To appear in R.J. Sternberg (2018), The Nature of Human Intelligence. New York, NY: Cambridge University Press

14

My Quest to Understand Human Intelligence

Scott Barry Kaufman

Abstract: This chapter traces the development of my thinking on the nature of human intelligence, from my early childhood experiences in special education to my scientific investigations of the boundary conditions of general cognitive ability, to the formulation of my Dual-Process Theory and Theory of Personal Intelligence, to my encounter with positive psychology. This chapter is a call to shift the perspective on intelligence from an individual-differences approach to one that recognizes the whole person. The goal of this approach is to reduce the number of children who fall between the cracks in an educational system that focuses so much on the results of standardized tests and IQ tests as the measure of an individual's intellectual and creative potential. I discuss the reasons why a broader, more personal perspective on intelligence is required to help all children live a meaningful life, and argue for greater integration with the fields of developmental and positive psychology.

Keywords: Intelligence, Associative Learning, Implicit Learning, Imagination, Creativity, Positive Psychology

It is truly an honor to contribute to this volume. Many of the contributors have had a significant influence on my interest to go into this field in the first place. In thinking through how to structure this chapter, I decided it would make the most

sense to go in chronological order and be as honest as I could be about the development of my thinking on this fascinating topic of human intelligence – a topic that has consumed my mind from as early as I can remember.

The Wonder Years (1979–1998)

My early experiences most certainly shaped my thinking about intelligence. By the age of three, I had 21 ear infections. As a result, I was diagnosed with Central Auditory Processing Disorder (CAPD), a hearing problem that made it difficult for me to process auditory input in real time. It would take me a few extra milliseconds to process new information because I had to replay in my head what was said before I could understand what was being spoken. I repeated third grade, and was placed in special education. I remained in special education until ninth grade, unquestioningly, despite feeling I was capable of more intellectual challenges. Every time I asked to take more challenging courses, I was denied. Also, even though the learning disability no longer posed a challenge to my learning, I was kept in special education because the educators felt as though I was too anxious. Of course, I was anxious because I was not being challenged. So this was a vicious cycle that did nothing to enhance my learning.

Respite came in ninth grade, when a special-education teacher who was covering class one day took me aside and asked why I was still there. I realized I had no good answer to that question, and also realized I had been waiting for just this moment when someone would believe in a higher potential for me. While my parents were certainly well meaning by wanting to ease any burden on me in school, they did not challenge the authorities. So I knew I would have to take myself out of special education, which I did. Once I was in regular classes, I learned a lot about myself – my strengths and weaknesses. I was grateful for the opportunity to fully explore the depths of my being.

Why tell this story? Perhaps it seems out of place in such an academic volume. But I believe my personal experience, and the other experiences I saw firsthand, are very relevant to the discussion of the nature of human intelligence. As I went through these early years, I very much wondered about the nature of human intelligence and potential. I knew that my friends in special education weren't disabled just because they had specific difficulties in learning. I witnessed the negative expectations from teachers, and became sure that such expectations were being signaled loud and clear to all of us.

So, long before I started to scientifically investigate intelligence, I had intuitions, based on personal experiences, that our dominant paradigm of intelligence was practically limiting the potential of students. I could plainly see

it all around me. Even those on the "other side" – the students who did well on standardized tests and received accolades from teachers – yearned to be valued for something more than their test performance. It would take me awhile before I was able to formulate my thoughts into a formal scientific theory, but a major impetus along this path was my encounter as an undergraduate with cognitive psychology.

Introduction to Intelligence Research (1998–2003)

While I didn't initially get accepted as a psychology major at Carnegie Mellon University, I transferred into the department soon after I entered as an opera major. During a course in cognitive psychology taught by Anne Fay, I discovered the science of intelligence. I remember very clearly the crystallizing experience (Walters & Gardner, 1998).

