

INDIVIDUAL DIFFERENCES IN COGNITION

CHAPTER OUTLINE

Setting the Stage

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- Cognitive Styles
- Learning Styles
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- The Effects of Aging on Cognition

Gender Differences in Cognition

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- Gender Differences in Learning and Cognitive Styles
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SETTING THE STAGE

My son and daughter share many characteristics, but when it comes to school they really show different aptitudes. My son adores literature, history, and social sciences. He ceremoniously handed over his calculator to me after taking his one and only college math course, noting, “I won’t ever be needing this again.” He has a fantastic memory for all things theatrical, and he amazes his fellow cast members and directors with how quickly he can learn lines and be “off book.” In contrast, my daughter is really adept at noticing patterns and problem solving, and she is enjoying an honors science course this year while hoping that at least one day in the lab they will get to “blow something up.” She’s a talented dancer and picks up new choreography seemingly without much effort. These differences really don’t seem to be about ability; Tim can do statistics competently, if forced, and did dance a little in some performances, and Kimmie can read and analyze novels or learn about historical topics and has acted competently in some school plays. What I’m talking about here is more differences in their interests, their preferred way of learning, maybe even their *style* of learning.

So far, we have been assuming that cognitive development proceeds in pretty much the same way for everyone. In the previous chapter, of course, we saw that children often don't approach cognitive tasks in exactly the same way as adults do, but we made the assumption that with time, maturity, and perhaps education they come to do so. In effect, we've been ignoring what psychologists call **individual differences**, stable patterns of performance that differ qualitatively and/or quantitatively across individuals.

In Chapter 15, we will consider differences in cognition as a function of one's culture. Here, we will consider some other sources of individual differences—differences in cognitive abilities, concentrating on intelligence, and differences in cognitive styles of approaching particular tasks. We will also consider

gender differences in cognition: stable differences in cognition or cognitive processing of information that varies as a function of one's biological sex and psychological attitudes associated with one's sex.

Why are cognitive psychologists interested in individual or gender differences in cognition? Simply stated, if people vary systematically in the way they approach cognitive tasks, then psychologists cannot speak of "the" way cognition works. To present only one approach if in fact there are several approaches is to ignore human diversity and to assume that only one way of carrying out a task exists. Researchers interested in individual and gender differences try to explain why some people seem to consistently outperform others on cognitive tasks and why some people feel more comfortable with certain cognitive tasks than with others.

INDIVIDUAL DIFFERENCES IN COGNITION.....

The term *individual difference* is meant to capture the intuition that different people may approach the same task in different ways. Psychologists who study personality traits are among those most likely to be interested in individual differences. The individual differences of interest to cognitive psychologists are generally of two distinct types: individual differences in abilities (i.e., the capacities to carry out cognitive tasks) and individual differences in style (i.e., the characteristic manner in which one approaches cognitive tasks).

ABILITY DIFFERENCES

Many psychologists equate **cognitive abilities** with **intelligence**. Hunt (1986), for example, stated that "intelligence" is solely a shorthand term for the variation in competence on cognitive tasks that is statistically associated with personal variables. . . . Intelligence is used as a collective term for 'demonstrated individual differences in mental competence'" (p. 102). Other psychologists do not equate the terms, but most agree that people vary in their intellectual (as well as several other important) abilities. Psychologists disagree over whether the best way to describe this variation is in terms of one general mental ability (called intelligence) or in terms of more numerous and varied intellectual abilities (Sternberg & Detterman, 1986).

Even psychologists who accept the idea of a general mental ability called intelligence debate just what the ability is. Some see it in terms of a capacity to learn efficiently; others see it in terms of a capacity to adapt to the environment. Other conceptions of intelligence include viewing it as mental speed, mental energy, and mental organization (Gardner, 1983, 1999; Sternberg, 1986). Many psychologists who study intelligence have looked at stable individual differences among various cognitive capacities to describe more general differences in people's performance on broader intellectual tasks. There are many lively and ongoing debates over what the set of cognitive capacities are; one representative list, described by Horn (1989),

follows (note that the list below does not purport to represent totally independent skills or capacities):

Verbal comprehension—Understand words, sentences, paragraphs.

Sensitivity to problems—Suggest ways to solve problems.

Syllogistic reasoning—Draw conclusions from premises.

Number facility—Compute arithmetic operations.

Induction—Indicate a principle of relations.

General reasoning—Find solutions to algebraic problems.

Associative memory—Recall associated element when given another element.

Span memory—Immediately recall a set of elements after one presentation.

Associational fluency—Produce words similar in meaning to a given word.

Expressional fluency—Produce different ways of saying the same thing.

Spontaneous flexibility—Produce diverse functions and classifications for an object.

Perceptual speed—Find instances of a pattern under speeded conditions.

Visualization—Mentally manipulate forms to visualize how they would look.

Spatial orientation—Visually imagine parts out of place and put them in place.

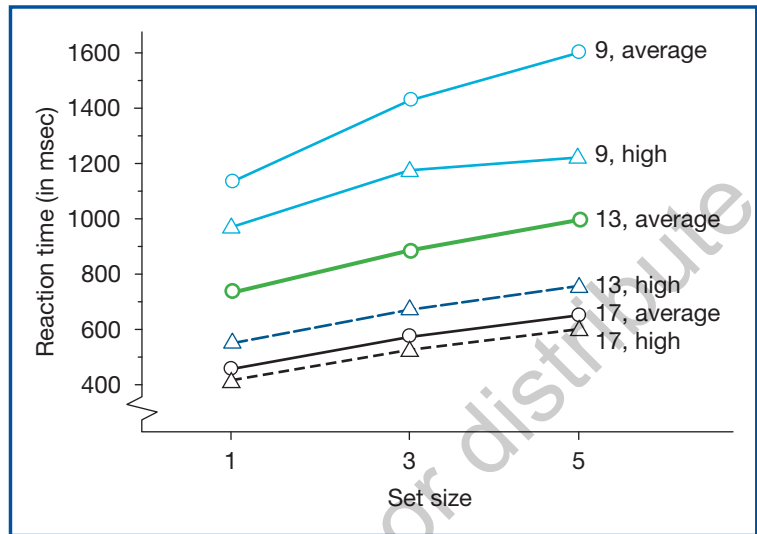
Length estimation—Estimate lengths or distances between points.

The point here is that people (both adults and children) can vary in many ways. Just as we all vary in athletic prowess, musical talent, and sense of humor, so too can we vary in intellectual and cognitive ways: in terms of memory capacity, attention span, concentration, and so on. These differences in turn can cause differences in how we approach and perform cognitive tasks.

A study by Keating and Bobbitt (1978) illustrates this point. These investigators conducted three experiments with both high-mental-ability (as assessed by a nonverbal intelligence test) and average-mental-ability 3rd, 7th, and 11th graders. All experiments were based on cognitive tasks previously used with adults, including the memory-scanning experiments described in Chapter 5. The authors found that when they controlled for the effects of age (and therefore presumably for developmental level), ability differences were still apparent, especially on the more complicated cognitive tasks. Figure 14.1, for instance, shows results of the memory-scanning task as a function of set size, age, and ability level. Note that older children had faster reaction times than younger children and that, within each age group, high-ability students were faster than average-ability students.

Keating and Bobbitt (1978) believed that both age and ability differences result from the efficiency with which basic cognitive processes (such as encoding and memory scanning) are carried out. They asserted that high-ability children (and adults) simply acquire, store, and manipulate basic information more rapidly and efficiently than their same-age, normal-ability peers. The same kinds of speed and efficiency differences also occur between older and younger children.

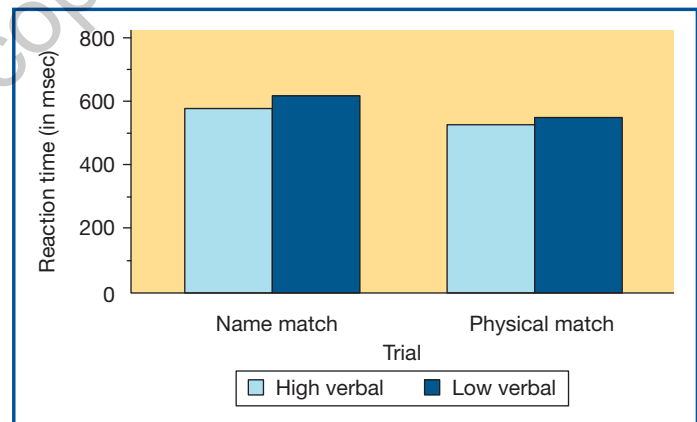
A related, and classic, study by Hunt, Lunneborg, and Lewis (1975) examined a specific hypothesized component of intelligence, verbal ability. These authors examined two groups of undergraduate students: those with relatively high scores on a verbal subtest of a standardized test similar to the College Board's SAT and those with relatively low scores on the same test. (The authors pointed out that the latter group had scores that would be considered "average" in the general population.) The aim of the study was to investigate whether differences in verbal ability, as reflected in standardized scores, might be explained by differences in basic cognitive skills.



■ **Figure 14.1: Mean reaction times in a memory-scanning task for children of different ages and abilities.**

Source: Keating, D. P., & Bobbitt, B. L. (1978). Individual and developmental differences in cognitive-processing components of mental ability. *Child Development*, 49, p. 161.

One of the many cognitive tasks Hunt et al. (1975) assigned to the participants was based on a perceptual matching task created by Posner, Boies, Eichelman, and Taylor (1969). In this task, participants are presented with two letters—for example, A and B, A and a, or A and A. They are to decide, as quickly as possible, whether the two letters presented are the same. In one condition (called "physical match"), they are instructed to respond *yes* only when the two stimuli match exactly—"A A" or "a a," for example, but not "A a." In another condition (called "name match"), participants are instructed to respond *yes* if the two stimuli refer to the same letter, so that "A A," "a a," and "A a" all should receive *yes* responses.



