Bridges® Science

The varied Bridges learning programs are designed to develop the cognitive abilities and perceptual skills that make all teaching and learning possible. Bridges applies brain science to raise student achievement, in turn contributing to comprehensive school reform while encouraging realignment of resources.

What We Can Cognize, We May Learn

Cognition is everything. A sample of our cognitive abilities includes –

- Memory
- Concept formation
- Rule following
- Process orientation
- Symbol decoding
- Context comprehension
- Comparison/contrast
- Deductive reasoning
- Inferencing

These are not 'all or nothing' abilities. Every student will develop all his/her cognition abilities to a lesser or greater degree, but each student may be expected to have a significant variability in the fitness and stamina of each different cognitive ability. Therefore, Bridges addresses the student's individual profile of weaker and stronger cognitive abilities so all students may maximize their mental powers *before* they encounter instruction that depends upon those very powers.

For 35 years, individual teachers have adapted Meeker & Meeker's SOI (Structure of Intellect) assessments and instructional materials to develop students' cognitive abilities on a pupil-by-pupil basis. This was mainly within gifted/talented programs – a paradox which implies that only the most able students should enhance their cognitive abilities. Now, faced with broad cognitive diversity in every classroom, teachers seek a group-based, site-managed SOI design that can develop age/developmental-level cognition in all students while dedicating the pupil-by-pupil approach to at-risk and special-needs students.

What We Can Perceive, We May Cognize

Perception is attentiveness. It is the basis of education. While 80 percent of what we perceive is visual information, our visual sense must be neurologically integrated with our auditory senses and the other three of our 'far senses,' those which respond to outside stimuli. Simultaneously, the brain, the spinal cord and the nerves – the whole Central Nervous System – must integrate the dozen or so 'near senses' that we neither direct nor feel, such as our senses of posture, balance and physical synchronization.

Each of our students' multiple senses – far *and* near senses – is a receiver tuned to a distinct feature of the 360-degree world around them. To cognize the classroom, students must present adequately developed perceptual skills to the task. Otherwise, cognition may be impeded by eyestrain, shallow depth perception, phonemic confusion, or poor visual or auditory concentration; and/or clumsiness, hesitation, withdrawal, messiness, disorganization, or perfunctory engagement.

Perceptual dysfunctions are often silent or invisible impairments. Intervention should prevent students from failing to reach their potential – from diluting instructional efforts – from diminishing overall campus performance – from distracting the classroom – from damaging the learning and teaching environment for everybody.

Research & Development

The foundation of the Bridges programs is Dr. Mary Meeker & Dr. Robert Meeker's SOI (Structure of Intellect) model and instruments. These are founded on the work of Dr. J.P. Guilford (PhD, Cornell University). In military research, Dr. Guilford first proved that the human intellect is a structure of multiple intelligences, each of which could be assessed independently from the others (Guilford, 1956).

Brain Plasticity

In the late 1970s and 1980s, models and techniques for improving the intelligences of children essentially demonstrated that intelligence is *plastic* and, thus, can be affected by cognitive skills training. For example, Anastasi (1988) found a number of well-designed, high-quality early childhood programs able to positively shape learning abilities of educationally disadvantaged children by means of targeted training in specific cognitive abilities: "Findings of this type of research point the way to . . . the type of intervention programs that can alter the course of intellectual development in the desired directions" (p. 341). This is the thrust of ongoing work within Harvard's Project Zero by Dr. David Perkins (1995).

A child's brain will already have grown to nearly its adult size before he/she enters school. Brain tissue is not a single organ, but different substructures that develop at different times through at least age 15 (Thompson et al., 2000). Dr. Marian Cleeves Diamond is widely credited with originating this line of study, in seminal research on brain plasticity in the 1960s (e.g., Diamond, 1998). All told, the body of evidence for the brain's ability to change physically, according to the way it is used, should have important implications for parents, teachers, clinicians and scientists. Instruction in broad cognitive skills has as its goal the development of widely applicable intellectual skills, work habits and problem-solving strategies. The effects of this type of training have been demonstrated in both test scores and in criterion performances with a broad range of students.

