Multiplying the Problems of Intelligence by Eight: A Critique of Gardner's Theory

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Howard Gardner has theorized that the mind comprises seven (or eight) intelligences. Multiple intelligence theory has inspired educational innovations across North America, but has received little critical analysis. I contend that Gardner is on the horns of a dilemma. A "weak" version of multiple intelligence theory would be uninteresting, whereas a "strong" version is not adequately supported by the evidence Gardner presents. Pedagogically, multiple intelligence theory has inspired diverse practices, including balanced programming, matching instruction to learning styles, and student specialization. However, the theory shares the limitations of general intelligence theory: it is too broad to be useful for planning curriculum, and as a theory of ability, it presents a static view of student competence. Research on the knowledge and strategies that learners use in specific activities, and on how they construct this knowledge, may prove more relevant to classroom practice.

D'après la théorie de Howard Gardner, on trouve sept (ou huit) types d'intelligence dans l'esprit humain. Cette théorie a inspiré diverses innovations pédagogiques à travers l'Amérique du Nord, mais a fait l'objet de peu d'analyse critique. L'auteur soutient que Gardner est pris dans un dilemme. Une version "allégée" de la théorie des intelligences multiples ne serait pas intéressante tandis qu'une version "enrichie" de cette théorie n'est pas adéquatement corroborée par Gardner. En pédagogie, la théorie des intelligences multiples a inspiré diverses méthodes, dont le programme coordonné, l'appariement de l'enseignement aux styles d'apprentissage et la spécialisation des élèves. Toutefois, cette théorie offre les mêmes limites que la théorie de l'intelligence générale: elle est trop vaste pour être utile lors de la planification de programmes d'études et, en tant que théorie de l'aptitude, elle présente une vue statique des compétences de l'élève. Des études portant sur les connaissances et les stratégies dont se servent les apprenants dans des activités précises et sur la manière dont ils développent ces connaissances pourraient s'avérer plus pertinentes pour les méthodes pédagogiques.

Howard Gardner introduced the theory of multiple intelligences (MI) in his book *Frames of Mind* (1983). In place of the traditional view that there is one general intelligence, he contended that there are seven, each operating in a specific cultural domain: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal. Since then, Gardner (1995) has tentatively added "the intelligence of the naturalist," which includes the ability to understand living things and to use this knowledge productively, as in farming. Each intelligence has its own core set of operations and supports specific activities. Spatial

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intelligence, for example, mentally represents and transforms objects, and underpins navigation, mechanics, sculpture, and geometry. Because the intelligences are independent, most individuals show an uneven profile, with some intelligences greater than others (Gardner, 1983, 1993b; Gardner & Hatch, 1989).

MI has swept education in the 15 years since its inception. ERIC citations favourable to the theory run into the hundreds, including some in prestigious or widely circulating journals (e.g., Armstrong, 1994; Gardner, 1994, 1995; Gardner & Hatch, 1989; Nelson, 1995). Most authors cite MI theory as an egalitarian alternative both to the theory that there is one general intelligence, and also to the practice of teaching a curriculum that emphasizes language and mathematics. They recommend innovations ranging from planning units of study that span each intelligence (Wallach & Callahan, 1994), to enriching education for gifted or learning-disabled students in their areas of strength (Hearne & Stone, 1995; Smerechansky-Metzger, 1995), to using virtual reality to educate each intelligence (McLellan, 1994).

However, few authors have systematically evaluated MI theory. D. Matthews (1988) argued in favour of it, noting that gifted students usually excel in a single domain, such as mathematics or music. Other authors have suggested friendly revisions, such as the need for a "moral" intelligence, clarification of the theory or its implications, more evidence, or recognition of other educational concerns (Boss, 1994; Eisner, 1994; Levin, 1994). Some researchers in the psychometric tradition have rejected MI theory outright, claiming that Gardner's intelligences correlate positively with I.Q. and therefore are factors of general intelligence (Brand, 1996; Sternberg, 1983). Morgan (1992) noted the same positive correlations, and added that several of Gardner's intelligences cannot be conceptually distinguished from one another. Instead, Morgan interpreted these "intelligences" as cognitive styles. In the most sustained critique of MI, Ericsson and Charness (1994) suggested that expert performances are based on highly specific skills developed largely through extended deliberate practice, rather than on broad abilities.

CONCEPTUAL PROBLEMS

If someone were to ask, "Why is Michael a good dancer?," the MI answer would be "Because he has high bodily-kinesthetic intelligence." If the questioner then asked, "What is bodily-kinesthetic intelligence?," the answer would be "[It] is the ability to use one's body in highly differentiated and skilled ways, for expressive as well as goal-directed purposes . . . [and] to work skillfully with objects" (Gardner, 1983, p. 206). This explanation, however, is circular: the definition of bodily-kinesthetic intelligence is virtually a definition of dance, so the explanation says, in effect, that Michael is a good dancer because he is a good dancer. In fact, the explanation is less informative than the original question, which at least identified the type of physical activity in which Michael excels. MI's reliance on this sort of explanation makes the theory tautological, and, therefore, necessarily true (Smedslund, 1979). It also makes it trivial.

On the other hand, ascribing an achievement to an "intelligence" has a series of far-from-trivial implications. It means that performances are expressions of moderately general abilities, such as bodily-kinesthetic intelligence, rather than either very general abilities, such as general intelligence, or very specific skills, such as knowing how to dance. It also implies that whereas Michael may be better at dance than at other physical activities, his high "bodily-kinesthetic intelligence" should give him an advantage in these areas as well. Conversely, he need not be good at non-physical tasks, such as writing poems or solving mathematics problems. Furthermore, ascribing some level of achievement to an ability such as an "intelligence," rather than to an acquisition, such as "knowledge," suggests that this level will be relatively stable over time, and that its origins may be innate (Gardner, 1995).

