Cognitive Deficits in Specific Language Impairment: Decision In Spite of Uncertainty

Les déficits cognitifs en trouble spécifique du langage : prise de décision malgré l'incertitude

Judith R. Johnston, PhD
University of British Columbia
Vancouver, British Columbia

ABSTRACT

Studies of children with specific language impairment (SLI) have reported a wide array of cognitive deficits. While the findings themselves are not disputed, experts interpret them quite differently, some minimizing their importance and others assigning them a fundamental causal role. This commentary presents four strategies for evaluating conflicting scientific claims and illustrates them with a discussion of the literature on cognitive deficits.

ABRÉGÉ

Les études d'enfants présentant un trouble spécifique du langage ont relevé une vaste gamme de déficits cognitifs. Quoique les conclusions ne soient pas remises en question, les experts les interprètent de manières très différentes, certains minimisant leur importance, tandis que d'autres leur imputent un rôle causal fondamental. Ce commentaire présente quatre stratégies pour l'évaluation de revendications scientifiques opposées et les illustre en examinant la littérature sur les déficits cognitifs.

KEY WORDS: specific language impairment • critical thinking • cognitive processing disorder

For over thirty years, specific language impairment (SLI) has presented us with both promises and puzzles. For researchers, the dissociation of language from other aspects of development seems to provide a natural laboratory for investigating the architecture of the mind. By studying the abilities and skills of children with SLI, they should be able to discover the connections between language and other mental functions. Clinicians too have viewed the diagnosis of SLI with optimism. The specificity of the impairment suggests a focused intervention program with good probabilities of success. Once the initial language barriers are overcome, the child's cognitive strengths should lead to effective communication and improved classroom learning. Ultimately, however, the value of these research and clinical opportunities depends on the truth of the dissociation. Therein lie the puzzles. How *specific* are the impairments of children with SLI ?

The relevant investigations concern aspects of cognition - those mental activities and products directed at 'knowing'. The classic picture of SLI posits deficits in language acquisition and use, with cognitive functions otherwise normal. However, researchers over the last two decades have actually reported a wide array of cognitive difficulties in such children. Here is a representative sampling of tasks in which children with SLI have performed less well than their age or language peers:

- memory for location of dots in a matrix (Doehring, 1960);

- perceiving rapid sequences of tones or lights (Tallal, Stark, Kallman, & Mellits, 1981);
- replicating rhythmic motor patterns (Kracke, 1975);
- noticing change in a visual display (Mackworth, Grandstaff, & Pribram, 1973; Nichols, Townsend, & Wulfeck, 1995);
- mental rotation of geometric arrays (Savich, 1984);
- recognizing a visual form given haptic data (Kamhi, 1981);
- imagining objects from a different spatial perspective (Camarata, Newhoff, & Rugg, 1981);
- symbolic play (Terrell & Schwartz, 1988);
- hypothesis testing (Ellis Weismer, 1991);
- inferential reasoning (Johnston & Smith, 1989);
- seriation of size (Siegel, Lees, Allan, & Bolton, 1981);

This is not a literature that reveals the sparing of cognitive functions. Instead, children with SLI evidence difficulties with perception, memory, attention, spatial cognition, conceptual development, and reasoning. Replication studies are rare, but there is a convergence of findings within domains. The validity of these findings - and others like them - is seldom in public dispute (but see e.g. Casby, 1997), but interpretations of their significance and meaning vary widely. Again, I offer a representative sampling of opinion:

- "This category of language impairment...seems not to affect or be affected by...intellectual problems" (Owens, 1999, p. 37).
- "Nonlinguistic deficits [that were] reported tend to be subtle" (Lahey, 1988, p. 53).
- "It is still unclear whether the cognitive and the linguistic disorders are causally connected or simply co-occur in some subjects" (Gopnik, 1997, p. 5).
- "There is evidence of certain processing vulnerabilities, but it is difficult to know if the observed differences provide sufficient explanation for the observed linguistic limitations" (Rice, 1995, p. 23).
- "The notion of generalized slow processing within a speech production model seems viable as an account of performance limitations in children with SLI" (Leonard, 1998, p. 268).
- "[Children with SLI have] trouble with more complex concepts [that]... may require language for their solution" (Siegel et al., 1981, p. 157).
- "We have documented the reality and extent of their cognitive deficits and in so doing have validated the connectedness of language and thought" (Johnston, 1992, p. 113).