Teaching the Ability to Learn

Dr. Guilford's doctoral student, Dr. Mary Meeker (Ed.D., University of Southern California) refined his "structure of intellect" measure and applied it directly to K-12 learning by developing instructional materials to strengthen specific areas of cognitive or perceptual weakness (M. Meeker, 1969). In her model, intelligences, like physical abilities, can be exercised and developed through cognitive and perceptual exercises. She asserts: "Teaching the ability to learn should be considered equally as important a goal as is a mastery of prescribed content." If students do not have the requisite skills needed for learning curricular content, regardless of what intelligences such content might involve, attempts to remediate content deficiencies are likely futile. In contrast, SOI and Bridges provide skill-development activities to improve the student's cognitive abilities across content areas. Once students develop these skills, teachers can then approach the essential skills of education confident in their students' abilities to learn challenging material. These learning skills will then become the basis for lifelong tools for mastering any learning task.

Perceiving & Comprehending

As of about 15 years ago, teachers began seeking a group-based, site-managed SOI design to develop age/developmentally-appropriate cognition in all students. Faced with sweeping cognitive diversity in every classroom, teachers sought to apply the modern 'brain science' popularized by such as Sousa (1997) and Hart (1999), which has invoked CAT scans, MRIs and other neuroscientific evidence to espouse classroom reforms first proposed by Dr. Mary Meeker in the early 1960s.

Also about 15 years ago, Dr. Robert Meeker joined Dr. Mary Meeker in creating their IPP (Individualized Practice Protocol) method and materials, whereby educators may remediate certain perceptual and motor dysfunctions that often impair students' abilities in Comprehension – the most basic mental operation in the SOI model (i.e., attention, concentration, focus, mindfulness). Whereas SOI develops the cognitive dimension of Comprehension, IPP develops its perceptual and psychomotor dimensions that, in turn, enable the cognitive dimension. IPP does so by assessing and developing Sensory Integration (see page 4) and Visual Processing (see page 6). IPP's Auditory Processing component was released in 2002 to develop the brain's ability to work with what the ears hear.

Building Bridges

Meeker & Meeker's IPP methodology is based on contemporary neuroscientific research. McCall, Appelbaum & Hogarty (1973) found a major condition associated with increases in the child's intelligence was the extent to which caregivers deliberately trained him/her in various cognitive abilities and sensory integration skills prior to those skills being essential for him/her. Such findings were concurrent with the pioneering of work of Ayres, who wrote on the theory and remediation of sensory integration dysfunctions for special educators and therapists (Ayres, 1973) and for teachers and parents (Ayres, 1979). In the next decade, Ornstein & Thompson (1984) and Gazzaniga (1989) established that, among low-

achievers, a commonly shared factor is underdeveloped cognitive abilities and sensory integration skills, which prevent the students from 'learning how to learn.'

Mueller (1991) demonstrated how sensory integration skills impact the student's reading, spelling, memorization and handwriting. Recently, Hannaford (1995) has made an excellent case for sensory integration's model of learning disorders: the brain's management of neural activity is what produces the higher-order cognition that we recognize as 'learning.' Indeed, it appears likely that developed sensory integration skills are what enable the student's abilities critical to learning.

The most comprehensive and effective schoolwide application of the SOI model was the result of a "School of the 21st Century" grant in the state of Washington. Fidalgo Elementary School incorporated a system of SOI cognitive assessment and individualized abilities training in every classroom, with Meeker & Meeker's IPP remediation of perceptual and sensory integration dysfunctions for selected students. Over the course of the six-year grant, the program achieved significant and sustained growth in academic achievement, and produced corresponding evidence of intellectual growth in the student population by measurements on standard IQ tests. Meeker & Meeker served as consultants to the Fidalgo program, which was lauded by the *The New York Times* as one of the seven most promising innovations in education since the 1990's.

