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Cognitive Style as Environmentally Sensitive Individual Differences in Cognition: A Modern Synthesis and Applications in Education, Business, and Management

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Summary
The key aims of this article are to relate the construct of cognitive style to current theories in cognitive psychology and neuroscience and to outline a framework that integrates the findings on individual differences in cognition across different disciplines. First, we characterize cognitive style as patterns of adaptation to the external world that develop on the basis of innate predispositions, the interactions among which are shaped by changing environmental demands. Second, we show that research on cognitive style in psychology and cross-cultural neuroscience, on learning styles in education, and on decision-making styles in business and management all address the same phenomena. Third, we review cognitive-psychology and neuroscience research that supports the validity of the concept of cognitive style. Fourth, we show that various styles from disparate disciplines can be organized into a single taxonomy. This taxonomy allows us to integrate all the well-documented cognitive, learning, and decision-making styles; all of these style types correspond to adaptive systems that draw on different levels of information processing. Finally, we discuss how the proposed approach might promote greater coherence in research and application in education, in business and management, and in other disciplines.

Keywords
cognitive styles, environmentally sensitive individual differences, cognitive psychology, neuroscience, taxonomy of cognitive styles

Introduction

The key aims of this article are to relate the construct of cognitive style to current theories in cognitive psychology and neuroscience and to outline a framework that integrates the findings on individual differences in cognition across different disciplines. Rather than providing a comprehensive review of the literature on cognitive style, we have three particular goals in this article. First, we want to show that research on cognitive style in psychology and cross-cultural neuroscience, on learning styles in education, and on decision styles in business and management all address the same phenomena: environmentally sensitive individual differences in cognition that develop as a result of adaptation to physical and sociocultural events and circumstances. Second, we want to show that the various styles from disparate disciplines can be organized into a single taxonomy, which is informed by contemporary cognitive psychology and neuroscience. Third, we aim to demonstrate that the present approach can illuminate the use of cognitive style in applied disciplines, particularly in education and in business and management.

Historically, the term "cognitive style" has referred to consistencies in an individual's manner of cognitive functioning, particularly in acquiring and processing information (Ausburn & Ausburn, 1978). Messick (1976) defined cognitive styles as stable attitudes, preferences, or habitual

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strategies that determine individuals' modes of perception, memory, thought, and problem solving. Similarly, Witkin, Moore, Goodenough, and Cox (1977) characterized cognitive styles as individual differences in the ways people perceive, think, solve problems, learn, and relate to others. Although it seems obvious that there are differences in how people habitually process information, it is not obvious how best to characterize such differences or determine their significance. Despite being popular from the 1950s through the 1970s, research on cognitive styles has been seriously questioned in recent decades. Currently, many cognitive scientists appear to believe that research on this topic has reached a standstill and doubt whether the concept of cognitive style has utility. In fact, many researchers in basic and applied fields of psychology now use concepts such as "perceptual affordances," "dispositions," "patterns of learning," and "learning orientations" to conceptualize differences in how individuals perceive and interpret information, and to avoid the negative connotations associated with the idea of "cognitive style."

Despite the rapid decline in research on cognitive styles in mainstream psychology by the end of the 1970s, in applied fields (e.g., education, business and management), publications on the topic continued to increase dramatically—reflecting the high practical value of the construct in applied settings. However, working in isolation from one another, researchers in each of the applied fields developed their own terms, such as "learning style" (education) or "decision-making style" (business and management). These terms did not have clear definitions, nor was it clear how they differed from traditional characterizations of cognitive styles. Furthermore, some applied practitioners made frequent reference to and focused on naïve or outdated assumptions about how the brain processes information (as exemplified by, e.g., the popular narrative about left-brain vs. right-brain individual differences) or confounded and combined cognitive style with other psychological constructs. These efforts produced more chaos and led to greater skepticism among cognitive psychologists and neuroscientists about the utility of the concept of cognitive style.

As many reviews have noted (Curry, 1990; Evans & Cools, 2011; Kogan & Saarni, 1990; Kozhevnikov, 2007; Rayner & Cools, 2011; Sternberg & Grigorenko, 1997; Zhang, Sternberg, & Rayner, 2012), one reason that the concept of cognitive style fell short is the lack of a framework that unites and systematizes hundreds of proposed style dimensions. In response, advocates of the construct of cognitive style proposed a variety of unifying frameworks (e.g., Allinson & Hayes, 1996; Curry, 1983; Riding & Cheema, 1991; Sternberg & Grigorenko, 1997). Although some of these frameworks are sophisticated and elegant, as we will show in the present article, they did not solve the problem. In particular, none of these frameworks integrated the cognitive-style construct with contemporary cognitive-psychology and neuroscience theories of information processing; in fact, because the vast majority of cognitive-style studies were conducted before the rise of cognitive science, the concept of cognitive style has not been integrated with contemporary theories of cognition. Moreover, mainstream cognitive psychology and neuroscience have been primarily focused on the capacities and constraints all human minds have in common, and until recently barely considered individual differences in cognition. Thus, the basic-science fields could not offer the applied fields a coherent framework for organizing and understanding individual differences in cognition to which the concept of cognitive style could have been mapped. Thus, although cognitive style refers to ways of processing information, a relationship between the construct of cognitive style and contemporary information-processing theories has never been firmly established.

Systematic cognitive-psychology and neuroscience research on individual differences in cognition gained traction in the 1990s (e.g., Kosslyn, Thompson, Kim, Rauch, & Alpert, 1996), but most of this work focused on such basic factors as speed of processing, working memory capacity, and general fluid intelligence (Gf). Although variations in all of these factors could lead an individual to cope with specific environmental challenges more or less effectively, the research on individual differences did not have this focus; rather, it was focused on variations in the functioning of specific aspects of information processing per se. In contrast, cognitive-style researchers consistently used the concept of cognitive style to describe individual differences in cognition that help the individual to adapt to physical and sociocultural events and circumstances. As such, a particular cognitive style represents particular environmentally sensitive individual differences in cognition that arise from a system of interacting processes, not a single process working in isolation: The system takes individual differences in basic processes (e.g., speed of processing, working memory) as constraints, while environmental influences and the sociocultural environment engender particular habitual approaches to processing. The sorts of individual differences in cognition that underlie cognitive styles are likely to change only when the physical or sociocultural environment itself changes in fundamental ways (G. S. Klein, 1951; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). The idea that cognitive style is an adaptive system that is constrained by basic processes invites a novel approach to understanding cognitive styles.

The present article has the following major sections. First, we review experimental research that introduces the concept of cognitive style as patterns of adaptation to the external world; these patterns develop in part on the basis of innate predispositions, but are modified as a result of changing environmental demands. In addition, we will review more recent trends in cognitive-style research that have attempted to develop further the concept of cognitive style as well as to build models to systematize numerous style dimensions.

Second, we review research on cognitive styles in the field of education and in business and management. Specifically, we review style dimensions used in these fields and show that the conceptual and methodological problems in these fields result from (a) combining cognitive style and nonstylistic dimensions (e.g., motivation, personality, abilities) into one instrument and (b) focusing on a limited number of style constructs that are not supported by current cognitive research (i.e., the right/left brain topology). Furthermore, we review the most recent trends in style research in applied fields and outline the limited utility of the matching hypothesis (in education) and person-interaction-fit (in business and management), which state that individuals should be taught or trained in ways that match their preferred cognitive style. We also address the importance of developing an individual's style flexibility so that he or she can choose the most appropriate resources and the most appropriate styles and strategies in relation to the requirements of a given task.

