Spatially Gifted, Verbally Inconvenienced

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I am honored once again to have the opportunity to address this gathering. I would like to say that I am happy to do so, but I am not. Speaking in public is something I do only with great effort. Indeed, the topic of my talk will be why it is that I cannot trust myself to be a coherent public speaker, and why it is that I must write my words in advance and read them to you. It is not always so. Sometimes the words are there and I can call them up effortlessly and deliver them to my listeners with reasonable fluency. But sometimes the words are not there, and I find myself struggling to express with clarity even the simplest of ideas. When I was fresh out of graduate school, flush with ideas but inexperienced in public speaking, I trusted that words would always be there when I summoned them. Now I know better, and so I prepare.

I have discovered that I am not unique. Indeed, my battles with words pale in comparison to those that others have waged against them. The astonishing fact is that even some of the great masters of the language could not always trust their fluency. One of my favorite examples is Winston Churchill. He wrote with power and conviction, crafted sentences that are among the finest examples of English prose. He also could remember the language well. At 12 he recited without a slip 1200 lines of poetry. At 78, after some prodding from an incredulous reporter, he recited the entire 14th chapter of Gibbon's *Decline and Fall of the Roman Empire*, which he claimed not to have read since he learned it almost 50 years before. Yet early on he learned that fluency was something else. Once, as a young member of Parliament, he found himself at a complete loss for words. After describing the incident, his biographer Manchester (1983) says "Thereafter, when delivering a major speech, he came armed with everything he was going to say, including pauses and the pretended fumbling for the right phrase in the first few sentences, and…[even the anticipated reaction of his audience, such as] 'Cheers' or 'prolonged cheering' or even 'standing ovation'… . He said accurately 'I am not an orator. An orator is spontaneous.'" (Manchester, p. 32). Churchill is interesting in other respects. He could never use a dictionary, could not keep track of time, preferred from his adolescent years to dictate rather than to write, and struggled to learn Latin, Greek, French, and elementary mathematics. He once remarked that one of the greatest ordeals the French Resistance had to endure during World War II was to listen to him address them over the BBC in their own language. But he was brilliant. Field Marshal Alanbrooke (who was chief of the Imperial General Staff) was constantly astonished by his method of suddenly arriving at decisions seemingly by intuition, without first engaging in a logical examination of the problem. Another colleague once described it as "his zigzag streak of lightening in the brain." (Manchester, p. 19). With the clarity of vision afforded by hindsight, one can now see many examples of his ability quickly to apprehend the whole of a situation, and then to act accordingly. But he sometimes misperceived the whole. As one friend put it "Winston was often right, but when he was wrong, well, my God" (Manchester, p. 20).

Churchill's case is particularly interesting because it clearly illustrates the fallacy of most attempts to understand a problem that many gifted scientists, mathematicians, artists, and yes, even writers and poets face. It is also the locus of the major sex difference in abilities. The problem is erroneously labeled a discrepancy between verbal and spatial abilities, which it is not.

The key is not verbal ability, but fluency in retrieving words, particularly on the basis of their sound patterns, or fluidity in assembling novel utterances. On the spatial side, it is the ability to generate and manipulate gestalten or whole patterns, usually of a fairly concrete sort, but in a fluid and flexible way. I will try to describe what these sorts of spatial abilities look like, and why they are important for thought. But first, I must take a slight detour to explain why some of you may find this difficult to understand.

In October of 1976, the psychologist Roger Shepard addressed a conference here in Iowa City on the topic of visual thinking and creativity. An expanded version of his talk was published two years later (see Shepard, 1978). Although many have surely read it (indeed, I suspect that some who have recently described the plight of the high-spatial dyslexic are more familiar with it than they have acknowledged), the chapter is not widely referenced in the literature on spatial abilities. In the same year that this book was published, I commenced my dissertation on spatial abilities. Like Shepard's chapter, it also went unnoticed by the mainstream, but for good reason. In fact, the only reason I mention this confluence of events is that Roger Shepard was one of the three members of my dissertation committee (the others were Dick Snow and the statistician Ingram Olkin). Because of this, and because I had read much of the other experimental work Shepard had published, I thought I knew something about him. However, this chapter told me much about him that I did not know, and showed me how personal experience had shaped his contributions to psychology. He has since published another, more extensive account of the development of his interest in matters perceptual and spatial (see Shepard, 1990). What I have to say here today will be largely a footnote to what Shepard has already said in these two publications.

