

The Theory of Multiple Intelligences

Katie Davis, Harvard University
Joanna Christodoulou, Harvard University
Scott Seider, Boston University
Howard Gardner, Harvard University

PART 1: Background

The theory of multiple intelligences, developed by psychologist Howard Gardner in the late 1970's and early 1980's, posits that individuals possess eight or more relatively autonomous intelligences. Individuals draw on these intelligences, individually and corporately, to create products and solve problems that are relevant to the societies in which they live (Gardner, 1983, 1993, 1999, 2006b, 2006c). The eight identified intelligences include linguistic intelligence, logical-mathematical intelligence, spatial intelligence, musical intelligence, bodily-kinesthetic intelligence, naturalistic intelligence, interpersonal intelligence, and intrapersonal intelligence (Gardner, 1999). According to Gardner's analysis, only two intelligences—linguistic and logical mathematical—have been valued and tested for in modern secular schools; it is useful to think of that language-logic combination as “academic” or “scholarly intelligence”. In conceiving of intelligence as multiple rather than unitary in nature, the theory of multiple intelligences, or (hereafter) MI theory, represents a departure from traditional conceptions of intelligence first formulated in the early twentieth century, measured today by IQ tests, and studied in great detail by Piaget (1950, 1952) and other cognitively oriented psychologists.

As described elsewhere in this volume, French psychologist Alfred Binet (1911; Simon & Binet, 1916) designed the precursor to the modern-day intelligence test in the early 1900's in order to identify French school children in need of special educational interventions. Binet's scale, along with the contemporaneous work of English psychologist Charles Spearman (1904, 1927) on 'g', served as the principal catalysts for conceiving of all forms of intellectual activity as stemming from a unitary or general ability for problem-solving (Perkins & Tishman, 2001). Within academic psychology, Spearman's theory of general intelligence (or 'g') remains the predominant conception of intelligence (Brody, 2004; Deary et al, 2007; Jensen, 2008) and the

basis for more than 70 IQ tests in circulation (e.g. Stanford-Binet Intelligence Scales Fifth Edition, 2003; Wechsler Adult Intelligence Scales Third Edition, 2008). MI theory, in contrast, asserts that individuals who demonstrate a particular aptitude in one intelligence will not necessarily demonstrate a comparable aptitude in another intelligence (Gardner, 2006b). For example, an individual may possess a profile of intelligences that is high in spatial intelligence but moderate or low in interpersonal intelligence or vice versa. This conception of intelligence as multiple rather than singular forms the primary distinction between MI theory and the conception of intelligence that dominates Western psychological theory and much of common discourse.

A second key distinction concerns the origins of intelligence. While some contemporary scholars have asserted that intelligence is influenced by environmental factors (Diamond & Hopson, 1998; Lucas, Morley, & Cole, 1998; Neisser et al, 1996 Nisbet 2008), many proponents of the concept of general intelligence conceive of intelligence as an innate trait with which one is born and which one can therefore do little to change (Eysenck, 1994; Herrnstein & Murray, 1994; Jensen, 1980, 1998). In contrast, MI theory conceives of intelligence as a combination of heritable potentials and skills that can be developed in diverse ways through relevant experiences (Gardner, 1983). For example, one individual might be born with a high intellectual potential in the bodily-kinesthetic sphere that allows him or her to master the intricate steps of a ballet performance with relative ease. For another individual, achieving similar expertise in the domain of ballet requires many additional hours of study and practice. Both individuals are capable of becoming strong performers—experts-- in a domain that draws on their bodily-kinesthetic intelligence; however, the pathways along which they travel in order to become strong performers may well differ quantitatively (in terms of speed) and perhaps qualitatively (in terms of process).

MI theory is neither the sole challenger to Spearman's (1904, 1927) conception of general intelligence, nor the only theory to conceive of intelligence as pluralistic. Among others, Thorndike (1920; Thorndike, Bregman, Cobb, & Woodyard, 1927) conceived of intelligence as the sum of three parts: abstract intelligence, mechanical intelligence, and social intelligence. Thurstone (1938, 1941) argued that intelligence could better be understood as consisting of seven primary abilities. Guilford (1967; Guilford & Hoepfner, 1971) conceptualized intelligence as consisting of four content categories; five operational categories; and six product categories; he ultimately proposed 150 different intellectual faculties. Sternberg (1985, 1990) offered a triarchic theory of intelligence that identified analytic, creative, and practical intelligences. Finally, Ceci (1990, 1996) has described multiple cognitive potentials that allow for knowledge to be acquired and relationships between concepts and ideas to be considered.

Gardner's theory of multiple intelligences, however, is perhaps the best known of these pluralistic theories. This notoriety is due, in part, to the sources of evidence on which Gardner drew, and, in part, to its enthusiastic embrace by the educational community (Armstrong, 1994; Kornhaber, 1994; Shearer, 2004). Many hundreds of schools across the globe have incorporated MI principles into their mission, curriculum, and pedagogy; and hundreds of books have been written (in numerous languages) on the relevance of MI theory to educators and educational institutions (Chen, Moran, & Gardner, 2009). In 2005, a 10-acre 'science experience park' opened in Sonderberg, Denmark with more than 50 different exhibits through which participants can explore their own profile of intelligences (Danfoss Universe, 2007). In what follows, we outline the major claims of this far-reaching theory as well as some of the adjustments to the theory made over the past twenty-five years.

It should be pointed out that Gardner’s conceptualization of multiple intelligence does not belong exclusively to Gardner; other scholars and practitioners have made numerous applications of the principal tenets, sometimes with little regard to Gardner’s own claims. In this chapter, however, we focus principally on MI theory and practices, as put forth by Gardner.

Gardner’s (1983, 1999) conception of intelligence as pluralistic grew out of his observation that individuals who demonstrated substantial talent in domains as diverse as chess, music, athletics, politics, and entrepreneurship possessed capacities in these domains that should be accounted for in conceptualizing intelligence. Accordingly, in developing MI theory and its broader characterization of intelligence, Gardner did not focus on the creation and interpretation of psychometric instruments. Rather, he drew upon research findings from evolutionary biology, neuroscience, anthropology, psychometrics and psychological studies of prodigies and savants. Through synthesis of relevant research across these fields, Gardner established several criteria for identification of a unique intelligence (see *Table 1*).

Table 1. Criteria for Identification of an Intelligence

Criteria for Identification of an Intelligence
<ul style="list-style-type: none"> • It should be seen in relative isolation in prodigies, autistic savants, stroke victims or other exceptional populations. In other words, certain individuals should demonstrate particularly high or low levels of a particular capacity in contrast to other capacities.
<ul style="list-style-type: none"> • It should have a distinct neural representation—that is, its neural structure and functioning should be distinguishable from that of other major human faculties
<ul style="list-style-type: none"> • It should have a distinct developmental trajectory. That is, different intelligences should develop at different rates and along paths which are distinctive.
<ul style="list-style-type: none"> • It should have some basis in evolutionary biology. In other words, an intelligence ought to have a previous instantiation in primate or other species and putative survival value.
<ul style="list-style-type: none"> • It should be susceptible to capture in symbol systems, of the sort used in formal or informal education.
<ul style="list-style-type: none"> • It should be supported by evidence from psychometric tests of intelligence.

<ul style="list-style-type: none"> • It should be distinguishable from other intelligences through experimental psychological tasks.
<ul style="list-style-type: none"> • It should demonstrate a core, information-processing system. That is, there should be identifiable mental processes that handle information related to each intelligence.