Third, we review material that supports the validity of the concept of cognitive style. Specifically, we first review evidence that cognitive style reflects specific patterns of neural activity, even in the absence of difference in behavioral performance. Second, to support our idea that cognitive style represents environmentally sensitive individual differences in cognition, we review evidence for the existence of environmentally sensitive patterns of neural and cognitive processing in members of different cultures as well as in members of different professions.

Fourth, we introduce a taxonomy of cognitive styles, grounded in the empirical literature and basic distinctions from cognitive psychology and cognitive neuroscience. We infer that a finite number of adaptive systems gives rise to different cognitive styles, and that each adaptive system operates at different levels of information processing. This framework thereby suggests a way to unify numerous types of cognitive styles. This taxonomy is based in part on earlier attempts to develop an integrative framework, but takes them in a new direction.

Finally, we conclude by noting the broader implications of the approach we advocate, and make some suggestions about possible future directions for productive research on cognitive styles.

Experimental Studies of Cognitive Style

The first experimental studies of individual differences in cognition were conducted in the '40s (Hanfmann, 1941; Witkin, 1950; Witkin & Asch, 1948). Hanfmann (1941) showed that some individuals employed a perceptual approach when grouping blocks whereas others used a more conceptual approach, trying first to formulate hypotheses about possible groupings. Seven years later, Witkin and Asch (1948) presented participants with the rod-and-frame test to examine their perception of the orientation of a rod in different surrounding fields. They found that some people perceived the rod as upright only when it was aligned with the axes of the field, whereas others were not influenced by the field's characteristics. The main conclusion of these early studies was that individual differences in perception and cognition do exist and that people differ not only in their overall success at a task, but also in the ways in which they perceive, conceptualize, and solve tasks. At that time, there was no established term for these individual differences; they were called "perceptual attitudes," "predispositions," "modes of responses," or "cognitive system-principles" (see Kozhevnikov, 2007, for a review).

Introducing cognitive style as environmentally sensitive individual differences

G. S. Klein introduced the concept of cognitive style (which he called "perceptual attitudes") in the early '50s to describe cognitive processing that helps an individual to cope with the requirements of his or her environment. To examine how accurately individuals make judgments about changes in perceptual stimuli, G. S. Klein (1951) showed participants projected squares that constantly changed in size, and distinguished two types of individuals: "sharpeners," who tended to notice contrasts and had the ability to maintain a high degree of stimulus differentiation, and "levelers," who were most likely to notice similarities among stimuli and ignore the differences. G. S. Klein (1951) proposed that cognitive style could be conceptualized as patterns of adaptation to the external environment that regulate an individual's cognitive functioning. In support of his theory, Klein reported that in terms of personality, the leveler group exhibited a "self-inwardness" pattern, characterized by "a retreat from objects" and "avoidance of competition or any situation requiring active manipulation" (G. S. Klein, 1951, p. 339). Sharpeners, on the other hand, were more manipulative and active, and had high needs for attainment and autonomy. Thus, Klein considered both poles of the leveling/sharpening dimension as equally useful in helping an individual adapt to, and function in, the environment (i.e., each pole presents a way for individuals to achieve a satisfactory equilibrium between their inner needs and outer requirements)—but noted that different style poles drew on different information-processing capacities. Several years later, Holzman and Klein (1954) defined cognitive styles as "generic regulatory principles" or "preferred forms of cognitive regulation" in the sense that they are an "organism's typical means of resolving adaptive requirements posed by certain types of cognitive problems" (p. 105).

At about the same time, Witkin and his colleagues (1954) carried out their first large-scale experimental study of field dependence/independence, which led them to distinguish between field-dependent individuals, who depend on the surrounding context, and field-independent individuals, who do not depend on the surrounding context. Researchers also reported a relationship among participants' performance on perceptual tests, their personality characteristics, and their social behavior. Field-dependent people were more attentive to social cues than were field-independent people, and field-independent people had a more impersonal orientation than did field-dependent people, psychologically and physically distancing themselves from others (see also Witkin & Goodenough, 1981, for a review). Witkin et al. concluded that although the "core" of cognitive style might be rooted in an individual's innate predispositions, the two opposite poles of the field-dependence/independence style dimension represent outcomes of different modes of adjustment to the world.

Thus, similarly to Klein, Witkin et al. (1954) considered cognitive style to be patterns or modes of adjustment to the world; in their view, everyone adapts as best as possible, given his or her basic capacities, to the requirements of the external environment. Later, Witkin and Berry (1975) comprehensively reviewed cross-cultural studies of field-dependent/independent individuals, and suggested that cognitive style could be conceptualized as environmentally and culturally sensitive individual difference in cognition—and could be predicted from the analysis of an individual's cultural and acculturation characteristics (based on an "ecological analysis"; Berry, 1980).

Witkin and his colleagues, however, did not fully elaborate their theory, and as a consequence, the conceptualization of cognitive style as environmentally sensitive individual differences in cognition was somehow overlooked during later research in the 1950s, when a tremendous number of "styles" appeared in the literature; such styles included impulsivity/reflectivity (Kagan, 1966), tolerance for instability (G. S. Klein & Schlesinger, 1951), breadth of categorization (Pettigrew, 1958), field articulation (Messick & Fritzky, 1963), conceptual articulation (Messick, 1976), conceptual complexity (Harvey, Hunt, & Schroder, 1961), range of scanning, constricted/flexible control (Gardner, Holzman, Klein, Linton, & Spence, 1959), holist/serialist (Pask, 1972), verbalizer/visualizer (Paivio, 1971), locus of control (Rotter, 1966), and many others.

Studies of these styles typically focused on lower-order cognitive tasks, often assessed using performance measures (error rate and response time) with simple "right" and "wrong" answers. This approach is especially evident in the most common measures of cognitive styles, such as Witkin et al.'s (1954) Embedded Figures Test and Kagan's Matching Familiar Figures Test (Kagan, Rosman, Day, Albert, & Phillips, 1964). Instead of measuring bipolar dimensions representing two equally efficient ways of solving tasks, these tests measure only a single pole of the dimension (e.g., the Embedded Figures Test assesses only the level of field independence). The result is that these tests are more like tests of spatial intelligence than measures of a style. Given the nature of the tests, it is not surprising that researchers often found a correlation between results of intelligence and cognitive-style tests (e.g., Cooperman, 1980; Goodenough & Karp, 1961; McKenna, 1984), sparking ongoing debates as to whether two opposite poles of cognitive-style dimensions have an equal value or whether some of them, such as field independence, sharpening, and narrow categorization, are simply indicators of greater intelligence.

Furthermore, because the majority of these studies were conducted before the advent of cognitive science, they lacked a unifying theoretical approach to information processing, which could have laid the foundation for systematizing numerous overlapping cognitive-style dimensions. In the 1970s, mainstream cognitive psychology and neuroscience were primarily focused on the capacities and constraints all human minds have in common, and they barely considered individual differences in cognition until recently. Thus, cognitive science did not provide a coherent framework of individual differences in cognition that could have been used to organize and understand the various proposed cognitive styles. Consequently, the potential benefits of studying cognitive styles were lost amid the chaos, and research on cognitive style declined dramatically by the end of the 1970s.