■ **Figure 14.2: Mean reaction times for high- and low-verbal participants in a perceptual matching task.**

Source: Adapted from Hunt, E., Lunneborg, C., & Lewis, J. (1975). What does it mean to be highly verbal? *Cognitive Psychology*, 7, 194–227.

Hunt et al. (1975) designed their experiment according to the following logic: A person's being highly verbal ought to imply "an ability to interpret arbitrary stimuli" and, in particular, an ability to translate "from an arbitrary visual code to its name" (p. 200). Thus, they expected the highly verbal students to be especially adept in the name match condition relative to the students of less verbal ability.

Indeed, as Figure 14.2 indicates, this is what they found. Both groups were approximately equally fast in the physical match condition (the highly verbal group was in fact a little faster here as well); the highly verbal group's superiority really became evident only when the task became a little more complex. The authors explained that high verbal ability stems at least in part from an ability to make a conversion rapidly between a physical stimulus and a conceptual meaning—in this case, recognition of the particular letters.

Psychologists and educators debate fiercely the issue of whether intelligence is one thing or several things. A controversial book aimed at the general public, *The Bell Curve* (Herrnstein & Murray, 1994), stirred a simmering pot of contention when it appeared, making the following strong assertions (among others):

Here are six conclusions regarding tests of cognitive ability, drawn from the classical tradition, that are by now beyond significant technical dispute:

1. There is such a thing as a general factor of cognitive ability on which human beings differ.
2. All standardized tests of academic aptitude or achievement measure this general factor to some degree, but IQ tests expressly designed for that purpose measure it most accurately.
3. IQ scores match, to a first degree, whatever it is that people mean when they use the word *intelligent* or *smart* in ordinary language.
4. IQ scores are stable, although not perfectly so, over much of a person's life.
5. Properly administered IQ tests are not demonstrably biased against social, economic, ethnic, or racial groups.
6. Cognitive ability is substantially heritable, apparently no less than 40 percent and no more than 80 percent. (Herrnstein & Murray, 1994, pp. 22–23)

A large part of the reaction to this work stemmed from what critics took to be the authors' refusal to present other points of view in a balanced or responsible way (Gould, 1995; Kamin, 1995). Many critics in particular decried the idea that there is one basic cognitive ability called *intelligence* that is accurately measured by IQ tests. Many others complained about the assumption that intelligence (whatever it is) is fixed and heritable. A more recent article (Nisbett et al., 2012) reviewed these and other issues.

One theorist, Howard Gardner (1983, 1993, 1999), had previously offered a theory directly contradicting the claims of Herrnstein and Murray. Gardner (1993) offered what he called a "pluralistic" theory of mind. He began by questioning what "an intelligence" is and offered this definition: "the ability to solve problems, or to fashion products, that are valued in one or more cultural or community settings" (p. 7). On the basis of a review of clinical data from brain-damaged individuals, studies of prodigies and gifted individuals, and experts in various domains from various cultures, Gardner (1983) proposed the existence of (at least) seven distinct independent "human intellectual competences, abbreviated hereafter as 'human intelligences'" (p. 8). These intelligences, with two others added in Gardner's 1999 work, are listed in Table 14.1.

Gardner (1983, 1993, 1999) argued that our Western culture places certain kinds of intelligence, specifically linguistic and logical–mathematical, on a pedestal. At the same time, our culture gives short shrift to the other intelligences, especially bodily–kinesthetic and interpersonal. We regard skilled athletes and politicians as people with talents but not as people who have a different sort of intelligence like famous scientists and great poets. We make a distinction between talents and intelligence, Gardner believed, only so that we can hold on to the concept that there is only one mental ability. Gardner called for a broader view of people's mental and cognitive abilities. He argued for a different kind of schooling that, instead of focusing only on linguistics and logic, also trains students as carefully in music, self-awareness, group processes, dance, and the performing arts.

Gardner's theory has captured the attention and enthusiasm of many psychologists and educators, some of whom are trying to implement the previously described **multiple**

■ **Table 14.1: Multiple Intelligences**

Linguistic intelligence	The capacity to use language to communicate and to accomplish other goals; sensitivity to subtleties in both written and spoken language; the ability to learn foreign languages
Logical–mathematical intelligence	The ability to solve problems, design and conduct experiments, draw inferences; the capacity to analyze situations
Musical intelligence	The ability to analyze and respond to musical patterns; to compose or perform music
Bodily–kinesthetic intelligence	The ability to use one's body to perform artistically or athletically; to create physical products; to use either the whole body or parts of the body skillfully
Spatial intelligence	The ability to navigate skillfully through both wide and confined spaces; to visualize spatial scenes; to create products with spatial properties
Interpersonal intelligence	The capacity to understand other people's emotions, motivations, intentions, and desires; the ability to work effectively with others
Intrapersonal intelligence	The ability to understand one's own emotions, motivations, intentions, and desires and to use the information for self-regulation
Naturalist intelligence	The ability to recognize flora and fauna of one's environment; to skillfully classify organisms with respect to species and to chart the relationships among different species
Existential intelligence	The capacity to see one's place in the cosmos, especially in light of such issues as the nature of the human condition, the significance of life, the meaning of death, and the ultimate fate of the world both physical and psychological (Note: Gardner is still evaluating whether this capacity fully merits the label "intelligence.")

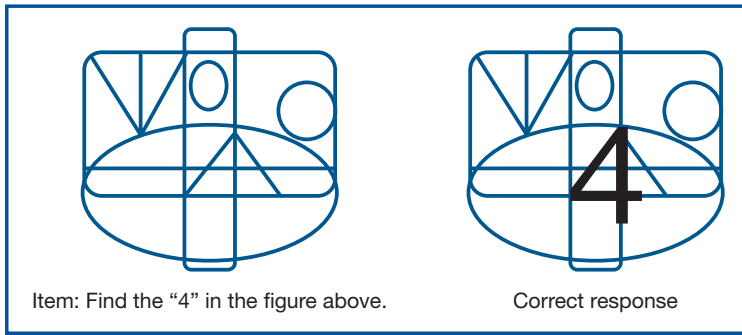
Source: Adapted from Gardner, H. (1999). *Intelligence reframed: Multiple intelligences for the 21st century*. New York: Basic Books. (The first seven items were presented in Gardner, H. [1983]. *Frames of mind: The theory of multiple intelligences*. New York: Basic Books. The last two items are from Gardner, 1999.)

intelligences (MI) theory in their classes (see Gardner, 1993, 1999, for some descriptions). There exist proposals for multiple creativities as well as intelligences, and educators have adopted these ideas enthusiastically (Han & Marvin, 2002). However, Gardner's theory awaits the development of assessment tools for each intelligence. Researchers and educators who hold to the concept of IQ as measuring the one true mental ability called intelligence have sophisticated tests that generally predict school performance adequately. Those interested in the idea of multiple intelligences have a great deal of work ahead of them to define the parameters of all the intelligences, to create valid measures of each one, and to describe the interrelationships among different kinds of intelligences (see Almeida et al., 2010, for a report on one such attempt).

COGNITIVE STYLES

Gardner's theory of multiple intelligences points to the idea that people differ in their cognitive equipment. This idea comports well with another long-standing idea: that people differ not only in their abilities, capacities, and the efficiency with which they use each one but also in terms of their **cognitive style**, that is, their habitual and preferred means of approaching cognitive tasks (Globerson & Zelnicker, 1989; Tyler, 1974). The term *cognitive style* is meant to imply certain personality and motivational factors that influence the way a person approaches a cognitive task (Kogan, 1983).

One example of a type of cognitive style is **field dependence/field independence (FD/FI)**, a term coined by psychologists who study perceptual processing (Witkin,



■ Figure 14.3: Example of a field dependence/field independence (FD/FI) test item.

perceptually to divorce the embedded picture from its context), whereas field-independent people would find this task relatively easy.

Witkin and his associates see this style of cognition as being related to issues broader than perception of figures. According to the theory, this cognitive style refers to “the degree to which the person relies primarily on internal [field-independent, FI] or external [field-dependent, FD] referents in processing information from the self and the surrounding field” (Kogan, 1983, p. 663).

Dyk, Faterson, Goodenough, & Karp, 1962; Witkin & Goodenough, 1981). The term refers to several phenomena, one of which is that some people find it much easier than other people to identify parts of a figure as being separate from a whole. An example of a task of field independence is shown in Figure 14.3. Field-dependent individuals would have a more difficult time finding the embedded picture in the larger picture (they are less able

Later conceptualizations broadened the definition of the style still more, associating the FI style with a generally autonomous manner in interpersonal relationships (people who might be likely to form their own opinions regardless of what their friends think), whereas FD individuals are seen as more likely to rely on others, especially in ambiguous situations.



■ Figure 14.4: Example of a Matching Familiar Figures Test (MFFT) item.

Source: Kagan, J., Rosman, B. L., Day, D., Albert, J., & Phillips, W. (1964). Information processing in the child: Significance of analytic and reflective attitudes. *Psychological Monographs*, 78(1, Serial No. 578), p. 22.

A second example of different types of cognitive styles has been called **cognitive tempo**, or the style of **reflectivity/impulsivity**. Kogan (1983) defined this style as “the extent to which a child delays response during the course of searching for the correct alternative in a context of response uncertainty” (p. 672). This can be illustrated with reference to Figure 14.4, which depicts an item from the Matching Familiar Figures Test (MFFT) developed by Kagan and his associates to assess cognitive tempo (Kagan, Rosman, Day, Albert, & Phillips, 1964).

