

TUTORIAL: SLOW INFORMATION PROCESSING

WHAT IS SLOW INFORMATION PROCESSING?

Speed of information refers to how quickly students can react to incoming information, understand it, and think about the information, formulate a response, and execute that response. Speed of information processing is not the same as intelligence. It is possible to be very bright, yet process information slowly. Similarly, speed of information processing is not the same as physical quickness. It is possible to have complete physical recovery and yet process information slowly.

Speed of information processing is influenced by a variety of factors. Neurologically, speed is affected by neurotransmitters in the brain and their balance, by the fatty covering of neurons (myelin) that speeds transmission, by the size of synaptic spaces (unusually large synaptic gaps slowing information processing), by the organization of neural networks that support a concept or procedure, and by the efficiency of the frontal lobes in organizing and directing information flow. A person with slowed information processing may also be physically slow, for example with slow speech production or slowed arm and leg movements. However, it is possible to have intact physical movements that are normally fast, but nevertheless to process information slowly.

Speed is also affected by knowledge and experience. The more a person knows about a topic, the easier it is to process new information about that topic quickly. The more experience a person has with a phenomenon, the easier it is to react and think quickly. For example, children and adults alike playing a new game – board game, card game, video game, or sport – take a great deal of time to do what takes very little time once the game is mastered. Similarly, foreign languages that one does not know seem to be spoken very rapidly. But once the language is mastered, it seems to slow down. Therefore, “familiarity with the game”, including thorough familiarity with routines in school and increasing content knowledge, is very important for individuals who process information slowly.

WHY IS SLOW INFORMATION PROCESSING IMPORTANT FOR MANY STUDENTS AFTER TBI?

From a neurologic perspective, generally slowed information processing can be a consequence of widespread diffuse axonal injury (DAI), frontal lobe injury, damage in any of the circuits that support storage and retrieval of information, or damage to multiple sites in the brain. **[See: Tutorials on Diffuse Axonal Injury; Frontal Lobe Injury]** Furthermore, a variety of medications, including anti-convulsants, can slow information processing. DAI, which is common in closed head injury, has been strongly linked to slow information processing. DAI results in shearing of white matter pathways in subcortical brain regions. These pathways are often important linkages between cortical areas. Damage to these pathways therefore interferes with interconnections within the brain, thereby slowing all types of complex information processing. Significant amounts of DAI may be manifest as enlarged ventricles on images of the brain (e.g., CT or MRI scans).

From a cognitive perspective, students with TBI may respond slowly as a result of difficulty controlling attention, inefficient access to stored knowledge and skills, or breakdowns in the systems that support organized thinking and processing. Furthermore, impaired self-regulation (or executive dysfunctions) can result in slowed processing because of weak control over attention, organization, memory, and other cognitive processes. All of these possible causes of slowed processing are commonly seen in students with TBI; therefore, slowed processing is a common phenomenon and should be anticipated. Slowed processing can also be a consequence of mild TBI.

Conversely, slow processing can underlie problems that may be identified as attention, memory, organization, language, or executive function problems. For example, slowed processing is known to result in difficulties on shifting and dividing attention tasks, on memory and retrieval tasks, on tasks that require cognitive flexibility, and on problem-solving tasks.

From an emotional perspective, slow processing can be a consequence of depression or anxiety, or simply a focus on unrelated issues as a result of emotional struggles.

Slowed processing can generally be observed in all types of tasks, particularly those that are cognitively demanding (e.g., academic tasks in school; social activities like chatting with peers). However, when tasks or activities become increasingly routine or automatic, even slow processors of information may appear to be unimpaired. For example, a student who normally processes information slowly may repeatedly practice a video game to the point at which he plays the game at normal speed. Because slow processing has a lesser effect when tasks are routine, instructional activities should become as routine or automatic as possible for students with TBI. **(See: Tutorial on Instructional Routines.)**

It is additionally important to understand slowed information processing because it is easily misunderstood as a behavior problem. For example, students who do not respond to teachers' questions or instructions within a usual time frame may be considered defiant or manipulative. Alternatively, teachers may interpret their behavior as attention seeking.

WHAT ARE THE MAIN THEMES IN INSTRUCTION AND SUPPORT FOR STUDENTS WHO ARE SLOW PROCESSORS OF INFORMATION AFTER TBI?