Gardner (1983) goes even further, claiming that the "intelligences" are modules (pp. 55–56, 280–285) in approximately the sense proposed by Fodor (1983) or Allport (1980). Modules are neural structures that quickly process particular kinds of content. Colour vision, speech perception, and facial recognition have all been ascribed to modules. Each module is "computationally autonomous," meaning that it carries out its operations independently, and, for the most part, does not share resources with other modules. This autonomy implies that the internal workings of one module are not available to others, although the "output" of one module can become the "input" of another. In short, the implication of modularity for MI theory is that the mind is made up of seven (or eight) innate mechanisms, each of which works largely independently to handle one kind of content.

However, this independence makes the theory insufficient to account for some familiar experiences. Most activities involve several intelligences (Gardner, 1983, p. 304). Dance is both musical and physical; conversation is both linguistic and interpersonal; and solving a physics problem is both spatial and logical-mathematical. Modularity *per se* is not the problem, because the output of one module can become the input of another. But Gardner has defined the intelligences of MI in terms of their differing content, which raises the question of how they could exchange information. The intelligences conceivably could be coordinated by a central executive, but Gardner is reluctant to endorse this option. He and Walters (1993a, pp. 42–43) concede that there could be a "dumb executive" that simply prevents conflicts among intelligences, but this concession does not explain how they can work together productively.

The phenomenon of intentionality drives this problem home. As Husserl (1962/1977) observed, our mental acts are *about* something, so they include two poles: the intending act ("noesis"), and the intended object ("noema"). Often, MI theory assigns the intending act and intended object to different "intelligences."

Many intending acts express logical-mathematical intelligence: inferring, classifying, hypothesizing, counting, calculating, and so on. But the objects of these intentions are assigned to other intelligences. They include material things ("spatial intelligence"), other people ("interpersonal intelligence"), physical activities ("bodily-kinesthetic intelligence"), personal experience ("intrapersonal intelligence"), music ("musical intelligence") and living things ("naturalist's intelligence"). These other intelligences carry out their own operations. Consequently, MI theory makes it difficult to understand how people can use logic and mathematics to think *about* anything.

Similarly, MI theory places our ability to use language in one intelligence, and the representation of most objects that can be spoken about in other intelligences. This breach is especially problematic when Gardner assigns "semantics" to linguistic intelligence. If the concept "mammal" is in linguistic intelligence, how does "naturalist's intelligence" function without this knowledge? And if the mammal concept is in a shared code, what becomes of modularity? The same problem arises with the overlap between, on the one hand, the pragmatic aspect of linguistic intelligence, and on the other hand, interpersonal intelligence.

The "strong" claim that humans have several distinct intelligences is difficult to defend, and Gardner sometimes presents MI theory in a "weak" form.[1] He has written that it is "less a set of hypotheses and predictions than it is an organized framework" (Gardner, 1994, p. 578). He has allowed that the components of each intelligence can dissociate or uncouple (Gardner, 1983, p. 173). He also acknowledges that pairs of intelligences may "overlap" or be correlated (Gardner & Walters, 1993a, pp. 41–42). Finally, he has suggested that "many people can evaluate their intelligences and plan to use them together in certain putatively successful ways" (p. 43), leaving some room for an executive that spans the intelligences.

These concessions risk, however, returning Gardner to the first problem of MI theory: triviality. If the intelligences extensively exchange information, cooperate in activities, or share a common executive, then there is little warrant for characterizing them as independent entities. Of course, Gardner could claim that although the intelligences are distinct, in practice they always work together. However, this concession makes the multiplicity of the intelligences a distinction without a difference, and invites the reply that the system as a whole is one single intelligence, and specific abilities, such as spatial reasoning, are mere components of this intelligence.

These two contrasting kinds of conceptual objections place Gardner on the horns of a dilemma: If he claims that the intelligences are independent, then it is difficult to account for their interaction during many human activities. If he weakens the theory by claiming that they are not independent, then it is difficult to warrant either calling them "intelligences" or claiming that they are "modules." And if Gardner equivocates by trying to claim that both the strong and the weak versions of the theory are true, then MI theory become ambiguous and contradictory.

Fortunately, Gardner is generally committed to presenting the theory in its strong version, so that it can be meaningfully evaluated:

> Controlled experiments could either confirm or disconfirm MI. Several come to mind: a test of the independence of intelligences, for example. . . . If there turned out to be a significant correlation among these faculties, as measured by appropriate assessments, the supposed independence of the faculties would be invalidated. (Gardner & Walters, 1993a, p. 38)[2]

This claim invites a review of the empirical evidence for MI theory.

EMPIRICAL PROBLEMS

Exceptional Populations

Gardner views the existence of groups that he believes to be high or low in one specific intelligence as part of the evidence for MI. The first of these are the geniuses: Yehudi Menuhin illustrates exceptional musical intelligence; Babe Ruth, outstanding bodily-kinesthetic intelligence; and Barbara McClintock, outstanding logical-mathematical intelligence (Gardner, 1993b). However, the abilities of Gardner's candidates do not appear to correspond to the categories of MI theory. Many excel in more than one domain: Barbara McClintock's work spanned the logical-mathematical and natural domains (pp. 19–20), Virginia Woolf's, the linguistic and intrapersonal domains (pp. 24–25), and Albert Einstein's, the spatial and the logical-mathematical domains (Gardner, 1993a, pp. 104–105). It is to be expected that if the intelligences are independent, then some individuals will excel in two or more domains, but if Gardner fails to show that most achieve excellence in one specific domain, then his claim that the intelligences are independent is threatened. Conversely, Gardner does not show that any of the geniuses excel throughout one of the domains defined by MI theory; instead, each seems to excel on some smaller subset of activities within a domain. Unless Gardner can show that most geniuses perform relatively well throughout a domain, then the notion that the intelligences are integrated structures is threatened. Generally, the difficulty with Gardner's discussion of genius is that many psychological theories imply some way of categorizing individuals of exceptional ability; he has not yet shown that MI theory fits the data better than other theories.