Studies of individual differences in cognitive psychology and neuroscience

Systematic cognitive-psychology and neuroscience research on individual differences in cognition gained traction in the 1990s (e.g., Kosslyn et al., 1996), but most of this work focused on such basic dimensions as speed of processing, working memory capacity, and executive functions (e.g., updating). One approach to understanding such findings hinges on the idea that all of these aspects of information processing are related to Gf. During the past decades, researchers in cognitive neuroscience have proposed several theories of the brain bases of Gf. One view is that Gf arises from processing in the prefrontal cortex (Duncan et al., 2000; Gray, Chabris, & Braver, 2003; Kane & Engle, 2002) and depends on the flexibility of the algorithms that can be generated and executed by executive processes. An alternative view is that Gf corresponds to the ability to configure dynamically a collaborative information-processing network to deal with novel challenges (Carpenter, Just, & Reichle, 2000; Prat & Just, 2008) and, thus, that Gf does not arise from functioning in a particular place in the brain but, rather, reflects the capacity to bring together capabilities that are distributed across its different parts. Indeed, neuroimaging studies of working memory and Gf have demonstrated temporal, parietal, occipital, and cerebellar activations in addition to activation in distinct regions of the prefrontal cortex (Cabeza, Anderson, Locantore, & McIntosh, 2002; Prabhakaran, Smith, Desmond, Glover, & Gabrieli, 1997).

Other approaches to the study of individual differences in cognitive psychology and neuroscience attempted to relate variations in activation of specific parts of the brain to variations in performance. For example, Kosslyn et al. (2004) scanned brain activation while participants performed four different mental-imagery tasks (e.g., generating and rotating mental images). Individuals differed in how strongly different brain areas were activated during the different tasks. But more than that, individual differences in the amount of activation in different brain areas predicted response times and error rates in different tasks (see also Ganis, Thompson, & Kosslyn, 2005). Independent of the approach, however, many neuroscience studies on individual differences in cognition converged in suggesting that although the variability in Gf is affected by environmental constraints (e.g., a person in an impoverished environment might never fully develop his or her intelligence), it can be largely attributed to biological factors (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990; Devlin, Daniels, & Roeder, 1997; Posthuma et al., 2002; Thompson et al., 2001; see also Gray & Thompson, 2004, for a review).

None of the studies of individual differences in information processing in cognitive psychology or neuroscience helped conceptualize the nature of cognitive style—nor did the sorts of theories developed in cognitive psychology and neuroscience lend themselves to organizing and understanding cognitive style as conceived by early cognitive-style researchers. As discussed earlier, the concept of cognitive style was introduced to describe individual differences in cognition that are shaped by environmental demands and life experiences (although they are constrained by efficacy with specific aspects of information processing—e.g., a person with low spatial ability might never be able to develop a field-independent style in perception). But the theoretical frameworks in cognitive psychology and neuroscience did not focus on how information processing produced such environmental accommodations. This mismatch of interests and orientations led to significant problems in bridging the construct of cognitive style and contemporary theories in psychology and neuroscience.

Recent experimental studies of cognitive styles

Since the 1990s, a number of theoretical and empirical studies of cognitive style have begun to re-emerge in mainstream psychology. These studies can be roughly divided into three main categories described in the following paragraphs.

The first category comprises studies that support the existence of cognitive styles (*metastyles*) that operate on a metacognitive level (e.g., Keller & Ripoll, 2001; Kholodnaya, 2002; Niaz, 1987). The existence of such metastyles (e.g., mobility/fixity) had already been suggested by Witkin, who was the first to point out that there might be "mobile" individuals who possess both field-dependent and field-independent characteristics and can employ one style or the other depending on the situation (Witkin, 1965; Witkin et al., 1962), as well as by other early researchers (e.g., Eska & Black, 1971; Pinston, 1978). A decade later, Niaz (1987) identified four groups of college students on the basis of their field dependence/independence and intelligence measures: mobile field dependent, mobile field dependent, fixed field dependent, and fixed field dependent. Niaz showed that the fixed-field-independent group received the highest intelligence scores among all the groups, but mobile individuals (both field dependent and field independent) performed significantly better than fixed individuals in three college courses (chemistry, mathematics, and biology). More recently, Kholodnaya (2002) administered a number of different conventional cognitive-style measures (i.e., of field dependence/independence, constricted/flexible cognitive control, impulsivity/reflexivity, and narrow/wide range of equivalence) and intelligence tests. Using cluster analysis, Kholodnaya demonstrated that each of the cognitive-style dimensions could be split further along mobile versus fixed subcategories. Reviewing the literature on the mobility of styles, Kozhevnikov (2007) suggested that mobility/fixity can be viewed as a metastyle that defines the level of flexibility with which an individual can choose a particular cognitive style in a particular situation.

A second trend in recent cognitive-style studies has been a focus on reformulating the concept of cognitive style within a unifying theoretical framework. One example of these attempts is Sternberg's theory of thinking styles (Sternberg, 1988, 1997; Sternberg & Grigorenko, 1997), which differs from previous theories because it does not systematize existing cognitive styles but offers a

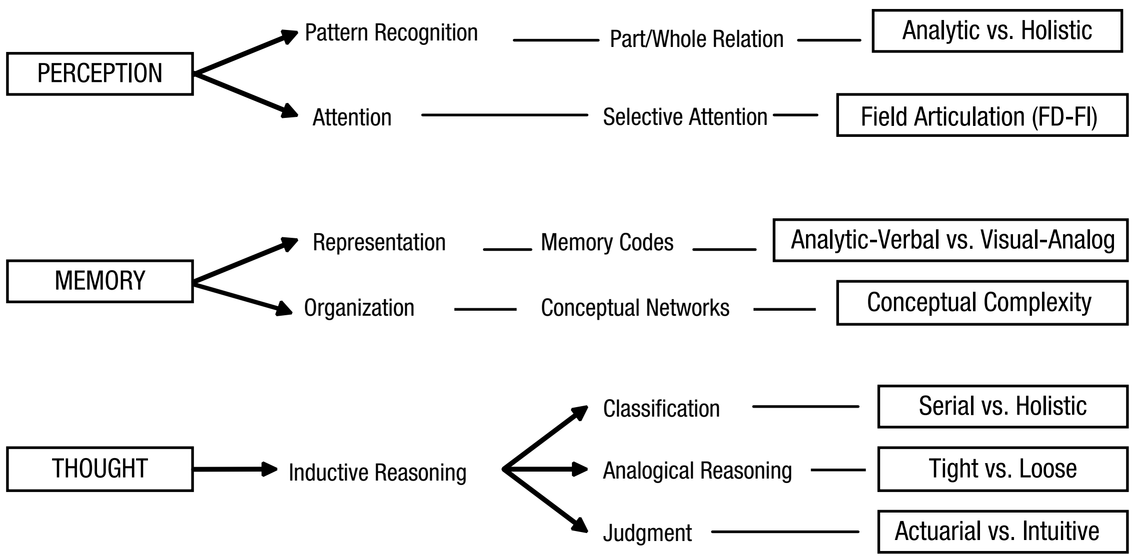

Fig. 1. A hierarchical model of analytic versus holistic cognitive style. FD = field dependent; FI = field independent. Adapted from "Cognitive Styles: An Integrated Model," by A. Miller, 1987, *Journal of Educational Psychology, 11*, p. 253. Copyright 1987 by the American Psychological Association. Adapted with permission.

new multidimensional system of intellectual (originally, "thinking") styles. The model uses the structure of real government as a metaphor for understanding and explaining individual differences in the regulation of a person's intellectual activity. Although Sternberg's (1988) original theory described 13 thinking styles, numerous follow-up studies (Zhang & Sternberg, 2000) revealed that most of these styles can be classified into two main groups: Type I styles, which are more creativity generating and denote higher levels of cognitive complexity (e.g., legislative, judicial, hierarchical, global, and liberal styles), and Type II styles, which suggest a norm-favoring tendency and denote lower levels of cognitive complexity (e.g., executive, local, monarchic, and conservative styles), with the remaining styles including characteristics from both groups, depending on the demands of the specific task. However, even this innovative approach did not solve the problem of integrating the cognitive-style construct into contemporary theories of cognitive psychology and neuroscience, nor did it explain the possible relationship between the posited thinking or intellectual styles and existing cognitive-style dimensions.