As is evident here, experts in the field differ widely in their interpretation of the cognitive deficits found in children with SLI. Some ignore them; some conclude they exist but are minor; some believe they are independent of language; still others see them as the direct cause or consequence of language learning difficulties. These differences arise in part out of differences in viewpoint on the nature of SLI, and, more broadly, of human language abilities. On the one extreme we have SLI understood as the lack of innately provided language representations in a modular mind. From this vantage, cognitive impairments are either overlooked or are seen as concomitant problems. At the other extreme we have SLI understood as the product of compromised general cognitive mechanisms struggling with a particular learning task. From this perspective cognitive impairments are viewed as causal or as outcomes. Both of these interpretations are theoretically motivated and coherent. They are also in radical conflict. There may be concensus on the facts, but their meaning is clearly in dispute. Neutral readers of this literature will find true scientific uncertainty

As researchers and clinicians, the problem we face is essentially epistemological: How can we decide what course of action to take in the face of uncertainty? Or, in this specific case, how can we decide which claim about the significance of cognitive deficits is *better* than others, if not yet quite true? This is not an arcane question. Many of us are clinicians or speak to a clinical community. Many of us are applied scientists who must advocate and advise in the absence of certainty. Our solutions to this epistemological problem will thus have ramifications for

therapy plans, resource allocation, and public policy at all levels. Philosophers of science offer us four strategies for evaluating the merits of various claims: (a) identify the motivating research question or inquiry, (b) evaluate the evidence, (c) analyze costs and benefits, and (d) acknowledge values. Let's apply these strategies to the claims about cognitive deficits and SLI.

Identify the Inquiry

In evaluating the merits of various claims about cognitive deficits, we need to remember first that conflicts may reflect differences in research agendas. Several summers ago, Mabel Rice and I were among a small group of researchers invited to discuss SLI at the Summer Institute of Linguistics. After lengthy discussion came the 'light bulb' recognition that we were pursuing two very different research goals. She was trying to describe the nature of language representation in the minds of children with SLI, and I was trying to explain psychologically how it ended up that way. We each recognized the importance of the other's question, and knew that the final story would need answers from both of us, but our current inquiries and, hence, our expertise and investments, were quite different. This fact may partly explain our differing conclusions about cognitive deficits as exemplified in the quotations above. Dr. Rice can afford to be an agnostic on questions of psychological explanation since those explanations are not at the core of her inquiry; I can't.

Research agendas influence more than just relative expertise or strength of conviction on a particular issue. They also fundamentally limit the nature of valid conclusions. Although serendipity happens, most researchers can only find what we look for and know how to see. If, for example, a line of investigation focuses exclusively on *language* processing, it will not be possible to address the specificity of any processing disorder that is found. The existence of deficits in *language* representation or processing is compatible with all models of SLI, those that claim specificity and those that do not. Conclusions about the specificity of language impairment require observations of nonverbal as well as verbal behaviour. As we approach the literature on cognitive deficits in children with SLI, identification of research agendas can help us determine biases, relative expertise, and unfounded conclusions.