The argument from genius could be bolstered by a second special population: prodigies. Gardner acknowledges that an individual's level of each intelligence is the result of both "nature" and "nurture." Furthurmore, if outstanding individuals were to show exceptional abilities at a very early age, and these abilities were specific to domains, then it could be inferred that the structures of MI theory are "biopsychological potential[s]" (Gardner & Walters, 1993a, p. 36). But a competing theory would hold that prodigies appear in various fields because societies divide activities in specific ways and enculturate individuals accordingly. Gardner never tells the reader enough about any one case to indicate which alternative is more plausible. For example, he implies that Pablo Picasso was genetically prepared for prodigy, but later adds that no work he did prior to age 9 has survived (Gardner, 1993a, pp. 138–146). This kind of fragmentary anecdotal evidence raises a "chicken-and-egg" question: Is early tutoring a response to early talent, or vice versa? Howe (1990) has noted that children with exceptional abilities intensely explore and practise in their area of interest, observe models, and receive tutoring from an early age. In one historical study, Fowler (1986) found that of 24 outstanding mathematicians, 21 received special stimulation in mathematics before the age of 5, and several before the age of 3. Another objection to Gardner's view is that the talents of many prodigies simply do not fit the categories of MI theory; instead, they reflect the importance of specific enculturation. Talent at chess is a prime example. Thus, although the achievements of these children are impressive and difficult to explain, they do not establish the eight discrete "biopsychological potentials" that MI theory requires. And given that prodigy is rare, even among the most accomplished members of a field (Bloom, 1985; Feldman, 1986), this phenomenon is probably not a useful touchstone for educational practice.

In any case, exceptional accomplishments may not be based on the domain-wide abilities Gardner proposes. For example, he claims that excellence in chess expresses spatial intelligence (Gardner, 1983, pp. 192–195). But chess is one of the most-researched human cognitive activities, and general abilities, spatial or otherwise, seem to contribute little to its mastery (Ericsson & Smith, 1991). Chess masters are no better than other persons at spatial tasks, except at recognizing strategically significant board arrangements (Chase & Simon, 1973; Pfau & Murphy, 1988). Highly ranked players are less likely to work in professions that involve solving spatial problems, such as engineering, than they are to work in professions in the humanities, such as writing (de Groot, 1978; Elo, 1978). A defender of MI might counter that there are many domains of spatial abilities, and an individual who excels in one need not excel in others. But as this rebuttal tacitly concedes, if this were the case, then there is no reason to speak of a general "spatial intelligence" in the first place.

The third exceptional population Gardner discusses are savants, individuals who do one thing exceptionally well, such as calculating large products mentally, stating the day of the week for any given calendar date, or playing a piano piece after a single hearing. These include "idiot savants," many of whom are autistic. Savantry could support the coherence and independence of the intelligences if it were shown to embody one high intelligence in an otherwise average or low profile. However, savants usually do not excel across an entire domain. For example, hyperlexic autistic readers decode print better than other children their age, but because their comprehension is poor (Snowling & Frith, 1986), they could not be said to show high linguistic intelligence.

Gardner interprets autism as a limitation on intrapersonal intelligence (Gardner & Walters, 1993b, p. 25). However, its effects are not limited to this domain. Sloboda, Hermelin, and O'Connor (1985) described NP, a musical autistic savant, who could accurately play a piece on the piano after one hearing. Interestingly, 24 hours later, NP played the same piece in a way that sounded "metronomic in the extreme" (p. 165). Most autistic savants have difficulty planning and monitoring the use of their exceptional skills, which may explain why many cannot find employment in their areas of special interest (Frith, 1989). It appears that autism, primarily an impairment in intrapersonal understanding, affects other "intelligences," showing that these are not independent, but affects only some aspects of each intelligence, suggesting that they are not coherent entities.

Like the achievements of geniuses, those of savants are probably not based on the general operations that Gardner posits. Instead, these achievements rely on knowledge and skills specific to particular activities. When autistic savants replay a piece of music after one hearing, the errors they make are reversions to forms typical of the piece's genre, which indicates that they rely on matching the new tune to the repertoire of melodic forms they already know (Sloboda et al., 1985). Similarly, a case study of a non-autistic mathematical savant showed that through thousands of hours of practice she had learned the characteristics of a huge repertoire of numbers, recognizing at a glance, for instance, that 720 equals 6 factorial (i.e., 6 x 5 x 4 x 3 x 2 x 1). She had also learned a collection of computational algorithms. This knowledge allowed her quickly to fit a routine to the numbers in most questions, and to solve those questions efficiently. In contrast, her basic cognitive processes did not differ from those of other adults (Jensen, 1990).

MI researchers also cite learning disabilities as evidence for their theory (Gardner & Hatch, 1989). The most common of these disabilities is dyslexia. Most dyslexic students have difficulty discriminating sounds in language, matching them to letters, and combining them to form words; some appear to have difficulty recalling word images (Patterson, Marshall, & Coltheart, 1985). However, because many dyslexic students equal their normal classmates in aspects of language other than reading, such as listening comprehension (Mosberg & Johns, 1994; Torgesen, 1988), dyslexia affects a range of abilities too narrow to comprise "linguistic intelligence." Another learning disability, Gerstmann syndrome, initially seems to represent difficulties in spatial reasoning (Gardner, 1983, p. 156). But its symptoms include problems in distinguishing left from right, making mathematical computations, and recognizing and remembering finger contact. Because these difficulties involve logical-mathematical and bodily-kinesthetic intelligence, Gerstmann syndrome corresponds to a broader set of abilities than does spatial intelligence. Indeed, I was not able to identify a single learning disability that maps onto an intelligence of MI theory.