Subsequently, Meeker & Meeker created a schoolwide design incorporating the successful elements of the Fidalgo scheme, but restructured to fit the realities of schools without long-term grants. Together with Diane Hochstein – now the Chief Education Officer for Bridges LearningSystems – they produced the design that is now the basis of the Bridges programs, which develop age-appropriate cognition and perception in all students, centrally managed within each school. Unlike the original SOI model, Bridges includes the crucial IPP component. Whereas SOI develops the cognitive dimension of comprehension, IPP develops its perceptual and sensory integration dimensions. Further, Bridges includes program evaluation, support services, and structured staff development.

Effects of the Bridges programs on school management are pervasive. When students actively engage in learning, discipline problems decrease markedly. Bridges schools report decreases in discipline referrals and an educational climate more conducive to learning. Because academically challenged students require much more attention than the typical classroom can handle, and because they are often too difficult to manage in a group, Bridges provides individualization for the most challenged students in the Bridges Lab, a learning-center setting, freeing the regular classroom teacher to provide higher level instruction to the less-challenged students. Once these students can learn to learn effectively, they can be successfully reintegrated into the classroom, ameliorating the challenges they once presented to the regular classroom teacher.

Sensory Integration

Research into Sensory Integration is ongoing, so our knowledge about it may change in the future. Still, we know that children usually develop optimum Sensory Integration by toddling the ways that toddlers toddle. Yet 12 to 30 percent of students have Sensory Integration dysfunction that is so great as to necessitate intervention (Kranowitz, 1998, p. 25)

Seventeen Senses?

Since the time we were school children ourselves, we've been able to recite the names of our five senses and to direct our concentration to attend to each of them. "These are sometimes called the 'far senses' because they respond to external stimuli that come from outside our bodies" (Kranowitz, 1998, p. 39). Yet, even before the time our youngest students entered Kindergarten, modern brain science had established there are additional senses that are critical to students and teachers alike.

- Some of these additional senses are refinements of the five Far Senses, such as color vision and temperature awareness.
- Others are among the 'Near Senses' (Kranowitz, 1998, p. 40) – sensory capacities that we neither direct nor feel. Examples include perceiving pheromones and synchronizing body rhythms to the movements of the sun (which partially explains jet-lag). Indeed, the Near Senses may be so unusual to our thinking that they seem baffling!

How many senses are there? "Five was obviously just not enough to account for the huge range of sensory possibilities of which the human species is capable; seventeen is probably a more accurate count" (Rivlin & Gravelle, 1984, p. 17).

Each of our multiple senses – the Far Senses and the Near Senses – is a receiver tuned to a distinct feature of the 360-degree world around us.

What is Sensory Integration?

Sensory Integration is the subliminal process by which we merge and organize the information received from each and every sense into one cohesive mental picture of the natural environment – who we are, where we are, what we're doing, what else is happening. The field was established by Dr. A. Jean Ayres, based on earlier investigations by Dr. Marianne Frostig. Ayres, in her germinal study *Sensory Integration and the Child* (1979), defines Sensory Integration as "the organization of sensory input for use. The 'use' may be a perception of the body or the world, or an adaptive response, or a learning process, or the development of some neural function" (p. 184). Sensory Integration occurs in the brain, the spinal cord and the nerves – the whole Central Nervous System. When adults have a Sensory Integration dysfunction, it may affect some activities, but most adults have taught themselves compensatory work-arounds.

When students have a Sensory Integration dysfunction, it may affect almost all activities, because students cannot learn in the ways that teachers expect. Sensory Integration dysfunction can be so subtle that it goes unrecognized. Particularly in children, it is easy to attribute it to other causes – *"He's always been stubborn." "She's lazy." "He's not trying." "She's so clumsy."*

It is imperative to screen and develop Sensory Integration functioning. Otherwise, the child may never function at his/her optimum level.

Developing Near Senses & Sensory Integration

Of our many senses, some have a **direct impact on classroom success.** Sensory Integration screening and development seeks to strengthen and consolidate particular Near Senses.