(Gardner 1983; Kornhaber, Fierros, & Veneema, 2004)

Drawing on these criteria, Gardner initially identified seven intelligences. However, in the mid-1990's, Gardner concluded that an eighth intelligence, naturalistic intelligence, met the criteria for identification as an intelligence as well (see *Table 2*). Naturalistic intelligence allows individuals to identify and distinguish among products of the natural world such as animals, plants, types of rocks, and weather patterns (Gardner, 1999). Meteorologists, botanists, and zoologists are all professions in which one would likely find individuals who demonstrate high levels of naturalistic intelligence. In a world where this particular skill is less important for survival than it was in earlier times, naturalistic capacities are brought to bear in making consequential distinctions with respect to manmade objects displayed in a consumer society.

Table 2. Gardner's Eight Intelligences.

Intelligences	Description
Linguistic	An ability to analyze information and create products involving oral and written language such as speeches, books, and memos.
Logical-Mathematical	An ability to develop equations and proofs, make calculations, and solve abstract problems.
Spatial	An ability to recognize and manipulate large-scale and fine-grained spatial images.
Musical	An ability to produce, remember, and make meaning of different patterns of sound.
Naturalist	An ability to identify and distinguish among different types of plants, animals, and weather formations that are found in the natural world.

Bodily-Kinesthetic	An ability to use one's own body to create products or solve problems.
Interpersonal	An ability to recognize and understand other people's moods, desires, motivations, and intentions
Intrapersonal	An ability to recognize and understand his or her own moods, desires, motivations, and intentions

The above descriptions of the eight intelligences that comprise MI theory relied upon the domains or disciplines in which one typically finds individuals who demonstrate high levels of each intelligence. This is because we do not yet have psychometric or neuro-imaging techniques that assess directly an individual's capacity for a particular intelligence. For example, no test has been devised to assess directly whether an individual possesses a profile of intelligences high in spatial intelligence; however, one might reasonably infer that an individual who demonstrates excellent performance in the domain of architecture or sculpture or geometry possesses high spatial intelligence. Likewise, excellence in the domains of ballet or orthopedic surgery suggests the possession of high bodily-kinesthetic intelligence. It is possible that in the future more direct methods of measuring intelligences may be devised—for example, through evidence about neural structures or even through genetic markers.

In the twenty-five year history of the theory, numerous researchers have proposed additional intelligences that range from moral intelligence to humor intelligence to cooking intelligence (Boss, 2005; Goleman, 1995). Gardner (2006b) himself has speculated about an existential intelligence that reflects an individual's capacity for considering 'big questions' about life, death, love, and being. Individuals with high levels of this hypothesized intelligence might be likely to be found in philosophy departments, religious seminaries, or the ateliers of artists. To date, however, naturalistic intelligence has been the only definitive addition to the original set of seven intelligences. In Gardner's judgment, neither existential intelligence nor any of the other

proposed intelligences sufficiently meet the criteria for identification as a unique intelligence (a discussion of the reliability of these criteria in identifying candidate intelligences is offered in Part 2 of this chapter). In future years, new proposed intelligences might be found to meet the criteria for identification as a unique intelligence (Battro & Denham, 2007; Chen & Gardner, 2005). Conversely, future research may reveal that existing intelligences such as linguistic intelligence are more accurately conceived of as several sub-intelligences. These inevitable adjustments and adaptations of MI theory, however, are less important than the theory's overarching principle: namely, that intelligence is better conceived of as multiple and content-specific rather than unitary and general.

In describing intelligence(s) as pluralistic, MI theory conceives of individuals as possessing a profile of intelligences in which they demonstrate varying levels of strengths and weakness for each of the eight intelligences. It is a misstatement within the MI framework, then, to characterize an individual as possessing “no” capacity for a particular intelligence (Gardner, 1999). Individuals may certainly demonstrate low levels of a particular intelligence, but, except in cases involving severe congenital or acquired brain damage, all individuals possess the full range of intelligences. It would be equally inaccurate within the MI framework, however, to assert that everyone demonstrates superiority or giftedness in at least one of the intelligences (Gardner, 1999). As a pluralistic theory, the fundamental assertion of MI theory is that individuals *do* demonstrate variation in their levels of strength and weakness across the intelligences. Unfortunately this variation does not mean that every individual will necessarily demonstrate superior aptitude in one or more of the intelligences.

After twenty five years of reflection on the theory, Gardner accentuates two primary claims: 1) All individuals possess the full range of intelligences—the intelligences are what

define human beings, cognitively speaking; 2) No two individuals, not even identical twins, exhibit precisely the same profile of intellectual strengths and weaknesses. These constitute the principal scientific claims of the theory; educational or other practical implications go beyond the scope of the theory, in a strict sense.

PART 2: Review of Issues and pseudo-issues spawned by the theory

During the years since its inception, MI theory has drawn considerable attention, primarily from psychologists and educators. The attention has come in many forms, from scholarly critiques regarding the development, scope, and empirical basis of the theory, to educational curricula that claim to develop children's intelligences in an optimal way. This attention has led to new developments in the theory and promising practical applications in the classroom. Yet, several reviews and critiques of MI theory reveal misunderstandings regarding its empirical foundation and theoretical conception of human cognition. In this section, we use these misunderstandings as a springboard for exploring the theory in greater depth, with the purpose of illuminating its major claims and conceptual contours.

The foundation and province of MI theory

Some critics of MI theory argue that it is not grounded in empirical research and cannot, therefore, be proved or disproved on the basis of new empirical findings (Waterhouse, 2006; White, 2006). In fact, MI theory is based entirely on empirical findings. The intelligences were identified on the basis of hundreds of empirical studies spanning multiple disciplines (Gardner, 1983, 1993; Gardner & Moran, 2006). Noted, too, is the relative lack of empirical studies specifically designed to test the theory as a whole (Visser, Ashton, & Vernon, 2006). Like other broad theories, such as evolution or plate tectonics, which synthesize experimental,

observational, and theoretical work, MI theory cannot be proved or disproved on the basis of a single test or experiment. Rather, it gains or loses credibility as findings accumulate over time. Indeed, subsequent findings have prompted ongoing review and revisions of MI theory, such as the addition of new intelligences and the conceptualization of intelligence profiles. Much of the empirical work conducted since 1983 lends support to various aspects of the theory. For instance, studies on children's theory of mind and the identification of pathologies that involve losing a sense of social judgment provide strong evidence for a distinct interpersonal intelligence (Gardner, 1995; Feldman & Gardner, 1988; Gardner, Feldman & Krechevsky, 1998a, 1998b, 1998c; Malkus, Feldman, & Gardner, 1988; Ramos-Ford, Feldman, & Gardner, 1988).

Relatively few critiques of MI theory have addressed the criteria used to identify and evaluate a candidate intelligence. This state of affairs is somewhat unexpected, since the criteria serve as the theory's foundation. Moreover, by drawing on cross-disciplinary sources of evidence, the criteria represent a pioneering effort to broaden the way in which human intellectual capacities are identified and evaluated. White (2006) is one of the few scholars to question this effort. He suggests that the selection and application of the criteria is a subjective – and therefore flawed – process. A psychologist with a different intellectual biography, he argues, would have arrived at a different set of criteria and, consequently, a different set of intelligences.

