perform different tasks; this is what researchers mean when they refer to a limited capacity theory of language impairment (Ellis Weismer, 1994; Ellis Weismer & Hesketh, 1996; Johnston,
1995). In the case of language performance, the individual processing strengths and weaknesses of children with SLI can selectively limit their performance. Take, for example, a child with syntactic formulation problems. A clinician taking a language sample may note that the child also demonstrates word-finding problems. It is noteworthy that such problems seem to occur at the end of sentences or in a final clause. It is plausible that this child may need to devote more resources to formulating sentences than his peers. In so doing, by the time the sentence is nearly formulated, the child may have insufficient resources left to retrieve all the words (Snyder & Godley, 1992). In this instance, the youngster's word finding difficulties, then, may not reflect true lexical retrieval difficulties, but may reflect the resource-draining demands of sentence formulation.

This type of interference has been studied extensively by Pashler (1998) using dual tasks, studies in which participants are asked to perform two tasks at the same time or close to each other in time. He has observed that when the resources needed to perform more than one task at a time exceed the supply, there may be a log jam in the system and performance is diminished. For example, when two tasks occur very close to each other in time, the second task usually has to wait for the first one to be completed before it can be processed. The limited capacity results in a postponement of the second response. This is sometimes called capacity sharing.

A somewhat different result, a bottleneck, may occur in some instances. This is typified by Perfetti's (1985) discussion of reading comprehension in children with specific reading disability (SRD). The majority of children with SRD have difficulty decoding words because of their underlying weak phonological processing skills. Typically, they decode slowly and make many errors that require self-correction. When asked comprehension questions at the end of the reading selection, they may not be able to finish answering them in the time allotted to them or they may answer them incorrectly. The result is often a low reading comprehension score. When these same children, however, are read a story and asked comprehension questions, they have no difficulty answering them. Perfetti suggested that the low reading comprehension scores of children with SRD were the result of a bottleneck in the reading process for these children. Their slower decoding of the print created a bottleneck in the system.

Although these principles provide some compelling explanations for the performance limitations that we observe in some children with language impairment, there is another side to the limitations coin. There are other principles of information processing within a limited capacity system that can result in a performance advantage for some children.

**Concurrence, trade-offs, and recruitment**

Looking at the other side of the information processing coin, Navon and Gopher (1979) suggest that we have access to multiple resources for performance, but that there is a cost-benefit ratio to performing more than one task at a time. They point out that multi-tasking may necessitate that some resources be allocated to integrate the activity; this would be a concurrence cost. For example, most five-year old children are able to learn simple rhymes. They are also able to learn hand actions. It is not unusual,
however, for some children to perform poorly when they have to learn a rhyme that uses simultaneous hand actions, such as *The Itsy Bitsy Spider*. This is an example of concurrence cost. Although the children are able to accomplish each task with ease, the job of performing the hand actions while reciting the rhyme requires integration of the two tasks. The concurrence cost of integrating those actions may require more resources than the children have available.

On the other hand, some multiple tasks may be learned in a holistic manner. For example, preschool children can learn simple songs while tapping their feet in rhythm to music they hear. In many instances, tapping their feet can facilitate learning the songs. This is an example of a concurrence benefit.

We are often aware of instances when we are faced with our capacity limitations and develop strategies to allow us to perform with some degree of success. Children using language are no different. Snyder and Godley (1992), German (1992), and Lahey and Bloom (1994) relate instances in which children (and adults as well) can be observed using a trade-off strategy in order to perform a task. For example, when rapid naming is difficult for a child, such as rapidly naming the color and geometric shape of items in rows on the Rapid Naming subtest of the *Clinical Evaluation of Language Functions*-3, the child may adopt a trade-off strategy. The child may name the items very slowly, focusing on being very accurate. Or, the child may name the items very quickly, and pay less attention to accuracy. This is called a time-accuracy trade-off and it allows the child to perform in one of the areas scored.

