The basic processing mechanism of the first route comprises two processors: verbal and spatial. These two processors should be normally distributed, uncorrelated with each other, and have their own unique explanatory powers.

In contrast, the second route for acquiring knowledge in Anderson’s model is related to dedicated information processing modules. Such modules consist of the perception of three-dimensional space, syntactic parsing, phonological encoding, and theory of mind. It is this route that is linked to cognitive development as these modules undergo developmental changes in cognitive competence across the life span. Anderson (2005) argues that modular processes can be acquired through extensive practice, but that the common features of both acquired and innate modules are that they operate automatically and independently of the first route and thus are not constrained by central processing mechanisms.

The modular component of Anderson’s cognitive theory is intended to allow a reconciliation between Gardner’s MI Theory and notions of a general intelligence by acknowledging the importance of domain-specific abilities as well as a central basic processing mechanism. Furthermore, Anderson believes his theory explains how low-IQ individuals can nonetheless be capable of remarkable feats and how various developmental and learning differences such as dyslexia and autism can occur in the presence of an average or even high IQ (Anderson, 2008).

S. B. Kaufman (2011) has questioned Anderson’s notion that there are few meaningful individual differences in route 2. Furthermore, S. B. Kaufman notes that Anderson does not propose more than just processing speed as a central mechanism and does not propose any domain-general learning mechanisms (e.g., implicit learning, latent inhibition) underlying route 2, focusing instead on the Fodorian definition of modules. S. B. Kaufman argues that by focusing on individual differences in processing speed as underlying one information processing route, and species-typical cognitive modules with minimal individual differences underlying the other processing route, Anderson’s model unnecessarily restricts the number of cognitive mechanisms that can be investigated within each information processing route.

**Dual-Process Theory**

The Dual-Process (DP) theory of human intelligence (Davidson & Kemp, 2011; S. B. Kaufman, 2009, 2011, 2013) incorporates modern dual-process theories of cognition (see Epstein, 1994; Evans, 2008, 2010; Evans & Frankish, 2009; Kahneman, 2011; Kahneman & Frederick, 2002, 2005; Stanovich, 2004, 2011—but also see Keren & Schuit, 2009; Kruglanski & Grigerezner, 2011; Osman, 2004) into a theory of human intelligence. By doing so, the Dual-Process theory organizes many constructs relating to both explicit and implicit cognition that are at least partially separable and are meaningfully related to a wide range of socially valued intelligent behaviors. In particular, performance across a wide range of intelligent behaviors—across the arts and sciences—are predicted by a hierarchical structure of goal-directed and spontaneous cognitive processes. Goal-directed processes consume limited attentional resources, whereas spontaneous processes are not dependent on input from higher-level control processes (see Stanovich & Toplak, 2012).

The theory has a few key tenets. The first tenet is that there are meaningful and adaptive individual differences in both goal-directed and spontaneous cognitive processes. The second tenet is that both goal-directed and spontaneous cognitive processes jointly determine all intelligent behaviors, although in varying degrees depending on the behavior. A third tenet is that neither mode of thought is more “intelligent” than any other across the board, but what is important is the ability to flexibly switch mode of thought depending on the situation (for applications of this idea to creativity, see Gabora, 2003, 2010; Gabora & S. B. Kaufman, 2010; Howard-Jones & Murray, 2003; Martindale, 1995, 2010; Vartanian, 2009). A fourth tenet is that there are many different paths to the same intelligent behavior, with different people drawing on a different mix of cognitive traits to reach the same outcome. Finally, abilities are not conceptualized as static entities, but are seen as constantly changing through the life span as the individual continually engages with the world. This is where passion and inspiration comes into play (see Thrash & Elliot, 2003; Vallerand et al., 2003). The more one engages in a mode of thought, the more that individual will develop skills in that modality, which in turn increases the desire for engaging with that skill.

Goal-directed cognition is at the top of the hierarchy (alongside spontaneous cognition). Goal-directed cognition consists of a class of cognitive processes that involve the ability and tendency across situations to think about thinking (i.e., metacognition—see Dennett, 1992; Hertzog
& Robinson, 2005), reflect on prior behavior, and use that information to modify behavior and plan for the future. Constructs that are part of the controlled cognition hierarchy include reflective engagement, self-regulation, self-control, perseverance, long-term planning, dissociable components of executive functioning—working memory, cognitive and affective inhibition, and mental flexibility—explicit cognitive ability (the skill set that lies at the heart of highly g-loaded tasks), intellectual engagement, and elementary cognitive tasks that support explicit cognitive ability. What links all of the processes together is that they all draw on a limited pool of attentional resources.