The professional training that preceded MI theory no doubt played an important role in its formulation. We do not argue the fact of this influence, simply its effect. MI theory is the product of several years spent examining human cognition through several disciplinary lenses, including psychology, sociology, neurology, biology, and anthropology, as well as the arts and humanities. The criteria that emerged from this examination formed the basis of a systematic investigation of candidate faculties. Thus, in contrast to White's depiction of an idiosyncratic process marked by

one researcher's intellectual preoccupations, the identification and application of the criteria represent a systematic and comprehensive approach to the study of human intelligence. Moreover, any attempt to pluralize intelligence inevitably involves either an agreed upon stopping point (an acceptance of the criterion as stated or an infinite regress --what stimulated this criterion rather than another criterion?). Nonetheless, White is correct that ultimately the ascertainment of what is, or is not, a separate intelligence involves a synthesizing frame of mind (Gardner, 2006a), if not a certain degree of subjectivity.

Many critiques of MI theory pay scant attention to the criteria and focus instead on the level of analysis used to classify human intellectual faculties. Some scholars argue that the eight intelligences are not specific enough. Indeed, findings from neuroscience lend support to the call for increased specificity in the classification of intellectual capacities. As Gardner pointed out in the original publications (Gardner, 1983, 1993), it is likely that musical intelligence comprises several sub-intelligences relating to various dimensions of music, such as rhythm, harmony, melody, and timbre. An analogous comment can be stated for each of the other intelligences. In fact, one test of MI theory would be whether the sub-intelligences within each intelligence correlate more highly with each other than they correlate with sub-intelligences within other intelligences. Were the classification of intelligences expanded to include such specific faculties, however, the number would quickly become unwieldy and virtually untranslatable to educators. At the other extreme are those scholars who claim that MI theory expands the definition of intelligence to such a degree that it is no longer a useful construct. Gardner has argued elsewhere that a concept of intelligence that is yoked to linguistic and logical-mathematical capacities is too narrow and fails to capture the wide range of human intellectual functioning (Gardner, 1995;

Gardner & Moran, 2006). MI theory seeks a middle ground between an innumerable set of highly specific intelligences, on the one hand, and a single, all-purpose intelligence, on the other.

The description of individuals in terms of several relatively independent computational capacities would seem to put MI theory at odds with ‘g’ (psychometricians’ term for general intelligence). Willingham (2004) argues that a theory of intelligence that does not include ‘g’ is inconsistent with existing psychometric data. These data, consisting typically of correlations between scores on a series of oral questions or paper-and-pencil instruments, do provide considerable evidence for the existence of ‘g.’ They do not, however, provide insight into the scope of ‘g,’ or its usefulness as a construct. Neither Willingham nor other “geocentric” theorists have yet provided a satisfactory definition for ‘g.’ One might argue that ‘g’ is merely the common factor that underlies the set of tasks devised by psychologists in their attempt to predict scholastic success. Perhaps ‘g’ measures speed or flexibility of response; capacity to follow instructions; or motivation to succeed at an artificial, decontextualized task. None of these possibilities necessarily places ‘g’ at odds with MI theory—and indeed Gardner has never denied the existence or utility of ‘g’ for certain analytic purposes. The current perseveration on ‘g’ does, however, suggest a narrowness that fails to capture adequately the broad range of human cognition. Just how much of excellence across the range of intelligences reflects a current or future version of ‘g’ is at present not known.

Delineating the boundaries of an intelligence

It is sometimes challenging to draw clear distinctions between intelligences and other human capacities (Gardner, 2006c). Indeed, even when we have mapped out completely the neurological underpinnings of the human mind, the drawing of these boundaries will probably

continue to involve considerable judgment. At the same time, the undergirding criteria and level of analysis of MI theory can be usefully employed to draw a number of key distinctions. For instance, since intelligences operate on specific content (e.g., language, music, the apprehension of other persons), they can be separated from so-called “across the board” or ‘horizontal’ capacities like attention, motivation, and cognitive style. Whereas these general capacities are thought to apply across a range of situations, the ‘vertical’ intelligences are used by individuals to make sense of specific content, information, or objects in the world. Thus, while attention is required to engage in any type of intellectual work and motivation is needed to sustain and enhance it, attention and motivation remain separate from the operation of an intelligence. Moreover, it is possible that an individual may be quite attentive and/or motivated with respect to one kind of content, and much less so with respect to other contents.

Similarly, an individual’s cognitive style (sometimes referred to as a learning or working style) is not tied to specific content in the same way as is an intelligence (Gardner, 1995). A cognitive style putatively denotes the general manner in which an individual approaches cognitive tasks. For instance, where one person may approach a range of situations with careful deliberation, another person may respond more intuitively. In contrast, the operation of an intelligence entails the computation of specific content in the world (such as phonemes, numerical patterns, or musical sounds). A closer look at individuals’ cognitive styles may reveal content-specificity. For instance, a student who approaches a chemistry experiment in a methodical and deliberative manner may be less reflective when practicing the piano or writing an essay. By the same token, individuals bring to bear different styles depending on the intelligence or group of intelligences they are using. The key distinction is that one can bring

either a deliberative or intuitive style to the interpretation of a poem, but there is no question that some degree of linguistic intelligence will be needed.

Indeed, in an illuminating discussion of the relation between style and intelligence, Silver and Strong (1997) suggest that an introvert strong in linguistic intelligence might become a poet, while an extrovert with comparable linguistic competence is more likely to become a debater. This observation also highlights the fact that there is not a one-to-one correspondence between specific types of content and the intelligences. Writing a poem and engaging in a debate are two distinct activities that each draw on linguistic intelligence. Moreover, it is not the case that a skilled debater will necessarily be a successful poet. In addition to using linguistic intelligence, a debater may employ logical-mathematical intelligence to structure a coherent argument, whereas a poet may draw on musical intelligence to compose a sonnet. Other factors besides intelligence, such as motivation, personality, and will power, will likely prove influential, as well.

Other putative general capacities, like memory and critical thinking, may not be so general, either. For instance, we know that individuals draw on different types of memory for different purposes. Episodic memory enables us to remember particular events like a high school graduation or wedding, whereas procedural memory allows us to recall how to drive a car or knit a scarf. These different types of memory draw on different neural systems of the brain. Neuropsychological evidence documents that memory for one type of content, such as language, can be separated from memory for other types of content, such as music, shapes, movement, and so on (Gardner, 2006b). Similarly, the kind of critical thinking required to edit a book is certainly different from the kind of critical thinking required to balance a budget, plan a dinner party, transpose a piece of music, or resolve a domestic conflict.

The understanding that intelligences operate on specific content can also help to distinguish them from sensory systems. Whereas sensory systems are the means through which the brain receives information from the outside world, the intelligences have been conceptualized as computational systems that make sense of that information once it has been received and irrespective of the means of reception. Thus, the senses and the intelligences are independent systems. The type and quality of the information received by a sensory system determines the intelligence, or set of intelligences, employed, not the sensory system itself. Thus, linguistic intelligence can operate equivalently on language that is perceived through eye, ear, or touch. Even musical intelligence, which is most closely linked to a specific sensory system (audition), may be fractionated into information that can be obtained via diverse transducers (e.g. rhythm, timbre).

The distinction between an intelligence and a skill is another common source of confusion. Unlike sensory systems, which precede intellectual work, skills manifest as a product of such work. More specifically, they are the cognitive performances that result from the operation of one or more intelligences (Gardner & Moran, 2006). Within and across cultures, the types of skills displayed by individuals vary widely, from cartoon drawing to swimming, from writing computer code to navigating ships. Skills act on the external world. As a result, they are shaped by the supports and constraints of the environment. Thus, whether an individual's bodily-kinesthetic and spatial intelligences are put to use in swimming or marine navigation depends on an individual's access to a body of water, a willing instructor, and time for practice. Living in a culture that values the ability to swim or sail (or scuba dive or catch fish) is another influential factor.

