CHC Cognitive Abilities and Learning Differences in Computer Science

Broad Cognitive Ability	**Narrow Cognitive Abilities**	**Description**	**Examples in CS**	**Potential Challenges in CS**	**Associated Learning Differences**
Fluid Intelligence	*Induction, sequential reasoning, quantitative reasoning*	Determining the underlying concept/process in a problem; noticing patterns and relationships; starting with defined rules/conditions and taking steps to find a solution	Developing an idea for a program that achieves a certain goal	*Sequencing, cause and effect, pattern recognition, formal logic, understanding and using algorithmic structures, complex reasoning, problem-solving, big-picture thinking*	Dyscalculia, dyslexia, intellectual disability, nonverbal learning disorder
Short-term Memory	*Memory span, working memory*	Remembering the order of steps or ideas after they are presented; temporarily storing and manipulating information	Copying and modifying syntax from a reference sheet	*Following directions, remembering the order of steps in a solution, holding an algorithm in memory while translating it to code, keeping track of variables and functions*	ADHD, auditory processing disorder
Long-term Storage & Retrieval	*Meaningful memory, associational fluency, alternative solution fluency, originality & creativity, ideational fluency*	Creative use of stored knowledge; generating relevant ideas, responses, or solutions	Adapting a previously-learned structure (e.g., loops) to use in a new context	*Learning new concepts and terminology, applying existing skills in the novel context of CS, applying newly learned concepts to problems/tasks, generating possible solutions, synthesizing multiple concepts/facts*	ADHD, intellectual disability, speech & language impairment
Executive Function*	*Decision making, planning & organizing, task initiation & completion, self-monitoring, coping with frustration, metacognition (awareness of one's own thought processes)*		Persisting in solving a sticky bug	*Getting started, staying on-task, having realistic self-expectations and goals, debugging*	ADHD, intellectual disability

**Not a CHC cognitive ability.*

Broad Cognitive Ability	**Narrow Cognitive Abilities**	**Description**	**Examples in CS**	**Potential Challenges in CS**	**Associated Learning Differences**
Crystallized Intelligence	*General information, language development, vocabulary, listening & communication ability*	Using general (cultural) knowledge; fluency with language; communicating ideas	Learning and using CS terms; formulating questions	*Sensory perception, sustained focus/concentration, debugging*	ADHD, auditory processing disorder, dyscalculia, dyslexia, intellectual disability, nonverbal learning disorder, speech & language impairment
Reading & Writing	*Reading decoding & comprehension, writing ability, etc.*	Facility with reading and writing, understanding written information, putting thoughts into writing	Interpreting written instructions for a task	*Understanding tasks or instructions, communicating with classmates, expressing confusion or asking for help, formulating an algorithm or explanation, learning technical vocabulary*	Dysgraphia, dyslexia, intellectual disability, speech & language impairment
Processing Speed	*Perceptual speed, rate of test taking, reading & writing fluency*	Fluency in repetitive tasks; attention, efficiency, and accuracy in simple tasks	Using correct syntax in a long list of strings	*Understanding written information or instructions, notetaking, comprehending and writing code, interpreting error messages*	ADHD, dysgraphia, dyslexia, intellectual disability, speech & language impairment
Decision/ Reaction Time or Speed	*Semantic processing speed, mental comparison speed, inspection time*	Mental manipulation and recognition of details and differences between items	Identifying typos and syntax errors	*Comprehending code, debugging*	ADHD, dyscalculia, intellectual disability, nonverbal learning disorder

Adapted from E. Wald, "Instructional Strategies for Teaching Computational Thinking to K-12 Students with Learning Differences" (2021), Table 3.