The task posed to respondents in the MFFT is to find the item that exactly matches the item shown at the top. As you look at the other six pictures, notice that each one is very similar to the top item. Thus, finding the exactly matching figure requires your careful attention.

Children vary in how they respond to MFFT items. Some respond very quickly; others respond more slowly. Some make very few errors even on difficult items; others make a number of errors even on easy items. Many children fall into one of two categories: those who respond rapidly and make many errors (demonstrating an impulsive style) and those who respond slowly and make relatively few errors (demonstrating a reflective style) (Tyler, 1974).

Originally, cognitive styles were thought of as optional modifiable manners or problem-solving approaches that were independent of both intelligence and age. More recent research has challenged these assumptions. Cognitive styles do not appear to be easily modified through training. Moreover, cognitive styles show developmental differences; younger children are more likely to display impulsive and field-dependent styles, and older children tend to show more reflective and field-independent styles (Zelnicker, 1989).

Zelnicker (1989) also argued that reflectivity/impulsivity and FD/FI are not completely independent dimensions and that each relates to three underlying dimensions: selective attention, in particular the tendency to respond to whole stimuli or to their parts; attentional control, the focusing and shifting of attention; and stimulus organization, the mental transformation of stimulus input (e.g., in mental rotation tasks as described in Chapter 9). Zelnicker asserted that an individual's cognitive style "determine[s] the quality of stimulus information accessible for further processing in solving . . . problems" (p. 187).

Another recent area of attention among cognitive style researchers concerns a concept called **need for cognition**, which roughly means a person's motivation to take on intellectual tasks and challenges (Cacioppo & Petty, 1982). Individuals with high need for cognition (NFC) seem to enjoy more of those kinds of endeavors that involve thinking, problem solving, and reasoning and to derive more satisfaction from accomplishing an intellectual challenge than do individuals with a lower NFC. For example, high-NFC individuals might enjoy doing crossword or Sudoku puzzles as a form of recreation, whereas low-NFC individuals might enjoy recreation that involves less intellectual engagement such as watching TV game shows. Klaczynski and Fauth (1996) demonstrated no significant relationship between NFC and cognitive ability, suggesting that NFC really is a stylistic dimension and is not derived from intellectual power such as IQ. At the same time, the authors showed that low-NFC individuals were more likely to drop out of college, suggesting that styles do affect important life outcomes. Stanovich and West (1997, 1998, 2000) went on to show that cognitive style measures such as NFC do correlate with performance on a variety of specific reasoning and decision-making tasks.

LEARNING STYLES

Some psychologists are now turning their attention to whether people with different cognitive styles approach learning tasks differently, that is, have different **learning styles**. One example comes from the work of Rollock (1992), who gave 35 field-independent and 42 field-dependent undergraduates a task in which they listened to an audiotaped lecture followed by a quiz and then participated in an interactive demonstration followed by another quiz. Rollock thought that the first learning condition would favor FI learners and that the second would favor FD students. Although the first prediction was not supported, the second one received marginally significant

support. Other researchers have looked at people with so-called visual versus verbal learning styles (e.g., Green & Schroeder, 1990), although again with mixed results in supporting the idea of distinct styles. The general idea here is that learners learn best when the mode of information presentation best suits their own individual learning style (Kirschner & van Merriënboer, 2013).

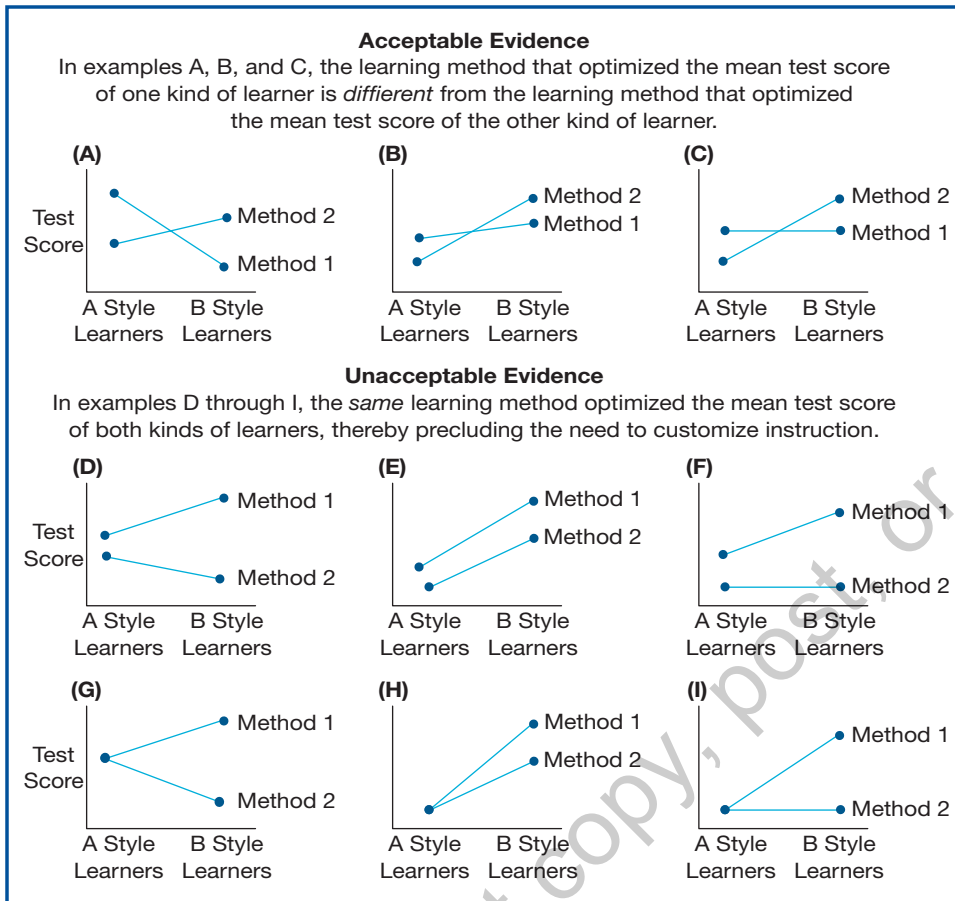
In a review of the literature on literature styles, Pashler, McDaniel, Rohrer, and Bjork (2008) looked for evidence of what they called the meshing hypothesis: the idea that instruction is most effective when it matches, or “meshes with,” the learning style of the learner. They also looked for evidence for a weaker hypothesis, the “learning styles” hypothesis, which states that learning tailored to a learner’s style can allow people to achieve “a better learning outcome” than they would achieve if this tailoring did not take place (p. 108).

Pashler et al. (2008) talked in advance about what kind of evidence a study would need to provide in order to support either of these hypotheses:

First, on the basis of some measure or measures of learning style, learners must be divided into two or more groups (e.g., putative visual learners and auditory learners). Second, subjects within each learning-style group must be randomly assigned to one of at least two different learning methods (e.g., visual versus auditory presentation of some material). Third, all subjects must be given the same test of achievement (if the tests are different, no support can be provided for the learning-styles hypothesis). Fourth, the results need to show that the learning method that optimizes test performance of one learning-style group is different than the learning method that optimizes the test performance of a second learning-style group.

Thus, the learning-styles hypothesis (and particular instructional interventions based on learning styles) receives support if and only if an experiment reveals what is commonly known as a *crossover interaction* between learning style and method when learning style is plotted on the horizontal axis. Three such findings are illustrated in [Figures 14.5(A) to 14.5(C)]. For each of these types of findings, the method that proves more effective for Group A is not the same as the method that proves more effective for Group B. One important thing to notice about such a crossover interaction is that it can be obtained even if every subject within one learning-style group outscores every subject within the other learning-style group (see [Figure 14.5(B)]). Thus, it is possible to obtain strong evidence for the utility of learning-style assessments even if learning style is correlated with what might, for some purposes, be described as ability differences. Moreover, the necessary crossover interaction allows for the possibility that both learning-style groups could do equally well with one of the learning methods (see [Figure 14.5(C)]).

[Figures 14.5(D) to 14.5(I)] show some hypothetical interactions that would not provide support for the learning-styles hypothesis because, in each case, the same learning method provides optimal learning for every learner. Note that these findings are insufficient even though it is assumed that every interaction in [Figure 14.5] is statistically significant. It is interesting to note that the data shown in [Figures 14.5(D) and 14.5(G)] do produce a crossover interaction when the data are plotted so that the horizontal axis represents learning method. . . . Thus, as noted earlier, a style-by-method crossover interaction constitutes sufficient evidence for the learning-styles hypothesis if and only if the horizontal axis represents learning style, as in [Figures 14.5(A) to 14.5(C)]. (p. 109)



■ **Figure 14.5:** Acceptable and unacceptable evidence for the learning-styles hypothesis. In each of the hypothetical experiments, participants were first classified as having Learning Style A or B and then were randomly assigned to Learning Method 1 or 2. Later, all participants took the same test. The learning styles hypothesis is supported if and only if the learning method that optimized the mean test score of one group is different from the learning method that optimized the mean test score of the other group, as in (A), (B), and (C).

Source: Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning styles: Concepts and evidence. *Psychological Science in the Public Interest*, 9, 105–119. Figure is on p. 110.