The second main component (alongside controlled cognition) of the DP theory is spontaneous cognition. At the broadest level, individual differences in spontaneous cognition reflect the ability to acquire information automatically and the tendency to engage in spontaneous forms of cognition. For instance, whereas most people have the ability to spontaneously experience gut feelings and daydreams, there may be individual differences in the extent to which people are willing to engage with them. Constructs that are part of the spontaneous cognition hierarchy include the following: mindwandering, daydreaming, implicit learning, latent inhibition, intuition, acquired forms of expertise and long-term memory, and implicit domains of mind that are universal human domains pertaining to knowledge of spatial relations, number, probability, logic, language, people, language, music, aesthetics, living things, the inanimate physical world, or the beliefs and desires of other minds (Gelman, 2009; Hirschfeld & Gelman, 1994; Feist, 2008; Pinker, 1997).

Other technical details about the theory, including the hierarchical nature of the model, can be found in S. B. Kaufman (2009). Thus far, there is support for the theory, from different branches of psychology and neuropsychology. For instance, a recent study found that individual differences in implicit learning predict intelligent behaviors such as language learning and verbal analogical reasoning above and beyond g and the cognitive mechanisms underlying g (S.B. Kaufman et al., 2010). Since the theory is so new, however, it has not had enough time to garner much criticism or support. The extent to which the various components of the DP theory increase prediction of intelligent behaviors across a wide range of situations remains an open question.

Theories of Intelligence

Broadly speaking, we can divide the theories we have discussed into three categories. There are theories that are closely tied to the measurement of intelligence. CHC theory and the PASS model (along with Spearman’s g) form the theoretical foundation for nearly all commercial tests of intelligence. These contemporary theories demonstrate the potential to bring psychometric, experimental, and neuroscientific research more in line with each other. For instance, the PASS model and the development of related testing instruments are explicitly tied to cutting-edge neuroscience findings. Additionally, tests based on the CHC model are also incorporating the latest research on the cognitive mechanisms related to g, such as working memory. Still, there is more work to be done to bring these various perspectives together. Clearly, this work is important, since both the PASS model and the CHC model have the most impact in terms of people’s lives affected. Decisions about which students have a learning disability or which students are labeled “gifted” are nearly always made based on these theories (S.B. Kaufman & Sternberg, 2008).

The second class of theories comprises those that have been created, in part, to respond to what is missing in traditional intelligence tests. The theories of Multiple Intelligence and Successful Intelligence argue for additional abilities (from creativity to bodily/kinesthetic ability) to be treated with the same importance as the standard analytic abilities measured by most tests. The theory of Emotional Intelligence offers an entirely new “intelligence” that some argue is as important as traditionally conceived intelligence.

The third class of theories (The Multiple Mechanisms Approach and the Parieto-frontal Integration, Minimal Cognitive Architecture, and Dual-Process theories) are grounded in the latest research on cognition and neuroscience. These theories, although advancing the scientific understanding of human intellectual differences, are less clearly tied to practical applications in terms of intelligence testing. This may change, however, as these theories evolve and more tests of the specific predictions of the theories are conducted in applied settings.

Looking Inside the Crystal Ball

Speculating on the future of intelligence theories is a difficult—yet intriguing—task. Throughout the history of the study of intelligence, related theories have largely reflected the emphases in psychology and even the broader society at the time. For
example, it is tempting to criticize Galton’s seminal work in the late 1800s as being obsessively focused on an assumption of heredity (and more than a little social Darwinism), but such a criticism takes Galton’s work completely out of its historical and cultural context. At that time in Western society, Galton’s conclusions were hardly considered revolutionary (his methods, however, were truly innovative). Viewed from this context lens, then, the current move to interdisciplinary theories that incorporate findings from psychology, cognitive science, neurology, and so on is not surprising, and we expect this trend to continue. However, we also note that truly interdisciplinary systems theories, which combine the cognitive and neurological perspectives with those from sociology, education, and related areas are not in wide circulation, and that this area appears to be a likely future direction for theories of intelligence.

Notes

1. Note that other definitions of “controlled cognition” have been put forward (see Schneider & Shiffrin 1977).

2. The distinction between goal-directed and spontaneous cognition, according to the DP theory, is not always the same as that between conscious and unconscious cognition. Spontaneous cognitions can be either conscious, such as when an individual is aware of his or her vivid fantasies, or nonconscious such as when an individual feels an intuition without knowing what brought about that intuition or when an individual implicitly learns the underlying rule structure of the environment. Likewise, some goal-directed processes can operate without meta-awareness while still consuming limited attentional resources.

References


Anderson, M. (2008). What can autism and dyslexia tell us about that intuition or when an individual implicitly learns the underlying rule structure of the environment. Likewise, some goal-directed processes can operate without meta-awareness while still consuming limited attentional resources.