Shepard's case is important to me because I learned that I really did not understand his psychology until I understood something of his experience. I have subsequently rediscovered many times the importance of personal experience both in doing good science and in understanding the science that others do. My best experiments have come only after careful reflection on my own experiences and, even more importantly, after attempting to transcend the barriers of my skin and catch a glimpse of the world through someone else's eyes. From Alfred Binet and William James through Jean Piaget to the more recent work of Howard Gardner or the case studies of Oliver Sacks—good psychology has succeeded because it helped us see the world as others see it.

But just as the good psychologist must take the perspective of the subject, so too must the good student of psychology take the perspective of the theorist he or she hopes to understand. Why? Because we are at best imperfectly rational. Our beliefs shine through the silk screen of our rationality more vividly than we realize. Philosophers of science have now recognized how value- and theory-laden our facts are. But good scientists have long known it. In my course on human intelligence, I require students to read Fancher's (1985) account of the lives of protagonists in the great debates on human intelligence. Although Fancher may overstate the impact of life experiences on scientific theories, mostly we underestimate their influence. For example, the early experiences of Sir Francis Galton and John Stewart Mill seemed to have shaped the psychological theories they advanced as adults. Early in life, Galton was cast in the role of the family prodigy. His accomplishments were noted and catalogued and compared with those of other children. He picked up the theme, and became obsessed with his own rank among his peers. But trouble loomed heavy on the horizon. Like many others before and since, the young Francis could not keep up in Greek and Latin. Years later, after several failures to obtain the honors in mathematics that he sought, Galton suffered a nervous breakdown and withdrew from the university altogether.

John Stewart Mill's experiences were of a different sort. He was educated at home by his father, and thus was not cast in the role of prodigy. In his autobiography he recounted the clearly memorable moment in his life in which he learned about his uniqueness.

> *I remember the very place in Hyde Park where, in my fourteenth year, on the eve of leaving my father's house for a long absence, he told me that I should find, as I got acquainted with new people, that I had been taught things which youths of my age did not commonly know; and that many persons would be disposed to talk to me of this, and to compliment me upon it. What other things he said on this topic I remember very imperfectly; but he wound up saying, that whatever I know more than others, could not be ascribed to any merit in me, but to the very unusual advantage which had fallen to my lot, of having a father who was able to teach me, and willing to give the necessary trouble and time; that it was no matter of praise to me, if I knew more than those who had not a similar advantage… . I felt that what my father had said respecting my peculiar advantages was exactly the truth and common sense of the matter, and it fixed my opinion and feeling from that time forward. (Mill, in Fancher, 1985, p. 9)*

Mill's ready acceptance of his father's explanation for his genius led him to emphasize the role of the environment in his psychology. However, Galton's fixation on individual differences, and the experience of being unable to surpass classmates in spite of his best efforts led him to emphasize the role of hereditary factors in human intelligence. My concern here is not with how we should react to precocious development, but rather with the impact of personal theories and beliefs on scientific theories. Galton is not the villain here. Indeed, he is another example of the high imagery—low phonemic fluency individual I have described. Latin and Greek grammar were probably as much responsible for his academic defeat as was his view of himself.