Skills can be grouped according to the domain in which they operate. A domain (a neutral term designed to encompass a profession, discipline, or craft) is any type of organized activity in a society in which individuals demonstrate varying levels of expertise. A list of domains can readily be generated by considering the broad range of occupations in a society, such as lawyer, journalist, dancer, or electrician. (In modern society, the yellow pages serve as a convenient index of significant domains). As such, a domain is a social construct that exists outside the individual, in society; skills in that domain can be acquired through various routes. An intelligence, on the other hand, is a biopsychological potential that all individuals possess by virtue of being human.

Because some domains have the same name as certain intelligences, they are often conflated. However, an individual can, and often does, draw on several intelligences when performing in a given domain. A successful musical performance, for example, does not simply depend on musical intelligence; bodily-kinesthetic, spatial, and even interpersonal and intrapersonal intelligences are likely at work, as well. By the same token, fluent computation of an intelligence does not dictate choice of profession; a person with high interpersonal intelligence might choose to enter teaching, acting, public relations, sales, therapy, or the ministry.

Domains are continually being reshaped by the work of creative individuals (Feldman, 1980). Newton changed the domain of physics with his universal law of gravitation and laws of motion, and Einstein re-conceptualized it again with his theory of relativity. Like intelligences, creativity involves solving problems or fashioning products; however, creativity requires doing so in *a novel way*. Yet, novelty in itself does not constitute creativity. An individual who fashions a novel product may not necessarily alter a domain. Sufficient mastery of a domain is

required to detect certain anomalies and formulate new techniques or ideas that resolve these anomalies. Since it generally takes ten years, or several thousand hours, to master a domain, and several more years to alter it (Hayes, 1989; Simon & Chase, 1973), creativity requires concerted focus and dedication to one domain. For this reason, a person rarely achieves high levels of creativity in more than one domain. Moreover, individuals do not have the final word on their creativity. According to Csikszentmihalyi (1996), creativity is a communal judgment that is ultimately rendered by the gatekeepers and practitioners of the domain; there is no statute of limitations as to when these judgments are made.

In contrast, the intelligences are used daily across a variety of domains. In one day, a person may use linguistic intelligence to write a letter to a friend, read the assembly instructions for a piece of furniture, and question the fairness of a government policy in a class debate. In developing one or more intelligences to a high degree, individuals become experts in a domain and are readily recognized as such. It may well be that individuals who become experts exhibit a personality configuration and motivational structure quite different from that displayed by creators (Gardner, 1993). For example, creators are likely to take on risks and deal easily with setbacks, while experts may be risk-averse and aim toward perfection in well-developed spheres.

In delineating the boundaries of an intelligence, Gardner hesitated to posit an executive function (a “central intelligences agency”) that coordinates the relationships among the intelligences, or between the intelligences and other human capacities (Gardner, 1983, 2006b). The first problem one encounters when considering an executive function is the prospect of infinite regression: who is in charge of the executive? Further, it is worth noting that many human groups, whether artistic, athletic, or corporate, follow a decentralized model of organization and perform effectively without an executive whose role it is to coordinate and

direct behavior. At the same time, neuropsychological evidence suggests that particular executive functions, such as self-regulation and planning, are controlled by mechanisms in the frontal lobe. Instead of viewing such functions as constituting a separate entity that oversees the intelligences and other human capacities, Gardner and Moran (2007) argue that executive functions are likely one, clearly vital, emerging component of intrapersonal intelligence. Defined as the capacity to discern and use information about oneself, intrapersonal intelligence engenders a sense of personal coherence in two ways: by providing understanding of oneself, or self-awareness; and by regulating goal-directed behavior, or executive function. Thus, executive function is that part of intrapersonal intelligence responsible for planning and organizing actions in a deliberative and strategic way. Viewed in this way, executive function does not form the apex of a hierarchical structure, but rather constitutes one vital component of an essentially decentralized process.

Assessing candidate intelligences

Over the years, there have been many calls for new intelligences to be added to the original list of seven. Yet, as noted above, in more than twenty five years, the list has only grown by one (and a possible second). This relatively small expansion is partly due to Gardner's intellectual conservatism; mostly, however, it can be attributed to the failure of candidate intelligences to meet sufficiently the criteria for inclusion. For instance, some of the proposed intelligences are really general capacities that do not operate on specific content. Posner's (2004) "attention intelligence" and Luhrmann's (2006) "absorption intelligence" fall into this category. Absorption is arguably one component of attention and both are prerequisites for intellectual work. It is not evident how either one is tied to specific content, information, or objects in the world. For this reason, attention and absorption are perhaps more properly viewed as

components of the sensory systems that precede and facilitate the operation of any one of the intelligences.

Artistic intelligence is another candidate intelligence that is not tied to any specific content. Since each intelligence can be used in an artistic or a non-artistic way, it does not make sense to speak of a separate artistic intelligence. Linguistic intelligence is used by both playwrights and lawyers, and spatial intelligence is used by sculptors and building contractors. Musical intelligence may be used to compose a symphony, to announce the arrival of horses onto a race track, or to soothe pain in the dental chair. The decision to deploy an intelligence more or less artistically is left to the individual. The culture in which he or she lives can also prove consequential, as cultures vary in the degree to which they encourage and support artistic expression.

Candidate intelligences raise additional considerations. Scholars (including Gardner himself) have explored the possibility of a moral intelligence (Boss, 1995; Gardner, 1997, 2006b). Morality is clearly an important component of human society, but it is not clear that it is felicitously described as an intelligence. MI theory is descriptive, not normative. As computational capacities based in human biology and human psychology, intelligences can be put to either moral or immoral uses in society. Martin Luther King, Jr. used his linguistic intelligence to craft and deliver inspiring speeches about the quest for civil rights through peaceful means. In stark contrast, Slobodan Milosevic used his linguistic intelligence to call for the subjugation and eventual extermination of entire groups of people. The two men also deployed their interpersonal intelligences in distinct ways. MI theory merely delineates the boundaries of biopsychological capacities; the way in which one decides to use these capacities is a separate matter.

A closer look at another oft-proposed candidate—humor intelligence—underscores a second ploy. There is no need to add a new intelligence when it can be explained through a combination of existing intelligences. Thus, humor can be seen as a playful manipulation of our logical capacity. Comedians draw on their logical-mathematical intelligence to turn the logic of everyday experience on its head. They also employ their interpersonal intelligence to “read” an audience and make decisions about the timing of individual jokes and the overall direction of their act. In this way, it is more appropriate to speak of comedians as exercising a particular blend of logical-mathematical and interpersonal intelligences rather than as displaying separate humor intelligence. In a similar manner, Battro and Denham (2007) make an intriguing case for a digital intelligence, but it is not clear whether or how digital intelligence can be untangled from logical-mathematical intelligence (with a smidgeon of bodily-kinesthetic intelligence tacked on).

Cooking is another candidate intelligence that is more properly viewed as an amalgam of existing intelligences. In preparing a meal, for instance, one might draw on interpersonal intelligence to decide on a menu that will please the guests; linguistic intelligence to read the recipe; logical-mathematical intelligence to adjust the ingredient measurements for the size of the party; and bodily-kinesthetic intelligence to dice the vegetables, tenderize the meat, and whip the cream. The preparation of a fine meal may also draw on the only full-fledged addition to the original list of intelligences: naturalist intelligence. Cooks will draw on their naturalist intelligence to distinguish among ingredients and perhaps tweak a recipe by combining ingredients in an unexpectedly flavorful way. Of course, sensory systems are important in cooking, but it is the operations performed upon the sensory information that yields intelligent (or non intelligent!) outcomes.