A third category of recent cognitive style research comprises theoretical studies that have attempted to build hierarchical models of cognitive styles on the basis of information-processing theories (e.g., A. Miller, 1987, 1991). Although criticized for a lack of empirical support (Zhang & Sternberg, 2005), A. Miller (1987) proposed a hierarchical model of cognitive style in which he posited two dimensions: a horizontal dimension specifying an analytic/holistic style continuum and a vertical dimension specifying different stages of cognitive processing, such as perception (pattern recognition and attention), memory (representation, organization, and retrieval), and thought. According to Miller, at each stage of cognitive processing, one can identify different cognitive styles (Fig. 1).

Nosal (1990) subsequently introduced a similar model of cognitive style with four main stages of information processing: perception, concept formation, modeling (reasoning, judgment, and decision-making processes), and program (i.e., metacognitive). Similar to Miller's model, Nosal's model suggested that different cognitive styles might be identified at each stage of information processing—for instance, field dependence/independence represents a style operating at the perceptual level, whereas mobility/fixity is a style operating at the program (metacognitive) level. A significant innovation of Nosal's approach is that he presented styles in a matrix form (see Fig. 2), expanding the analytical/holistic continuum proposed by Miller to accommodate other cognitive-style continua ("families"), such as (a) field structuring (context dependent vs. context independent), which describes a tendency to perceive events as separate versus inseparable from their context; (b) field scanning (rule driven vs. intuitive), which describes a tendency for directed, rule-driven versus intuitive information scanning; (c) equivalence range (compartmentalization vs. integration), which represents a tendency to process information as global units (simultaneously) or part by part (sequentially); and (d) control allocation (internal vs. external locus of processing), which describes methods of locating criteria for processing at the internal versus

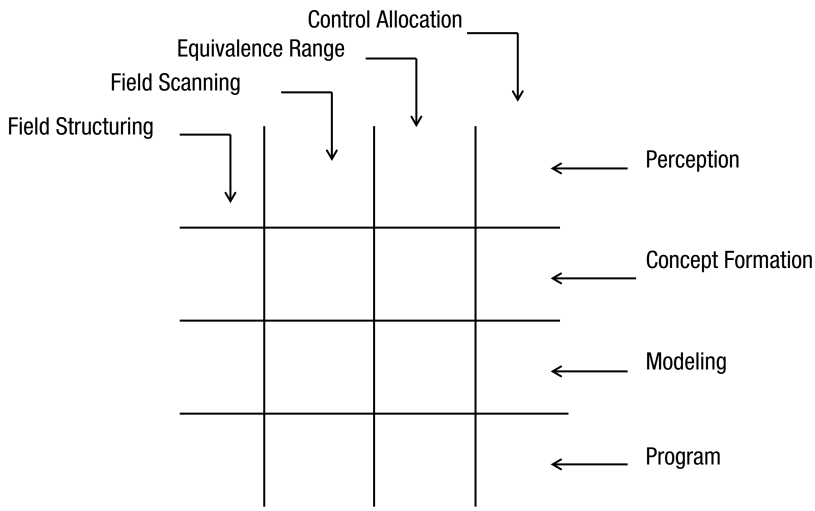

Fig. 2. Nosal's matrix of cognitive-style organization.

external center. Nosal described these four style families as four regulatory mechanisms or "invariant aspects" of information processing.

In short, the research on cognitive style in psychology suggests that some styles might operate at a superordinate metacognitive level, and that such metastyles will determine the flexibility with which an individual chooses the most appropriate subordinate style for a particular situation. More generally, the research suggests that it is useful to organize styles hierarchically. Such an organization consists of dimensions that relate to lower-order cognitive processing, to higher-order complex cognitive skills, and to metacognitive functioning. Moreover, cognitive style can be represented in a matrix form, with its vertical dimension representing different levels of information processing and its horizontal dimension representing different cognitive-style families.

Cognitive Styles in Education

Despite declining interest in cognitive style in cognitive psychology and neuroscience, by the end of the '70s, the number of publications on styles in education increased rapidly. Reviewing the application of cognitive-style research to education during the recent period of 1999 through 2010, Evans and Waring (2012) identified 486 articles on cognitive styles; Evans (2013) subsequently updated this review to include a further analysis of an additional 221 articles from 2010 through 2013. Most of this research was conducted in the United States (29%), the United Kingdom (16%), Australia and China (11%; Evans & Waring, 2012). Evans (2013) noted an increasing representation of research reports from countries such as Australia and China (11%), Turkey (9%), Taiwan (7%), and the Netherlands, Greece, and Belgium (7%), which implies an increased interest in the concept of cognitive style around the world.

Learning styles as environmentally sensitive individual differences in cognition

Similar to early cognitive-style research, the field of education introduced the idea of cognitive style as individual differences in cognition that develop as a result of an individual's adaptations to external (usually learning) environments or situations. However, although the major focus of early cognitive-style research was on individual differences in perception and lower-order cognitive processes (e.g., concept formation), most of the educational studies have focused on cognitive styles (often referred to as "learning styles") related to higher-order cognitive functioning (e.g., problem solving, hypothesis generation, modeling).

Kolb (1984) was the first to conceptualize learning styles as stable and enduring patterns of learning that arise from consistent interactions between the individual and his or her environment. The "cycle of learning," according to Kolb, involves four adaptive learning modes: two opposing modes of grasping experience, concrete experience and abstract conceptualization, and two opposing modes of transforming experience, reflective observation and active experimentation. The *diverging* style is a preference for concrete experience and reflective observation; *assimilating* is a preference for abstract conceptualization and reflective observation; *converging* is a preference for abstract conceptualization and active experimentation; and *accommodating* is a preference for concrete experience and active experimentation. In support of his approach, Kolb (1984) reviewed evidence regarding the relationship between his proposed learning styles and educational or professional specialization, and suggested that our particular life experiences and environmental demands shape a preferred way of choosing among the four learning styles.

Although the idea that cognitive style arises from environmental influences was suggested by a number of other educational researchers (Anderson, 1988; Schellens & Valcke, 2000; Shade, 1997), not all researchers embraced this conceptualization. Similarly to early cognitive-style research, in which the number of styles was defined by the number of cognitive tasks used as assessors, here the number of styles was defined by the number of factors characterizing a learner and/or learning situation (e.g., cognitive, physical, motivational). Even restricted to the field of education, many different terms have been introduced to refer to the concept of style, such as "approaches to learning," "strategies," "learning patterns," "dispositions to learning," "personal learning styles," "intellectual styles," and so on. Some researchers have sought to clarify the differences among the different terminologies (e.g., Peterson, Rayner, & Armstrong, 2009), as well as to organize key learning-style constructs (Cools & Rayner, 2011; Evans & Cools, 2011; Evans & Waring, 2009, 2012). Nevertheless, the variety of styles continues to multiply without clear definitions of new learning-style constructs or how they differ from traditional cognitive styles.