That scientific theories are colored by personal experience is a contemporary phenomenon as well. Theories of spatial thinking are a good example. For years, the main controversy in this domain concerned whether all thought could be explained by a common set of mental processes operating on a common mental representation, or if instead, spatial imagery required a different code and a different set of processes. For years, I followed this debate with the sort of naive interest that is possible only if you believe that scientists are inherently rational creatures. Then I met some of the protagonists. One advocated the view that spatial images were in no wise special, and in fact argued all spatial knowledge could be modeled by the same propositional representations used to model verbal utterances. Then I met this person and asked how she came to study the imagery problem and was told: "I never was any good as those tests that requires you to rotate things." And the light went on. My friend Pat Kyllonen, who in his doctoral dissertation developed an information-processing theory of spatial abilities, also concluded that imagistic representations were not necessary. But in the preface to this 300 page tome he gives himself away: "The only time I have experienced a true mental image…has been when I've been hit in the eyes—I see sparkles" (Kyllonen, 1984, p. iii).

Thus, if you do not experience vivid spatial imagery, then you may not understand the pervasive influence of such imagery in the lives of those who do experience it. One way to do so, however, is to try to see the world a bit through the eyes of someone who does experience imagery, and who has tried to externalize it for the rest of us. Roger Shepard has done this better than any other I have encountered. He explains how it all began:

> *My efforts toward the faithful externalization of particular, spontaneous visual images began in earnest following my involuntary experience of an extraordinarily vivid and geometrically regular visual image just before awakening one morning in 1970. With eyes still closed on that morning, I suddenly saw before me an immense, luminously shimmering, golden array of diamond-shaped panels separated by burnished beveled strips. Each panel contained one of two regular arrays of small black arrows or spadelike forms that were identical except for the direction in which these forms pointed, which was uniformly upward or to the left, in alternating panels. The vision lasted for what I retrospectively estimated to have been several seconds, until I became fully awake. Even then, my memory of the image remained so vivid and my feeling of awe at its vast scale, its pristine regularity, and its preternaturally luminous and shimmering quality remained so keen that I immediately set about making a pencil sketch of it together with notations as to its colors and other details. I then used this annotated sketch as the basis for a larger-scale, full-color reconstruction.* (Shepard, 1990, p. 35)

A color plate of this drawing and drawings of other dream images are reproduced in Shepard (1978). Note that this description does not suggest poor verbal abilities, although it does not preclude problems in verbal fluency.

Routinely dreaming not just in color, but in colors that are clearer and more vivid than those experienced during waking hours, has been reported to me by several high spatial subjects (female as well as male). I am reminded of the description of childhood as the time when colors were bright. One hypothesis is that these high-spatial individuals preserve into adulthood imagery abilities that are lost to most individuals as they mature.

But of what use are these imagery abilities? Are they simply an entertaining night-time display? On the contrary, many have noted that their most creative contributions have occurred when, for one reason or another, the verbal-analytical regions of the brain were relatively quiet. For Shepard (1978), this has been just before waking. He writes: “Certainly many of the more original of my own ideas have taken sudden and essentially complete, though unverbalized, form in a [dream state] just preceding full awakening” (p. 182). Involuntary dream images were the source of many of his most creative and influential contributions, including the idea for his experiment with Metzler on mental rotation, the first method of nonmetric multidimensional scaling, and the computer algorithm underlying additive nonhierarchical cluster analysis. Contributions of imagery to both routine and creative thinking are also evident in the lives of many other eminent individuals, such as the physicists James Clerk Maxwell, Michael Faraday and Herman von Helmholtz, inventors such as Nikola Tesla and James Watt, and generalists such as John Herschel, Francis Galton, and James Watson. Shepard (1978) summarizes the biographies of these individuals. More extensive treatment and additional case studies may be found in West (1991).