I was sitting on the sofa in my dorm reading the chapter on intelligence that was in the cognitive psychology textbook we were assigned. I remember becoming so overwhelmingly excited by this material that I flipped to the inside cover to see who wrote the book. It said, "Robert J. Sternberg, Yale University." I made a commitment in that moment that *one day, no matter what*, I would study

the science of human intelligence with Sternberg. In fact, if you told my 20-year-old self that I would not only study with Sternberg, but I would end up coediting a handbook on intelligence with him (Sternberg & Kaufman, 2011), and even be a contributor to this very volume that is in your hands, I would have probably fainted! So with the help of Professor Fay, I read voraciously on the topic, virtually reading every single book in the CMU library on the topic of human intelligence. In addition to Sternberg's work, I was also exposed to the ideas of Howard Gardner on multiple intelligences, and Ellen Winner's work on gifted children. I also took Herbert Simon's graduate course on cognition and learned about the role of expertise in skill development.

Nevertheless, I knew that if I ever were to go beyond the traditional view of intelligence, I would have to go into the lion's den and learn as much as I could about IQ. So I reached out to University of Cambridge professor Nicholas J. Mackintosh, author of *IQ and Human Intelligence* (Mackintosh, 2011). To my great surprise and excitement, he accepted me as an intern for a semester study abroad. So I took a semester off of CMU, and attempted to learn as much as I could about IQ from one of the most sensible and thoughtful scientists in the field. It was to be the start of a fascinating journey to understand the nature of IQ and its boundary conditions.

Dual-Process Theory of Human Intelligence (2003–2009)

After interning for both Robert J. Sternberg and Nicholas J. Mackintosh as an undergraduate, I was accepted to continue my studies with both of them – Sternberg at Yale for my PhD, and Mackintosh at Cambridge for my M. Phil under a Gates Cambridge Scholarship. Once embarking on this adventure, I made two commitments to myself: (1) I would keep my personal story a secret, fearful that I would be perceived as not objective in my science, and (2) I would take my own personal feelings out of the equation, and work as hard as possible to understand human intelligence, regardless of where the search led.

One of the first questions I had was whether the field was missing any lower-order factors. After all, Carroll (1993) did such a wonderful job cataloging the many subcomponents of general intelligence (*g*). But were we missing anything?

Through working with Mackintosh, I was exposed to his seminal work on associative learning (Mackintosh, 1974). While more rudimentary forms of associative learning were included in Carroll's model, Mackintosh and I were interested in looking at the unique contribution of more sophisticated forms of associative learning, such as the forms that Mackintosh and his colleagues had

investigated in other animals. Evolution has endowed animals (including humans!) with quite sophisticated mental structures for associative learning.

So we adopted the three-term contingency learning task from Williams and Pearlberg (2006), which, over the course of four learning blocks, requires participants to learn word associations that are contingent on a particular key press. For example, one trial the word "LAB" might be shown with the letters "A," "B," and "C" shown underneath. When participants selected one letter (e.g., "A"), they would see one association (e.g., PUN), when they selected another letter (e.g., "B"), they would see a second association (e.g., "TRY"), and so on. During the test blocks, participants were required to type in the outcome word corresponding to a particular stimulus-response pair.

We found that this more complex form of associative learning showed stronger correlations with *g* than paired-associates learning, a form of associative learning not dependent on contingencies (Kaufman et al., 2009). What's more, an overarching associative learning factor predicted *g* above and beyond the effects of two other well-known contributors to *g*: working memory and processing speed. We concluded that these findings added to a growing literature on the existence of multiple cognitive mechanisms supporting *g* (see Conway & Kovacs, Chapter 4, this volume), and that the ability to explicitly learn complex associations between stimuli was one of those important mechanisms.

Was that it? Were there other forms of associative learning that made a contribution to intelligence? As I continued to study with Mackintosh, I became fascinated with a form of learning called *implicit learning*, which involves the learning of information without conscious intent or awareness of what has been learned (Stadler & Frensch, 1997). What fascinated me so much about this form of learning is that it seemed to be independent of general intelligence (Gebauer & Mackintosh, 2007; Reber, Walkenfeld, & Hernstadt, 1991). This was quite remarkable to me since in my reading of the intelligence literature it seemed that every form of cognition under the sun loaded onto *g*.