Learning-style models and instruments in education

Although the recent review of Evans and Waring (2012) identified more than 84 differently named models of learning styles used in educational studies, 74% of the reviewed empirical articles were primarily based on the following 10 instruments: (a) Kolb's (1986) Learning Style Inventory, which assesses four styles, as noted above, that are produced as a combination of concrete-experience/abstract-conceptualization and reflective-observation/active-experimentation dimensions; (b) the Approaches to Studying Inventory (Entwistle & Ramsden, 1983), which relates styles to four dimensions—deep (intention to understand), surface (intention to reproduce), strategic (intention to excel), and apathetic (lack of direction and interests); (c) the Study Process Questionnaire (Biggs, 1987), which measures both strategy dimensions (deep vs. surface) and motivational dimensions (defined as intrinsic, extrinsic, and achievement orientation); (d) the Group Embedded Figures Test (Witkin et al., 1962), which measures the field-dependence/independence dimension; (e) the Index of Learning Styles (Felder & Silverman, 1988), which assesses preferences on four dimensions—active/reflective, sensing/intuitive, visual/verbal, and sequential/global; (f) the Thinking Styles Inventory (Sternberg & Wagner, 1992), which assesses the use of 13 styles (e.g., legislative, executive, judicial) related to different dimensions; (g) Dunn, Dunn, and Price's (1989) Learning Style Inventory, which relates to a number of different dimensions, such as environmental, emotional, sociological, physical, and psychological (psychological dimensions include measures of global/analytic processing, impulsive/reflective processing, and cerebral dominance); (h) the Cognitive Styles Analysis (Riding, 1991), which measures two orthogonal dimensions—analytic/holistic and visual/verbal; (i) the Inventory of Learning Styles (Vermunt, 1994), which includes four styles—undirected (difficulty with assimilating the material), reproduction (information is reproduced to complete the task), application-directed (application of learning material to concrete situations), and meaning-directed learning (drawing on existing and related knowledge to achieve deeper understanding); and (j) the Gregorc Style Delineator (Gregorc, 1982), which relates to abstract/concrete and sequential/random tendencies, creating a combination of four styles—abstract sequential, abstract random, concrete sequential, and concrete random.

Two of the style instruments (Witkin's field dependence/independence and Riding's Cognitive Styles Analysis), as well as Gregorc's sequential/random dimension, tap cognitive styles at perceptual and conceptual levels, whereas all the other learning-style instruments assess styles that operate at higher-order information-processing levels. This finding is consistent with a recent review by Evans (2013), who also acknowledged a significant shift in the focus within educational literature from the use of low-order cognitive styles to styles operating at higher levels of information processing.

Educational research also provided empirical evidence that even similar styles operating at different levels of information processing may differ in an individual. For example, Mayer and Massa (2003) reported that cognitive style as measured by the Visualizer-Verbalizer Questionnaire (related primarily to perceptual and conceptual levels of information processing) was loaded on a different factor than was cognitive style as measured by a questionnaire tapping visual/verbal preferences for multimedia science learning (operating at higher levels of information processing). This finding further supports the idea that cognitive styles should be organized hierarchically and that styles operating at a higher level of information processing, such as learning styles, might be different from similar styles operating at lower levels of hierarchy.

Another strand in educational research is that most of the style instruments appear to assess “compound” styles. Some instruments attempt to integrate at least two traditional cognitive-style families into one instrument, such as the Cognitive Styles Analysis (Riding, 1991), which combines two orthogonal dimensions—analytic/holistic and visual/verbal—or the Study Process Questionnaire (Biggs, 1987), which combines integration/compartmentalization (deep vs. surface approaches) with locus of control (intrinsic vs. extrinsic motivation) styles. Another set of instruments attempt to integrate some of the cognitive-style families with other psychological (noncognitive) variables that can interact with styles. For instance, Dunn et al.’s (1989) Learning Style Inventory integrates several sorts of styles (e.g., compartmentalization/integration, rational/intuitive) with environmental, emotional, sociological, and physical factors. Such efforts have been aimed at developing more complex, integrated styles models that take into account different factors involved in the learning process. However, without a clear definition of cognitive style, this approach might impede understanding the nature of cognitive style and how it relates to other individual-difference variables (e.g., motivation, self-regulation, abilities, personality), leading to correlations among variables that are impossible to interpret.

Critical reviews of learning styles have appeared repeatedly in the educational literature (Cassidy, 2004; Coffield, Moseley, Hall, & Ecclestone, 2004; Sharp, Bowker, & Byrne, 2008), but—as noted by Desmedt and Valcke (2004)—such reviews have been less than illuminating. One of the problems with many of these reviews is that the approaches adopted within different reviews were based on different conceptions of cognitive style, which were not always clearly articulated. Another problem is that the reviews were often highly selective and not systematic, without clear justification for why certain cognitive-style models were included or excluded. In addition, a number of the reviews (Landers, 2009; Mayer, 2011; Pashler, McDaniel, Rowher, & Bjork, 2009; Pham, 2012; Riener & Willingham, 2010; Rohrer & Pashler, 2012) criticized the utility of learning styles because they assumed that such styles are relevant only in the context of the matching hypothesis, which states that students learn better when their learning style is aligned with the style of instruction. However, the fact that a simple version of the matching hypothesis—which rests on the assumption that a given person can be characterized by a single type of style, independently of the task—has not been supported does not imply that the concept of cognitive style itself is invalid. We turn to this topic in the following section, along with some of the most central trends that have emerged in educational research during the past years (Evans, 2013; Evans & Waring, 2012), such as style flexibility and investigations of the relationship between learning styles and culture.

The matching hypothesis

The matching hypothesis states that students will learn more efficiently when a teaching method matches their preferred cognitive style. For instance, according to this hypothesis, using visual media should help visual learners to engage with material, whereas using auditory presentation should help auditory learners to engage with the material.

Many debates have taken place in the educational literature over whether matching learning styles and instructional styles does enhance learning, and it has never been clear that “matching” is an effective approach. Sometimes the same author has taken different positions on this issue. For example, Kolb (1986) proposed that if material is presented in a way that is incompatible with a student’s learning style, then it is likely that he or she will reject the learning environment. In contrast, on another occasion, Kolb (1984) argued that potential long-term benefits may result from such a mismatch, when a student is taught to experience the tension and conflict between different learning modes. Consistent with such varying views, the literature is mixed: Although a number of studies suggested that learning is more effective when there is a match (e.g., Hudak, 1985; James, 1973; McLeod & Adams, 1977; also see Hayes & Allinson, 1996, for a review), other studies have suggested that learning is more effective when there is a mismatch (Nelson, 1972, as cited in Nicholls, 2002). And yet other studies found no evidence of reliable or useful interactions between student preferences and instructional treatments (e.g., Cronbach & Snow, 1977; Pashler et al., 2009). Specifically, Kavale, Hirshoren, and Forness (1998) found that learning was not facilitated by tailoring instruction to a student’s modality preference; a finding confirmed by Coffield et al. (2004) and Willingham (2005). In a particularly influential review, Pashler et al. (2009) found no evidence to support the view that students receiving instruction that matched their style preferences performed better than those who did not receive such treatment. On the basis of Pashler et al.’s (2009) review, Pham (2012), Riener and Willingham (2010), and Scott (2010) have argued that learning styles lack validity and should not be used to guide instruction within educational settings.