PART 3: Scholarly Work in the wake of MI theory

Since its inception the theory of multiple intelligences has been a subject of scholarly inquiry and educational experimentation. We here examine three major fronts: research, assessment, and educational interventions.

Research

A notable point of departure is the problem of how to decide which research is relevant to testing MI theory as it has been described in these pages. Some research that is described in MI terms may be irrelevant (e.g., informal and unvalidated questionnaires, assessments using paper and pencil or multiple-choice tests alone), whereas research that does not mention MI explicitly could be important (e.g., transfer and correlations between competencies, aptitude-treatment interactions, parsimonious models of cognitive neuroscience brain activation patterns, etc.). Other conceptions of intellect have faced a similar challenge in psychology (Mayer & Caruso, 2008).

Cognitive Neuroscience and MI

Evidence for the several intelligences came originally from the study of how mental faculties were associated or dissociated as a consequence of damage to the brain, and especially to cortical structures. With the surge in the types of neuroimaging tools in the recent decades, far more specified inquiries relevant to MI are possible. Nowadays a consensus obtains that there is not a one-to-one correspondence between types of intelligence and areas of the cortex. Nonetheless it is still germane to detail how the constructs outlined by MI can relate to brain structure and function.

Until this point, most neuroimaging studies of intellect have examined the brain correlates of general intelligence (IQ). These studies have revealed that general intelligence is

correlated with activations in frontal regions (Duncan et al., 2000) as well as several other brain regions (e.g., Jung & Haier, 2007), and with speed of neural conduction (Gotgay et al., 2004). An analogous kind of study can be carried out with respect to specific intelligences (cf. emotional intelligence as reviewed by Mayer, Roberts & Barsade, 2008). Ultimately it would be desirable to secure an atlas of the neural correlates of each of the intelligences, along with indices of how they do or not operate in concert. Researchers should remain open to the possibility that intelligences may have different neural representations, in different cultures—the examples of linguistic intelligence (speaking, reading, writing) comes to mind.

From a neuropsychological point of view, the critical test for MI theory will be the ways in which intellectual strengths map onto neural structures and connections. It could be, as proponents of general intelligence claim, that individuals with certain neural structures and connections will be outstanding in all or at least, predictably, in some intelligences. Were this to be the case, the neuropsychological underpinnings of MI theory would be challenged. It could also be the case that individuals with intellectual strengths in a particular area show similar brain profiles, and that those who exhibit contrasting intellectual strengths show a contrasting set of neural profiles. It might also be the case that certain neural structures (e.g. precociously developing frontal lobes) or functions (speed of conduction) place one “at promise” for intellectual precocity more generally, but that certain kinds of experiences then cause specialization to emerge—in which case, a profile of neurally-discrete intelligences will ultimately consolidate.

Similar lines of argument can unfold with respect to the genetic basis of intelligence. To this point, those with very high or very low IQs display distinct combinations of genes, though it is already clear that there will not be a single gene, or even a small set of genes, that code for

intellect. What remains to be determined is whether those with quite distinctive behavioral profiles (e.g. individuals who are highly musical, highly linguistic and/or highly skilled in physical activities) exhibit distinctive genetic clusters as well. Put vividly, can the Bach family or the Curie family or the Polgar family be distinguished genetically from the general population and from one another? Or, as with the neural argument just propounded, certain genetic profiles may aid one to achieve expertise more quickly, but the particular area of expertise will necessarily yield quite distinctive cognitive profiles in the adult.

It is germane to inquire whether, should neural evidence and genetic evidence favor the notion of a single general intelligence and provide little evidence for biological markers of the specific intelligences, MI theory will be disproved scientifically. A question will still remain about how individuals end up possessing quite distinct profiles of abilities and disabilities. Whether the answer to that question will lie in studies drawn from genetics, neurology, psychology, sociology, anthropology, or some combination thereof, remains to be determined.

MI Assessments

From the start, a distinctive hallmark of MI theory has been its spurning of simple paper-and-pencil or “one shot” behavioral measures. Instead, with respect to assessment, Gardner has called for multiple measures of performance and ecologically valid testing environments and tasks. This approach to MI has been actualized by a large initiative for children, Project Spectrum.

Project Spectrum is an assessment system for young children that features a classroom rich in opportunities to work with different materials—in the manner of a well-stocked children’s museum (Gardner, et al, 1998a, 1998b, 1998c; Malkus et al 1988; Ramos-Ford, Feldman, &

Gardner, 1988; see also <http://www.pz.harvard.edu/research/Spectrum.htm>). The Spectrum approach yields information based on meaningful activities that allow for a demonstration of the strengths of the several intelligences. While validity is not something that can be examined with preschoolers, Spectrum tasks have been shown to demonstrate reliability (Gardner et al., 1998a, 1998b, 1998c).

Spectrum transcends traditional assessments such as the IQ tests in several ways. First, it highlights components of thought (e.g. musical competence, knowledge of other persons) that are not typically considered indices of smartness (Gardner, 1993). Second, the assessment is based on “hands on” activities that have proved to be engaging and meaningful for preschool children drawn from a range of social backgrounds (Chen & Gardner, 1997). Third, the initiative seeks to document approaches to learning (working styles) as well as the distribution of strengths and weaknesses across the several intelligences—the so called Spectrum Profile. (For a comprehensive description of components and guidelines by domain for *activities*, see Adams & Feldman, 1993; Krechevsky, 1998; Krechevsky & Gardner, 1990; for *observational guidelines* see Chen and Gardner, 1997).

Empirical studies using the Project Spectrum materials have been instructive and useful. In one study, researchers worked with at-risk students in a local elementary school’s first grade (Chen & Gardner, 1997). The majority of students (13/15) demonstrated identifiable strengths based on assessments spanning many areas of performance including visual arts, mechanical science, movement, music, social understanding, mathematics, science and language (Chen & Gardner, 1997). Gardner (1993) has described this approach as efforts to identify *how* a student is smart as opposed to *whether* the student is smart. Identifying such strengths has the potential

to detach an at-risk or struggling student from uni-dimensional labels and offer a more holistic formulation with respect to student strengths and potentials.

Other empirical investigations have sought to document the validity of MI claims. Visser et al. (2006) operationalized the 8 intelligences and selected two assessments for each. Further, the researchers categorized the intelligences into purely cognitive (linguistic, spatial, logical-mathematical, naturalistic, and interpersonal), motor (bodily-kinesthetic), a combination of cognitive and personality (intrapersonal and possibly interpersonal), and a combination of cognitive and sensory (musical). Study results showed a strong loading on *g*, or general intelligence, for intelligences categorized as cognitive as well as intercorrelations among intelligences, suggesting that strong MI claims are not held up empirically.

The study findings stand in contrast to those reported from Project Spectrum studies, as well as those put forth by other investigators (e.g. Maker, Nielson, & Rogers, 1994). These contrasting results may be attributed to the use of standard psychometric measures, as opposed to the employment of broader (but less specific) tasks that aim for ecological validity and that can be used routinely in the course of daily school activities.