Vestibular Processing is our sense of posture and balance, and whether objects around us are in motion or at rest. It contributes to attention and a stable visual field, verbal comprehension and speech. It is foundational for all activities where the student's body must be 'centered' to the task.

Proprioception is our sense of our body's position in space. In tandem with the Vestibular system, it helps us move and synchronize our body parts, limbs and extremities, such as to sit upright and hold the head erect. It is critical for bodily well-being, which empowers emotional and mental well-being.

Bilateral Coordination is our sense of organizing the two hemispheres of our brain with our two feet, legs, arms, hands and eyes. It starts from well-regulated Vestibular Processing, separately, on our two sides of the 'midline' of the body. It empowers development of many gross- and fine-motor skills and is the foundation for tool use.

Praxis (or Motor Planning) is our sense of synchronized physical performance. It is our primal stage in learning new skills and introduces us to novel physical experiences, whose mastery further synchronizes our planning, organizing, sequencing, timing and execution of unfamiliar movements.

Fine Motor Coordination is our sense of control over our hands, fingers and thumbs, as in handwriting; and our oral muscles, tongue and lips, as in oral language activities. It culminates in Hand Dominance, and then Tool Control, of pencils, brushes, rulers, scissors, etc.

From Movement to Creativity & Reasoning

Sensory Integration screening and development should strengthen and consolidate particular Near Senses. Results of an intake Sensory Integration screening should be combined with the student's scores on an intake assessment of multiple intellectual abilities, for analysis by expert Sensory Integration practitioners or else 'expert system' software that automates their expertise. Such analysis should result in an individualized plan of low-impact physical activities that promote the student's Near Senses and Sensory Integration.

Classroom performance can only improve when Sensory Integration is structured into the experience of the student. Developmental programs nurture the capacity for the brain, spinal cord and nervous system to accurately process all information received from all senses – all seventeen senses. Development is stimulated by physical activities that require just enough floor space for each student to move in place in disciplined sequences. Other activities require balance boards and rebounders for more practicing precise body postures and movements. "Each movement becomes a vital link to learning and thought processing. Just as with our sensory systems, all of us must develop our own elaborate

nerve networks of movement patterns, an 'action encyclopedia.' Thinking is a response to our physical world" (Hannaford, 1995, p. 107).

Visual Processing

Science values the human eyes as being exceptionally refined nerve endings linked directly to the brain. The magnitude of Visual Processing for learning is that about 80 percent of the information that reaches us comes through our eyes (Seiderman & Marcus, 1989, p. 6).

Eyesight vs. Vision

What is the difference between eyesight and vision?

- **Eyesight** concerns the physical shape of the eyeball and its medical health. Perfect eyesight is measured as 20/20 on the Snellen Chart, which is the chart with the large **E**. This measurement dates back to the mid-1850s, to find out if a child could read from 20 feet when the few children who did attend school didn't have textbooks, but just followed the teacher's writing on a blackboard.
- **Vision** is the brain's learned response to messages perceived by the eyes. Each eye sends the brain 1,000,000,000 messages every second, so the brain's ability to process that input is at least as important as the health and shape of the eyeball. Especially important is the student's ability to read from 20 inches – from books, computer screens and the hand-held devices of the 21st century. This ability is known as *near-point vision.*

Students with underdeveloped near-point vision become at-risk learners whenever they are assigned extended reading, writing or other typical learning tasks. Common near-point Visual Processing problems include eyestrain, poor visual concentration, narrow peripheral vision, shallow depth perception, slow visual reaction time and difficulty tracking the eyes left to right and top to bottom. Such vision problems are addressable by trained educators, using exercises that develop the cognitive, perceptual and motor aspects of vision.

Developing Visual Processing

"In 1958 my brother applied for admission into the Naval Academy but was sent back because his vision was not perfect. However, they said he could reapply if his vision improved, and they gave him eye exercises to develop more visual acuity. A month later he passed the entrance eye exam. The exercises had trained his eye muscles and his brain's visual circuits." In this recollection of neuropsychiatrist Dr. John J. Ratey (2001, p. 56) we grasp the potential in developing one's Visual Processing.