However, it is premature to conclude that “focusing on students’ learning styles adds little, if anything, of educational benefit to this process” of individualizing instruction (Landrum & McDuffie, 2010, p. 16). Such a conclusion is unwarranted for several reasons. First, as Curry (1990) noted, to be able to match a teaching method to a cognitive style, we need to be able to identify the cognitive style—and many of the current instruments are of questionable reliability and validity. Second, some teaching formats are better suited for particular material. For example, visual presentation would be better for teaching painting, whereas a verbal presentation would be better for teaching poetry. This sort of material/method matching may override differences in cognitive styles.

Accepting the limitations of the matching hypothesis, the question becomes, how can cognitive styles be applied to instructional settings? One approach is essentially to abandon any attempt at matching and, instead, to focus on the nature of the materials to be taught. Kolloffel (2012), in the context of perceptual preferences, has argued that learning is more influenced by the extent to which an instructional format affords appropriate and effective cognitive processing than by the match between a used and preferred format. He found that regardless of their cognitive-style preferences, students received higher scores using a verbal format than using their preferred tree-diagram format, and that cognitive styles were not related to cognitive abilities. Hence, students should not choose instructional formats on the basis of their preferences, because this might lead them to select a format that is less effective for learning.

Similarly, P. D. Klein (2003) argued for greater emphasis on what are the most appropriate representations of information in specific contexts rather than focusing on matching learner and instruction styles. Menaker and Coleman (2007) highlighted the importance of focusing on how learners' different modalities (visual, verbal) work together rather than isolating a purported preference for one modality regardless of context. In a similar vein, for certain tasks, certain styles have been found to be more desirable (i.e., efficient), and, therefore, emphasis should be placed on developing such styles rather than matching learners' style preferences. For example, Corcoran, Epstude, Damisch, and Mussweiler (2011), in their studies on comparative thinking styles (concerned with information focus and transfer), found that in different contexts, similarity-focused comparisons and dissimilarity-focused comparisons were more advantageous.

Another approach, called style flexibility (which we review in the following section), focuses on developing a metastyle—that is, teaching a student to select among styles and monitor how effectively he or she is learning—and know how to switch styles if necessary.

Style flexibility

The style-flexibility approach is similar to an idea described by martial-arts artist Bruce Lee: When asked about the best fighting style, Bruce Lee responded that the best style is "no style," in the sense that an individual should choose the style that is most appropriate in a given situation (White, 2004) "I have not invented a "new style," Bruce Lee noted, "composite, modified or otherwise . . . On the contrary, I hope to free my followers from clinging to styles, patterns, or molds." Furthermore, Bruce Lee continued, "a teacher must never impose this student to fit his favorite pattern; a good teacher functions as a pointer, exposing his student's vulnerability [and] causing him to explore both internally." Bruce Lee's idea about having "no style" leads us to focus on helping students to be proficient in multiple styles and to choose the most appropriate style for a given situation.

Shipman and Shipman (1985) were one of the first to highlight the importance of helping students to become sensitive and proficient in multiple alternative strategies, and there has been an increasing focus in educational research during the past decades on helping students to self-regulate their learning and flexibly switch between styles, according to situational requirements (e.g., Alferink & Farmer-Dougan, 2010; Barnett, 2011; Rittschof, 2010; Sharma & Kolb, 2011). Zhang (2013) has also noted that individuals can demonstrate both stability and flexibility in their intellectual styles. Through analysis of 90 publications, Zhang emphasized the power of training in supporting style flexibility.

There is also growing support for the idea that online learning environments can support multiple cognitive styles and strategies, provided that the relevant technologies are available and that the teacher has designed the environment to allow this (Barak & Dori, 2011; Bolliger & Supanakorn, 2011; Bouhnik & Carmi, 2012; Popescu, 2010; Samah, Yahaya, & Ali, 2011; Triantafillou, Pomportsis, & Demetriadis, 2003). Support for this view comes from mixed findings of attempts to match cognitive styles in e-learning contexts and significant evidence that students can adapt their styles to the requirements of the e-learning environment (Aliweh, 2011; Barak & Dori, 2011; de Boer, Kommers, & de Brock, 2011; Fan, 2013). Indeed, the advantages of e-learning may arise, at least in part, from giving learners greater control and flexibility in how they learn.

However, other researchers take a middle ground, urging caution when trying to teach style flexibility to all students (Curry, 1990). Evans and Waring (2012) noted that at certain points in learners' transitions and in the completion of certain tasks, matching specific styles is important (Riding & Rayner, 1998)—a finding that has also been confirmed in the context of research on e-learning styles (Handal & Herrington, 2004; Rittschof, 2010). In summary, a general recommendation is that instructors should help students to develop appropriate cognitive styles in relation to the needs of the task or tasks and be mindful that students may vary in how flexibly they can use different cognitive styles (Evans & Waring, 2012).

Learning styles and culture

Another growing trend in the educational literature focuses on examining the relations between learning styles and culture—in particular, country of origin. This trend may reflect efforts to understand different environmental influences that affect style formation. Recent educational research has acknowledged that although a person's country of origin may be an important factor in determining his or her cognitive styles (Cheng, Andrade, & Yan, 2011; Eaves, 2011), assumptions about cultural differences in cognitive styles must be carefully examined, given the complex interwoven nature of an individual's cultural dispositions (Marambe, Vermunt, & Boshuizen, 2012; Taher & Jin, 2011).

For example, Marambe et al. (2012) found in their study of Dutch, Indonesian, and Sri Lankan students' learning styles that the "Asian learner turned out to be a myth" (p. 299). Sri Lankan students made the least use of memorizing strategies of all the three groups and showed no propensity for rote learning. Marambe et al. suggested that the relatively high scores of the Sri Lankan students for concretizing and analyzing were more likely to be due to the construction of powerful learning environments than to culture. Furthermore, although Cheng et al. (2011) did find American students to be more analytic and active learners than their Chinese counterparts, they also reported that the Chinese students did not perceive themselves to be passive in their learning. Cheng et al. (2011) urged caution in how behaviors are interpreted and raised issues about the nature of learning-style measures and how suitable they are for use in different cultural contexts.

The demands of a specific educational context, socialization, or purposeful training may be as important an influence on students' cognitive styles as broader cultural variables (Eaves, 2011; Zhang, 2013). It is therefore important to consider culture along with other individual and contextual variables in understanding cognitive-style formation (see also Papageorgi et al., 2010). Eaves (2011) has highlighted that although culture-specific learning styles may exist in some countries, these may be flexible in different educational contexts, and any necessary adaptations to curriculum design and delivery should be supported by well-informed teaching processes that address the diverse learning styles of all learners (see also Evans & Waring's Personal Learning Styles Pedagogy, 2009).

Summarizing the research on learning styles in education, we conclude that—similar to early cognitive-style researchers—educational researchers have introduced the construct of cognitive style to reflect individual differences in cognition that are shaped by environmental demands, such as learning environments, educational experiences, and global culture. Furthermore, learning styles introduced by recent educational research primarily represent cognitive styles operating at higher levels of information processing. At the same time, a large number of learning-style instruments have combined measures of cognitive style with other nonstylistic dimensions, making it difficult to separate style from other individual-difference variables. Finally, we note an increasing emphasis on the relation between style flexibility and self-regulation, taking the application of styles in education beyond the limited concept of the matching hypothesis.