As a visit to any search engine will document, many researchers and practitioners of an educational bent have developed rough-and-ready measures of the several intelligences. The best known such effort is Branton Shearer's *Multiple intelligences developmental assessment scale* (MIDAS) (1999), which has been used as a tool for measuring MI in many research projects (i.e., dissertations, Masters' theses; see <http://209.216.233.245/aerami/dissertations.php>). Such measures provide a snapshot of how individuals view their own intellectual profiles. Such self descriptions do not, however, allow one to distinguish one's own preferences from one's

own computational abilities, nor is it clear that individuals are necessarily competent to assess their areas of strength. (How many persons consider themselves in the bottom half of the population with respect to driving skill, or sense of humor?) Optimally, descriptions of a person should come from several knowledgeable individuals, not just the person him- or herself. And optimally, the measures should tap actual intellectual strengths. Of the methods with which we are familiar, Project Spectrum comes closest to meeting these desiderata.

With respect to assessment generally, Gardner and colleagues (Chen & Gardner, 1997) have advocated several key points. As reviewed earlier, an important starting point is the assumption that intelligence may be pluralistic rather than a unitary entity. Another key point is that the intelligences are shaped by cultural and educational influences; it follows that measuring them in natural contexts is preferable, if the results are to be ecologically valid. Recognizing the limitations of static assessment is also important – while such assessment sessions may serve other purposes, they do not fulfill the tenets of MI which calls for dynamic assessment to accompany the use of intelligences in culturally-meaningful contexts.

Perhaps most important, intelligences can never be observed in isolation; they can only be manifest in the performance and tasks of skills that are available, and optimally, valued in a cultural context. Hence the notion of a single measure of an intelligence makes little sense. Rather, any intelligence—say linguistic—ought to be observed in several contexts—speaking, reading, telling a story, making an argument, learning a foreign language, etc. Taken together, such diverse measures would converge on linguistic intelligence; one assumes that what each task shares in common with the remaining tasks is reliance on some facet of linguistic intelligence. In sum, MI assessment calls for multiple measures for each intelligence and “intelligence-fair” materials that do not rely on verbal or logical-mathematical skills. Gold

standard MI assessments should avoid several pitfalls and aim for several goals, summarized in Table 1.

Table 1. Assessment characteristics for the multiple intelligences and traditional counterparts

Traditional Assessments	MI Assessments
Over-reliance on linguistic and logical mathematical abilities and measures	Sample the gamut of intelligences and domains
Deficit-focused	Identify relative and absolute strengths
Minimal intrinsic value to activity/tasks	Immediate feedback to students; Meaningful for students; materials with which children are familiar
Performance captured in a single score	Scores on a range of tasks, across several domains. for each intelligences
Detached from context	Ecological validity; Present problems in the context of problem solving; Instructive for teachers

(Adapted from Chen & Gardner, 1997)

Research on MI as an Educational Intervention

We turn finally to studies of educational settings that have developed methods based on the core ideas of MI theory. In the most ambitious study to date, Kornhaber, Fierros, and Veenema (2004) compiled data on the impact of MI across many educational settings using

interview and questionnaire data on educators' perceived impact of MI. Featured were interview data from 41 schools, which had been implementing MI-inspired curricular practices for at least three years. Staff at four fifths of schools associated improvements in standardized test scores with the implementation of MI. Additionally, MI was also associated with improvements in student discipline (54% of schools), parent participation (60% of schools), and performances of students diagnosed with learning disabilities (78% of schools). The researchers attributed the success of MI-based practices to six *compass point practices*: attention to the school culture, readiness to use MI, use of MI as a tool for improved work quality, collaborations, opportunities for choice, and a role for the arts.

Investigations of MI in educational settings have taken several forms, including descriptions of how the theory contributes to education (e.g., Barrington, 2004), how MI can be applied in the curriculum (e.g., Dias-Ward & Dias, 2004; Nolen, 2003; Ozdemir, Guneyusu, & Tekkaya, 2006; Wallach & Callahan, 1994), and how MI operates within or across schools (e.g., Campbell & Campbell, 1999; Greenhawk, 1997; Hickey, 2004; Hoerr, 1992, 1994, 2004; Wagmeister & Shifrin, 2000). MI approaches have been credited with better performance and retention of knowledge as compared to a traditional approach (for science instruction for 4th graders) (Ozdemir et al., 2006) and with understanding content in more complex ways (Emig, 1997). Similarly, MI approaches in the curriculum have been credited with giving teachers a framework for making instructional decisions (Ozdemir et al., 2006). Teele, who has devised one of the principal MI self-administered instruments, suggests that “intrinsic motivation, positive self-image, and a sense of responsibility develop when students become stakeholders in the educational process and accept responsibility for their own actions” (1996, p. 72).

PART 4: Conclusion: Looking ahead

In a number of ways, MI theory differs from other psychological approaches to intelligence. Rather than proceeding from or creating psychometric instruments, the theory emerged from an interdisciplinary consideration of the range of human capacities and faculties. The theory has garnered considerable attention, far more in educational circles than in the corridors of standard psychological testing and experimentation. Consistent with that emphasis, numerous educational experiments build on MI theory, and many of them claim success. However, because MI theory does not dictate specific educational practices, and because any educational intervention is multi-faceted, it is not possible to attribute school success or failure strictly to MI interventions. Direct experimental tests of the theory are difficult to implement and so the status of the theory within academic psychology remains indeterminate. The biological basis of the theory—its neural and genetic correlates—should be clarified in the coming years. But in the absence of consensually-agreed upon measures of the intelligences, either individually or in conjunction with one another, its psychological validity will continue to be elusive.

What does the future hold for MI theory? It seems reasonable to expect that these ideas will continue to be of interest to educators and other practitioners. Having initially catalyzed an interest in elementary schools, particularly with respect to students with learning problems, the theory has been picked up by schools of all sorts, as well as museums and other institutions of informal learning. MI ideas are also invading other occupational spheres, such as business, and have proved of special interest to those charged with hiring, assembling teams, or placement of personnel (Moran & Gardner, 2006).

Uses of MI ideas within and outside of formal educational settings hold great promise. In particular, new digital media and virtual realities offer numerous ways in which learners can master required knowledge and skills. At one time, it may have seemed advisable or even necessary to search for the ‘one best way’ to teach a topic. Now, at a time when computers can deliver contents and processes in numerous ways, and when learners can take increasing control of their own educational destinies, a plurality of curricula, pedagogy, and assessments figures to become the norm. Individualized education does not depend on the existence of MI theory; and yet MI-inspired practices provide promising approaches for effective teaching and learning (Birchfield et al., 2008). Moreover, as lifelong learning becomes more important around the world, the prospects of developing, maintaining, and enhancing the several intelligences gains urgency.

Initially, MI ideas were introduced in the United States and the first MI-inspired experiments took place there. But over the last two decades, MI ideas and practices have spread to numerous countries and regions. There are both striking similarities and instructive differences in the ways in which these regions implement MI ideas, formally and informally. An initial survey appears in ‘Multiple Intelligences Around the World’ (Chen, Moran, & Gardner, 2009). In addition to chronicling numerous implementations of MI theory in more than a dozen countries, this work also provides a fascinating and original portrait of how “memes” about intelligence take and spread in different educational soils.

Gardner has long maintained that MI cannot be an educational goal in itself. Educational goals, value judgments, must emerge from discussions and debates among responsible leaders and citizens. Once goals have been laid out, the question then arises: How and in what ways, can MI ideas aid in the achievement of these goals? To be sure, a tight answer to that question can

rarely be given. Nonetheless, over time it should certainly become clearer which MI ideas, in combination with which goals, have pedagogical effectiveness and which do not. Within Project Zero, the research group with which Gardner has been associated since its inception in 1967, MI ideas have proved particularly congenial with the goal of ‘education for deep understanding.’ (Gardner 1999, 2006b).