So when I returned to Yale to complete my PhD, I rounded up as many implicit learning tasks as I could from the cognitive science literature, and adapted them for the individual-differences paradigm. With the assistance of Luis Jiménez, a leading researcher on attention and implicit learning, we found that the ability to *implicitly* detect complex and noisy regularities in the environment (by learning complex probabilities in a sequence) showed a weak correlation with *g* (Kaufman et al., 2010). Nevertheless, individual differences in implicit learning independently predicted verbal analogical reasoning, processing speed, and academic performance on two foreign-language exams. What's more, implicit-learning ability was correlated with self-reported

intuition, openness to experience, and impulsivity – three variables that have also been linked to increased creativity (see Kaufman & Gregoire, 2015).

These findings excited me greatly, because it suggested a boundary condition for *g*: *implicit cognition*. For me, this opened up a whole new universe of investigation from an individual-differences perspective (Kaufman, 2011)! The field of human intelligence had been so focused on the ability to explicitly learn, but what about the ability to *implicitly* learn? These findings dovetailed nicely with extant dual-process theories of cognition, which posited two forms of information processing: a slower mode that was more dependent on working memory, and a faster mode that was relatively independent from executive functioning, but nevertheless quite cognitively complex (see Kaufman, 2011, for a review).

However, despite the various dual-process theories of cognition that existed, there wasn't explicitly a dual-process theory of human intelligence. What's more, the dual-process theories that existed tended to devalue the importance of the implicit route. Rationality and explicit reasoning were held up as the most important contributor to adaptive cognition. Not only was there such a preponderant focus on the foibles of implicit cognition, but individual differences in implicit cognition were thought to be minimal and unimportant.

So I was inspired to propose the Dual-Process Theory of Human Intelligence for my doctoral dissertation (Kaufman, 2009) that attempted to overcome these limitations. Arguing that all human intelligent behaviors are the result of a mix of both goal-directed and spontaneous cognitive processes (in varying degrees depending on the task), I argued that there are adaptive individual differences along both dimensions. What's more, I argued that neither mode of information processing is more universally "intelligent" than any other, but that intelligence is better thought of as the ability to *flexibly* switch mode of thought depending on the situation. Finally, and foretelling the work that would yet to come, I argued that there are a variety of paths to the same intelligent behavior, with different people drawing on a different mix of cognitive traits to reach the same intelligent outcome.

In addition to my dissertation data, I also drew on other collaborations I was having at the time (e.g., Brown et al. 2010, Pretz et al., 2010). For example, Jaimie Brown and I found that the ability to implicitly learn a variety of information was not impaired in those with autism-spectrum conditions, and this was not a consequence of compensation by explicit-learning ability or IQ. A major implication of this finding was that a sole focus on explicit cognition would underestimate the intellectual capabilities of this population, and, I suspected, many other populations as well.

Coming out Ungifted and the Theory of Personal Intelligence (2009–2013)

After I completed my PhD, I moved to New York City. While the academic journey I had been on to understand intelligence was enriching, I ultimately was left unsatisfied. I certainly had learned a lot about the nature of human intelligence, but *how was it actually helping children*? What about all of those classmates of mine who clearly had so much potential: how would knowing the structure of *g* impact their lives in any concrete way? I was ready to go beyond the science of the structure and correlates of cognitive ability and contemplate the implications for creating an education system that gives opportunities for everyone to intellectually and creatively flourish.

Something that became clear is that psychologists – whether we like it or not – have a real impact on the lives of children, however indirect that effect may seem. For instance, school psychologists in training learn about the latest IQ tests, and are taught how to use that information to inform a custom-tailored intervention for the child. Conceptualizations of intelligence coming from scientists do trickle down to the students via the educators. As much as scientists may wish to operate in a vacuum and do "pure science," the stakes are too high when it comes to the study of human intelligence. The scientists'

conceptualization of what intelligence means, how it is measured, and what it foretells about a person's future prospects in life is often taken at face value by educators in training, who make high-stakes decisions on a daily basis about what a child is and is not capable of achieving in life. So I wanted to really think through how all of the latest research on human intelligence, talent, creativity, and potential could inform an education system that brings out the best in *all* children.