What are some common characteristics these high-spatial individuals? Potential for visual-spatial creativity of a high order seems most likely to be revealed and/or fostered in a child: (a) who is kept home from school during the early school years and, perhaps, is relatively isolated from agemates as well, (b) who is, if anything, slower in language development, and (c) who is furnished with and becomes unusually engrossed in playing with concrete physical objects, mechanical models, geometrical puzzles, or simply wooden cubes. However, such children also evidence an increased predisposition toward some degree of dyslexia, and later in life, of mental breakdowns, aberrations, or even hallucinations (Shepard, 1978). Such children would probably not have been included in the Terman sample since only students nominated by teachers were tested. Many of these children, like Churchill, Einstein, Thomas Aquinas, and others, experienced considerable difficulty in grammar school. Thus, attempts to debunk folk wisdom about genius at least sometimes being akin to insanity are not convincingly made from the Terman data.

Finally, it is important to note that the relative strength of imagery and phonological coding/fluency abilities impacts routine thought, not just creative thought. One example comes from research on reading comprehension. For years, reading comprehension was modeled as the process of creating an internal model of the text that mimicked its logical structure. In other words, to comprehend something meant to construct an internal outline or summary of it. Then Kintsch and Greeno (1985) joined forces to understand how children solve—or better, why they fail to solve—word problems in mathematics. What they discovered was that a text model was not enough. Students needed also to construct a visual mental model that could be coordinated with the text model. Further, the visual model (or analog) becomes increasingly important as problem complexity is increased. It provides a way to integrate and coordinate much information about ideas and the relationships among them. A good example of what this means for comprehension comes from the experience of assembling a toy or a lawnmower or whatever from printed directions that only look like English. I can read the words "Put hex nut K and lockwasher Q on spindle d-1, and tighten loosely." I may be able to repeat them, to paraphrase them, even to summarize them. But if I cannot visualize what I must do, then I do not understand. Similarly, children need pictures to help them understand stories. Remember how sophisticated you felt when you graduated to texts without pictures? Thus, by this model, understanding means using linguistic clues to construct a text model and imagery clues (or analogy or metaphor) to construct an image model, and then coordinating the two. These two aspects of working memory are nicely depicted in Baddeley's (1986) theory. Baddeley claims that working memory contains a central executive (whose functioning remains somewhat mysterious. In fact, he calls it "the area of residual ignorance") and two slave systems: a phonological loop and a visual-spatial scratch pad. As I see it, the most important function of imagery in the visual-spatial scratch pad is simply to help us keep track of what we are doing, to see relationships among concepts we have represented either literally or metaphorically by our images. Thought without imagery would be like prose without metaphor. Indeed, one indication of the importance of these models in our thought is the pervasiveness of metaphor in our speech.

The relative ease with which we can create imagistic versus semantic elaborations also influences our personality. One of the clearest demonstrations of this comes from the work of Riding (1983). Riding was interested in children's habitual modes of thinking. He developed a task in which he read a short story to a child and then asked a series of two types, those that depended on imagery and those that depended on semantic elaboration. For example, the story may have mentioned the fact that someone knocked on the door of a cottage. The question might be “What color was the door?” Of course, there is no right answer, since color of the door was not specified. Response latency was recorded. However, the dependent variable of interest was an ipsative score that compared latencies on semantic and imagery questions. The idea was to identify children who were much quicker to answer one type of question than the other. Correlations were then computed between this ipsative score and a personality scale. Children who showed a preference for imagistic processing were much more likely to be introverted, whereas those who showed a preference for verbal elaboration were more likely to be extroverted.

To summarize, then, some individuals experience extraordinarily vivid visual-spatial imagery. Even the most cursory examination of their lives shows the pervasive influence of such imagery on their style of thinking. How many of these individuals are there? We really don’t know. One of the problems is that tests that are routinely administered to children rarely include good measures of both phonological fluency and analog spatial abilities. Our best guess is that the correlation is only about $r = .4$. This means that there are many who show uneven development of the two abilities. It also means that it is possible to be high on both abilities, or low on both. Thus, high spatial ability is not a marker for problems in phonological fluency. Both the profile and the overall average (or G) provide important information.