Developmental Research

Many researchers would share Gardner's belief that innate modules focus children's attention on the kinds of relationships important in various domains of phenomena (e.g., Hirschfeld & Gelman, 1994; Leslie, 1994). One such domain is biology, corresponding to Gardner's tentatively nominated "naturalist's intelligence." Infants can distinguish between animate and mechanical or random motion by 4 months of age (Bertenthal, Proffitt, Spetner, & Thomas, 1985). At age 6 months, they show surprise if an inanimate object moves in an unusual way; for example, when there is a delay between the time a second object bumps a first, and the time that the first moves (Leslie, 1988). Aged 12 months, infants viewing a series of objects react to changes from animate to inanimate, or vice versa, as well as to changes in specific objects, which suggests that the distinction between these categories is conceptual, rather than simply perceptual (Smith & Heise, 1992). By the time they are in preschool, children generalize the behaviour of one animal to others of a related kind (e.g., from a flamingo to a blackbird), rather than to those that superficially appear similar (e.g., from a bat to a blackbird) (Gelman & Markman, 1983).

This kind of evidence is not yet strong enough, however, to clinch the case for MI theory. The existence of distinct domains of knowledge does not entail the existence of a corresponding set of abilities. In part, the pre-existing modules position is an argument from ignorance: infants appear to use categories to make predictions; researchers do not know where these categories come from, so they must be innate. Theoretically, these general categories could be learned, and yet productively channel new inferences and predictions (Holland, Holyoak, Nisbett, & Thagard, 1986). Moreover, there is some empirical evidence that children only gradually learn these categories and their properties. For example, many children initially believe that plants are not alive (Carey, 1985), or that if an animal changes in appearance, then it changes in kind as well (Keil, 1989). Therefore, although domain-specific knowledge may turn out to be one of the stronger forms of evidence for MI theory, this issue is not yet settled.

Studies Concerning Transfer of Learning

If, as Gardner suggests, the core of each "intelligence" consists of knowledge and procedures that operate across a wide domain, then it would make sense to build school curricula around these cores. The "Rightstart" program illustrates this approach in mathematics. Griffin, Case, and Siegler (1994) researched the concepts central to understanding Grade 1 arithmetic. Then they created a set of mathematical games and activities, and engaged students in discussions that highlighted these concepts. As a result, the children's understanding of number improved dramatically compared with a control group, and transferred to a variety of new quantitative activities, such as telling time and predicting the behaviour of a balance scale. The Rightstart results are impressive. However, to support MI theory, it is necessary to show that students' gains transferred across the logical-mathematical domain, but not further (e.g., to spatial tasks).

Moreover, other kinds of transfer research bears on MI theory quite differently. When students articulate and elaborate on a concept, this helps them to apply it to new problems, a phenomenon called "high road transfer" (Brown & Kane, 1988; Chi & Bassok, 1989). Similarly, when teachers explicitly state the rules for solving a problem, this articulation adds significantly to the value of examples alone in helping students to transfer these rules to new content (Cheng, Holyoak, Nisbett, & Oliver, 1986; Fong, Krantz, & Nisbett, 1986). This transfer of strategies *across* domains is difficult to explain within MI theory. Even more problematic is the role of language in moving information within and among other "intelligences." Gardner (1983) is aware of transfer across domains, and notes that it is problematic, but does not attempt to reconcile this transfer with the notion of autonomous intelligences, except by alluding to "waves of symbolization" (pp. 306–309). In this sense, research on transfer is a double-edged sword for MI theory.

Psychometric Research

Gardner also relies on statistical research. Factor analysis is a procedure that can be used to tease out themes appearing within, or across, tests. Several factors similar to Gardner's intelligences have emerged in such analyses, including linguistic (Wiebe & Watkins, 1980), spatial (Gustafsson, 1984), and social factors (Rosnow, Skleder, Jaeger, & Rind, 1994). But this kind of research provides shaky support for MI. First, the factors in these studies typically are not independent, but instead correlate positively with one another, a fact that has been used to argue both for the existence of general intelligence and against MI (Brand, 1996; Sternberg, 1983). Although Gardner has replied that this evidence comes almost entirely from tests of logical-mathematical or linguistic intelligence (Gardner & Walters, 1993a, p. 39), it is important to note that spatial tasks correlate substantially with verbal tasks even when performance measures are used (Wechsler, 1974). Second, each factor splits into several smaller factors, each of these narrower than the intelligences of MI theory. For instance, in a review of "visual perception" abilities (similar to Gardner's "spatial intelligence"), Carroll (1993) examined 230 data sets. The factors of visual perception found in each study varied in number from one to six, which Carroll grouped into five categories "despite much difficulty" (p. 309). These results can be accommodated by theories of intelligence that recognize both general and specific components, but they present difficulties for MI theory, which recognizes only one level of structure.

Surprisingly, a re-examination of Gardner's own assessment research also challenges MI theory. He and his colleagues have developed assessment tasks based on authentic activities in several different domains. According to MI theory, students' performances on activities derived from the same intelligences should show high correlations, and activities derived from different intelligences should show low correlations, or none at all. However, in two studies with primary school children, several pairs of tasks that were supposed to represent independent intelligences correlated strongly, and those that were supposed to represent the same intelligences failed to correlate significantly, except for two number tasks (Gardner & Hatch, 1989; Gardner & Krechevsky, 1993). In both studies, the researchers interpreted these patterns as evidence against the existence of a single general intelligence. However, they failed to acknowledge that these same findings also weigh crucially against MI theory.