To my delight, Giles Anderson – a literary agent in New York City – was interested in having me develop my ideas about intelligence into a book. Thus began the period of writing *Ungifted: Intelligence Defined*. In this book, I decided to "come out" as ungifted, and reveal my personal story, in the hopes that it would inspire others to overcome their own learning difficulties. Weaving my personal story with the latest science of IQ testing, general intelligence, talent, and creativity, I proposed the Theory of Personal Intelligence, which was informed by my Dual-Process Theory, but went beyond it so it could have more of a direct impact on the real lives of children.

Surveying 13 widely used definitions of intelligence, I noticed a serious mismatch between conceptualizations of intelligence in the literature and its operationalization. One common theme across various definitions of intelligence was adaptation to the environment: not just dealing with the school

environment, but also the capacity for flexibility, resiliency, tenacity, motivation, and coping strategies for dealing with the inevitable daily stressors and unknowns of life. These skills clearly go beyond what is measured on an IQ test, or what could possibly *ever* be captured by a single snapshot of intelligence.

Indeed, David Wechsler, creator of one of the most widely used intelligence tests, the *Wechsler Adult Intelligence Scale* and the *Wechsler Intelligence Scale for Children*, explicitly noted:

> One need not be afraid or ashamed to acknowledge impulse, instinct, and temperament as basic factors in general intelligence. My point has always been that general intelligence cannot be equated with intellectual ability, but must be regarded as a manifestation of the personality as a whole.

Similarly, Richard Snow made a call to take into account a broader range of personal characteristics (or as he put it, "aptitudes"), and to conceptualize potential as "degree of readiness" to perform in a particular situation or domain. Critically, he believed in the importance of multiple paths to the same outcome, and helping students figure out for themselves the best path to develop their expertise given their unique set of aptitudes. In his 1980 paper "Intelligence for the Year 2001," Snow writes:

> It is not unreasonable to hypothesize that both conative and affective aspects of persons and situations influence the details of cognitive processing … A theoretical account of intelligent behavior in the real world requires a synthesis of cognition, conation and affect. We have not really begun to envision this synthesis.

Certainly, my goal was never to lambaste IQ tests. As I recognized in the book, IQ tests can be useful for scientifically investigating the mind and brain. What's more, by adopting an intelligent testing approach (see A. S. Kaufman, 1979; A. S. Kaufman, Raiford, & Coalson, 2016), the pattern of strengths and weaknesses identified by a comprehensive IQ test battery can usefully inform educational interventions. So I fully acknowledged the existence of general cognitive ability. But from a real, practical perspective, I felt the need to propose a much more personal form of intelligence, which I referred to as Personal Intelligence and defined as "the dynamic interplay of engagement and abilities in pursuit of personal goals."

I argued that this form of personal intelligence is not well captured by IQ tests, for a number of reasons. For one, IQ tests are so reliant on working memory, and these tests will under-predict the intellectual potential of many children with different kinds of minds (e.g., children with dyslexia, autism, etc.)

who may have working memory deficits, but still have immense capability and drive to master the rules of a domain (for my definition of talent, see Kaufman, 2013b). Second, engagement and skill development feed off each other. Engaging in an IQ session is not an inherently motivating task for most people! However, I reviewed examples throughout the book of what people are capable of achieving once they are fully engaged in something that they have an inclination for and are passionate about. Ability and engagement dynamically shape each other over time. I'd like to emphasize that last point: *intelligence develops over time, in a particular context* (see Ceci, 1996; Sternberg & Grigorenko, 2001; Vygotsky, 1978). While IQ tests may be able to reliably measure abstract reasoning ability and working memory, let's not underestimate what a person is capable of accomplishing intellectually or creatively given a long period of active engagement. There are many cases of children with learning disabilities who have been written off, only to far surpass expectations once engaged in a particular area of interest.

To achieve this perspective on intelligence, I found it necessary to shift from the individual-differences level to the *personal* level. I was particularly inspired by the work of developmental psychologists who are developing exciting new techniques to study variation *within* the person (e.g., Blair & Diamond, 2008; Kaufman & Duckworth, 2015; Molenaar et al., 2004, 2009;

Sternberg & Grigorenko, 2001). Instead of selecting a few fixed time points, a select range of cognitive skills, and aggregating the results across subjects, the new "person-specific paradigm" focuses on a single person, selects a range of time points, and considers the trajectory of a dynamic system of cognitive, emotional, and personality processes as they unfold over time.