EXPERT/NOVICE DIFFERENCES

Throughout earlier chapters, we have seen that people with expertise in a certain realm often approach a cognitive task differently from novices. We first encountered this topic in Chapter 3 when we discussed perceptual learning. If you recall, the point was made there that experts and novices, given equal exposure to information, acquire or “pick up on” different amounts of it. In general, experts will perceive more distinctions, especially subtle ones, than novices do. This point is illustrated by an example of an art historian and a layperson unfamiliar with art both standing before a Picasso painting. The layperson (novice) “sees” less information than the art historian (expert), who may be effortlessly picking up information about brushstrokes or composition that the novice simply cannot perceive.

We saw in Chapter 8 that experts and novices differ in their conceptual representations of information. Novices in a given domain, for example, tend to classify objects or instances together on the basis of superficial or perceptual similarities; experts often use their knowledge to form deeper principles with which to classify. For example, if given a number of paintings, a novice might categorize on the basis of the subject of the picture (e.g., landscape, still life, portrait). An art expert would be far more likely to categorize on the basis of artist, historical period, composition, and other aspects of a painting that require a certain degree of knowledge.



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■ **Photo 14.1:** Research suggests that experts and novices perceive and categorize stimuli in different ways.

Work by de Groot (1965) and Chase and Simon (1973) on chess experts and chess novices suggested other relevant cognitive-processing differences between the two groups. For example, when shown a chessboard arranged in a mid-game configuration (i.e., the pieces arranged in such a way as to represent a game in process), an expert chess player could reconstruct the positions of approximately 16 (out of 25) pieces after only a 5-second glance. A chess beginner, given the same board and the same exposure, could reconstruct the positions of only about 5 pieces.

Interestingly, the authors showed it was not simply that the experts had better memories. Indeed, when shown chessboards with 25 chess pieces arranged randomly, the expert and the beginner showed equivalent performance, being able to reconstruct the positions of only 2 or 3 pieces. Instead, Chase and Simon (1973) argued that the chess expert used chess knowledge to group or “chunk” chess pieces into meaningful configurations. As Chapter 5 suggests, the chunking process can increase the amount of information held in working memory.

The findings on **expert/novice differences** just described sound a common theme: Your level of knowledge in a domain affects your cognition within that domain. Many cognitive processes—including perception and recognition; encoding; classification and categorization; and problem solving, reasoning, and decision making about information within the domain of expertise—appear affected.

THE EFFECTS OF AGING ON COGNITION

We saw in the previous chapter that cognitive skills and abilities develop, which means that children of different ages and levels of development may approach the same cognitive task in different ways. Age-related changes in cognitive processing do not cease during adolescence. In fact, researchers looking at adult development and aging have found a number of differences in cognitive processing between younger and older adults (Salthouse, 2012). Once again, this topic is a broad one, and we have space to mention only a few examples.

Relative to younger adults (those in their 20s and 30s), older adults (those in their 60s and older) show several differences in cognitive abilities and skills. For example,

older adults perform less well on tasks of divided attention (such as those discussed in Chapter 4) (McDowd & Craik, 1988), show age-related decrements in speech recognition and speech discrimination (Corso, 1981), and show declines in memory performance on a variety of memory tasks (Cavanaugh, 1993) as well as on a Tower of Hanoi problem-solving task (Davis & Klebe, 2001).

One example of these findings has to do with performance on working memory tasks. Salthouse and Babcock (1991) studied the performance of adults aged 18 to 87 years on various working memory tasks such as digit span, sentence comprehension, and mental arithmetic. The authors found, first, that older participants had shorter spans than younger participants. Salthouse and Babcock hypothesized, after extensive statistical analyses of their data, that the major factor accounting for this decline in span length was a decline in processing efficiency, or the speed with which various elementary cognitive operations (such as performing simple addition and comprehending a simple sentence) could be carried out.

Campbell and Charness (1990) found similar age-related declines in working memory. They gave three groups of adults (20-, 40-, and 60-year-olds) a task in which they learned an algorithm for squaring two-digit numbers. Participants worked for six sessions lasting 1 or 2 hours each. The authors reported two significant findings. First, practice with the algorithm improved performance in that errors declined over sessions. However, adults in the oldest group made more errors than the “middle-aged” adults, who in turn made more errors than the youngest adults. Even with practice, these age differences remained.

Baltes, Staudinger, and Lindenberger (1999), in a review of the literature, concluded that a general decline in the speed of processing of elementary cognitive operations occurs with age, perhaps accounting for the pattern of findings just reviewed. However, Paul Baltes, a well-known researcher on aging, has argued that older adults often can strategically compensate for such declines by using selective optimization with compensation:

When the concert pianist Arthur Rubinstein, as an 80-year-old, was asked in a television interview how he managed to maintain such a high level of expert piano playing, he hinted at the coordination of three strategies. First, he played fewer pieces (selection); he practiced these pieces more often (optimization); and to counteract his loss in mechanical speed he now used a kind of impression management, such as playing more slowly before fast segments to make the latter appear faster (compensation). (Baltes et al., 1999, pp. 483–484)

It is important to keep in mind, however, that differences in cognitive processing as a function of aging are still subject to individual differences from other sources. Such factors as intelligence, health, years of formal education, expertise, and cognitive style all continue to play important roles. The topic of the effects of aging on cognition, still in its relative scholarly infancy, will no doubt continue to support the idea that any individual's level of cognitive functioning depends on many factors, including factors specific to the individual such as those just described as well as those of the task and the overall context (Lerner, 1990; Salthouse, 2012; Verhaeghen, 2011; Zöllig, Mattli, Sutter, Aurelio, & Martin, 2012).

This brief look at individual differences in cognitive abilities was intended to stress an important point: Not all people approach cognitive tasks in exactly the same way. Age, ability, expertise, and stylistic differences among people can affect their efficiency in

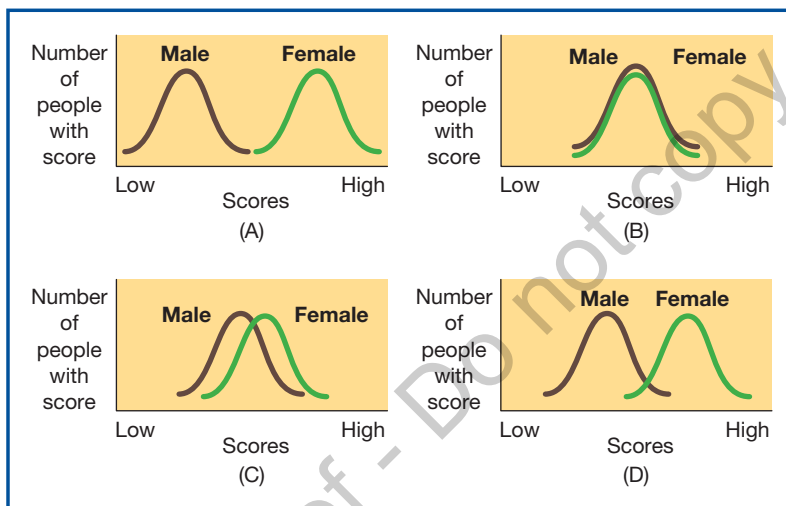
acquiring or processing information, leading to differences in how much information is picked up or how thoroughly it is processed. These differences in turn could have great effects on how well a complicated cognitive task is performed.

During the last four decades, some psychologists have also wondered about gender as a source of individual differences in cognition. In the next section, we will examine whether men and women adopt different cognitive styles or strategies in their approaches to cognitive tasks.

GENDER DIFFERENCES IN COGNITION

The possible existence of gender differences can be fascinating. This fascination is especially pronounced in our culture, as psychologist Carol Nagy Jacklin (1989) noted:

Speculation about differences between females and males is a national preoccupation. In our culture, people care whether there are fundamental differences between girls and boys, and we place more emphasis on the possibility of such differences than on other kinds of distinctions that could be made. For example, we rarely wonder whether blue-eyed and brown-eyed or short and tall children differ from one another in intellectual abilities or personality. (p. 127)



■ **Figure 14.6:** Examples of hypothetical gender distributions. Each curve depicts a hypothetical distribution of scores on some test for persons of one gender.

Some cautions are in order before we examine the evidence regarding gender differences in cognition, especially because of the sensitive nature of the topic. One of the most important cautions concerns the term *gender difference*.

To say there is a gender difference in performance on Task X can mean a number of very different things, as illustrated in Figure 14.6. One possible meaning is that the scores from members of one sex are higher than the scores from members of another sex, a possibility illustrated in Figure 14.6(A). Notice that the lowest-scoring member of one sex (the distribution to the right)

still outperforms the very best member of the lower-scoring sex. Although many people interpret statements about gender (or other group) differences in these terms, reality is almost never this simple.

More realistic depictions of gender differences in performance are given in (B), (C), and (D) of Figure 14.6. The first of these illustrates no gender difference. The last two illustrate real gender differences in the mean level of performance, with different degrees of overlap in scores between people of different genders. In each case, although women on average score higher than men, some men score higher than some women. In both cases, then, it is impossible to predict how any individual (Sally Smith or Jack Jones) would score. All we can say is that, given large numbers of men and women, the average score for women will be higher than the average score for men.

A second caution concerns built-in biases in the research literature. Scientific journals are simply much more likely to publish research that reports significant differences between or among groups of people than to include research that does not find differences. (This is known as the “file drawer problem” because studies that do not obtain statistically significant results often languish in a researcher’s file drawer.) In part, this is because journal space is limited, and studies that find differences tend to be more interesting than those that don’t (Tavris & Wade, 1984). In part, this is also because of difficulties in interpretation; researchers who find no group differences cannot conclude there are no differences. Halpern (1992) explains why:

Suppose you formulate the null hypothesis that no one has more than or less than one head. You could collect a large sample of people, count the number of heads per person, and presumably find that each has only one. However, you have not proved the null hypothesis, because only one exception, that is only one person with more or less than one head, can disprove it, and it is possible that you failed to include this person in your sample. Similarly, even large amounts of negative evidence cannot be used to prove that sex differences do not exist. (p. 33)

Another set of problems in interpreting research on gender differences concerns experimenter expectancy effects, the tendency for researchers unintentionally to influence the responses or behavior of research participants in the direction of the experimenter’s hypothesis (Rosenthal & Rosnow, 1984). To remind you, we first discussed the influence of such effects in Chapter 9 when we reviewed imagery studies.