Sex Differences

I remarked earlier that the nature of the deficit in phonological coding and fluency is often inappropriately described as a deficit in verbal ability. The same mistake is often made in explaining sex differences in abilities. Men are said to be superior in spatial ability, women in verbal ability. But this misleads. Figure 1 shows sex differences in abilities for a sample of California high school students that I helped Snow collect almost 20 years ago. We first administered a large battery of aptitude and achievement tests to these student, then grouped tests on the basis factor analyses. The figure shows sex differences in factor scores. The test clusters at the top showed the largest female advantage. These tests require rapid, sequential processing of arbitrary sequences of letters or phonemes, or what Anderson (1983) calls a linear order code. The spelling test is a good example. Knowing the correct letters is not enough; sequence is crucial. Similarly, Hunt’s (1978) studies of verbal ability indicate that a key information processing characteristic of verbal ability is the ability to keep track of order information in working memory. Note, however, that typical tests of verbal ability showed much smaller sex differences.

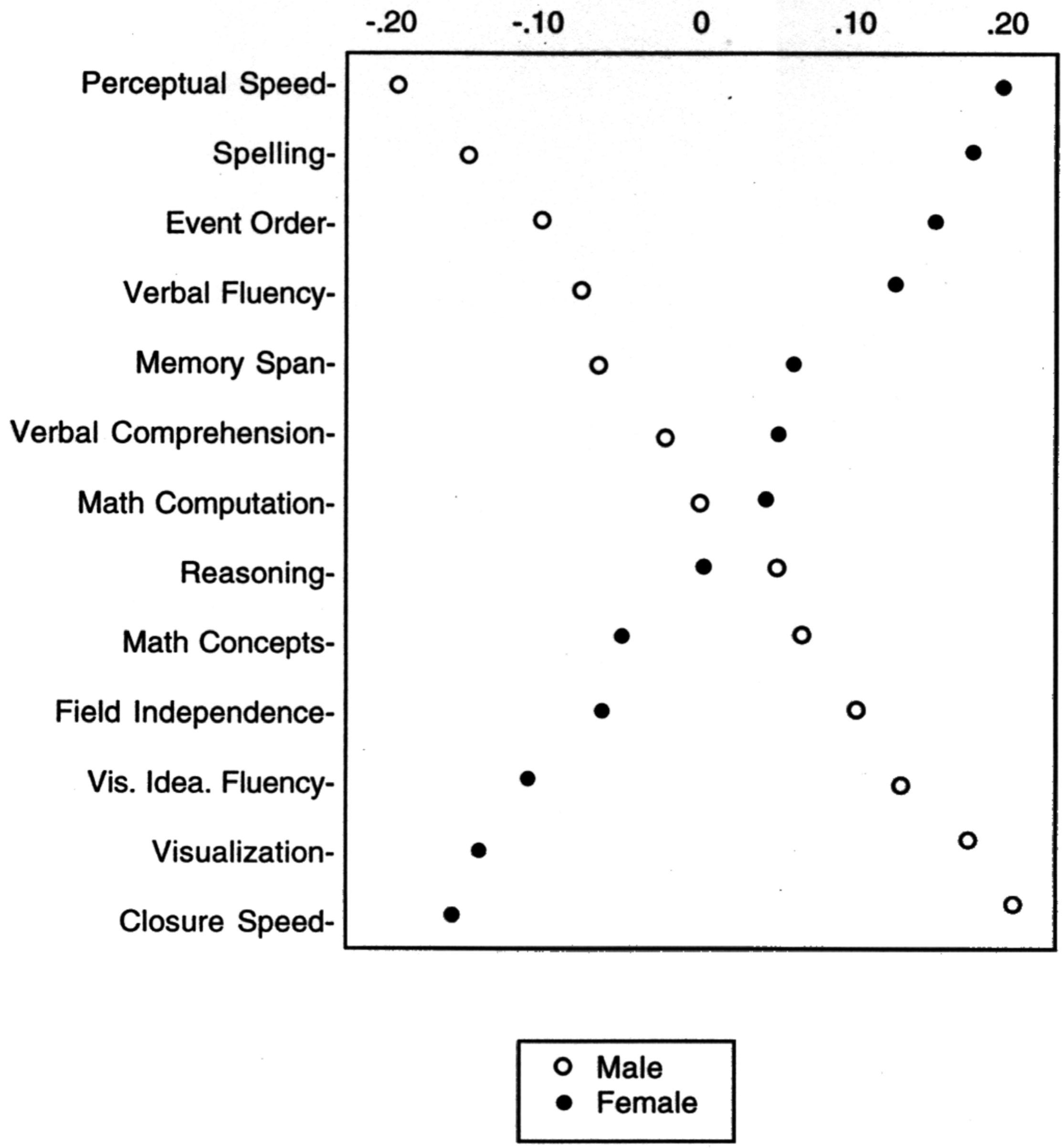

Figure 1. Sex differences in abilities for a sample of 243 high-school students. All abilities are on a z-score scale. Thus, the largest differences are approximately .5 SD (after Marshalek, Lohman, & Snow, 1983).

The clusters at the bottom showed the largest male advantage. These tests require rapid identification of a gestalt or the ability to perform analog transformations on such images. However, those tests in the middle—on which sex differences are small and non-significant—require reasoning about the meaning of ideas. In Anderson's (1983) system, this is modeled by an abstract proposition memory code. Thus, as I see it, general reasoning reflects the ability to create and transform memory traces that encode the meaning of events. I also believe that this corresponds to the general factor in mental test scores. In other words, those who are high in general ability are able to extract meaning from their perceptual experiences. The so-called savant typically lacks the ability to extract or impose meaning on these experiences, yet exhibits extraordinary ability to process information in one of the more peripheral codes. The existence of such individuals supports Anderson's multicode theory of memory.