Whether or not explicitly recognized as such, MI ideas are likely to endure within the worlds of education, business, and daily practice—like the terms ‘emotional intelligence’ and ‘social intelligence’ (Goleman 1995, 2006), they are already becoming part of the conventional wisdom. The status of MI theory within psychology, biology, and other social and natural sciences remains to be determined. Attempts will be made to define and redefine the set of intelligences, to evaluate the criteria by which they are identified and measured, to consider their relationships to one another, and their status vis-à-vis ‘general intelligence.’ In all probability, like other attempts at intellectual synthesis, some facets will become accepted in scholarship, while other parts will fade away or remain topics for debate. What is most likely to last in MI theory is the set of criteria for what counts as an intelligence and the idea of intelligence as being pluralistic, with links to specific contents in the human and primate environments. The particular list of intelligences and sub-intelligences will doubtless be reformulated as a result of continuing studies in psychology, neuroscience, and genetics.

References

- Adams, M., & Feldman, D. H. (1993). Project Spectrum: A theory-based approach to early education. In R. Pasnak & M. L. Howe (Eds.), *Emerging themes in cognitive development*. New York: Springer-Verlag.
- Armstrong, T. (1994). *Multiple intelligences in the classroom*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Barrington, E. (2004). Teaching to student diversity in higher education: How multiple intelligence theory can help. *Teaching in Higher Education*, 9, 421-434.
- Battro, A. M., & Denham, P. J. (2007). *Hacia una inteligencia*. Buenos Aires: Academia Nacional de Educación.
- Binet, A., & Simon, T. (1911). *A method of measuring the development of the intelligence of young children*. Lincoln, IL: Courier Company.
- Binet, A., & Simon T. (1916). *The development of intelligence in children*. Baltimore: Williams Wilkins.
- Birchfield, D., Thornburg, H., Megowan-Romanowicz, C., Hatton, S., Mechtley, B., Dolgov, I., Burleson, W. (2008). Embodiment, multimodality, and composition: Convergent themes across HCI and education for mixed-reality learning environments. *Journal of Advances in Human-Computer Interaction*, Volume 2008, Article ID 874563.
- Boss, J. (2005). The autonomy of moral intelligence. *Educational Theory*, 44 (4), 399-416.
- Brody, N. (2004). What cognitive intelligence is and what emotional intelligence is not. *Psychological Inquiry*, 15 (3), p234-238.
- Campbell, L., & Campbell, B. (1999). *Multiple intelligences and student achievement*. Alexandria, VA: ASCD.
- Ceci, S. J. (1990). *On intelligence, more or less: A bioecological treatise on intellectual development*. Englewood Cliffs, NJ: Prentice Hall.
- Ceci, S. J. (1996). *On Intelligence* (rev. ed.). Cambridge, USA: Harvard University Press.
- Chen, J.-Q., & Gardner, H. (1997). Assessment based on Multiple-Intelligences Theory. In D. P. Flanagan & P. L. Harrison (Eds.), *Contemporary Intellectual Assessment: Theories, tests, and issues* (Vol. 2, pp. 77-102). NY: Guilford Press.
- Chen, Jie-Qi. & Gardner, H. (2005). Multiple Intelligences: Assessment based on Multiple-Intelligence Theory. In D. Flanagan and P. Harrison (Eds.) *Contemporary intellectual assessment: Theories, tests and issues*. New York: Guilford Press.

- Chen, J., Moran, S., & Gardner, H. (2009). *Multiple intelligences around the world*. New York: Jossey-Bass.
- Csikszentmihalyi, M. (1996). *Creativity : Flow and the psychology of discovery and invention* (1st ed.). New York: HarperCollinsPublishers.
- Danfoss Universe. (2007). Retrieved July 1, 2007 from <http://www.danfossuniverse.com>.
- Deary, I., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence*, 35, 13-21.
- Diamond, M., and Hopson, J. (1998). *Magic trees of the mind: How to nurture your child's intelligence, creativity, and healthy emotions from birth through adolescence*. New York: Dutton.
- Dias Ward, C., & Dias, M. J. (2004). Ladybugs across the curriculum. *Science and Children*, 41(7), 40-44.
- Emig, V. B. (1997). A multiple intelligences inventory. *Educational Leadership*, 55(1), 47.
- Eysenck, H. (1994). Manual for the Eysenck personality questionnaire (EPQ-R Adult). Educational Industrial Testing Service.
- Feldman, D. H. (1980). *Beyond universals in cognitive development*. Norwood, N.J.: Ablex Pub. Corp.
- Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.
- Gardner, H. (1993). *Frames of mind: The theory of multiple intelligences* (10 anniversary ed.). New York, NY: Basic Books.
- Gardner, H. (1997). Is there a moral intelligence? In M. Runco (Ed.), *The creativity research handbook*. Cresskill, NJ: Hampton Press.
- Gardner, H. (1999). *The disciplined mind : What all students should understand*. New York: Simon & Schuster.
- Gardner, H. (2006a). *Five minds for the future*. Boston, MA: Harvard Business School Press.
- Gardner, H. (2006b). *Multiple intelligences: New horizons*. New York: Basic Books.
- Gardner, H. (2006c). Replies to my critics. In J. A. Schaler (Ed.), *Howard gardner under fire: The rebel psychologist faces his critics* (pp. 277-344). Chicago: Open Court.
- Gardner, H. Feldman, D.H. & M. Krechevsky, M. (Gen. Eds.). (1998a). Project Zero frameworks for early childhood education: Volume 1, Building on children's strengths: The

- experience of Project Spectrum. Volume authors Chen, J-Q., Krechevsky, M., and Viens, J. with E. Isberg. New York: Teachers College Press. Translated into Chinese, Italian, Spanish, and Portuguese.
- Gardner, H. Feldman, D.H. & Krechevsky, M. (Gen. Eds.). (1998b). Project Zero frameworks for early childhood education: Volume 2, Project Spectrum early learning activities. Volume author Chen, J-Q., with E. Isberg and M. Krechevsky. New York: Teachers College Press. Translated into Chinese, Italian, Spanish, and Portuguese.
- Gardner, H. Feldman, D.H. & Krechevsky, M. (Gen. Eds.). (1998c). Project Zero frameworks for early childhood education: Volume 3, Project Spectrum preschool assessment handbook. Volume author Krechevsky, M. New York: Teachers College Press. Translated into Chinese, Italian, Spanish and Portuguese.
- Gardner, H., & Laskin, E. (1995). *Leading minds: An anatomy of leadership*. New York, NY: BasicBooks.
- Gardner, H., & Moran, S. (2006). The science of multiple intelligences theory: A response to Lynn Waterhouse. *Educational Psychologist*, 41(4), 227-232.
- Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., et al. (2004). Dynamic mapping of human cortical development during childhood through early adulthood. *PNAS*, 101(21), 8174-8179.
- Goleman D. 1995. *Emotional intelligence*. New York: Bantam Books.
- Goleman, D. (2006). *Social intelligence: The new science of human relationships*. New York: Bantam Books.
- Greenhawk, J. (1997). Multiple intelligences meet standards. *Educational Leadership*, 55(1), 62-64.
- Guilford, J. P. (1967). *The nature of human intelligence*. New York: McGraw-Hill.
- Guilford, J. P., & Hoepfner, R. (1971). *The analysis of intelligence*. New York: McGraw-Hill.
- Haier, R. J., & Jung, R. E. (2007). Beautiful minds (i.e., brains) and the neural basis of intelligence. *Behavioral and Brain Sciences*, 30(02), 174-178.
- Hayes, J. R. (1989). Cognitive processes in creativity. In J. A. Glover, R. R. Ronning, C. R. Reynolds, J. A. Glover, R. R. Ronning & C. R. Reynolds (Eds.), *Handbook of creativity*. (pp. 135-145). New York, NY US: Plenum Press.
- Herrnstein R.J. & Murray C. (1994). *The Bell Curve: Intelligence and Class Structure in American Life*. New York: Free Press.