In many psychological studies, experimenters can avoid or minimize these effects by remaining “blind” to which condition a participant is in. For example, in a memory study, one experimenter could randomly assign participants to the experimental and control groups, and a second experimenter, who did not know which participants came from which groups, could administer the tests.

Gender differences research, however, is a different story. Whenever participants are observed or interviewed, it is almost impossible for the observer or interviewer to remain blind to the participant’s gender. Thus, the observer or interviewer runs a risk of unintentionally and subtly “leading” the participant to behave in ways consistent with the study’s hypotheses, cultural stereotypes, or both. For example, an interviewer who expects women to be more “verbal” or more “emotionally expressive” may unconsciously reinforce this behavior in women, perhaps by smiling more, thereby allowing or encouraging more responses in the predicted direction. Some studies avoid these problems by having participants respond in writing (and then having their responses typed and scored by raters who do not know the gender of the writers), but this approach limits the kinds of observations and data that can be collected.



■ Photo 14.2: In a face-to-face interview, it is impossible to keep the respondent’s gender hidden from the researcher.

For these reasons, it is important to keep in mind throughout our discussion that there can be significant problems of bias, particularly in studies of gender differences.

GENDER DIFFERENCES IN SKILLS AND ABILITIES

Is there an overall difference in cognitive ability between women and men? Many people in our culture have different and strongly held opinions on this question (e.g., “Everyone knows men are smarter,” “Women are smart enough to let men think that they [men] are more talented”). But a cognitive psychologist needs more than opinion, however loudly voiced. Asked this question, she must first begin by defining what it means to have greater overall cognitive ability. Then she must translate this definition into specific behaviors or patterns of responses on specific tasks (this is called operationalizing the question—making it operational). Finally, she must recruit appropriate samples of men and women and administer the chosen tasks.

One kind of task the psychologist might choose is an intelligence test. However, a problem with this approach stems from the way intelligence tests are constructed. As Halpern (1992) pointed out, constructors of intelligence tests work hard to ensure that no overall differences exist between the scores of men and women. That is, many test constructors exclude from intelligence tests any items that show a reliable gender difference in responses.

However, this does not mean that men and women never show any differences in cognitive performance. In an early classic—but later heavily criticized—review of the sex differences literature, Maccoby and Jacklin (1974) identified three kinds of cognitive abilities that appeared to show reliable gender differences: verbal abilities, visuospatial abilities, and quantitative abilities. In this section, we will look at each of these in turn.

To do so, we will first need to consider methodological techniques used by psychologists when reviewing existing literature. Three major kinds of techniques have been used. The first, **narrative review**, involves locating and reading as many sources as one can and then writing up one’s conclusions. Although such summaries can be useful, as Hyde and Linn (1988) pointed out, the narrative review has several shortcomings: “It is nonquantitative, unsystematic, and subjective, and the task of reviewing 100 or more studies simply exceeds the information-processing capacities of the human mind” (p. 54).

A second technique, used by Maccoby and Jacklin (1974), is called **vote counting**. As the name implies, this technique involves listing each study and counting the number of studies in the total that demonstrate a particular effect. In essence, each study then receives one “vote” in the final tally. Studies that do demonstrate a gender difference “vote” for the idea that gender differences really exist; studies that do not find a gender difference “vote” for the opposite proposition. Although an advance over the narrative review, vote counting still suffers from a number of problems. The most important one is that each study is given equal weight, although many studies differ in overall quality, sample sizes, precision of the instruments used, and statistical power (Block, 1976; Hedges & Olkin, 1985; Hyde & Linn, 1988).

A more powerful technique for combining results from different studies is called **meta-analysis**. This involves the use of statistical methods to integrate the findings from different studies (Hedges & Olkin, 1985). Meta-analysis is gaining widespread popularity among psychologists. It allows the investigator to compare different studies quantitatively. A measure commonly used in meta-analysis is d , defined as the difference in mean scores between two groups divided by the average standard deviation for the two groups. This measure is known as the **effect size**.

For a concrete example of effect size, suppose the following. Women outperform men on a specific verbal task. If the mean score for women is 100 and the mean score for men is 50, but if on average the standard deviation for the two groups is 75, the effect size of the study would be $(100 - 50) / 75$, or .67. Essentially, an effect size tells us how much standardized difference lies between two (or more) means. Cohen (1969) provided rules of thumb for interpreting this value: Effect sizes of .20 are considered small, those of .50 are considered medium, and those of .80 are considered large. So our hypothesized value of .67 would count as a medium-to-large effect.

Verbal Abilities

What kinds of abilities count as “verbal abilities”? Different authors provide different definitions, of course, but a typical description includes breadth of vocabulary, speech fluency, grammar, spelling, reading comprehension, oral comprehension, and the ability to solve language puzzles such as verbal analogies and anagrams (Halpern, 1992; Williams, 1983). Maccoby and Jacklin (1974) concluded that the bulk of studies conducted up until 1974 suggested that although girls and boys showed approximately the same pattern of verbal abilities, after about 11 years of age, and continuing through high school and beyond, females outperformed males on a variety of verbal tasks, including language comprehension and production, creative writing, verbal analogies, and verbal fluency.

A later review (Hyde & Linn, 1988) challenged Maccoby and Jacklin’s conclusion. Using meta-analysis, Hyde and Linn (1988) surveyed 165 studies (both published and unpublished) that met the following criteria: Participants were from the United States and Canada, were over 3 years old, and lacked language deficits (such as dyslexia); the studies reported original data; and the studies’ authors provided enough information for the calculation of effect sizes. The types of verbal abilities examined included vocabulary, analogies, reading comprehension, oral communication, essay writing, general ability (a mixture of other measures), SAT verbal scores, and anagrams.

Of the studies surveyed, roughly a quarter showed superior male performance and three quarters showed superior female performance. However, when data were assessed in terms of statistical significance, 27% of the studies found statistically significant higher female performance, 66% found no statistically significant gender differences, and only 7% found statistically significant higher male performance. When the types of verbal tasks were taken into account, the only tasks to show reliable female superiority were those for anagrams, speech production, and general ability. The average d measures for these tasks were .22, .20, and .33, respectively, suggesting that even the significant gender differences were rather small. Analyzing gender differences as a function of age, the authors also found little variation in d measures according to whether the participants were preschoolers, children of elementary school age, adolescents, or adults.

Interestingly, studies published before 1973 showed a significantly larger gender difference (mean $d = .23$) than more recent studies (those published after 1973; mean $d = .10$). Early work suggested that females had greater verbal abilities than males. More recent analyses, however, have disputed this claim. Hyde and Linn (1988) concluded,

We are prepared to assert that there are no gender differences in verbal ability, at least at this time, in American culture, in the standard ways that verbal ability has been measured. We feel that we can reach this conclusion with some confidence,

having surveyed 165 studies that represent the testing of 1,418,899 subjects . . . and averaged 119 values of d to obtain a mean value of 10.11. A gender difference of one tenth of a standard deviation is scarcely one that deserves continued attention in theory, research, or textbooks. Surely we have larger effects to pursue. (p. 62)

Visuospatial Abilities

The term *visuospatial abilities* is awkward and hard to define, as previous authors have noted (Halpern, 1992; McGee, 1979; Williams, 1983). Typically, it refers to performance on tasks such as the mental rotation or mental transformation of different objects, shapes, or drawings, similar to those described in Chapter 9. Maccoby and Jacklin (1974) reported gender differences in visuospatial abilities as extremely reliable, asserting that boys “excel” in them once childhood is over. They reported a d measure of up to .40.

One task that appears to show reliable gender differences is mental rotation. On average, males perform better than females, although many individual females can outperform many individual males even on this task. Over the past 25 years, researchers have reported consistently large ($d = .90$) gender effects on mental rotation tasks (Loring-Meier & Halpern, 1999).

Loring-Meier and Halpern (1999) performed a study to investigate which components of a mental rotation task showed gender differences. Was it the initial generation of an image? The maintenance of an image in working memory? The ability to scan a mental image? The ability to transform a mental image? The researchers had 24 males and 24 females complete four tasks originally designed by Dror and Kosslyn (1994). Two of the four tasks are described here.

The first, an image generation task, asked participants to image a particular block letter, say L , by cueing it with a script lowercase version of the letter, say l . Following this, a set of four brackets would appear, with an X mark appearing somewhere within it. Participants needed to decide whether the X appeared within the space where the uppercase block letter would be if it had been drawn inside the four brackets. Figure 14.7 provides an example.

The image maintenance task presented participants with a pattern such as one of those shown in Figure 14.8. Participants were asked to memorize the pattern and press a key, causing the pattern to disappear. After an interval of 2,500 milliseconds, the screen presented an X and participants needed to decide whether the pattern would have covered the X .

Results showed that, for all four tasks in the study, there was no difference in accuracy between males and females. However, on all four tasks, males were reliably faster than



■ Photo 14.3: One task that appears to show reliable gender differences is that of mental rotation. On average, males perform better than females. However, many individual females can outperform many individual males even on this task.