Like other 'brain training,' Vision Processing development restructures neural circuits and pathways. Because neuroscientists and specialist eye doctors cannot be professional educators, and educators, in turn, cannot be neuroscientists or specialist eye doctors, in-school development of Visual Processing can provide a common meeting ground for these professions.

Early expertise in developing Visual Processing was established by many authorities, including pediatrician Dr. Arnold Gesell (e.g., 1949) and occupational therapist Dr. Marianne Frostig (e.g., Frostig & Horne, 1964). It was popularized by optometrist Dr. Arthur S. Seiderman (e.g., Seiderman & Marcus, 1989).

Vision Processing development is indicated for students who have not developed what cognitive scientist Dr. Donald D. Hoffman (1998, p. 13) expects as normal vision: "Kids aren't taught how to see. Parents don't sit down with their kids and explain how to use motion and stereo to construct depth, or how to carve the visual world into objects and actions. …And yet it appears that each normal child comes to construct visual depth, shape, colors, objects, and actions petty much the same way as any other normal child."

Screening & Development

The greater part of all classroom tasks require the student to mind what the eyes carry to the brain. The screening and development of Visual Processing seeks to enhance particular physical and perceptual abilities.

- **Reading Distance** assesses the student's reading-distance eyesight, for which 'perfect' is 20/20. A student with eyesight impaired more than 20/40 should be referred to an optometrist or vision therapist.

- **Targeting an Object** is a critical function for good reading skills. It requires the eyes to move quickly and accurately from one point to another, which comprises most eye movements in reading. A deficiency in this area will cause excessive re-reading, especially at the beginning of each line of words or numbers.
- **Moving across the Page** should be subconscious, smooth and without excessive head movement. Even when eyesight is 20/20, a vision dysfunction may be revealed by jerky eye movements, excessive head movements, fatigue and general clumsiness – leading to poor reading comprehension and short attention span.
- **Aiming at the Target** requires coordinated movement and alignment of both eyes inward for an object held close – e.g., looking at a book – and outward to a distant object from a near one – e.g., looking up to the blackboard. Dysfunction in this area can cause double vision or cause the student to feel severe eyestrain, or lose his or her place when reading.
- **Shifting between Seat Work and Board Work** is the re-focusing ability that adjusts for the proximity of the target. Students with impairments here may experience 'print blur' when they read or see momentary distortion when looking from the blackboard to the paper. Eyestrain and fatigue are other consequences.
- **Teaming** is when the two eyes work in unison. Under certain conditions, one eye may not be used at the same time as the other; e.g., the brain, in effect, shuts off its attention to one eyeball so that it stops moving in unison with the other. This condition typifies a very inefficient visual system.

From Vision to Insight

Classroom achievement involves satisfactory Visual Processing. Results of intake Visual Processing screening should be combined with the student's scores on an intake assessment of multiple intellectual abilities, for analysis by expert Visual Processing practitioners or else 'expert system' software that automates their expertise. Such analysis should individualize visual and visual-motor activities, perhaps requiring just enough floor space for each student to move in place or on a balance board or rebounder. "There is no such thing as a *pure* perception of an object within a sensory channel, for instance, vision," states neurologist Dr. Antonio Damasio (1999, p. 147); "To perceive an object, visually or otherwise, the organism requires both specialized sensory signals *and* signals from the adjustment of the body, which are necessary for perception to occur."

Auditory Processing

Second to Visual Processing, Auditory Processing enables students to participate in classroom learning. Specifically in learning to read and reading to learn, the criticality of Auditory Processing has been established by the National Reading Panel (National Institute of Child Health and Human Development, 2000, p.2-3): "Teaching children to manipulate phonemes in words [is] highly effective across all literacy domains and outcomes."