It's becoming clear that not all results from the individual differences paradigm necessarily apply at the person-specific level (see Molenaar, 2009). When we select a single variable (e.g., IQ) and compare people on that variable, we can rank relative differences in performance. But within a person, any single variable is *inseparable* from the rest of the system. You can't just strip out reasoning ability from a single individual, as their reasoning performance is undoubtedly affected by a whole host of variables, including motivation, history of expectations from teachers and parents, and levels of anxiety.

Therefore, consistent with a long line of thinkers on the development of intelligence (e.g., Snow, 1980; Sternberg & Grigorenko, 2001; Vygotsky, 1978), I preferred to think of potential as *readiness for engagement*. So instead of any single test score representing a person's lifelong potential, it is merely viewed as a person's readiness to handle more enriched resources at that particular time (Vygotsky, 1978). In this view, potential is a moving target dependent on a variety of factors, including engagement. Therefore, when we apply arbitrary

thresholds without taking into account personal goals, engagement, and other within-person variables, we limit possibility. The Theory of Personal Intelligence is a call to be open to the incredible transformations people can undergo when they are allowed to engage in a domain that is aligned with their self-identity. After all, creativity researcher E. Paul Torrance found that a love for the domain was the single best predictor of lifelong creative achievement – both societal and personal – long after the effects of IQ and divergent thinking faded away (e.g., Torrance, 1983).

Of course, the Theory of Personal Intelligence was influenced by many different perspectives, and I really view it as a synthesis rather than a completely new theory. According to Sternberg (1997, 2011), successful intelligence is defined as the ability to achieve one's goals in life (in terms of one's own personal standards), within one's sociocultural context, by capitalizing on strengths and correcting or compensating for weaknesses, in order to adapt to, shape, and select environments, through a combination of analytical, creative, and practical abilities. Many elements of this theory have inspired the Theory of Personal Intelligence, including the personal definition of success, the importance of context and building on strengths, and the inclusion of abilities that go beyond IQ. The Theory of Personal Intelligence goes beyond ability, however, including engagement, character strengths, and other "noncognitive"

traits in the model (Heckman, 2000; Peterson & Seligman, 1994). Additionally, the Theory of Personal Intelligence is also more explicitly a developmental model of intelligence. Likewise, while Gardner's (1983, 1999) theory of multiple intelligences expands the repertoire of abilities that fall within the domain of intelligence, the theory doesn't highlight the deeply intertwined nature of engagement and ability during the course of intellectual and creative development.

Within the social domain, Gardner's (1983) intrapersonal and interpersonal intelligence, Kihlstrom and Cantor's (2011) social intelligence, Mayer and Salovey's (1993) emotional intelligence, and Mayer's (2008) personal intelligence all certainly elucidate the nature of the capacities for understanding and adaptively employing emotion, social cognition, and one's own personality. Even though my theory shares a similar name (and in one case, is the same exact name, which was a pure coincidence!), my Theory of Personal Intelligence has a broader focus, considering the whole person as a dynamic system as he or she works toward reaching personal goals and adapting to inevitable setbacks along the way. Social and emotional processes certainly play a role, but they are only part of a whole suite of traits that are unique to each individual, and that can be mixed and matched in unique ways to develop one's own unique style of adaptive intellectual and creative functioning.

This broader focus of the Theory of Personal Intelligence really resonated with teachers and parents, especially those who work with kids on the margins (e.g., children with learning difficulties, children in gifted and talented programs, and even those students who simultaneously have learning difficulties *and* qualify for gifted and talented education). I was pleased to make some sort of practical impact. Even within the academic world, however, I was pleased to read Earl Hunt's positive review of *Ungifted* in the journal *Intelligence* (Hunt, 2013). Nevertheless, I still felt as though I had partially left a world of academic scientific inquiry that had once captivated me so much.

As it would so happen, I would enter a whole new world of scientific inquiry that aligned very much with my thinking about intelligence: positive psychology.