- Hoerr, T. (2004). How MI Informs Teaching at New City School. *Teachers College Record*, 106(1), 40-48.
- Hoerr, T. R. (1992). How our school applied multiple intelligences theory. *Educational Leadership*, 50(2), 67-68.
- Hoerr, T. R. (1994). How the New City School applies the multiple intelligences. *Educational Leadership*, 52(3), 29-33.
- Jensen, A. R. (1980). *Bias in mental testing*. New York: Free Press.
- Jensen, A. R. (1998). *The g factor: The science of mental ability*. Westport, USA: Praeger/Greenwood.
- Jensen, A. (2008). Why is reaction time correlated with psychometric 'g'? *Current Directions in Psychological Science*, 2 (2), 53-56.
- Kornhaber, M. (1994) *Multiple intelligences: Why and how schools use it*. Unpublished qualifying paper, Harvard Graduate School of Education.
- Kornhaber, M., Fierros, E., & Veenema, S. (2004). *Multiple Intelligences: Best Ideas from Research and Practice*. Boston: Pearson Education Inc.
- Krechevsky, M. (1998). *Project Spectrum preschool assessment handbook*. New York: Teachers College Press.
- Krechevsky, M., & Gardner, H. (1990). The emergence and nurturance of multiple intelligences: The Project Spectrum approach. In M. J. Howe (Ed.), *Encouraging the development of exceptional skills and talents*. Leicester, UK: British Psychological Society.
- Lucas, A., Morley, R., Cole, T. (1998). Randomised trial of early diet in preterm babies and later intelligence quotient. *British Medical Journal*, 317, 1481-1487.
- Luhrmann, T. M. (2006). On spirituality. In J. A. Schaler (Ed.), *Howard gardner under fire: The rebel psychologist faces his critics* (pp. 115-142). Chicago: Open Court.
- Maker, C. J., Nielson, A. B., & Rogers, J. A. (1994). Giftedness, diversity, and problem-solving. *Teaching Exceptional Children*, 27(1), 4-19.
- Malkus, U. C., Feldman, D. H., & Gardner, H. (1988). Dimensions of mind in early childhood. In A. D. Pellegrini, & A. D. Pellegrini (Eds.), *Psychological bases for early education*. (pp. 25-38). Oxford England: John Wiley & Sons.
- Mayer, J. D., Roberts, R. D., & Barsade, S. G. (2008). Human Abilities: Emotional Intelligence. *Annual Review of Psychology*, 59(1), 507-536.

- Moran, S., & Gardner, H. (2006). Multiple intelligences in the workplace. In H. Gardner, *Multiple intelligences: New horizons* (pp. 213-232). New York: Basic Books.
- Moran, S. & Gardner, H. (2007). "Hill, skill, and will": Executive function from a multiple-intelligences perspective. In L. Meltzer (Ed.), *Executive function in education: From theory to practice* (pp. 19-38). New York: The Guilford Press.
- Neisser, U., Boodoo, G., Bouchard, T., Boykin, A. W., Brody, N., Ceci, S. J., Halpern, D., Loehlin, J., Perloff, R., Sternberg, R. & Urbina, S. (1996) Intelligence: Knowns and unknowns. *American Psychologist* 51, 77–101.
- Nisbett, R. E. (2009). *Intelligence and how to get it: Why schools and cultures count*. New York: W W Norton & Co.
- Nolen, J. L. (2003). Multiple intelligences in the classroom. *Educational Leadership*, 124(1), 115-119.
- Özdemir, P., Güneysu, S., & Tekkaya, C. (2006). Enhancing learning through multiple intelligences. *Journal of Biological Education*, 40(2), 74-78.
- Perkins, D. & Tishman, S. (2001). Dispositional aspects of intelligence. In J. Collis, S. Messick, & U. Scheifele (Eds.). *Intelligence and Personality: Bridging the Gap in Theory and Measurement*. Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.
- Piaget, J. (1950). *The psychology of intelligence*. London: Routledge & Paul.
- Piaget, J. (1952). *The origins of intelligence in children*. New York: International Universities Press.
- Posner, M. I. (2004). Neural systems and individual differences. *Teachers College Record*, 106(1), 24-30.
- Ramos-Ford, V., Feldman, D. H., & Gardner, H. (1988). A new look at intelligence through project spectrum. *New Horizons for Learning*, 8(3), 6-15.
- Shearer, B. (1999). *Multiple intelligences developmental assessment scale*. Kent, OH: Multiple Intelligences Research and Consulting.
- Shearer, C.B. (2004). Using a multiple intelligences assessment to promote teacher development and student achievement. *Teachers College Record*, 106(1), 147-162.
- Silver, H., & Strong, R. (1997). Integrating learning styles and multiple intelligences. *Educational Leadership*, 55(1), 22.
- Simon, H. A., & Chase, W. (1973). Skill in chess. *American Scientist*, 61, 394-403.

- Spearman, Charles. (1904) General intelligence, objectively determined and measured. *American Journal of Psychology*. 15, 201-293.
- Spearman, C. (1927). *The abilities of man*. London, UK: Macmillan.
- Stanford-Binet Intelligences Scales (SB5), Fifth Edition (2003). Riverside Publishing.
<http://www.riverpub.com/products/sb5/scoring.html>
- Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*.
 New York, USA: Cambridge University Press.
- Sternberg, R. J. (1990). *Metaphors of mind*. New York, USA: Cambridge University Press.
- Teele, S. (1996). Redesigning the Educational System To Enable All Students To Succeed. *NASSP Bulletin*, 80(583), 65-75.
- Thorndike, E (1920). A constant error in psychological ratings. *Journal of Applied Psychology*, 4, 25-29.
- Thorndike, E., Bregman, E., Cobb, M., & Woodyard, E. (1927). *The measurement of intelligence*. New York: Teachers College Bureau of Publications.
- Thurstone, L. (1938). *Primary mental abilities*. Chicago: University of Chicago Press.
- Thurstone, L. L., & Thurstone, T. G. (1941). *Factorial studies of intelligence*. Chicago: University of Chicago Press.
- Visser, B. A., Ashton, M. C., & Vernon, P. A. (2006). Beyond g: Putting multiple intelligences theory to the test. *Intelligence*, 34(5), 487-502.
- Wagmeister, J., & Shifrin, B. (2000). Thinking Differently, Learning Differently. *Educational Leadership*, 58(3), 45.
- Wallach, C., & Callahan, S. (1994). The 1st grade plant museum. *Educational Leadership*, 52(3), 32-34.
- Waterhouse, L. (2006). Multiple intelligences, the mozart effect, and emotional intelligence: A critical review. *Educational Psychologist*, 41(4), 207-225.
- Wechsler Adult Intelligence Scales, Fourth Edition (2008). Pearson.
<http://www.pearsonassess.com>
- White, J. (2006). Multiple invalidities. In J. A. Schaler (Ed.), *Howard gardner under fire: The rebel psychologist faces his critics* (pp. 45-72). Chicago: Open Court.
- Willingham, D. T. (2004). Reframing the mind. *Education Next*, 4(3), 19-24.