Another more positive side of the coin also appears in Washburn and Putney’s findings (1998, 2001) which indicated that resources can be recruited in a way that enhances performance. Their studies suggest that increasing some types of task difficulty may actually result in enhanced or improved performance because it recruits the participants’ attention to the task and they perform better. This is a rather counter-intuitive finding, given all of the preceding discussion. On the other hand, it has been at the very heart of Bates’ (1978) early observation that children and adults pay attention to new, different, and changing information in any context. Their attention is increased because the new information is more salient and it can result in enhanced language performance. For example, a child may be playing with his mother, pushing trucks down the ramp of a toy parking garage and not producing much language. When she changes the task to putting a block in each truck and then pushing it down the ramp, it is likely that the child will say “block” or “down,” despite the increased task difficulty. The increased salience of the novelty of the new task has recruited his attention and increased the likelihood that he will comment on the activity.

Successful performance, then, may not only depend on the child’s capacity, but it may also depend on properties of the information available. Recent work on normal language development suggests that cues present in the information to be processed may either bias a child to the correct response, or they may compete with one another and diminish performance.

**Cues: bias and competition**

The competition model, initially described by Bates and MacWhinney (1983, 1987) as part of their functionalist notion of
language development, is a dynamic model of language performance. The model contains several key principles that are grounded in the way we engage information processing in the service of language performance and acquisition. Of particular interest to our concerns, is their perspective on the perceptual cues available in the environment for language learning.

Bates and MacWhinney argued that perceptual cues influence children’s language learning when they are frequently available. For example, if stress on the first word of an utterance occurs when that word is the subject of the sentence, children would have an available cue (sentence initial stress) signaling a syntactic role, i.e., that subjects of sentences occur at the beginning of sentences. Further, if the cue availability is high and the task occurs very frequently, the cue will grow in strength. If a cue reliably leads the child or biases the child to a correct answer, it influences language learning. For example, a variety of very available and reliable cues in English, such as sentence initial position, sentence initial stress, agent cases (active doers) send the signal to toddlers that the subject of a sentence is usually found at the beginning (Bates & MacWhinney, 1983, Bates & Marchman, 1988).

Although cues seem to facilitate language performance in this model, there are instances when cues can “cost” the individual . . . the other side of the coin. If it is difficult to perceive or detect the perceptual cue, then it will cost the individual processing resources. Similarly, if a specific perceptual cue, such as increased stress, is associated with the object of verbs, but it is not always a reliable indicator of that role, then it will cost the child extra processing resources to clarify the presence of the role. Or, if the cue is difficult to perceive or detect, the language form may take longer to acquire. For example, the contracted copula, “‘s” emerges later in the order of development of grammatical morphemes than the uncontracted copula, “is,” the former being more difficult to perceive or detect than the uncontracted form.

The ideas that competition for resources during processing can “cost” us as well as “benefit” us are powerful ones. They seem to offer some explanatory power for instances when children’s language learning seems unpredictable or variable.

**Summary**

Despite the commonality of the components of information processing, thinking differs widely about the ways in which the direction of processing proceeds, whether or not it interacts or is modular and autonomous, and the focus on the ways in which performance is facilitated as well as limited. The great challenge is to remember that there are two sides to the coin: there is a side that relates to conditions that can interfere with and/or limit performance, and there is a side that relates to conditions that can facilitate and/or enhance performance.

**CLINICAL APPLICATIONS**

Information processing principles can be relevant to the clinical assessment of language performance and intervention for language impairment in children.

**Clinical assessment**

There are several ways in which we can apply principles of information processing
to the assessment of language in children. We can use task analysis to examine the LOP engaged in each task so that we can characterize the levels on which any performance limitations may be occurring. For example, when a child's performance seems to be limited on sentence formulation tasks but intact on various types of memory tasks, we may infer that higher LOP may be more implicated than lower levels. Also, analysis of children's errors and dynamic assessment techniques can reveal whether children are using top-down processing, making predictions about information that is to occur. A good place to observe this is to read a story to the child and engage in conversation about it (Wise & Snyder, in press). Questions can be used to see if the child can make predictions and draw inferences about story events based on world knowledge and information provided in the story. It is important to confine the majority of inferential questions to causal inferences because this type of inference predominates children's thinking during the elementary school years (Goldman, et al, 1999). Further, when task analysis is used in conjunction with performance obtained in multiple contexts of use, we have a better chance to observe gradations in demand for resources. For example, a child who does not yet print or write with automatic motor plans may produce incorrect written answers that are more an artifact of the resource demands made by his limited fine motor development than his language skills.