Evaluate the Evidence

The second approach to resolving uncertainty requires evaluation of the evidence, its quality, compatibility, weight, and convergence. The quality of the evidence in regard to cognitive deficits in children with SLI is admittedly uneven. Researchers have tended to ask ambitious questions of small data sets with weak analyses. We generally acknowledge that correlations can't support causal arguments, but we haven't always recognized other important limitations of our data: that strong causal relationships can yield quite modest correlations; that development may be nonlinear; that analyses of variance or correlational analyses require variance; or, that before we can compare performance in two domains, we must justify the relative developmental difficulty of the two tasks. And then there is the problem of subject selection criteria! Without meaning to minimize the importance of such methodological issues, I will ignore them for the moment and consider the evidence at its best. The following sections will consider in turn each of the interpretive claims about cognitive deficits in SLI - from the point of view of the evidence. This commentary is not meant to provide a comprehensive review but only to illustrate how evidence can be used to guide our understanding of research claims.

As indicated by the earlier list of findings, current evidence does not seem to support the claim that children with SLI have no cognitive deficits. Even if we imagine unpublished studies that found 'no differences', or remember that performance on many nonverbal tasks can be verbally mediated, the weight of the evidence seems to justify Leonard's (1998, p. 119) conclusion that "many children with SLI show weaknesses in areas of functioning that seem to require little or no language ability. Some of these areas are clearly cognitive."

Claims that minimize the importance of cognitive deficits are more interesting. The preferred adjective in these arguments is "subtle" - as in "subtle deficiencies" - a word whose first meaning, according to Webster, is "thin, rare, or tenuous". These descriptors do not seem appropriate for functions, such as perception, attention, and reasoning, that are basic to human intellect. However, the adjective "subtle", in its sixth sense, also means "working insidiously; not easily detected." This meaning may be more apt. Those who minimize cognitive deficits generally rely on the fact that the cognitive evidence from children with SLI includes numerous

test scores indicating normal range intellectual performance. In the context of these scores, cognitive deficits may indeed seem subtle and not easily detected. However, detection depends as much on the power and focus of the scope as on the size of the target. Performance IQ tests typically focus on static visual problems, immediate perception, and simple relations. Scanning the earlier list, we see that many of the reported cognitive problems in children with SLI have involved dynamic stimuli, mental representation in the absence of immediate stimuli, and/or higher level problem solving. They would therefore not be detectable with the usual tests.

Riddle's (1992) study of attention highlights another feature of current test batteries. In her dual-task paradigm, preschoolers with SLI categorized pictures with normal accuracy. However, they were slower than their age peers on an auditory vigilance task that was presented at the same time as the visual task. This indicated that the visual categorizing was consuming more than the normal amount of attentional resource. Preschoolers with normal language patterns had attention to spare for the buzzer, but the children with SLI were already at capacity. Since the typical intelligence test measures only success or accuracy, not mental cost, this sort of cognitive deficit would again be undetectable. In short, as long as we base our conclusions on the usual standardized assessment tools, the cognitive deficits of children with SLI will remain difficult to detect. But that "subtlety" may say more about the tests than about the importance or magnitude of the cognitive difficulties experienced by children with SLI. Here it is not the weight of the evidence, but its fundamental nature that raises doubts about the interpretive claims.

What about the conclusion that cognitive deficits coexist with, but are independent of, language impairment? Or the opposing claim that cognitive deficits, rather than being independent of language learning problems, are actually one of their causes? Support for this latter view would come from studies that demonstrate linkage between the two domains by: (a) identifying nonverbal deficits that are unique to children with SLI, (b) showing that change in one domain is a function of change in the other, or (c) demonstrating principled correlations in the degree of cognitive and linguistic impairments. When we search the literature for findings of these sorts, the evidence proves mixed.

On the one hand, the characteristic perceptual and reasoning deficits of children with SLI do not seem to be unique to the syndrome. Such children may have difficulty with the perception of rapid, sequenced stimuli (Tallal et al., 1981), but so do some children without language impairment (Ludlow, Cudahy, Bassich, & Brown, 1983). In a similar vein, spatial deficits are seen in children with Williams syndrome (Mervis, 1999) as well as those with SLI, and reasoning deficits are seen in many developmental disorders besides SLI. The evidence from training studies is too almost sparse to evaluate. The only clear attempt to test the language effects of cognitive intervention seems to be the recent study of perceptual training reported by Tallal and her associates (Tallal et al., 1996). Their data suggest that intensive practice with acoustically altered speech and sequenced tones may lead to improvements in language performance. Subsequent work by Gillam (1998), however, demonstrates similar success for intensive practice with unaltered speech alone, raising questions about which aspect of the Tallal program actually led to the observed gains.

