Responsiveness-to-Intervention Symposium

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The National Research Center on Learning Disabilities, a collaborative project of staff at Vanderbilt University and the University of Kansas, sponsored this two-day symposium focusing on responsiveness-to-intervention (RTI) issues.

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Neuropsychological Aspects for Evaluating Learning Disabilities

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Neuropsychological Aspects for Evaluating Learning Disabilities

Learning disabilities have been defined in various ways over history. Initially terms such as minimal brain dysfunction, word blindness, and dyslexia were widely used. The term learning disabilities then became more popular particularly with the advent of passage of P.L. 94-142 in 1975 (Goldstein, 1997). A definition proposed by the National Joint Committee for Learning Disabilities in 1981 suggested that "these disorders are intrinsic to the individual and presume to be due to central nervous dysfunction." (Hammill, Leigh, McNutt, & Larsen, 1981, p. 340). This definition included difficulties with reading, mathematics, listening comprehension, written language, and expressive/receptive language. Although learning disabilities has been understood to be a heterogeneous term, most lay people and many teachers interpret learning disabilities to mean difficulties in reading. The empirical field also shows this emphasis on reading with the abundance of articles about reading disabilities compared to those written on mathematics, written language, or social learning difficulties.

Learning disabilities have been found to be comorbid with other diagnoses including attention deficit hyperactivity disorder (ADHD), anxiety, depression, and others (Martinez & Semrud-Clikeman, in press). ADHD has been found to co-occur in approximately 20%-50% of children with reading difficulties depending on the method of calculating a learning disability (Semrud-Clikeman et al., 1992). ADHD has also been found to co-occur with difficulties in mathematics (Semrud-Clikeman, 2003), written language (Hargrave, Corlett, & Semrud-Clikeman, 2002), and social emotional learning disabilities (Semrud-Clikeman, 2003). Comorbidity of learning problems with other diagnoses makes it imperative to evaluate these possibilities when developing a remediation program for the child (Pennington, 1990). Moreover, our understanding of the contribution of these related but separate diagnoses to learning is just beginning to be understood. There is far more research evaluating the brain functioning in children with reading disabilities than those with other learning problems or those who show a combination of difficulties. Although the focus of this paper will be on reading disabilities due to restrictions in length and time, the other areas of learning disabilities are equally important and hopefully can be highlighted at another time.

The general procedure of identifying learning disabilities has been through the use of a discrepancy between measured ability (IQ) and achievement (Joshi, 1999). As noted by other speakers at this meeting, this type of assessment very narrow and does not directly lead to recommendations for remediation. It also ignores the various neuropsychological functions underlying the ability to read, speak, comprehend, write, and do mathematics well. This practice also has been found to over-identify those children with high IQs and average achievement and

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under-identify those with lower IQs and below average achievement (Birch & Semrud-Clikeman, 2002; Semrud-Clikeman et al., 1992).

The acknowledgment of deficient brain functioning in children with learning disabilities has become more widely accepted particularly with the advent of research evaluating the functioning of the brain. The findings of differential brain activation following remediation are very appropriate for this symposium. A discussion of the most recent findings about the neural structures involved in reading may highlight the various aspects of the learning process that need to be evaluated.

Brain Imaging and Learning Disabilities

Emerging findings suggest that children with learning disabilities process information differently from those without learning problems. Differences in developmental have shown that fluent adult readers utilize the frontal regions more than children who are beginning to read (Schlaggar, 2003). The left frontal region becomes more active over development with more fluent child readers activating this area more than children with difficulties (Schlaggar et al., 2002). Moreover, children with learning problems show a differential pattern from normal readers activating the parietal and occipital areas more than the frontal regions as well as more activation in the right hemisphere than in the left. This finding is important because activation of the left hemisphere, a region specialized for language functions, plays an important function in reading. The change from posterior systems in early reading (visual-perceptual processes) to frontal systems by more fluent readers suggest that the progression from simple letter and word calling to comprehension requires a maturation of neural pathways from the back of the brain to the front (Shaywitz, 2003). Moreover, children show a more diffuse activation when beginning to learn to read that gradually becomes more specialized as the reading process improves.