Cognitive Style in Business and Management

Similarly to the field of education, the fields of business and management have witnessed a growing interest in the application of cognitive style over the past 40 years (see Armstrong, Cools, & Sadler-Smith, 2012, for a review). In a systematic review of the literature from 1969 to 2009 related to cognitive style, Armstrong et al. identified 4,569 papers on cognitive styles relevant to the fields of industrial and organizational psychology, business, and management.

Decision-making styles as environmentally sensitive individual differences in cognition

By the end of 1970s, the business and management literatures began to focus increasingly on the idea of cognitive styles (often called "decision-making styles") as individual differences in cognition that developed as a result of an individual's adaptations to environmental (usually workplace) demands. Similar to learning styles, decision-making styles represent cognitive styles that operate at higher levels of information processing (e.g., decision making, judgment, reasoning).

Kirton (1976, 1989) was the first to consider decision-making styles by introducing the adaptor/innovator dimension ("doing things better" vs. "doing things differently"). Kirton considered decision-making patterns as emerging from interpersonal communication and group behavior, modified as a result of professional experiences and external demands. In particular, Kirton (1989) investigated the adaptor/innovator dimension in organizational settings, widening the concept of cognitive style to characterize not only individuals but also the prevailing style in a group (called the "organizational cognitive climate"), which in turn affects individuals' cognitive styles.

Another line of studies on decision-making styles was proposed by Agor (1984, 1989), who introduced three broad types of styles in management: the intuitive, analytical, and integrated styles of problem solving and decision making. Similarly to Kirton, Agor (1984) pointed out that one's decision-making style not only emerges from stable individual characteristics but also depends on interpersonal communications and group behavior. Agor (1984) surveyed 2,000 managers of various occupations, managerial levels, and cultural backgrounds, and (although it is not clear whether the differences found were indeed statistically significant) Agor stated that the data showed variation in executives' dominant styles of management practice by organizational level, service level, and gender and ethnic background (e.g., women were found to be more intuitive than men and managers of Asian background to be more intuitive than managers of other ethnic backgrounds).

Subsequent studies on cognitive styles in business and managerial fields supported similar ideas. First, they concluded that cognitive styles are related to management practice (Hayes & Allinson, 1994) and individual and organizational behavior (Armstrong et al., 2012; Sadler-Smith & Badger, 1998). Second, although they tend to be relatively stable, cognitive styles interact with the external environment and can be modified in response to changing situational demands, as well as influenced by professional experiences (Allinson & Hayes, 1996; Hayes & Allinson, 1998; Leonard & Straus, 1997; Zhang, 2013). Thus, the early characterization of cognitive styles as patterns of adjustment to the world was further specified in the business and management literature to include descriptions of the particular requirements of social and professional groups on an individual's cognitive functioning (e.g., Agor, 1984; Armstrong et al., 2012; Kirton, 1989; Sadler-Smith & Badger, 1998).

Models and instruments in business and management

In their review of the cognitive-style literature in business and management, Armstrong et al. (2012) reported that the most common assessments of styles (including traditional cognitive styles, learning styles, and decision-making styles) in business and management were: (a) the Myers-Briggs Type Indicator (MBTI; Myers, 1976; Myers & McCaulley, 1985), a self-report instrument developed on the basis of Jung's (1923) personality types—extraversion/introversion, sensing/intuition, thinking/feeling, and judging/perceiving (used in 24% of all the studies); (b) Kirton's (1976) Adaption-Innovation Inventory (KAI), which assesses an adaptor/innovator dimension (used in 21% of studies); (c) Allinson and Hayes's (1996) Cognitive Style Index, which assesses an individual's position on an analysis/intuition dimension (14% of studies); (d) Witkin et al.'s (1962) Group Embedded Figures Test, which assesses the field-dependence/independence dimension (10% of all studies); (e) Epstein, Pacini, Denes-Raj, and Heier's (1996) Rational-Experiential Inventory, a self-report measure of individual differences in experiential-intuitive/rational (analytical) thinking (7%); (f) Vance, Groves, Paik, and Kindler's (2007) Linear/Nonlinear Thinking Style Profile, which assesses two dimensions—linear (rationality, logic, analytical thinking) and nonlinear thinking (intuition, insight, creativity); and (g) Cools and Van den Broeck's (2007) Cognitive Style Indicator, which measures three dimensions—knowing, planning, and creating.

Although Armstrong et al. (2012) concluded that the use of such different instruments might lead to incomparable findings, a closer look at the dimensions assessed by these instruments indicates that this problem may not be so severe after all. For the most part, the instruments measure the analytical/intuitive dimension. The only real exceptions to this generalization are Kirton's KAI, which reflects context-dependent processing (adaptors adapt to the context) versus context-independent processing (innovators think out of context), and the MBTI thinking/feeling-style measure, whereas the Cognitive Style Index, the Rational-Experiential Inventory, the Linear/Nonlinear Thinking Style Profile, and the Cognitive Style Indicator all primarily reflect variations in rule-based (analytical) versus intuitive style.

The analytical style has commonly been described in the business and managerial literature as rational, convergent, differentiated, sequential, reflective, and deductive, whereas the intuitive style has been described as divergent, global, impulsive, inductive, and creative. This approach grew in part out of now-outdated ideas about hemispheric lateralization of the brain, specifically the idea that the left hemisphere processes information analytically and logically while the right hemisphere processes information intuitively and creatively.

Motivated by this purported left/right lateralization of the brain, researchers in organizational psychology have tried for decades to map cognitive styles onto a single analytic/intuitive dimension. To confirm that cognitive style is a unitary construct, Hayes and Allinson (1994) combined 29 different learning, decision-making, and traditional cognitive styles described in the literature into a new cognitive-style measure, called the Cognitive Style Index. Allinson and Hayes reasoned that if the Cognitive Style Index really measures the key dimension of cognitive style, its internal structure should be unifactorial. However, a factor analysis confirmed the hypothetical single-factor solution for only some of the samples studied by Allinson and Hayes (1996), casting doubt on the conception of a unitary cognitive style. More recently, Hodgkinson and Sadler-Smith (2003) reported empirical evidence that two-factor models (comprising separate analytic and intuitive dimensions) provide a significantly better approximation of responses to the Cognitive Style Index than did previously reported unifactorial solutions (but see the response of Hayes, Allinson, Hudson, & Keasey, 2003). In support of their arguments, Hodgkinson and Sadler-Smith highlighted the tenets of cognitive-experiential self-theory, developed by Epstein (1990), which posits that analysis and intuition are more likely to be separate modes of information processing served by different cognitive systems (rational and experiential) operating in parallel than stylistic differences along a bipolar dimension. However, in response to the above views, Hayes et al. (2003) argued, reasonably, that the existence of two different information-processing systems does not preclude the existence of a single bipolar continuum of analysis/intuition governed by a common set of principles.