Understanding the Problem

As always, the first task for teachers and parents is to correctly understand the problem. Slow processing can easily be misidentified as a behavioral problem, an emotional problem, or a specific cognitive problem. In most cases, slow processing interacts with these other areas of functioning in complex ways. But it is important to recognize the role played by slow processing and to implement intervention and support strategies specifically designed to address slow processing.

If processing is slowed as a result of medications, consultation with the prescribing physician might be needed to arrive at the best balance between pharmacologic effectiveness and processing efficiency.

Accommodations and Environmental Supports

1. Well established and understood daily routines: Students who process information slowly should thoroughly understand the sequence of activities that comprise their daily routines at home and at school. If they also have organizational or memory impairments, the daily routine should be graphically represented (e.g., a sequence of photographs, drawings, or written outline) for easy viewing and understanding. **[See Tutorial on Organization]** The greater the routine or automaticity of activities, the easier it is for slow students to keep up.

2. Well understood instructional routines: Teachers should ensure that all components of the instructional routine are well understood – that is, become “background information” – so that the student’s limited processing resources can focus on the new, to-be-learned information. **[See Tutorial on Instructional Routines]** Again, tasks that are “routinized” or “automatized” help students with processing speed impairments perform best.

3. A pace of instruction and interaction that is as rapid as the student can process: It might seem natural to slow the pace of instruction and interaction for students who process information slowly. In some cases, this slowing is necessary. In every case, the pace should be no faster than the student can tolerate and there should be appropriate pauses between the presentation of separate units of information. However, slowing the pace too much may result in difficulty maintaining attention and certainly results in fewer learning trials. If the instructional routine is well understood, the pace of instruction may be increased to ensure continued attention to task. This may require some experimentation with the student. **[See Instructional Pacing]**

4. Organizational supports: Students who process information slowly often have organizational problems as well – or in some cases the organizational problems are a cause of the slowness. **[See Tutorial on Organization]** These organizational problems are often more serious than they appear on the surface to be. Therefore, students usually benefit from advance organizational support. Advance organizers can be as simple as a checklist or outline of a task. Often the advance organizer is a graphic organizer for the task (e.g., a series of photographs that indicate the sequence of an activity; a series of boxes and connecting arrows depicting the key elements of a story and their organization). In some cases the organizer can be as explicit as a series of photos of the student moving through the steps of the task.

5. Nonverbal supports: Spoken language may be experienced as coming too fast for students who process information slowly. Even when teachers do not speak rapidly, students must be able to process the spoken language quickly in order to comprehend what the teacher says. Therefore it may be critical to repeat information and provide nonverbal supports to help the student comprehend. Nonverbal supports can include pictures, symbols, written words, written outlines, gestures, and the like.

6. Verification of student comprehension: Teachers and parents should verify that students have understood instructions or other information before proceeding to new information. Verification may include asking the student to repeat instructions or summarize new information.

7. Peer support: Students who process information slowly sometimes benefit from peer buddies or cooperative learning groups in which other students may take responsibility for some aspects of the academic tasks.

Interventions for the Student

There is no specific training program designed to improve processing speed across all domains if content if speed is negatively affected by diffuse axonal injury. Interventions are directed at addressing co-existing problems that may be making the processing speed worse or teaching the student how to advocate for himself.

1. Other primary problems: If information processing is slow because of attention problems, organization problems, memory problems, or other cognitive problems, staff and family should use intervention and support procedures that target the underlying problem. **[See Tutorials on Attention, Organization, Memory]**

2. Automatic routines: As routines become more and more automatic, speed of processing can increase. Thus there is a great advantage in automatizing routines for individuals who process information slowly. This includes routines of everyday living at home, instructional routines at school, social routines, and the like.

4. Content knowledge: The more students know in a domain of knowledge, the easier it is to process new information in that domain. Therefore, basic teaching of content knowledge can be understood as an intervention for individuals who process information slowly.

5. Request for help: Students who process information slowly should be taught to advocate for themselves, possibly saying with confidence and comfort, “Could you slow that down please? I need time” or “Could you repeat that for me please?” (or words to that effect). Students might also be taught to ask for organizational supports.

6. Additional time to complete tasks: Students who process information slowly and work slowly need additional time to complete tasks. They should be encourage to create a habit of starting assignments and projects early so that they do not get rushed to complete the task. They may need to advocate for additional time to complete timed tasks. Rushing will only increase errors for the student.