Similarly, when asked to read single words normal readers showed left hemispheric activation while those with dyslexia showed more right hemispheric activation (Breier, et al., 2003; Papincolaou, 2003). Changes from right hemispheric processing to left hemispheric processing have been found to occur with improvement in reading skills. These changes are also found when improvement in language functioning occurs. Such changes are not found for children with dyslexia as the reading process does not become automatic and effortless.

Gabrieli (2003) found that the region most responsible for auditory processing and language is more activated in good readers compared to those who had compensated for their dyslexia. The more activated the white matter tracts are that carry the signals throughout the brain, the better the scores on reading measures. These studies also found that improvements were found in activation following remediation of auditory processing ability. It is not clear, presently, whether these changes continue over time with further study needed to understand possible brain response to remediation.

The Neuropsychology of Learning Disabilities

An evaluation that centers solely on the simple process of subtracting, or regressing, IQ from achievement is a narrow procedure that misses much of the difficulties frequently seen in these children. The ability to process information is a very complex and distributed operation. Skills that are necessary to understand to evaluate the

child's learning skills include the ability to process language, to understand what he/she hears, to organize information, the speed information is processed, attention, the child's ability to hold information in mind while solving a problem, and the ability to self-monitor the reading process.

Language difficulties have frequently accompanied problems in learning to read. These language problems may be in receptive and/or expressive language. The phonology of the language can be tricky to master. Language is a natural process of our brain and there are structures devoted to its development. Reading, however, is an acquired skill and children must be directly taught how to do this task. When a child has a language problem in addition to reading deficits, the progress is much more difficult. Approximately 70 to 80 percent of children learn phonological coding skills without difficulty. The remaining 20 percent show differing levels of success and, based on previous studies, the determining aspect may be the intervention provided as well as the child's overall verbal skills.

The ability to decode words is a fairly well-known area of difficulty for children with learning disabilities—however, more recent research indicates the main difficulty is not just the decoding of the word but also the rate of decoding (Joshi, 1999; Woodcock, 1991). Speed of information processing has been found to separate fluent from nonfluent readers (Semrud-Clikeman et al., 2000). Children with reading disabilities were found to be slower at naming words and nonwords as well as with naming letters and numbers (Aaron et al., 1999).

An important aspect for reading is comprehension. Listening comprehension is mediated by the same cognitive processes as reading comprehension only through a different modality (Joshi, 1999). Assessing the ability to process information without the confound of decoding allows one to more fully evaluate the child's ability to understand and process language and to determine whether the difficulty lies with decoding or comprehension. An evaluation of these skills is necessary to understand where the breakdown in skills lies and thus, to develop the most appropriate intervention.

An additional neuropsychological process that is important to reading skills development is working memory. Working memory is the ability to hold information in mind while solving a problem, remembering a phone number, or decoding a word. Adele Diamond studied working memory in young children. The child observed her hiding an object and then was asked a few seconds later, where the object was. Children younger than one could not find the object and used the rule of "Out of sight, out of mind." Before age one the frontal lobes are unable to process delayed information. However, as the child grows, he/she becomes more able to retain information for a short amount of time while processing information. In order to decode words, one's working memory must be functional and allow the child to retain a "template" of the letters until the word is sounded out. If there is a breakdown in the ability to hold this information in mind or if the time required recalling the sound-symbol relationship is prolonged the child will experience difficulty reading (Semrud-Clikeman et al., 2000). Working memory is a crucial skill for early reading recognition and later reading comprehension and needs to be assessed in order to develop the most appropriate method of intervention.

Working memory has also been linked to the ability to organize a task's temporal aspect. Not only is input encoded, it is also tagged to a time when the task was learned (Gazzaniga, Ivry, & Magnum, 2002). The

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prefrontal cortex is linked to memory systems that allow the child access to previously learned materials. If difficulty is present at the outset, or the working memory stage, the child will have difficulty recalling previously learned skills (i.e., the letter c in c-a-t has a certain sound) and thus decoding will be slower and effortful. Similar difficulty arises in spelling and in learning mathematics. For example, in mathematics the child needs to remember certain mathematics facts as well as when to utilize what procedure.