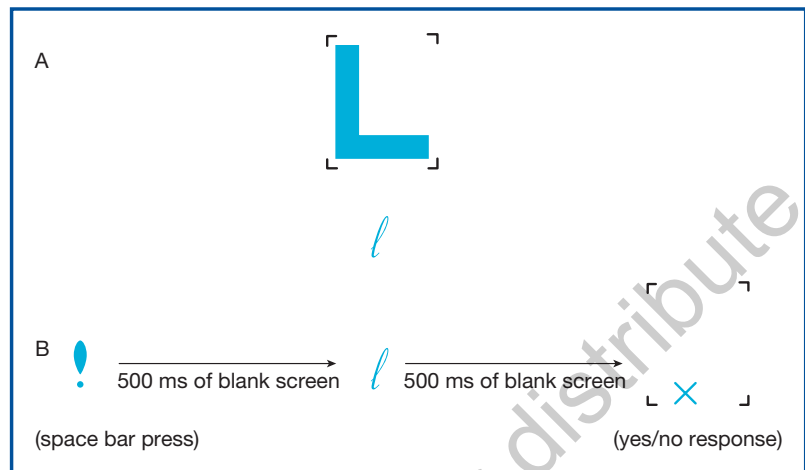
females, leading the authors to conclude that “males, in general, are more proficient in their use of visuo-spatial imagery” (Loring-Meier & Halpern, 1999, p. 470).

Linn and Petersen (1985), who conducted a meta-analysis of gender differences in spatial ability, concluded that the size of the gender difference in mental rotation differs as a function of the specific task. Generally speaking, the more rapid the processing of symbolic information required, the larger the gender difference. Mental rotation tasks that involved complex three-dimensional items generally showed larger gender differences than mental rotation tasks with simpler two-dimensional items. Linn and Petersen offered a number of possible reasons for the gender difference; for example, females may rotate items more slowly or may use different strategies in approaching the task.

Another reason may have to do with neurological findings on male and female brains. In a review, Levy and Heller (1992) noted that, in general, females tend to have cerebral hemispheres that are less lateralized, or specialized in function, than the cerebral hemispheres of males. It has long been known in psychology that the cerebral hemispheres have slightly different roles to play in our cognitive lives. For most of us (especially right-handed people), verbal fluency, verbal reasoning, and other types of analytical reasoning seem to be governed by left hemisphere functioning. The right hemisphere, in contrast, seems specialized for understanding spatial relations as well as for interpreting emotional information.

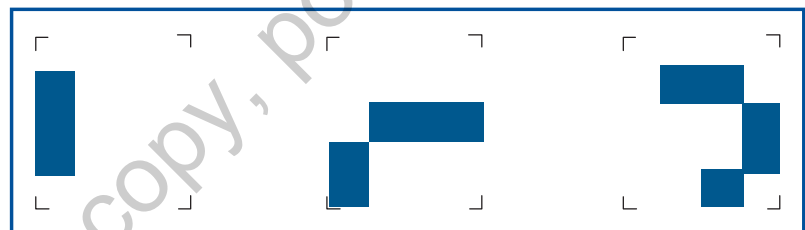
To say that males are more lateralized than females is to say that males show greater asymmetries in the functioning of their two cerebral hemispheres. Females, for example, appear to have language functions represented in both hemispheres, at least to some degree. Related to this, women who suffer left hemisphere damage often show better recovery of language functioning than do men with the same type of damage (Levy & Heller, 1992).

What might it mean to have greater asymmetries in functioning? It probably implies greater specialization in functioning; the more specialization, the more resources one has to perform a task. Overall, males’ greater lateralization may equip them with more resources to devote to specific spatial tasks such as mental rotation. Of course, this conclusion must be interpreted carefully. Although a gender difference in lateralization is well documented, this does not imply that every male shows greater lateralization than



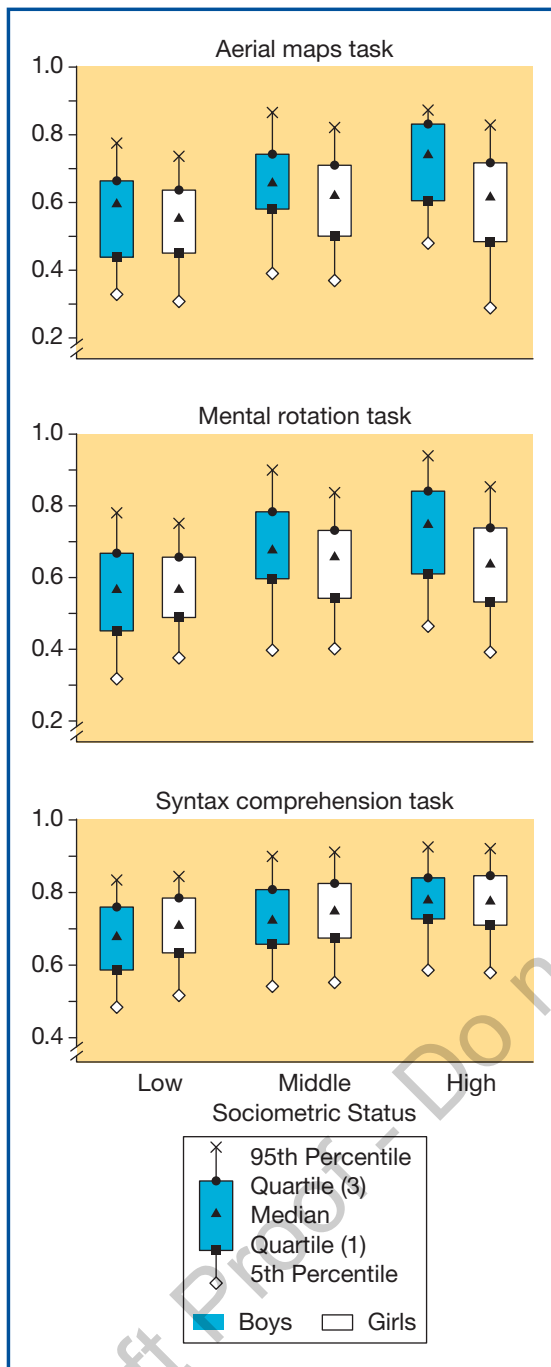
■ Figure 14.7: Examples of a stimulus presented during the learning stage (A) and a trial sequence in the image generation task (B).

Source: Loring-Meier, S., & Halpern, D. F. (1999). Sex differences in visuospatial working memory: Components of cognitive processing. *Psychonomic Bulletin & Review*, 6, p. 466. Copyright © 1999, Psychonomic Society, Inc. Reprinted with permission.



■ Figure 14.8: Examples of stimuli used for the image maintenance task.

Source: Loring-Meier, S., & Halpern, D. F. (1999). Sex differences in visuospatial working memory: Components of cognitive processing. *Psychonomic Bulletin & Review*, 6, 464–471. Copyright © 1999, Psychonomic Society, Inc. Reprinted with permission.



■ **Figure 14.9:** Box plots of score distributions (across time points) on the aerial maps task (top panel), mental rotation task (middle panel), and syntax comprehension task (bottom panel) as a function of sex and socioeconomic status.

Source: Levine, S. C., Vasilyeva, M., Lourenco, S. F., Newcombe, N. S., & Huttenlocher, J. (2005). Socioeconomic status modifies the sex difference in spatial skill. *Psychological Science*, 16, 841–845.

every female. Moreover, the tasks on which gender differences in spatial ability have been found are restricted to a narrow set.

Another study (Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005) adds a new wrinkle to the idea of gender differences in spatial abilities. Levine et al. (2005) gave two spatial tasks and one nonspatial task to boys and girls over a 1-year period, beginning during the participants' second-grade year. The researchers found no gender differences in the nonspatial (syntax comprehension) task, as expected. Also as expected, there was an overall gender difference in performance on the two spatial tasks (mental rotation and making correspondences between photographs and maps). Surprisingly, however, this overall difference showed variation as a function of the children's socioeconomic status (SES), as shown in Figure 14.9. Specifically, lower-SES students did not show any gender difference on the tasks; only middle- and high-SES students exhibited the traditional male advantage on the spatial tasks. One possible explanation for the SES-related differences is as follows:

An alternative explanation for the SES-related difference is that a differentially high level of engagement in the kinds of activities that promote the development of spatial skill is essential to the male spatial advantage. In lower-SES groups, these kinds of activities may be relatively unavailable to both boys and girls. Although little is known about what types of input can promote spatial skills, prior studies indicate that activities such as playing with Legos, putting puzzles together, and playing video games are correlated with spatial skill; further, boys spend more time on these activities than girls. . . . Although low-SES children certainly engage in sex-typed play, they may have less access than other children to toys and games that promote spatial skill, as some of these toys and games are relatively expensive. (Levine et al., 2005, p. 844)

Ultimately, the reasons for a gender difference in spatial ability may be found in biological factors (e.g., lateralization), socialization factors (e.g., access to puzzles and video games), or some combination. In any event, the differences have implications—for example, for the developers of important standardized tests such as the Graduate Record Examination (GRE) and SAT:

Many questions on these tests require the generation, maintenance, and transformation of visuospatial configurations. . . . On average, males score higher than females on these high-stakes tests. . . . These are speeded tests, which means that test takers who answer questions quickly are at an advantage compared with those who respond more slowly. (Loring-Meier & Halpern, 1999, p. 470)

Quantitative and Reasoning Abilities

The term *quantitative abilities* covers a variety of skills, including arithmetic knowledge and skill as well as an understanding of quantitative concepts (such as fractions, proportions, and inverses). As with the terms *verbal abilities* and *visuospatial abilities*, the term *quantitative abilities* has meant slightly different things to different investigators.