Positive Psychology, Imagination and Character (2014–2017)

When Martin Seligman, one of the founders of the field of positive psychology, asked me if I would be interested in moving to Philadelphia and becoming scientific director of the Imagination Institute, of course I said yes! Seligman and his graduate student Marie Forgeard (who is now a postdoc at McLean Hospital)

had received a large grant from the Templeton Foundation to advance the measurement and development of imagination across all sectors of society. About $3 million went toward a grants competition, in which we selected 16 research projects aimed at the development of better ways of assessing and developing imagination and creativity. The rest of the grant went toward a series of "Imagination Retreats," which consisted of a few days of discussion with some of the world's most imaginative thinkers across a wide range of fields – from psychology to comedy to physics to spiritualty – about how imagination operates within their specific domains, and how we can cultivate that form of imagination in young people in the field.

At the time of this writing, the findings from all of these endeavors are still coming in, but some research I've conducted on creativity made clear to me the importance of going beyond abstract cognitive ability, to other aspects of the person's cognition and personality that may lead to high accomplishment and fulfillment. For instance, in a series of papers, I showed that not only can intellectual curiosity, the drive for imaginative thinking, and appreciation of beauty predict creative achievement above and beyond the *g*-factor, but these aspects of personality are even a *better* predictor of creative achievement than knowing one's ranking on the *g*-factor (see Kaufman, 2013a; Kaufman et al., 2015).

Similarly, in a series of neuroscience studies led by Roger Beaty, we found that these personality drives – which form the personality domain "openness to experience" – are associated with the structure of the "default mode network" (Beaty et al., 2015a). This is interesting considering that this is *not* the network that has received the most attention in the intelligence field: the executive attention network (e.g., Barbey et al., 2012, see Conway & Kovacs, Chapter 4, this volume). To be sure, executive attention is important, and does significantly influence performance on IQ tests, but this research suggests that IQ tests are missing out on some really importance slices of human cognition, namely, curiosity and imagination.

Indeed, in another study, we found that divergent-thinking ability – the ability to generate a number of different solutions to a problem – involved the interaction of both the executive attention network *and* the default mode network (Beaty et al., 2015b). IQ tests are more known to tap into convergent thinking than divergent thinking (see Guilford, 1967). But life, and the ability to adapt to an ever-changing environment (which has been a common definition of intelligence by the test constructors themselves), requires much more than convergent thinking.

However, it's not just that IQ tests miss out on divergent thinking. In my view, these findings suggest that IQ tests miss out on the very heart of *human*

existence (see Maslow, 1968; May, Angel, & Ellenberger, 1958). The cognitive processes that have been associated with the default mode network in recent years – such as daydreaming, mental simulation, personal future planning, reflective compassion, and the construction of our sense of self (see Gottlieb et al., 2016) – are the processes that make us unique in this world.

Through my time at the Positive Psychology Center at the University of Pennsylvania, I learned a lot about the field of positive psychology and realized how much it dovetailed with the strengths-based approach to intelligence that resonated so strongly with me (also see Sternberg, 1997). However, stepping into the world of positive psychology felt like stepping into a different universe than the traditional field of human intelligence. Instead of scholars intensely debating which model of cognitive ability was the best fit to the data, psychologists were intensely debating which model of *the good life* was the best fit to the data.

Keeping my intelligence hat from my prior life closely by the bedside table, I could see how the kind of constructs studied in positive psychology – for example, positive emotions, life satisfaction, engagement, purpose, meaning, relationships, character, and achievement – fit into the realm of human intelligence. As Wechsler himself argued, general intelligence is broader than sheer intellectual ability, but involves the *whole person*. Indeed, this idea was a

major impetus for the proposal of the Theory of Personal Intelligence. I certainly could have attempted to redefine general intelligence, but I thought that would be a harder sell. The term "general intelligence" is used so synonymously with the *g*-factor (the common variance across a diverse battery of tests of cognitive ability) that it would be quite the uphill battle to tell an entire field – which has been using a particular term in a particular way for more than 100 years (e.g., Spearman, 1904) – to just think about the term differently.

Instead, I decided to adopt a different strategy. I have immense respect for the hard-working and rigorous scientists who have advanced our knowledge of the structure of cognitive ability. I really do think that line of research can exist peacefully alongside a different program of intelligence research, one that is no less important. This line of research, which is the direction I've been moving toward, conceptualizes and operationalizes intelligence in the way in which it has actually been defined over the past century, as adaptation to the environment. However, I go further and define (personal) intelligence as the ability to adapt to the environment *in pursuit of personal goals*.