On the other hand, there does seem to be some evidence of graded association between perceptual problems and language performance. Children with SLI who have shown difficulties with rapid auditory stimuli, have also shown analogous speech production problems with weak syllables (Leonard, McGregor, & Allen, 1992) and voicing (Stark & Tallal, 1979), as well as comprehension problems with grammatical forms of brief duration (Fellbaum, Miller, Curtiss, & Tallal, 1995). And, in normally developing infants, auditory gap detection at 6 or 12 months predicts vocabulary size and MLU at two years (Henderson & Trehub, 1995). Such fine-grained analyses are the exception, but they invite us to look more closely at the gross correlations between language difficulties and cognitive difficulties that are implicit in our original list of findings. Each study that identifies an area of cognitive weakness in children with SLI, identifies a potential link between that function and language. Are these data more compatible with a present-but-independent view, or with a present-and-causal view, of the role of cognition in SLI?

At first pass the observed cognitive deficits seem quite distinct from language, and incompatible with causal arguments. It is hard to imagine how skills such as memory

for dots or recognition of objects by touch could connect to language proficiency. Nevertheless, current research programs are attempting to do just that. Rather than linking surface tasks, however, investigators are looking for underlying factors that could compromise performance across domains. This line of inquiry has been aided considerably by computer simulations showing that very specific performance deficits can result from general lesions (Marchman, 1993). Memory for dots is unlikely to explain specific language impairment, but limitations in general cognitive processing capabilities, occurring at critical developmental moments, might.

One body of new evidence seems particularly compatible with idea that cognitive deficits play a causal role in SLI. Recent studies indicate that children with language impairment respond more slowly across a variety of tasks (Windsor & Hwang, 1999; Kail, 1994; Miller, Kail, & Leonard, 1998). Generalized slowing of cognitive processes could have widespread consequences for language behaviour. Accounts thus far have focused on how a slowed system would be stressed by the brevity of elements in the speech signal. But rapid input is just one of the challenges faced by a slow system. Language processing models suggest at least two others: memory decay and the coordination of incremental processing. We know from countless studies of normal cognition that material in working memory "fades" unless constantly refreshed, or rehearsed. We also know that sentences are processed in real time steps, with many points of necessary synchrony (Bock & Levelt, 1994). If all components of the system were equally slow and memory traces were stable, such incremental processing might not create problems. However, the data from children with SLI indicate poor phonological representation (e.g., Dollaghan, 1998) and late-learned morphology (e.g., Johnston & Schery, 1976), which suggests that access to stored knowledge in these domains might be especially difficult. The resulting dyssynchronies, in conjunction with slowing and memory decay, could easily lead to performance and learning breakdowns. Viewed thusly, generalized slowing could account for much more than problems with input.

The evidence on generalized slowing is not unequivocal. Over the past years, a sprinkling of studies have reported finding no group differences in simple reaction times (e.g., Johnston & Ellis Weismer, 1983; Townsend, Wulfeck, Nichols, & Koch, 1995) - a fact which seems incompatible with generalized slowing. The literature on aging suggests one way to restore compatibility: cognitive performance apparently reflects both processing speed and knowledge, in different proportional mixes according to task (Birrin & Fisher, 1995). Kail's (1999) recent path analysis of the causal chain between speed, memory, and reasoning yielded similar findings for children. The hypothesized cascading effects from speed to amount remembered to reasoning success, was seen only for nonverbal reasoning. Performance on verbal analogies, requiring specific vocabulary knowledge, was not predicted by memory and speed. This of course does not mean that processing speed had no influence on performance outcomes, only that the relationship was not a simple one.