Maccoby and Jacklin (1974) believed that boys and girls showed similar levels and patterns of mathematical ability through elementary school. Beginning at 12 or 13 years of age, however, boys' achievement and skill began to increase faster than that of girls. Hyde (1981), in conducting a meta-analysis of the studies originally cited by Maccoby and Jacklin, concluded that the median *d* score for all the studies was .43, showing that, on average, boys tend to outperform girls by about a half a standard deviation.

Studies by Benbow and Stanley (1980, 1983) provided more evidence in support of gender differences in mathematical ability. The investigators used data collected by the Study of Mathematically Precocious Youth (SMPY), a talent search used to identify extremely able junior high school students. The logic here is that until junior high, male and female students are exposed to the same math classes in school. Thus, using junior high school students reduced the role of differential exposure to mathematics that might occur in high school, when boys often enroll in more math classes than girls.

In the SMPY studies, seventh and eighth graders took the College Board's SAT, a test familiar to high school juniors and seniors. Table 14.2 presents some of the results. Benbow and Stanley (1980) found that boys' scores on the mathematical section of the SAT were approximately 30 points higher than girls' scores, although both groups performed equally well on the verbal section. Moreover, the higher the score, the higher the ratio of boys to girls who had that score. For example, considering SAT scores of 700 and above (only 1 in 10,000 students scores this high), the ratio of boys to girls was 13 to 1 (Benbow & Stanley, 1983). There is some evidence, however, that gender differences occurred only on specific items, usually having to do with algebra rather than geometry or arithmetic (Deaux, 1985).

Follow-up investigations of the SMPY students, conducted 20 years after they were first studied, revealed that gender differences did predict different outcomes in pursuit of educational degrees either in or related to mathematics (e.g., engineering, computer science, physical sciences). For example, men were 5 to 7 times more likely than women to obtain a doctorate in one of these areas. In the surveys, men endorsed the desire for achievement in their careers more highly than women, whereas women endorsed the desire for a balanced life more highly than men (Benbow, Lubinski, Shea, & Eftekhai-Sanjani, 2000; Lubinski, Webb, Morelock, & Benbow, 2001).

Anita Meehan (1984) examined gender differences in other related tasks, specifically Piagetian tasks of formal operations. Recall from Chapter 13 that formal operational tasks include such things as logical reasoning, the ability to think systematically, and the ability to consider all possibilities. Meehan examined three kinds of formal operational tasks: propositional logic tasks, combinatorial reasoning tasks, and proportional reasoning tasks. Performing meta-analyses on a total of 53 studies, Meehan discovered small and statistically nonsignificant values of *d* for the first two tasks, .22 and .10, respectively. The third task, a more explicitly quantitative task (having to do with ratios), showed an average *d* of .48.

So far, we have seen that gender differences on some cognitive tasks—namely, some visuospatial and some quantitative tasks—seem established. However, Hyde (1981)

■ **Table 14.2:** Mean SAT Scores of Mathematically Precocious Youths

Test Date	Grade	Number		SAT-V Score* ($\bar{x} \pm$ S.D.)		SAT-M Scores†				Percentage Scoring Above 600 on SAT-M	
		Boys	Girls	Boys	Girls	$\bar{x} \pm$ S.D.		Highest Score		Boys	Girls
						Boys	Girls	Boys	Girls		
March 1972	7	90	77			460 ± 104	423 ± 75	740	590	7.8	0
	8+	133	96			528 ± 105	458 ± 88	790	600	27.1	0
February 1973	7	135	88	385 ± 71	374 ± 74	495 ± 85	440 ± 66	800	620	8.1	1.1
	8+	286	158	431 ± 89	442 ± 83	551 ± 85	511 ± 63	800	650	22.7	8.2
January 1974	7	372	222			473 ± 85	440 ± 68	760	630	6.5	1.8
	8+	556	369			540 ± 82	503 ± 72	750	700	21.6	7.9
December 1976	7	495	356	370 ± 73	368 ± 70	455 ± 84	421 ± 64	780	610	5.5	0.6
	8+	12	10	487 ± 129	390 ± 61	598 ± 126	482 ± 83	750	600	58.3	0
January 1978	7 and 8+	1549	1249	375 ± 80	372 ± 78	448 ± 87	413 ± 71	790	760	5.3	0.8
January 1979	7 and 8+	2046	1628	370 ± 76	370 ± 77	436 ± 87	404 ± 77	790	760	3.2	0.9

N = 9,927.

*Mean score for a random sample of high school juniors and seniors was 388 for males and females (8).

†Mean for juniors and seniors: males, 416; females, 390.

‡These rare eighth-graders were accelerated at least 1 year in school grade placement.

Source: Benbow, C. P., & Stanley, J. C. (1980). Sex differences in mathematical ability: Fact or artifact? *Science*, 210, p. 1263. Copyright © 1980, American Association for the Advancement of Science. Reprinted with permission.

made an important point: A statistically reliable effect (i.e., with relatively low probability of occurring), if the null hypothesis is true, need not necessarily be a large effect. One way to measure the magnitude of an effect is to compute a quantity known to psychologists as the “percentage of variance accounted for.” In lay terms, this measure reflects how much of the difference among scores is explained by a given variable. Hyde computed various measures of this magnitude and found that even for the highly reliable gender differences, the percentage of variance accounted for by gender was only between 1% and 5%. That is to say, knowing that a person is male or female can improve your guess about how well he or she might perform on a specific cognitive task (such as visuospatial or quantitative) by at most only 5%. Thus, generalizations such as “Women should avoid engineering” and “Men make more natural mathematicians” are wholly unwarranted by the existing data.

GENDER DIFFERENCES IN LEARNING AND COGNITIVE STYLES

So far, the evidence reviewed suggests that gender differences in cognition occur for only a few very specific tasks and that even then the gender differences are often small. This, in turn, suggests we have yet to find evidence that men and women have different basic cognitive capacities, skills, or abilities except perhaps for certain specific spatial and quantitative tasks.

However, women and men, as well as girls and boys, certainly often appear to teachers and instructors to have differential aptitudes or preferences. More women than men exhibit a “fear of mathematics” and avoid quantitative or analytical courses (such as those in mathematics, science, and logic) when given a choice, beginning in high school (Oakes, 1990). Certainly, it seems to teachers and others who work with students that cognitive gender differences abound. What accounts for the discrepancy between this anecdotal information and the studies reviewed earlier? One possibility is that gender differences arise not so much in basic cognitive resources (capacities, abilities, etc.) as in how these resources are used. Recall our earlier discussion of cognitive styles.

Perhaps it is in such approaches that women and men differ. In the next two sections, we will review two different but related proposals relevant to this idea.

Motivation for Cognitive Tasks

Research by psychologist Carol Dweck and her associates (Dweck, 1999; Dweck & Bush, 1976; Dweck, Davidson, Nelson, & Enna, 1978; Dweck, Goetz, & Strauss, 1980) has shown that even in elementary school boys and girls show differential patterns of *achievement motivation*. This term refers to the ways people define and set goals, particularly the goals that are presumed to relate to their own competence (Dweck, 1986). Two major patterns of behavior that appear to affect the ways people approach a broad range of tasks have been identified: a mastery-oriented pattern and a helpless-oriented pattern (Dweck, 1999; Dweck & Leggett, 1988).

Children and adults who adopt a **mastery orientation** set goals to challenge themselves and therefore to increase their competence, understanding, or mastery of something new. These individuals persist when they encounter obstacles or difficulty. Often they also appear to enjoy putting in more effort when it is called for. In contrast, individuals with a **helpless orientation** fail to set challenging goals and give up rather easily when “the going gets tough.” (See Burnette, O’Boyle, VanEpps, Pollack, & Finkel, 2013,

for a meta-analytic review that provides support across a number of studies of an extension of Dweck's original proposals.)

In a number of studies, Dweck and her colleagues have given older elementary school-age children a number of puzzles or similar problem-solving tasks. Often the tasks are set up to be unsolvable, and children are given "failure feedback"—information that they have failed to complete a particular task correctly. In one study (Dweck & Bush, 1976), children received failure feedback from either a male or female adult or peer. When the evaluator was an adult, and especially when the adult was female, girls tended to adopt a "helpless" strategy, attributing the cause of their failure to their own inability or lack of competence. In contrast, boys in the same circumstances were likely to attribute the failure to the evaluator's "fussiness." It is interesting that when peers administered the failure feedback, boys were much more likely to demonstrate a helpless strategy and girls were much more likely to attribute problems to their own efforts.

Dweck et al. (1978) reported other findings that might explain why adults' feedback has such different effects on girls and boys. They examined the kind of feedback given to fourth- and fifth-grade girls and boys by classroom teachers. Every instance of feedback to children by the teachers was coded. The experimenters found that when looking at just the positive feedback given, for boys more than 90% of it related to the intellectual quality of their work, but for girls the corresponding figure was less than 80%. The discrepancy for negative feedback was even stronger; for boys only about a third of the feedback concerned intellectual quality (the rest tended to be about conduct, effort, neatness, etc.), but well over two thirds of the negative feedback girls received had to do with work-related aspects of their performance.