Experimental Studies

If the mind is composed of independent modules, as MI theory claims, then individuals should be able to carry out two activities that call on different intelligences at the same time, without one interfering with the other. Conversely, if two activities call on the same intelligence, then the speed or accuracy of at least one activity should suffer. Several studies have explored these possibilities using spatial and verbal tasks, and have shown that these predictions are largely true (e.g., Barton, Matthews, Farmer, & Belyavin, 1995; Liu & Wickens, 1992).

The picture is more complex, however, than MI theory would predict. First, verbal and visual tasks disrupt one another somewhat, indicating that they share some kind of resource, possibly an executive that switches attention between them (Logie, Zucco, & Baddeley, 1990). Second, experimental research indicates that people can translate information from verbal to visual form, or vice versa (Conrad, 1964; Holding, 1992, 1993; N. N. Matthews, Hunt, & MacLeod, 1980), which limits the notion that various kinds of knowledge are handled by separate intelligences. Most importantly, other "intelligences" seem to rely on linguistic or spatial resources: mathematical tasks interfere with verbal tasks (Logie & Baddeley, 1987; Logie et al., 1990), and verbal tasks interfere with musical tasks for novices (Pechmann & Mohr, 1992). Similarly, switching attention among sounds originating from different locations interferes with spatial tasks (Smyth & Scholey, 1994).

Summary of Empirical Evidence

On re-examination, the evidence for MI theory points to three levels of structure in thinking and learning. Gardner prefers the medium grain of analysis, focussing on moderately general intelligences that address broad domains of knowledge. The evidence he presents is not sufficient to support this preference, but research on the development of children's understanding of domains such as "living things" is promising. The coarser grain of analysis focusses on structures and processes broader than Gardner's intelligences, that cut across several domains. Research showing correlations among diverse abilities, the broad effects of autism, the phenomenon of high-road transfer, and dual-task research, all suggest that different parts of the mind exchange information and share resources extensively. The finest grain of analysis favours structures smaller than Gardner's intelligences: research on savantry and learning disabilities, analysis of expertise in areas such as chess and mental computation, and Gardner's own assessment research, warrant a focus on the concepts, strategies, and skills highly specific to each activity. An overview of the empirical research raises two kinds of problems for Gardner's theory: evidence for the influence of specific knowledge and abilities is stronger than evidence for the influence of the intelligences of MI theory; and if all three levels of analysis prove valid, this outcome will threaten MI's exclusive focus on middle-sized structures.

PEDAGOGICAL PROBLEMS

One response to these criticisms could be to claim that even though MI theory is conceptually and empirically weak, it remains a useful framework for teaching. But this is far from clear. Interpretations have been so diverse that Kornhaber has noted that "one reason for the success of MI is that educators can cite it without having to do anything differently" (cited in Gardner, 1994, p. 580). Some practices based on the theory are no doubt misinterpretations. Reiff (1996), for example, has suggested that if a child is weak in one intelligence, he or she can be taught "through" another. Because this view assumes that the same material can be learned using a variety of modes, it could be called the "learning styles" interpretation. Whether this view is true or false, it is essentially the opposite of Gardner's (1995) theory. If each intelligence operates on a different domain, and represents a specific kind of content, then only rarely can a given piece of knowledge be presented in different ways for different intelligences.

A second common interpretation of MI theory claims that schools currently overemphasize linguistic and logical-mathematical knowledge, so curricula ought to be changed to balance the intelligences more equally. Educators could plan units of study that include activities to engage each intelligence (Hoerr, 1994; Wallach & Callahan, 1994), or that give a more prominent place to the arts (Deluca, 1993). Balanced programming and MI theory are obviously compatible, but one does not entail the other. The notion that there are eight intelligences does not imply that school should be the institution responsible for developing all of them. Conversely, if educators choose to offer balanced programming, they do not require Gardner's theory for justification, which is why such alternative systems as Waldorf schools long predated MI theory.

A more elaborate version of the balanced programming proposal suggests educators should assess children's intelligences, then provide programs that include remediation in their areas of weakness, and enrichment in their areas of strength (Gardner & Walters, 1993b, p. 31; Hearne & Stone, 1995; Hoerr, 1994). This approach is appealing, but presents practical problems. The first, already noted, is that despite several years of effort, MI researchers have not yet developed reliable methods for assessing the intelligences. The second problem is that growing class sizes in many jurisdictions, multiplied by the supposed existence of eight intelligences, and the many levels at which children could operate in each of these intelligences, would yield an explosion in the workload of the teachers who would have to plan and deliver these programs.

Gardner favours a general education in primary school. His preferences for the middle elementary years are less clear, in that he mentions "mastering the crucial literacies," but stresses "early specialization" in areas chosen by each child and family, and informed by an assessment of his or her intelligences (Gardner, 1993b, pp. 194–196). Later, students would pursue a broader education during adolescence. This preference for specialization in middle childhood may contradict the political goals of MI theory. Gardner (1993b) has criticized conventional education, particularly in its use of intelligence testing, as ethnocentric and elitist, or "'Westist,' 'Testist,' and 'Bestist'" (p. 12). But, arguably, specialization represents a subtle kind of streaming. Opportunities for activities of various kinds are not allocated to all preschool children equally. Choosing specialties on the basis of the "intelligences" they have acquired by age 7 could potentially exacerbate these inequalities. And although Gardner wishes that society valued all intelligences equally, it does not. Mathematics, particularly, serves as a "gatekeeping" subject for admission to advanced study in many highly paid professions (Gainen, 1995). Therefore, contrary to Gardner's good intentions, his suggestions could lead to a hardening of traditional categories of privilege.