Thus far we have seen that there is little evidence of direct causal linkage between most of the cognitive deficits observed in SLI and the language impairment itself. This fact could be taken as support for the present-but-independent view. However, an emerging reinterpretation of the cognitive data focuses on underlying general processes and may ultimately provide the necessary causal links. This possibility reminds us that the evaluation, and reevaluation, of evidence must be ongoing since the compatibility of evidence with any given claim depends in part on the larger body of knowledge within which they are considered.

The final claim about the relationship between cognitive deficits and language impairment concerns the important role of language in higher level cognitive functions - what Nelson (1996) calls the "mediated mind." There is good argument, but little direct evidence to help us understand the intellectual costs of language impairment. Declining IQs (Leonard, 1998), academic failure, and difficulty with complex reasoning certainly suggest that there is a cost, but we are quite limited in our ability to observe 'inner language' at work. Three recent studies suggest a starting point for future work. Ron Gillam and his colleagues recently reported that children with SLI showed greater memory deficit on a visual-motor digit span task than on an auditory-verbal one (Gillam, Cowan, & Marler, 1998). They argue that the visual motor task required an additional manipulation of phonological code because verbal rehearsal codes needed to be converted into visual symbols before the response. They also

note, however, that the children with SLI may have attempted to remember the visual symbols without recourse to verbal code. Riddle (1992) made a similar interpretation of her findings. The categorization task in her study asked children to view a target object, and hold it in mind while finding a second object of the same type. In some items, the second object was identical to the original target, and in other items, it was only similar. The differing degree of resemblance affected the children with SLI, but not the controls. Since verbal codes would erase the distinction between identity and mere resemblance, Riddle argues that the control children used verbal codes and the children with SLI did not. Finally, Sturn and Johnston (1998) looked at the relationship between cognitive efficiency and use of problem-solving language. The two were positively correlated in the control group, but for preschoolers with SLI, cognitive efficiency was inversely related to use of language. The evidence in these studies converges on the notion of cognitive strategy. Children with SLI may show deficits in higher level cognition because they use verbal tools quite poorly - or because they choose, unwisely, not to use them.

So what does this illustrative evaluation of evidence tell us about the merit of various claims? Current evidence does seem to attest to the reality of cognitive deficits in children with SLI, especially if we remember the limitations of nonverbal assessment tests. However, the evidence alone does not yet provide compelling reason to accept the claims that cognitive deficits either explain, or result from, language impairment. Recent studies of general cognitive processes and strategies are providing new tools for understanding these relationships, but the evidential picture is still uncertain. To make our clinical or research decisions, we must rely on theoretical commitments, or turn to the third evaluative strategy, consideration of the costs and benefits of acting on various claims.

Cost/Benefit Analysis

To illustrate this mode of evaluation, let's first assume that cognitive deficits exist, and consider the claims that these deficits are, or are not, connected to language impairment, focusing on immediate clinical outcomes. For the clinician, the cost of wrongly assuming *connection* would lie in unfulfilled expectations for treatment effects. Imagine implementing an auditory perceptual training program in the belief that specific language impairment results from difficulties in processing the acoustic signal. When the ability to distinguish and recognize rapid sequences of sound improves, the child should have better success in learning and using language. If, in fact, language impairment is unrelated to perceptual abilities, this expectation would not be met. As a second example consider the clinician who believes that language impairment leads to cognitive deficit because language is needed for higher level intellectual activities. From this perspective, a program of language therapy might be implemented with the expectation that there would be academic payoffs because the child would have new access to classroom discourse, new supports for literacy, and new tools for reasoning. If language functions are not, in fact, key elements in academic success, these expectations would remain unfulfilled.