Dweck and Goetz (1978) concluded that girls, perhaps because of their greater compliance with adult demands, are seen by teachers as expending maximum effort and motivation. Therefore, teachers come to believe that girls' failure can be attributed only to lack of ability. Boys, in contrast, are more often seen by teachers as lacking in conduct or effort. Thus, when boys' performance falls short of expectations, teachers are more likely (in fact, 8 times more likely) to attribute the problem to a lack of motivation than to a lack of ability. As a consequence, boys may be inadvertently taught both to be less devastated by criticism (because they receive so much) and to take it less personally (because so much of it has to do with nonintellectual aspects of work and is instead directed to a perceived lack of motivation). Girls, in receiving less criticism, have less opportunity to learn how to handle it. Furthermore, adult criticism of girls' work tends to focus on a perceived lack of competence or ability. In short, girls get the message that failure signals a lack of ability (something there is little remedy for); boys get the message that failure signals a lack of effort (for which the remedy is obvious).

Dweck et al. (1978) tested these ideas in a follow-up study. In it, they had children work on anagram puzzles, and a male experimenter provided failure feedback. Sometimes the feedback was of the sort typically given by teachers to boys ("You didn't do very well that time—it wasn't neat enough") and sometimes it was of the sort typically given by teachers to girls ("You didn't do very well that time—you didn't get the word right"). Following these experiences, all children were given another puzzle and were again given negative feedback; then they were asked the following question: "If the man told you that you did not do very well on this puzzle, why do you think that was?" The following choices were provided: "(a) I did not try hard enough. (b) The man was too fussy. (c) I am not very good at it." Children (both girls and boys) in the teacher-girl condition were more than 2 times as likely to attribute failure to option

(c), a perceived lack of ability. Children (again, both girls and boys) in the teacher–boy condition were far more likely to attribute failure to option (a), a perceived lack of effort, or option (b), the “fussiness” of the evaluator.

This research supports the idea that “evaluative feedback given to boys and girls . . . can result directly in girls’ greater tendency to view failure feedback as indicative of their level of ability” (Dweck et al., 1978, p. 274). Whether and when these patterns of attribution become stable and generalized is an open question but may bode poorly for women’s self-assessment, particularly for tasks perceived to be difficult.

Connected Learning

Feminist critiques of psychology (Belenky, Clinchy, Goldberger, & Tarule, 1986; Gilligan, 1982; Goldberger, Tarule, Clinchy, & Belenky, 1996) make even stronger claims about the different ways men and women approach cognitive tasks. Belenky and collaborators (1986) believed that today’s predominant culture, historically dominated by men, has come to prize rationality and objectivity over other equally legitimate ways of understanding that may be more common among women:

It is likely that the commonly accepted stereotype of women’s thinking as emotional, intuitive, and personalized has contributed to the devaluation of women’s minds and contributions, particularly in Western technologically oriented cultures, which value rationalism and objectivity. . . . It is generally assumed that intuitive knowledge is more primitive, therefore less valuable, than so-called objective modes of knowing. (p. 6)

Belenky et al. (1986) obtained their data from interviews of 135 women, some of whom were college students or alumnae and others of whom were members of what the authors called the “invisible colleges”—human service agencies supporting women while they parented their children. Women were described by the investigators as seeking **connected knowing**, in which one discovers “truth” through a conscious process of trying to understand. The kind of understanding sought involves discovery of a personal connection between the individual and the thing, event, person, or concept under consideration. It entails an acceptance and appreciation for the thing, event, person, or concept on its own terms and within its own framework.

Another style of knowing these authors described, termed **separate knowing**, is perhaps more typical of men and also of women who are socialized in and successful in traditional male environments. This kind of knowing strives for objectivity and



■ Photo 14.4: The work of Dweck and others suggests that teachers and other adults who work with children might provide different patterns of feedback to boys and girls about their intellectual abilities.

rigor—for the learner to “stand apart from” the thing, event, person, or concept being learned or understood. The orientation is toward impersonal rules or standards, and learning involves “mastery of” rather than “engagement with” the information to be learned. Separate knowing, according to Belenky et al. (1986), involves a different intellectual style in which one looks for flaws, loopholes, contradictions, or omissions of evidence in arguments or propositions. Connected knowing, in contrast, “builds on the [learner’s] conviction that the most trustworthy knowledge comes from personal experience rather than the pronouncements of authorities. . . . At the heart of these procedures is the capacity for empathy” (pp. 112–113).

If men and women do indeed have different styles of learning and understanding, then perhaps certain ways of processing information also differ in ease or familiarity. For example, mathematics and logic, each with an emphasis on rigor and proof, might seem more attractive to someone with a “separate” way of knowing; more interpretive cognitive tasks, such as understanding a poem and seeking out alternative perceptions, might come more easily to a “connected knower.” If styles of knowing vary by gender, then this could influence the kinds of cognitive tasks men and women find easiest or most appealing.

Little has been done to assess the extent to which the different responses articulated by Belenky et al.’s (1986) female participants are a function of gender as opposed to socioeconomic status, level of education, or other factors. Some work has replicated the finding of gender differences in separate and connected knowing, even among college undergraduates at an elite liberal arts college (Galotti, Clinchy, Ainsworth, Lavin, & Mansfield, 1999; Galotti, Reimer, & Drebus, 2001; Marrs & Benton, 2009), but much more remains to be done. More recent work has suggested that a person’s “way of knowing” shifts with the context in which the person is interacting, arguing against the idea that ways of knowing are stable tendencies (Ryan & David, 2003). Even if ways of knowing turn out to be largely stable, it is not yet clear whether different ways of knowing predict different kinds of cognitive performance on actual tasks. It remains for future research to examine these important issues.

Proposals from feminist research suggest that cognitive gender differences might not occur on specific tasks but rather on broad approaches to cognition itself. Future work must establish how different the ways of knowing are for people of different genders and must investigate how these differences in approach might translate into performance on specific cognitive tasks. It will also be important to assess the effect of gender independent of other demographic variables such as socioeconomic status, level of education, and cultural heritage.

Summary

1. Cognition might not always operate the same way for all people. Potential sources of variation in the way people approach the cognitive tasks in their lives include individual differences in cognitive abilities, cognitive styles, and expertise as well as age and gender.
2. Individuals apparently differ in their cognitive abilities, especially in such things as mental speed, storage capacity, and attention span. Some psychologists equate these cognitive abilities with intelligence. Other cognitive psychologists do not equate the two but see cognitive abilities as a part of intelligence. Still other psychologists reject the idea that there is one single thing called intelligence.
3. In addition, people can have different cognitive approaches to, or styles in regard to, different tasks. Two of the most investigated cognitive stylistic dimensions are field dependence/field independence and reflectivity/impulsivity. Whether the two dimensions are unrelated and the degree to which cognitive styles are modifiable are two important questions for future research.
4. People's expertise can affect the ways they approach a cognitive task within their domain of expertise. Experts perceive more distinctions and categorize information differently than novices. Experts can use their domain-related knowledge to chunk information so as to use their memories more effectively.
5. Age-related changes in cognitive processing do not disappear during adolescence; adults of different ages show some systematic differences in cognitive performance. Older adults perform slightly less well than younger adults on tasks of divided attention and working memory, for instance, perhaps because of a general decline in processing speed.
6. Research on gender differences in cognition is very active; therefore, any conclusions must necessarily be tentative. Currently, it seems safe to say that with regard to ability, the overall patterns of performance of men and women, or of boys and girls, are far more similar than different except on very specific tasks. Many descriptions of cognitive gender differences (e.g., in verbal ability) have on close inspection proven either false or at best greatly exaggerated. Other better established cognitive gender differences (e.g., in mental rotation tasks, in certain mathematical tasks [especially algebraic ones]) often depend on the age and educational background of the people surveyed and on the particular items used. Even for differences that are very well established, the magnitude of the difference between the average performance for males and the average performance for females is often quite small, accounting for up to only 5% of the total variance.
7. Another set of questions has to do with gender differences in cognitive style or approach. The issue here is whether females and males adopt different strategies in the ways they gather, process, or evaluate information. Carol Dweck's work suggests that boys and girls adopt different approaches to cognitive tasks, with girls tending to adopt a more "helpless" outlook, especially in the face of failure. It is not yet clear how girls and boys come to adopt different strategies, although Dweck's work implicates the typical patterns of feedback teachers give to boys and girls. We can speculate that these kinds of feedback may also come from other agents of socialization—parents, siblings, peers, and others—but the evidence on this question remains to be gathered.
8. Proposals from feminist research suggest that cognitive gender differences might occur not on very specific tasks but rather on broad approaches to cognition itself. Future work must establish how different the "ways of knowing" are for people of different genders and must investigate how these differences in approach might translate into performance on specific cognitive tasks. It will also be important to assess the effect of gender independent of other demographic variables such as socioeconomic status, level of education, and cultural heritage.

Review Questions.....

1. Discuss the reasons why cognitive psychologists need to know about stable individual and/or gender differences in cognition.
2. What does it mean to assert that stable individual differences in cognitive capacities exist? Is this assertion synonymous with the belief that stable individual differences in intelligence exist?
3. Contrast the classical view of intelligence with Gardner's view.
4. Discuss the idea of cognitive styles. How does this concept differ from the concepts of intelligence and cognitive abilities?
5. What cautions must be given in interpreting findings on gender differences (or, for that matter, on any group-related individual differences) in cognition?
6. Explain the logic of a meta-analysis. How is it performed? Why is it considered better than vote counting or narrative review?
7. Discuss the implications of the major findings regarding gender differences in cognitive abilities.
8. How might the work of Dweck and colleagues and Belenky and colleagues bear on the research on gender differences in cognition?

Key Terms.....

cognitive abilities

cognitive style

cognitive tempo

connected knowing

effect size (*d*)

expert/novice differences

field dependence/field

independence (FD/FI)

helpless orientation

individual differences

intelligence

learning style

mastery orientation

meta-analysis

multiple intelligences (MI) theory

narrative review

need for cognition

reflectivity/impulsivity

separate knowing

vote counting



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