Executive functions are another skill that is important for the learning process. Executive functions are those skills that apply to the "how" something is accomplished rather than just the "what." These skills are also important in helping a child evaluate his/her performance. They also allow us to inhibit responding to irrelevant stimuli. The selection of what is important to encode is an important ability in learning to read, write, and do mathematics. In addition, a child needs to learn to listen to what he/she is reading (either orally or silently) and evaluate its correctness. This skill becomes more important in older grades as the child needs to be able to self-correct mistakes. The awareness of "how I'm doing" is crucial to the learning process and allows the child to change behaviors or to take corrective action as necessary. These skills do not come into full fruition until early adulthood and some would suggest not until one is 32 years of age do we have a fully mature brain (Denckla, 2003). Thus, an important issue to assessment would be to evaluate the child's ability to understand his/her thinking processes.

Identification Process

Remediation suggests that an understanding of the underlying processes in learning have been evaluated, either formally or informally. The three tier process suggested by Response to Intervention ties assessment and intervention for the tertiary level for those children requiring more specialized and intensive treatment. The first two tiers recommend screening with a tool that has been validated with continued monitoring if substantial progress has not been seen. However, the screening tool to be utilized is not defined nor even explained. This difficulty is reminiscent of the original definition of a learning disability that required a "significant discrepancy" but did not define what significant entailed. Such ambiguity has plagued this field and appears to be continuing.

The research base for learning disabilities has been complicated by difficulties with definitions. States vary in how learning disabilities are defined ranging from few criteria to very stringent. In Texas, for example, a child can be identified as learning disabled by a 16 point standard score point discrepancy while in Minnesota the discrepancy is more than 2 standard deviations. Moreover, a child who does not meet criteria for a learning disability in Texas but who shows at least an 8 point discrepancy from IQ is classified as dyslexic. Such unevenness of definitions makes it even harder to determine how to identify these children as well as how to set up appropriate interventions.

The RTI model suggests that for some children identification would not occur until they had failed and may deny services to those children clearly at risk. A full assessment would also not occur until after the child had repeatedly failed at some of the interventions. Although the goal to tie how the child responds to intervention has interesting possibilities, the difficulty lies in how this response to intervention is evaluated.

It is important to understand that the developing brain learns new information

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through a set of neuropsychological processes—these processes lay down new neural connections that once formed may be difficult to reteach. It is also important from a neuropsychological point of view to recall that the brain is most ready to learn these connections within certain points of time; namely from ages of 5 to 8 and for higher level thinking skills from the ages of 12-15 (Teeter & Semrud-Clikeman, 1997).

The longitudinal study of dyslexia by Shaywitz and Shaywitz (2003) found that poor readers who had compensated for their difficulties through remediation utilized brain areas that were different from those who continued to have difficulty reading. More importantly the children who showed compensation not only had higher verbal ability scores than those who did not, they also attended less disadvantaged schools. There was a control group that received the "usual" interventions and who showed very little improvement. By delaying intervention until failure it is possible that the compensated systems would not develop or develop as well as with younger children. The study of the time window when remediation is most effective has not been fully completed at this time.

Perhaps, the solution lies in developing appropriate screening instruments that can assist in isolating those children most at risk for later difficulties and tracking their progress carefully through the early school years. The three-tier system can easily utilize this procedure but there needs to be agreement as to what the most important aspects are that are evaluated and monitored early on.

Coupled with these concerns when developing a model for learning disabilities, is the suggestion that children with learning problems be provided instruction in the regular classroom until significant failure occurs. This model assumes that the regular education teacher has been taught the skills needed to not only identify children with learning problems, but also to devise an intervention to offset these difficulties. Most of the research has centered on children in kindergarten and first grade classrooms. There is very little empirical evidence that this program is appropriate for children at older ages. Prior to implementation of this program for all children it would be very appropriate to conduct studies with children in middle school and high school. In addition, it is important to be able to sort out variables such as attention and emotionality that may also be part and parcel of a reading problem.