Cleary's (1991) data on sex differences in achievement patterns shows a similar pattern. Female advantage is largest on spelling tests, intermediate on tests of grammar and style, and nonexistent on measures of general verbal comprehension. Parenthetically, some (such as Halpern, 1992) have wondered why so little attention has been paid to this phenomenon. When males excel, the scores are interrogated; when females excel, the difference is accepted without comment. There are understandable reasons for this one-sided look at the data. I suspect, though, that a closer look at each individual's relative strengths in these two domains would help us better explain the choices they make.

But are specific language skills just a matter of sequencing arbitrary symbols? Again, spelling provides the key. What is it that generates individual differences in spelling abilities? In his recent summary of the literature on human abilities, Carroll (1993) concludes that a cluster of abilities having to do with phonetic coding "is very close to the Spelling cluster, and may in fact be identical to it" (p.171). This same ability is labeled phonological awareness in the reading literature. It is among the best predictors of early reading performance, and, in other forms, of foreign language aptitude. Perhaps Churchill's inability to use a dictionary or his difficulty in learning French were not, as some biographers have claimed, a reflection of his stubbornness.

As I see it, the essential difficulty here is not so much in the ability to learn phonemes (for these people do learn to speak—although often more slowly than their peers), but the ability to reorganize sound sequences once learned, to play games with them, and to do so rapidly. Word games, tongue-twisters, secret languages all require these abilities. It is also manifest in the inability to acquire new phonemes, and new grapheme-phoneme correspondences, as when learning another language. It is as if phonemic skills—whether broad or narrow—are highly crystallized, and cannot be fluidly reassembled. Just the opposite occurs on the spatial side. The high spatial individual is able to combine and recombine clear visual images at will. Einstein claimed that he could begin the difficult and uncongenial task of attempting to communicate his ideas to others only after he conceptualized the matter using "more or less clear images which can be 'voluntarily' reproduced and combined" (Einstein, in Shepard, 1978, p. 135).