What I want to do is put the *whole person* back into the intelligence picture. For too long, intelligence researchers have focused on abstract on-the-spot reasoning divorced from the unique personal journey of the individual. While important, this work has not been fully integrated with the emerging

literature on what it means to live a full life of purpose, passion, meaning, and fulfillment. It is my belief that a new science of intelligence that explicitly aims to help individuals achieve their own personal goals must integrate the latest findings across these various fields to come to a more complete picture of what it means to be an intelligent human being.

chapter-references

References

Barbey, A. K., Colom, R., Solomon, J., Krueger, F., Forbes, C., & Grafman, J. (2012). An integrative architecture for general intelligence and executive function revealed by lesion mapping. *Brain,* 135, 1154–1164.

Beaty, R. E., Kaufman, S. B., Bender, M., Jung, R. E., Kenett, Y. N., Jauk, E., Neubauer, A. C., & Silvia, P. J. (2015a). Personality and complex brain networks: The role of openness to experience in default network efficiency. *Human Brain Mapping*.

Beaty, R. E., Benedek, M., Kaufman, S. B., & Silvia, P. J. (2015b). Default and executive network coupling supports creative idea production. *Nature Scientific Reports*.

Blair, C., & Diamond, A. (2008). Biological processes in prevention and intervention: The promotion of self-regulation as a means of preventing school failure. *Developmental Psychopathology,* 20, 899–911.

Brown, J. B., Aczel, B., Jimenez, L., Kaufman, S. B., Mackintosh, N., & Plaisted, K. (2010). Intact implicit learning in autism spectrum conditions. *Quarterly Journal of Experimental Psychology,* 1, 1–24.

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytic studies*. Cambridge: Cambridge University Press.

Ceci, S. (1996). *On intelligence ... more or less: A biological treatise on intellectual development*. Cambridge, MA: Harvard University Press.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Gardner, H. (1999). *Intelligence reframed: Multiple intelligences for the 21st century*. New York: Basic Books.

Gebauer, G.F., & Mackintosh, N.J. (2007). Psychometric intelligence dissociates implicit and explicit learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33,* 34-54.

Gottlieb, R., Hyde, E., Immordino-Yang, M. H., & Kaufman, S. B. (2016). Cultivating the social-emotional imagination in gifted education: Insights from educational neuroscience. *Annals of the New York Academy of Sciences*.

Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.

Heckman, J. J. (2000). Policies to foster human capital. *Research in Economics*, 54, 3–56.

Hunt, E. (2013). Book review: A gifted discussion of misclassification. *Intelligence*.

Kaufman, A. S. (1979). *Intelligent testing with the WISC-R*. New York: Wiley.

Kaufman, A. S., Raiford, S. E., & Coalson, D. L. (2016). *Intelligent testing with the WISC-V.* New York: Wiley.

Kaufman, S. B. (2009). *Beyond general intelligence: The dual-process theory of human intelligence (Unpublished Ph.D. dissertation)*. Yale University, New Haven, CT. Kaufman, S. B. (2011).

Kaufman, S. B. (2011). Intelligence and the cognitive unconscious. In R. J. Sternberg & S. B. Kaufman (Eds.), *The Cambridge handbook of intelligence* (pp. 442–467). New York: Cambridge University Press.

Kaufman, S. B. (2013a). Opening up openness to experience: A four-factor model and relations to creative achievement in the arts and sciences. *Journal of Creative Behavior*, 47, 233–255.

Kaufman, S. B. (2013b). *Ungifted: Redefining intelligence*. New York: Basic Books.

Kaufman, S. B., DeYoung, C. G., Gray, J. R., Brown, J., & Mackintosh, N. (2009). Associative learning predicts intelligence above and beyond working memory and processing speed. *Intelligence*, 37, 374–382.

Kaufman, S. B., DeYoung, C. G., Gray, J. R., Jimenez, L., Brown, J. B., & Mackintosh, N. (2010). Implicit learning as an ability. *Cognition*, 116, 321–340.