Some educators have claimed that a benefit of the MI framework is that children learn to identify their own "areas of strength," and some schools now issue report cards based on the theory (see Hanson, 1995; Hoerr, 1994; Wallach & Callahan, 1994). However, there is good reason to predict that these practices will backfire. The converse of being "high" in some intelligences is being "mediocre" or "low" in others. Students who believe that they are low in an ability often avoid activities that call on it, even when they might learn from the effort (Covington, 1992; Palmquist & Young, 1992). Paradoxically, students' beliefs that they are high in an ability can lead to the same result in the long run. Those who attribute their achievements to such ability approach tasks with confidence. But, when they encounter a problem that they cannot solve easily, they often quit. Apparently, their theory that achievement reflects ability leads them to interpret failure as a lack of this ability. In contrast, students who attribute achievement to effort, learning, and the application of appropriate strategies are more likely to persist when "the going gets tough," and to recover after initial failure (Dweck & Leggett, 1988).

These objections invite the fundamental pedagogical question: Is MI the right *kind* of theory for education? Although Gardner stresses the differences between general intelligence and multiple intelligences, the two frameworks nevertheless share fundamental characteristics that limit their relevance to teaching. Both identify cognitive structures far too broad to be useful for interpreting any specific educational tasks. For instance, the knowledge that basketball relies on "bodily-kinesthetic intelligence" tells a coach nothing about the skills that her players need to learn. Because both general intelligence and MI are theories of ability rather than theories of knowledge or learning, they offer only a static interpretation of children's performance; knowing that a student is high in "musical intelligence" provides no clues about how to enrich his music education; knowing that he is low in musical intelligence provides no clues about how to remedy it. Of course, both general intelligence theorists and MI theorists agree that both education and experience can affect ability (e.g., Neisser et al., 1996), and Gardner has argued for innovative practices, such as expert mentoring in settings outside of school. But learning is not the focus of ability theories, and the positive innovations Gardner advocates derive from other research traditions, such as sociocultural theory, rather than from MI itself (e.g., Gardner, Kornhaber, & Krechevsky, 1993).

CONCLUSION

In examining the nature of intelligence, Gardner and his colleagues have used a wider set of tools than have traditional psychometric researchers. They have contended compellingly that the arts are as much intellectual activities as are writing, mathematics, and science (Gardner, 1982). MI researchers have drawn educators' attention to an alternative to the theory of general intelligence. And Gardner (1983, p. 297) is admirably willing to consider criticisms of his own framework. However, I contend that MI theory offers a level of analysis neither empirically plausible nor pedagogically useful.

A promising alternative to this kind of research focusses on the knowledge and strategies that children and adults use in carrying out various, specific activities. Such analyses are already being carried out in areas as diverse as drawing (Cox, 1992), argument comprehension (Chambliss, 1995), and volleyball (Allard & Starkes, 1980). Innovative projects have explored the creation of classroom communities in which students collaborate to construct knowledge in areas such as science, mathematics, and interdisciplinary studies (e.g., McGilly, 1994). Such research seems likely to prove more relevant than ability theories in setting curricular goals and interpreting students' learning.

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NOTES

[1] The term "weak" is not meant to imply that this version of MI theory is inferior to the "strong" version. The difference between the two versions is that the weak theory has few theoretical, empirical, or practical implications, whereas the strong theory does have such implications. However, I argue that the strong version of the theory presents equally serious, but different, problems.

[2] See also Gardner, 1983, p. 297 and Gardner, 1995, p. 203.

REFERENCES

Allard, F., & Starkes, J. L. (1980). Perception in sport: Volleyball. *Journal of Sport Psychology, 2,* 22–33.

Allport, D. A. (1980). Patterns and actions: Cognitive mechanisms are content specific. In G. Claxton (Ed.), *Cognitive psychology: New directions* (pp. 26–64). London: Routledge & Kegan Paul.

Armstrong, T. (1994). Multiple intelligences: Seven ways to approach curriculum. *Educational Leadership, 52*(3), 26–28.

Barton, A., Matthews, B., Farmer, E., & Belyavin, A. (1995). Revealing the basic properties of the visuospatial sketchpad: The use of complete spatial arrays. *Acta Psychologica, 89,* 197–216.

Bertenthal, B. I., Proffitt, D. R., Spetner, N. B., & Thomas, M. A. (1985). The development of infant sensitivity to biomechanical motions. *Child Development, 56,* 531–543.

Bloom, B. S. (Ed.). (1985). *Developing talent in young people.* New York: Ballantine.

Boss, J. A. (1994). The anatomy of moral intelligence. *Educational Theory, 44,* 399–416.

Brand, C. (1996). *The g factor: General intelligence and its implications.* New York: John Wiley.

Brown, A. L., & Kane, M. J. (1988). Preschool children can learn to transfer: Learning to learn and learning from example. *Cognitive Psychology, 20,* 493–523.

Carey, S. (1985). *Conceptual change in childhood.* Cambridge, MA: MIT Press.

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

Chambliss, M. J. (1995). Text cues and strategies successful readers use to construct the gist of lengthy written arguments. *Reading Research Quarterly, 30,* 778–807.

Chase, W. G., & Simon, H. A. (1973). The mind's eye in chess. In W. G. Chase (Ed.), *Visual information processing* (pp. 215–281). New York: Academic Press.

Cheng, P. W., Holyoak, K. J., Nisbett, R. E., & Oliver, L. M. (1986). Pragmatic versus syntactic approaches to training deductive reasoning. *Cognitive Psychology, 18,* 293–328.