One further lead from the literature on sex differences. The early studies of Bock (1973), of his students Vandenberg and Petersen (see Bock, 1973), and the more recent work of Nyborg (1983) and others show quite clearly that effects of hormones on cognitive abilities on the development of verbal and spatial abilities are greatest not on spatial ability along, and not on verbal fluency alone, but on the contrast between the two. In other words, it is the relative strength of phonological/sequential and imagery abilities that is most related to hormonal levels, not their absolute levels.

Development

This brings me to the most interesting question of all: Is there a reciprocal relationship between these abilities? In other words, are advances in one linked somehow to declines in the other? There is remarkably little evidence on the development of these patterns of abilities. Some theorists, such as Bruner (1973) have hypothesized that children move predictably from an enactive (or motor) phase through an iconic (or imagery) phase to a linguistic phase. Bruner claims that earlier modes of learning are retained undiminished when a new mode is acquired.

On the other hand, he sees much benefit in programs for young adults that stimulate visual thinking and problem solving. Thus, decline (if it occurs) is due to disuse. However, research suggests that the decline in the relative strength of visual-spatial abilities is not entirely due to disuse, but to their incompatibility with sequential modes of processing.

One example of this incompatibility comes from recent research on the effects of the monthly fluctuations of hormones on women's performance on cognitive tests. Levels of estrogen in adult females vary widely. If the average level of estrogen in males is taken as the standard, then estrogen levels in women vary from approximately 3 times the male level immediately after menstruation to approximately 50 times the male level at ovulation. Hampson and Kimura (1988) found that women performed significantly better on a measure of verbal fluency when estrogen levels were high (i.e., midcycle), and significantly better on a spatial task when estrogen levels were low (i.e., immediately after menstruation). The effects are small, and so generalization to job performance is not warranted. My interest here is not in sex differences, but rather in the finding that verbal fluency and visual spatial abilities varied reciprocally. Increases in one were associated with decreases in the other.

Some of you may be able to understand fluctuations in your abilities this way. Unfortunately, it does not explain the ebb and flow in my battles with words (although more careful analysis may show similar effects for the much smaller fluctuations in male hormonal levels). A more likely explanation for my difficulties lies in the relative activation of one mode of thinking or the other. One of my students (who by the way is female) recounted this excellent example of reciprocity in verbal and spatial abilities:

> *I find this particularly true on a short-term basis. If I have been drawing for several hours and the phone rings, then I have difficulty forming words to answer the person on the other end.*

What this artist experiences as a short-term phenomena, others experience more regularly:

> *It is…a serious drawback to me in writing, and still more in explaining myself, that I do not so easily think in words as otherwise. It often happens that after being hard at work, and having arrived at results that are perfectly clear and satisfactory to myself, when I try to express them in language I feel I must begin by putting myself on another intellectual plane. I have to translate my thoughts into a language that does not run very evenly with them. I therefore waste a vast deal of time in seeking for appropriate words and phrases, and am conscious, when required to speak on a sudden, of being often very obscure through mere verbal maladroitness, and not through want of clearness of perception. That is one of the small annoyances of my life.* (Galton, in West, 1991, p. 170)

The case of Nadia is also suggestive. Nadia was a classically autistic child who showed poor language and social development. At age 4-1/2 she was enrolled in a special school for retarded. She made little progress in language, but enjoyed jigsaw puzzles, form boards, and threading shoes, and would persist at these activities until she mastered them. Her drawings were often transformations of pictures seen a day or two earlier. Observation suggested that she based her drawings on vivid mental images (Selfe, 1977). Early reports said that as her language skills improved, she drew less and eventually stopped altogether. This would support the hypothesis of reciprocal relationship between phonological and imagery abilities. It is also consistent with reports of other autistic children who lost their savant status as their autism declined. However, Selfe later reported that, with encouragement, Nadia began to draw again, seemingly with the same skill evidenced years earlier (Gardner, 1982). This suggests that, as Bruner claimed, earlier modes of processing are not lost, but decline through disuse.