Phonemic Awareness

Reading depends upon phonemic awareness, which is recognized as the auditory skill of comprehending and producing *phonemes,* the discrete sounds that comprise words. Each spoken word comprises one or more phonemes; e.g., the sounds /j/, /ɛ/ and /s/ in the word *yes.* A phoneme is the smallest phonetic unit. It is the basis of phonics.

Phonemic awareness is not the only ability enabling reading fluency, but it is an essential first step. The National Reading Panel found that well-developed phonemic awareness significantly increases performance in reading and spelling – and classroom listening.

Classroom Listening

Background noise makes it a challenge to comprehend phonemes. Environmental sounds combine with spoken phonemes, seeming to be new noises with little meaning. Students may exhibit poor phonemic awareness while testing for acceptable hearing.

Accordingly, auditory skills development must focus on classroom listening that includes reading readiness, not merely pre-phonics. So listening exercises with background noise are necessary to develop auditory performance with competing acoustic signals.

Auditory interventions should be scientifically based and systematic. Auditory Processing assessments and exercises should increase actual perceptual skills.

- **Auditory Comprehension of Figural Units** is the ability to discriminate discrete phonemes and discriminate them from other single sounds.
- **Auditory Comprehension of Figural Units with Background Noise** is the ability to selectively attend to discrete phonemes and other single sounds in the auditory foreground from noise in the background.
- **Auditory Comprehension of Semantic Systems** is the ability to comprehend structured verbal information.
- **Auditory Memory for Figural Units** is the ability to recall from working memory alphanumeric characters and other graphical information or details.
- **Judgment about Auditory Units** is the ability to discriminate between similar sounds (*ba* vs. *pa*), similar vowel sounds (*a* in *bag* vs. *beg*), segmenting words into phonemes, and blending phonemes into words.
- **Judgment about Auditory Units with Background Noise** is the ability to selectively attend to discrete sounds in the auditory foreground and discriminate them from noise in the background.

When the Brain Can't Hear

"Hearing without listening" may be the best definition of an Auditory Processing deficit. Adequate levels of hearing acuity may coexist with under-developed Auditory Processing. Audiologist Dr. Nancy A. Stecker (2002, pp. 4-6) includes students who "have difficulty keeping with the flow of communication, have poor phonemic skills, are slow responders, often have articulation errors (especially with /r/ and /l/), have difficulty following directions, and have weak oral reading and spellings skills. . . . [or] have poor reading comprehension skills and handwriting due to poor motor planning, have short attention spans, and are easily distracted."

Students with Auditory Processing deficits are helpless in the face of the unending stream of verbal content in the classroom. "I forgot" or "What?" responses cause adults to suspect a lack of interest, attention, intelligence, motivation, cooperation, or all of them. Confusion is more common than comprehension. Performance in all content areas – not just reading – is undermined.

The Listening Brain

Auditory Processing intake scores, when analyzed with cognitive intake scores, indicate individualized regimens of auditory skill-building exercises. More efficient processing of auditory information leads to improved comprehension – of the written word as well as the classroom environment.

The scientific basis for Auditory Processing development is found, says Audiologist Dr. Terri James Bellis (2002, p. 262), in "recent research into neuroplasticity – the ability of the brain to change, reorganize, and make new and stronger connections in response to the presence or absence of stimulation. . . . **Auditory training – therapy activities to develop listening skills – can, likewise, result in positive structural and functional changes of the central auditory pathways**."

Students previously making little or no progress in language arts may achieve reading fluency and spelling mastery. Overcoming persistent verbal problems, students are spared psychological/behavioral harm that affects them in and out of school.

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For the 2002-2003 school year, Bridges is available to more than 250,000 students in 26 states. It is a service of Bridges LearningSystems, Inc., based in Annapolis, Md., and founded in 1996 by former U.S. Senator and Secretary of Labor William E. Brock. For further information on Bridges products and services, including details on the many Bridges offerings, visit the Bridges website, ***www.bridgeslearning.com****, or call us directly at* ***800-639-4423****.*

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