Chi, M. T. H., & Bassok, M. (1989). Learning from examples via self-explanations. In L. B. Resnick (Ed.), *Knowing, learning, and instruction: Essays in honour of Robert Glaser* (pp. 251–282). Hillsdale, NJ: Erlbaum.

Conrad, R. (1964). Acoustic confusions in immediate memory. *British Journal of Psychology, 55,* 75–84.

Covington, M. V. (1992). *Making the grade: A self-worth perspective on motivation and school reform.* Cambridge, MA: Cambridge University Press.

Cox, M. (1992). *Children's drawings.* London: Penguin Books.

de Groot, A. D. (1978). *Thought and choice in chess* (2nd ed.). The Hague: Mouton.

Deluca, L. S. (1993). The arts and equity. *Equity and Excellence in Education, 26*(3), 51–53.

Dweck, C. S., & Leggett, E. L. (1988). A social cognitive approach to motivation and personality. *Psychological Review, 95,* 256–273.

Eisner, E. W. (1994). Commentary: Putting multiple intelligences in context: Some questions and observations. *Teachers College Record, 95,* 555–560.

Elo, A. E. (1978). *The rating of chessplayers, past and present.* New York: Arco.

Ericsson, K. A., & Charness, N. (1994). Expert performance: Its structure and acquisition. *American Psychologist, 49,* 725–747.

Ericsson, K. A., & Smith, J. (1991). Prospects and limits of the empirical study of expertise: An introduction. In K. A. Ericsson & J. Smith (Eds.), *Toward a general theory of expertise: Prospects and limits* (pp. 1–38). Cambridge: Cambridge University Press.

Feldman, D. H. (1986). *Nature's gambit: Child prodigies and the development of human potential.* New York: Basic Books.

Fodor, J. A. (1983). *The modularity of mind: An essay on faculty psychology.* Cambridge, MA: MIT Press.

Fong, G. T., Krantz, D. H., & Nisbett, R. E. (1986). The effects of statistical training on thinking about everyday problems. *Cognitive Psychology, 18,* 253–292.

Fowler, W. (1986). Early experiences of great men and women mathematicians. In W. Fowler (Ed.), *Early experience and the development of competence* (New Directions for Child Development No. 32, pp. 87–109). San Francisco: Jossey-Bass.

Frith, U. (1989). *Autism: Explaining the enigma.* Oxford: Basil Blackwell.

Gainen, J. (1995). Barriers to success in quantitative gatekeeper courses. *New Directions for Teaching and Learning, 61,* 5–14.

Gardner, H. (1982). *Art, mind, and brain: A cognitive approach to creativity.* New York: Basic Books.

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

Gardner, H. (1993a). *Creating minds: An anatomy of creativity as seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi.* New York: Basic Books.

Gardner, H. (1993b). *Multiple intelligences: The theory in practice.* New York: Basic Books.

Gardner, H. (1994). Intelligences in theory and practice: A response to Elliot W. Eisner, Robert J. Sternberg, and Henry M. Levin. *Teachers College Record, 95,* 576–583.

Gardner, H. (1995, November). Reflections on multiple intelligences: Myths and messages. *Phi Delta Kappan, 77,* 200–203, 206–209.

Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational Researcher, 18*(8), 4–9.

Gardner, H., Kornhaber, M., & Krechevsky, M. (1993). Engaging intelligence. In H. Gardner, *Multiple intelligences: The theory in practice* (pp. 231–248). New York: Harper Collins.

Gardner, H., & Krechevsky, M. (1993). The emergence and nurturance of multiple intelligences in early childhood: The Project Spectrum approach. In H. Gardner, *Multiple intelligences: The theory in practice* (pp. 86–111). New York: Basic Books.

Gardner, H., & Walters, J. (1993a). Questions and answers about multiple intelligences theory. In H. Gardner, *Multiple intelligences: The theory in practice* (pp. 35–48). New York: Basic Books.

Gardner, H., & Walters, J. (1993b). A rounded version. In H. Gardner, *Multiple intelligences: The theory in practice* (pp. 13–34). New York: Basic Books.

Gelman, S. A., & Markman, E. M. (1983, April). *Natural kind terms and children's ability to draw inferences.* Paper presented at a meeting of the Western Psychological Association, San Francisco.

Griffin, S. A., Case, R., & Siegler, R. S. (1994). Rightstart: Providing the central conceptual prerequisites for first formal learning of arithmetic to students at risk for failure. In K. McGilly (Ed.), *Classroom lessons: Integrating cognitive theory and classroom practice* (pp. 25–49). Cambridge, MA: MIT Press.

Gustafsson, J. E. (1984). A unifying model for the structure of intellectual abilities. *Intelligence, 8,* 179–203.

Hanson, R. M. (Executive Producer). (1995). *How are kids smart? Multiple intelligences in the classroom: Teachers' Version* [Videotape]. Port Chester, NY: National Professional Resources.

Hearne, D., & Stone, S. (1995). Multiple intelligences and underachievement: Lessons from individuals with learning disabilities. *Journal of Learning Disabilities, 28,* 439–448.

Hirschfeld, L. A., & Gelman, S. A. (Eds.). (1994). *Mapping the mind: Domain specificity in cognition and culture.* Cambridge, MA: Cambridge University Press.

Hoerr, T. R. (1994). How the New City School applies the multiple intelligences. *Educational Leadership, 52*(3), 29–33.

Holding, D. H. (1992). Theories of chess skill. *Psychological Research, 54,* 10–16.

Holding, D. H. (1993). Sharing verbal and visuospatial resources in working memory. *Journal of General Psychology, 120,* 245–256.

Holland, J. H., Holyoak, K. J., Nisbett, R. E., & Thagard, P. R. (1986). *Induction: Processes of inference, learning, and discovery.* Cambridge, MA: MIT Press.