My own bias is that childhood is, for some at least, the time when colors are bright. Further, I believe, as Gardner (1982) argues that it is possible to identify this visualizer style in young children. The interesting question, though, is what happens when the child is subjected to an almost exclusively verbal education. Perhaps something of the early style survives, and may be seen in avocations (such as woodworking as opposed to journal writing) and more subtly in the way problems are represented and thus solved. Churchill, in surveying the wreckage of his own boyhood said it best:

> *I would far rather have been apprenticed as a bricklayer's mate, or run errands as a messenger boy, or helped my father to dress the front windows of a grocer's shop. It would have been real; it would have been natural; it would have taught me more; and I should have done it much better. Also I should have got to know my father, which would have been a joy to me… . Certainly the prolonged education indispensable to the progress of Society is not natural to mankind. It cuts against the grain. A boy would like to follow his father in pursuit of food or prey. He would like to be doing serviceable things so far as his utmost strength allowed. He would like to be earning wages however small to help to keep up the home. He would like to have some leisure of his own to use or misuse as he pleased… . And then perhaps in the evenings a real love of learning would come to those who were worthy—and why try to stuff it into those who are not?—and knowledge and thought would open the "magic casements" of the mind.*
> (Churchill, in West, 1991, p. 154)

Cumulative Effects

If in fact it is the case that patterns of specific abilities in, say, phonological processing and image construction influence the way people think (and I think a reasonable argument can be made that they do), then such stylistic differences may have effects over the long haul that dwarf their immediate consequences. For example, I wonder how much of the sex difference in mathematics achievement can be explained by the cumulative effects of a relative female *strength* in phonological-sequential-string processing and a relative male strength in analog-image processing. In particular, if many young women find it easier to remember formulae than to construct a mental model, and if instruction is structured in a way that makes it possible to get good grades by doing so, and if knowledge thus assembled becomes increasingly unwieldy over time compared to knowledge represented in metal models (as research suggests), then some part of the cumulative female deficit in math and science and the even larger sex differences in career choices may be more a product of the within-person pattern of specific abilities than their absolute levels.

I would also like to know how instruction could be structured to assist those who prefer not to construct visual-spatial models so that they nevertheless learn in ways that encourages the sort of transfer that such images promote. In particular, I wonder if computers could be enlisted to perform the functions the individual finds difficult or unpleasant. Although there are difficult issues of capitalization versus compensation here (e.g., will computer images—like television—discourage learners from generating their own, or will they encourage them to think in ways heretofore impossible?), I am cautiously optimistic about the potential benefits of such computer-aided learning (see West, 1991). Proper use of tools to overcome physical limitations has ever been the lever that magnifies our capabilities. The computer can be a marvelous new tool, if used wisely.

I do not think that there are hordes of unidentified high spatial-low phonemic fluency children out there waiting to be discovered and brought into the fold. Abstract reasoning abilities are essential; superior skill in remembering images or sounds or numbers that is devoid of reasoning ability is the hallmark of the savant. On the other hand, I do believe that achievement tests—with their heavy emphasis on specific language abilities and mathematical calculation abilities—do miss children who can be among our most creative thinkers. The human toll is also substantial. As Churchill put it, “It is not pleasant to feel oneself so completely outclassed and left behind at the very beginning of the race” (in West, 1991, p. 149).

I began on a personal note, and so in keeping with the Gestalt principle of good form which is one of these spatial ideas that guides my thought—even the construction of an essay—it is appropriate that I should close with one as well. It is hard for me to imagine what thought would be like without the ability to coordinate my ideas with abstract forms. More concrete imagery sometimes gets me in trouble, though, when for example I finally meet someone whose work I have read and I exclaim (usually to myself) “But this is not at all what you are supposed to look like!” The vivid imagery of my youth has faded now, but so has the stuttering. I miss the former, but not the latter. Sometimes, though, I wonder what life would be like had my education given as much attention to the development of my visual-spatial abilities as to my verbal abilities.

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