Kaufman, S. B., & Duckworth, A. L. (2015). World-class expertise: A developmental model. *Wiley Interdisciplinary Reviews: Cognitive Science*.

Kaufman, S. B., & Gregoire, C. (2015). *Wired to create: Unraveling the mysteries of the creative mind*. New York: Penguin.

Kaufman, S. B., & Gregoire, C. (2016). *Wired to create: Unraveling the mysteries of the creative mind*. New York: Perigee Books.

Kaufman, S. B., Quilty, L. C., Grazioplene, R. G., Hirsh, J. B., Gray, J. R., Peterson, J. B., & DeYoung, C. G. (2015). Openness to experience and intellect

differentially predict creative achievement in the arts and sciences. *Journal of Personality*, doi: 10.1111/jopy.12156.

Kihllstrom, J. F., & Cantor, N. (2011). Social intelligence. In R. J. Sternberg & S. B. Kaufman (Eds.), *The Cambridge handbook of intelligence* (pp. 564–581). New York: Cambridge University Press.

Mackintosh, N. J. (1974). *The psychology of animal learning*. London: Academic Press.

Mackintosh, N. J. (2011). (2nd edn.) *IQ and human intelligence*. Oxford: Oxford University Press.

Maslow, A. H. (1968). *Toward a psychology of being* (2nd edn.). New York: Van Nostrand.

May, R., Angel, E., & Ellenberger, H. F. (Eds.) (1958). *Existence: A new dimension in psychiatry and psychology*. New York: Simon & Schuster.

Mayer, J. D. (2008). Personal intelligence. *Imagination, Cognition, and Personality*, 27, 209–232.

Mayer, J. D., & Salovey, P. (1993). The intelligence of emotional intelligence. *Intelligence*, 17, 433–442.

Molenaar, P. C. M. (2004). A manifesto on psychology as idiographic science: Bringing the person back into scientific psychology, this time forever. *Measurement*, 2, 201–218.

Molenaar, P. C. M., & Campbell, C. G. (2009). The new person-specific paradigm in psychology. *Current Directions in Psychological Science*, 18, 112–117.

Peterson, C., & Seligman, M. E. P. (1994). *Character strengths and virtues*. Washington, DC/New York: American Psychological Association/Oxford University Press.

Pretz, J. E., Totz, K. S., & Kaufman, S. B. (2010). The effects of mood, cognitive style, and cognitive ability on implicit learning. *Learning and Individual Differences*, 20, 215–219.

Reber, A. S., Walkenfeld, F. F., & Hernstadt, R. (1991). Implicit and explicit learning: Individual differences and IQ. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 17, 888–896.

Snow, R. E. (1980). Intelligence for the year 2001. *Intelligence*, 4, 185–199.

Spearman, C. (1904). "General intelligence," objectively determined and measured. *American Journal of Psychology*, 15, 201–293.

Stadler, M. A., & Frensch, P. A. (1997). *Handbook of implicit learning*. Thousand Oaks, CA: SAGE Publications.

Sternberg, R. J. (1997). *Successful intelligence: How practical and creative intelligence determine success in life*. New York: Plume.

Sternberg, R. J. (2011). The theory of successful intelligence. In R. J. Sternberg & S. B. Kaufman (Eds.), *The Cambridge handbook of intelligence* (pp. 504–527). New York: Cambridge University Press.

Sternberg, R. J., & Grigorenko, E. L. (2001). *Dynamic testing*. New York: Cambridge University Press.

Sternberg, R. J., & Kaufman, S. B. (Eds.) (2011). *The Cambridge handbook of intelligence*. New York: Cambridge University Press.

Torrance, E. P. (1983). The importance of falling in love with "something." *Creative Child & Adult Quarterly*, 8, 72–78.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Boston, MA: Harvard University Press.

Walters, J., & Gardner, H. (1998). The crystallizing experience: Discovering an intellectual gift. In R. S. Albert (Ed.), *Genius and eminence* (pp. 135–155). New York: Psychology Press.

Williams, B. A., & Pearlberg, S. L. (2006). Learning of three-term contingencies correlates with Raven scores, but not with measures of cognitive processing. *Intelligence*, 34, 177–191.