Automatic versus controlled processing can be an important distinction to make when observing a child's performance during assessment. For example, it is helpful to analyze a child's language sample to determine whether the child relies heavily on cliches and over-used idioms to communicate. A heavily formulaic style of language production may signal that the child has difficulty formulating sentences in a more precise, rule-governed manner. It may also be helpful to conduct error analyses that consider the information processing characteristics of the task. For example, we can look at the locus of word finding errors in a syntactic string. Do they occur in the initial vs. final positions in the clause? The loci of errors in a sentence or, even within a word, have different implications from a limited capacity model. Lastly, we can examine language tasks from the standpoint of cue salience. Is the child able to perform tasks in which the cues are more vs. less perceptually salient? For example, regular 3rd person singular verb marker -s and regular past tense -ed markers are less perceptually salient than other markers; they are short in duration and lower in intensity (Leonard, 1998). Similarly, closed class words, e.g., "by" are also less perceptually salient than open class words, e.g., "buy" (Herron & Bates, 1998). The difficulty children with SLI have in acquiring these verb markers and closed class words may, in part, be related to their reduced perceptual salience. These are a few direct applications of information processing principles to the assessment of language. Similarly, principles of information processing can be applied to intervention as well.

Language intervention

Language intervention seems to be one of the contexts in which children's language performance can be most unpredictable. It is in this context, in which principles of infor-
ation processing can be most helpful. For example, when we develop verbal memory strategies for children, it is important to consider the depth of processing issue. If we help them learn to access and use their stored world knowledge to create associations with material to be remembered, it is likely that they will experience greater success. Also, we can engage children in the use of top-down strategies such as predicting or guessing, when slower perceptual processing seems to contribute to poor language functioning in everyday contexts. Although language form and content are important, communication continues to be important. Unsuccessful language experiences can undermine children’s confidence in communicating (Pritchard-Dodge, 1990).

Principles of information processing suggest that it may be important to attend to instances where children may be making trade-offs. Are they sacrificing speed for accuracy or vice-versa? If this is the case, we may wish to add an intervention objective in which they increase the fluency or automaticity with which they are able to produce forms that they know well. Current trends in reading research suggest that the development of reading fluency is a key intervention goal for children with language-based reading disabilities (Wolf, 2001). Similarly, we need to determine when resources become compromised by hidden task requirements in intervention. A child, unfamiliar with the board game or the new geography text that you are using for the intervention activity, may make many linguistic errors. This may be more a result of needing to allocate resources to learning the new game or handling the new text, than of difficulty producing the desired linguistic form.

In designing intervention, it will also be helpful to place structures and forms to be learned into contexts where they will receive greatest perceptual salience. For example, we can use contrastive stress to increase the perceptual salience of past tense -ed markers by placing the child in the position of having to correct a model with the correct marker. Second, we can try to optimize language learning by providing models for new structures or forms that have many concurrent, reliable cues. We can participate in the “conspiracy” (Elman, 1999) to lead children to correct language solutions. For example, we can design stimuli that ensure that the subjects of sentences are animate agents and are located in a sentence initial position.

Information processing principles, then, can help us detect underlying resource limitations that may be compromising children’s language learning during intervention. On the other hand, they can also help us optimize our presentation of information and intervention strategies in such a way as to facilitate language learning.

At one time, information processing models of childhood language impairment were entertained as ways to assess children’s language functioning. They fell into disuse because they encouraged a disability perspective and did not describe what it was that children could do (Wolf-Nelson, 1998). Information processing models are not new. Then again, the human brain and the way in which language develops are not new either. What has changed, however, is the accumulation of new information in these areas. Current models of information processing
have assimilated and accommodated this new information, resulting in some fresh perspectives with increased explanatory power and productivity. The key to using this information is to look at it from both vantage points, both sides of the coin: how it can account for facilitation as well as limitation in children’s language learning.

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