The costs of wrongly assuming that cognitive deficits merely *coexist* with language impairment would lie in treatment inefficiencies. The clinician might implement therapy on syntax, vocabulary, and morphology when intensive work in auditory perception would accelerate growth in all aspects of language. Likewise, the clinician might implement tutoring in math, social studies, and geography when improvements in general language skill would remedy all academic areas. In both cases, the desired outcomes could have been achieved with a more focused, and less costly intervention program.

A comparison of these scenarios indicates that the assumption of *connection* has the lower immediate clinical cost. The therapist who wrongly assumes that cognitive deficits are the result or cause of language impairment can always expand her treatment programs given negative outcomes. In contrast, the therapist who wrongly assumes that cognitive deficits merely coexist with language impairment will have no evidence to reveal her treatment inefficiencies. She will observe progress on each intervention target and there will be no way to learn that part of the program was unnecessary.

Cost-benefit analysis can also apply to recommendations for service. Consider the case of the kindergartner who has a history of specific language impairment and language therapy services, but now seems to have 'recovered.' Should this child be seen by the school SLP? The clinician who assumes that cognitive deficits underlie SLI might be dubious about recovery. She would argue that the child has

learned the language of a five-year-old only with support, and further that cognitive processing disorders will persist and create new problems with classroom discourse and literacy. This clinician would continue the child's language therapy program until school success is certain. The cost of being wrong would be the cost of unnecessary treatment, and the potential stigma of receiving special services. The clinician who assumes that language impairment is independent of cognitive deficits has less cause for concern. Since the child's language and performance IQ are now within normal range, she might well decide that services are not needed. The cost of being wrong in this instance would be the emotional toll of the ensuing classroom failure. If resources were unlimited, the choice here would be simple: the risk of providing unnecessary, but useful, tutoring pales against the pervasive consequences of failure. Unfortunately, resources are not unlimited. Time spent on service to one child is time that can not be provided to someone else.

This brings us to a cost-benefit analysis of decisions about program priorities. In today's service economy children with more serious problems often have access to wider ranging, and more frequent, treatment. Public policy generally assumes that children with SLI have difficulties only with speech and language. They are thus allotted less money in the school district, and/or less service in the community, than children who are deaf, autistic, or developmentally delayed. What if policy assumptions are wrong, and SLI is actually the linguistic manifestation of a more widespread cognitive disorder? The cost of this error would be underservice for children with SLI and an unnecessary compromising of their educational, and hence life success. On the other hand, what if public policy were to change and treat SLI as a more serious condition? The risk here would be an unnecessary, but time-limited, investment in treatment services. This cost-benefit analysis indicates that the better decision would be to assume that SLI were the result of a wider cognitive impairment. The potential consequences of educational failure, with their life-long welfare and vocational training costs, are clearly greater than the costs of providing unnecessary educational support services during the early school years.

I opened this commentary by posing an epistemological question: Which claim about the significance of cognitive deficits in children with SLI shall we believe to be better than others, if not yet quite true? The answer, I have argued, is this. There is a body of evidence indicating that such deficits exist, and that at least some of them have direct linkage to language performance. There are also plausible accounts of how cognitive deficits can both lead to, and result from, language impairment. In the world of clinical service and public policy, these accounts carry the possibility of improved efficacy and resource savings. In the scientific world, these accounts open the door to several lifetimes of investigation. While not eliminating uncertainty, the evidence and the cost analysis do suggest directions for action. I must admit though, that final decisions are likely to entail personal values. And here may lie a further reason that I have decided that cognitive deficits do matter, and have chosen to study the relationship of language and cognition for over thirty years. I like the complexity of interacting systems and value puzzles that stretch the mind.

Acknowledgment

Preparation of this commentary was supported in part by a grant from the Natural Science and Engineering Research Council of Canada. An earlier version of this paper was presented at the Symposium on Research in Child Language Disorders, University of Wisconsin, Madison, June, 1999.

Submitted: November 1999
Accepted: December 1999

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