University training programs provide training for regular education methods and perhaps these students are required to take one course in special education. This training certainly does not reflect the degree of expertise that the three-tiered model is requiring. My teaching of undergraduate, aspiring teachers find them woefully uninformed about the nature of learning disabilities let alone appropriate methods for intervention. These students are eager to understand the difficulties and devour lectures on brain differences in learning as well as what it is like to have a learning disability. In order for the laudable goal of introducing regular education to working with these children, it is necessary to provide additional education for these teachers as well as providing Master teachers to allow support. It is important to understand that children having difficulty with learning to read or complete mathematics problems will likely not benefit from "more of the same" but require an alternative methods of teaching to assist their learning. It is also important to understand the nature of learning. The link from neuropsychological processes to

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intervention has not yet been forged but the previous section on brain imaging suggests that there is much to understand about how we learn and then, hopefully, how to intervene appropriately.

Summary and Conclusions

Educational practice is at an exciting time in development. Not only have we evidence that children with dyslexia (and possibly other learning disabilities) have brain differences compared to control children, emerging data indicates that they respond relatively quickly to brain-based and comprehensive teaching approaches that have empirical support (Berninger, 2003). Additional findings indicate that the most effective interventions are those that involve systematic instruction that is explicit and continues *throughout* their school experience (Shaywitz, 2003). Moreover, the ability to predict response to intervention is best completed by neuropsychological measures of language and attention rather than the use of a discrepancy model (Stage et al., 2003). These findings support the use of a multi-method evaluation of skills required for successful reading. Strassner, Semrud-Clikeman, and Gerrard-Morris (2003) found that teachers have lower expectations of academic performance from children that have ADHD or learning problems. These expectations may, in turn, lead to less attention in the classroom and fewer appropriate interventions.

One of the most important conclusions from research is that for children with learning problems, learning is hard work. A corollary to this finding is that for their teachers, instruction is very hard work and requires an enormous amount of training and support. Prior to this point, much of the emphasis has been on a specific type of educational placement (resource and/or inclusion). However, it appears from the data from neuroimaging studies that we need to incorporate methods that are developed from scientifically supported instructional strategies and that we need to understand whether different types of interventions are interchangeable or work as efficiently for most children. Work on this aspect of learning disabilities has not been completed.

The definitional struggle that has characterized the field of learning disabilities is continuing. The important piece of this puzzle that has been missing in the debate is how do children respond to various interventions and can we match the intervention to the difficulty. We have several years of experience showing that the "usual" method of teaching reading works for most children with an adjustment (going from phonics to look-say, etc.) works for many children who cannot profit from a single method. What we have not fully discovered and what is now developing, is the ability to work with those children who have been defined as "treatment resistant;" that is, those children who do not seem to profit from either general approach. It is also not fully understood how these children may differ early on so that our intervention can occur before significant failure sets in.

We also need to improve our teacher training programs throughout the country. The pendulum in education appears to swing from one extreme to the next. We began instruction for special education in the 1970s with pull out programs. Then when these programs did not show as much improvement for these children, the field moved to putting the children back in the classroom and charging the regular education teacher with their education. When inclusion was first introduced, there was a great deal of angst in the regular education field as many teachers were not prepared to deal with children with various learning and emotional difficulties.

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The three-tier approach to intervention has much promise but again we need to prepare our teachers so that they are best able to identify the children that need a fuller evaluation of their abilities. Given the findings from the neuroimaging and neuropsychological fields of deficient performance on measures of working memory, processing speed, auditory processing ability, and executive functions, evaluation of these skills are necessary to determine the most appropriate program to fit the individual child's need. The danger with not paying attention to individual differences is that we will repeat the current practice of simple assessments to evaluate a very complex learning process.

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