Howe, M. J. A. (1990). *The origins of exceptional abilities.* Oxford: Blackwell.

Husserl, E. (1977). *Phenomenological psychology: Lectures, summer semester, 1925* (J. Scanlon, Trans.). The Hague: Martinus Nijhoff. (Original work published 1962)

Jensen, A. R. (1990). Speed of information processing in a calculating prodigy. *Intelligence, 14,* 259–274.

Keil, F. C. (1989). *Concepts, kinds, and cognitive development.* Cambridge, MA: MIT Press.

Leslie, A. M. (1988). The necessity of illusion: Perception and thought in infancy. In L. Weiskrantz (Ed.), *Thought without language* (pp. 185–210). Oxford: Clarendon Press.

Leslie, A. M. (1994). ToMM, ToBy, and agency: Core architecture and domain specificity. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 119–148). Cambridge, MA: Cambridge University Press.

Levin, H. M. (1994). Commentary: Multiple intelligence theory and everyday practice. *Teachers College Record, 95,* 570–575.

Liu, Y., & Wickens, C. D. (1992). Visual scanning with or without spatial uncertainty and divided and selective attention. *Acta Psychologica, 79,* 131–153.

Logie, R. H., & Baddeley, A. D. (1987). Cognitive processes in counting. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 310–326.

Logie, R. H., Zucco, G. M., & Baddeley, A. D. (1990). Interference with visual short-term memory. *Acta Psychologica, 75,* 55–74.

Matthews, D. (1988). Gardner's multiple intelligence theory: An evaluation of relevant research literature and a consideration of its application to gifted education. *Roeper Review, 11,* 100–104.

Matthews, N. N., Hunt, E. B., & MacLeod, C. M. (1980). Strategy choice and strategy training in sentence-picture verification. *Journal of Verbal Learning and Verbal Behavior, 19,* 531–548.

McGilly, K. (Ed.). (1994). *Classroom lessons: Integrating cognitive theory and classroom practice.* Cambridge, MA: MIT Press.

McLellan, H. (1994). Virtual reality and multiple intelligences: Potentials for higher education. *Journal of Computing in Higher Education, 5,* 33–66.

Morgan, H. (1992). *An analysis of Gardner's theory of multiple intelligence.* Paper presented at the Annual Meeting of the Eastern Educational Research Association. (ERIC Document Reproduction Service No. ED 360 088)

Mosberg, L., & Johns, D. (1994). Reading and listening comprehension in college students with developmental dyslexia. *Learning Disabilities Research and Practice, 9,* 130–135.

Neisser, U., Boodoo, G., Bouchard, T. J., Jr., Boykin, A. W., Brody, N., Ceci, S. J., Halpern, D. F., Loehlin, J. C., Perloff, R., Sternberg, R. J., & Urbina, S. (1996). Intelligence: Knowns and unknowns. *American Psychologist, 51,* 77–101.

Nelson, K. (1995). Nurturing kids' seven ways of being smart. *Instructor, 105,* 26–30, 34.

Palmquist, M., & Young, R. (1992). The notion of giftedness and student expectations about writing. *Written Communication, 9,* 137–168.

Patterson, K. E., Marshall, J. C., & Coltheart, M. (Eds.). (1985). *Surface dyslexia: Neuropsychological and cognitive studies of phonological reading.* Hillsdale, NJ: Lawrence Erlbaum.

Pechmann, T., & Mohr, G. (1992). Interference in memory for tonal pitch: Implications for a working-memory model. *Memory and Cognition, 20,* 314–320.

Pfau, H. D., & Murphy, M. D. (1988). Role of verbal knowledge in chess skill. *American Journal of Psychology, 101,* 73–86.

Reiff, J. C. (1996). Bridging home and school through multiple intelligences. *Childhood Education, 72*(3), 164–166.

Rosnow, R. L., Skleder, A. A., Jaeger, M. E., & Rind, B. (1994). Intelligence and the epistemics of interpersonal acumen: Testing some implications of Gardner's theory. *Intelligence, 19,* 93–116.

Sloboda, J. A., Hermelin, B., & O'Connor, N. (1985). An exceptional musical memory. *Music Perception, 3,* 155–170.

Smedslund, J. (1979). Between the analytic and the arbitrary: A case study of psychological research. *Scandinavian Journal of Psychology, 20,* 129–140.

Smerechansky-Metzger, J. A. (1995). The quest for multiple intelligences. *Gifted Child Today, 18*(3), 12–15.

Smith, L. B., & Heise, D. (1992). Perceptual similarity and conceptual structure. In B. Burns (Ed.), *Percepts, concepts and categories: The representation and processing of information* (pp. 233–272). New York: Elsevier.

Smyth, M. M., & Scholey, K. A. (1994). Interference in immediate spatial memory. *Memory and Cognition, 22,* 1–13.

Snowling, M., & Frith, U. (1986). Comprehension in "hyperlexic" readers. *Journal of Experimental Child Psychology, 42,* 392–415.

Sternberg, R. J. (1983). How much gall is too much gall? A review of *Frames of mind: The theory of multiple intelligences. Contemporary Education Review, 2,* 215–224.

Torgesen, J. K. (1988). Studies of children with learning disabilities who perform poorly on memory span tasks. *Journal of Learning Disabilities, 21,* 605–612.

Wallach, C., & Callahan, S. (1994). The 1st grade plant museum. *Educational Leadership, 52*(3), 32–34.

Wechsler, D. (1974). *Manual for the Wechsler Intelligence Scale for children — Revised.* New York: The Psychological Corporation.

Wiebe, M. J., & Watkins, E. O. (1980). Factor analysis of the McCarthy Scales of Children's Abilities on preschool children. *Journal of School Psychology, 18,* 154–162.

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