In further research, Bokoros, Goldstein, and Sweeney (1992) identified three factors from 28 subscales associated with commonly used cognitive-style instruments. They dubbed these factors the "information-processing domain," the "thinking-feeling dimension," and the "attentional-focus dimension." Similarly, Leonard, Scholl, and Kowalski (1999) reported correlations between the various subscales of widely used cognitive-style instruments. The results indicated the existence of at least three types of cognitive styles, which operate at different levels of cognitive processing. Leonard et al. defined the first level as "pure cognitive style," which relates to the way individuals process information. The second was "decision-making style," which indicates individual preferences for various complex problem-solving and decision processes. The third level was "decision-making behavior style," which reflects the ways that individuals approach a decision based on the demands of the situation or task. It is interesting to note that the first and second levels identified empirically by Bokoros et al. (1992) and Leonard et al. (1999) closely resemble "perception" and "decision-making" levels, respectively. As for the third level—described by Bokoros et al. (1992) as "internal and external application of the executive cognitive function" (p. 99) and by Leonard et al. (1999) as responsible for the choice of style best suited to the demands of a given situation—it appears to characterize styles that operate at a metacognitive level of information processing. The important implications of these studies is that they supported empirically a hierarchical organization of cognitive-style dimensions and provided clear evidence that reducing cognitive style to a single dimension is an oversimplification.

In the following sections, we review several trends in style research identified by Armstrong et al. (2012) as particularly prominent in business and management literature, such as studies of person-environment fit, creativity, and style flexibility, as well as studies on the effect of global culture on decision-making styles.

Person-environment fit

As with the matching hypothesis in education, many studies in business and management have attempted to address person-environment fit by examining the effect of a match or mismatch between an individual's cognitive style and different types of tasks, work contexts, or organizational climates. And similar to the results on matching students' styles to instruction in education, the results on person-environment match have not been conclusive. Nevertheless, some support for the idea has been reported. For example, Fuller and Kaplan (2004) examined the effect of style on the performance of auditors and found that analytic auditors performed better on analytic tasks than on intuitive tasks, with intuitive auditors showing the opposite pattern. Pounds and Bailey (2001) investigated the effects of style differences on performance of air-traffic-control tasks and reported that performance improved across experimental trials for those who had a KAI adaptor style but not for those who had a KAI innovator style. Pounds and Bailey interpreted their results as indicating that the innovators' style led them to disregard rules for successful performance, such that they were unable to sustain repetitious procedures for extended periods. Similarly, others reported that cognitive misfit led to decreased performance (Chilton, Hardgrave, & Armstrong, 2005; Fuller & Kaplan, 2004).

In contrast, other findings have not supported the importance of person-environment fit. For example, Chan (1996) introduced the concept of cognitive misfit to specify the degree of mismatch between an individual's cognitive style and the predominant style demands of a given work context. Although Chan predicted lower performance when there is such a mismatch, his results indicated that cognitive misfit is uncorrelated with employee performance. Similarly, Cools, Van den Broeck, and Bouckenooghe (2009) found that the relationship between cognitive style and work attitude (e.g., job satisfaction, job-search behavior, and intention to leave) did not depend on the cognitive climate in which people work. Overall, based on their review, Armstrong et al. (2012) concluded that given the ambiguity in the research literature, future studies need to adopt models that reflect more complex relationships between individual and environmental factors as well as take a longitudinal perspective. In addition, to resolve the difficulties with the person-interaction-fit hypothesis, further replication and extension studies using broader occupational and professional groups and alternative style-assessment instruments are needed.

More recently, business and management researchers have become interested in cognitive-style diversity rather than person-interaction fit in organizations. Similar to educational researchers studying style flexibility, researchers in business and management expect that diversity and flexibility in cognitive styles may lead to more perspectives, which in turn can enhance problem solving and creative thinking and increase an organization's flexibility in responding to changing environments (Elfenbein & O'Reilly, 2007; McMillan-Capehart, 2005).

Creativity and style flexibility

A number of studies in the field of business and management have examined the role of cognitive styles in explaining and predicting creative behavior and outcomes. For example, Puccio, Treffinger, and Talbot (1995) found that people who have an innovator style are likely to focus on developing products that are unusual and expressive, whereas people who have an adaptor style are likely to focus on developing products that are useful and adequate. Munoz-Doyague, González-Álvarez, and Nieto (2008) examined the effects of intrinsic motivation, expertise, and cognitive style on creativity and concluded that a combination of these individual attributes had the greatest effect on creative outcome.

In contrast, Meneely and Portillo (2005) reported that cognitive style on its own does not predict creative performance, but style flexibility is related to having a creative personality. Other research found that entrepreneurs do not tend to have a more intuitive style but, rather, have a balance between intuition and analysis (e.g., Groves, Vance, Choi, & Mendez, 2008). In addition, research on cognitive style in organizational settings suggests that although experienced managers are more likely to use an intuitive cognitive style (Leybourne & Sadler-Smith, 2006), they can also make appropriate shifts in their style to fit the problem at hand (Robey & Taggart, 1981) and are more likely to switch between analytical and intuitive processing strategies, depending on the situation (Armstrong & Cools, 2009).

Decision-making styles and culture

As in the field of education, investigation of the relations between decision-making styles and culture has been a growing trend in business and management. Early studies (e.g., Doktor, 1983) speculated about information-processing differences between Americans and Japanese, describing Japanese as concrete, holistic thinkers and Americans as abstract, sequential thinkers. However, recent evidence in the field of business and management indicates that this generalization is inconclusive. For instance, ambiguous and contradictory findings were reported when Kirton's KAI questionnaire was given to different occupational groups in different nations, including the United Kingdom, Australia, Slovakia, Italy, and the United States (Foxall, 1990; Tullett, 1997). Hill et al. (2000) administered the Cognitive Style Index (Allinson & Hayes, 1996) to managers in Finland, Poland, and the United Kingdom and concluded that differences in their styles were due to different learning, socialization, and acculturation processes. Furthermore, Savvas, El-Kot, and Sadler-Smith (2001) reported statistically significant differences between Egyptian, United Kingdom, and Hong Kong postgraduate and professional-development students: Participants in the United Kingdom were more intuitive than their counterparts in Egypt and Hong Kong. At the same time, there were no significant style differences between management and business students from Egypt, Greece, and the United Kingdom; this finding was attributed to an influence from similar business-school contexts. Armstrong et al. (2012) suggested that increasing globalization in business and business education might overshadow the effect of culture on the formation of decision-making styles.

In summary, research on cognitive style in business and management has led to conclusions similar to those from research in education. First, the field provided empirical evidence for a hierarchical organization of cognitive styles, which allows us to understand differences in cognitive styles found in different fields: The cognitive styles proposed in early research can be conceived as operating at perceptual and conceptual levels of information processing, whereas most styles formulated by researchers in applied fields—such as learning styles (in education) and decision-making styles (in business and management)—can be conceived of as cognitive styles operating at higher levels of information processing. Second, researchers in both business/management and education are becoming increasingly interested in exploring cognitive styles that operate at the highest metacognitive level, which allows individuals flexibly to switch between different styles, depending on the situation. Third, both fields seem to have serious difficulties in formulating a taxonomy of styles; researchers in business and management have tended to overemphasize a single analytical/intuitive dimension, whereas researchers in education have taken too broad an approach when attempting to include nonstyle factors into models of cognitive style.

These difficulties appear to stem from confusion surrounding the notion of cognitive style and the lack of an integrated approach to organizing and understanding cognitive style. Clear characterizations of different styles, and a clear way to organize them, are essential if we are to create coherence between the fields.

Evidence for Cognitive Styles

In what follows, we first discuss cognitive-psychology and neuroscience evidence for the existence of cognitive style as distinct patterns of cognitive and neural activity. Second, we review empirical evidence from experimental studies and cultural neuroscience that supports the conceptualization of styles as environmentally sensitive individual differences in cognition that help one adapt to the environment.

Evidence for existence of style as different patterns of cognitive and neural activities

Patterns of neural activity provide another form of support for the claim that cognitive styles are distinct systems of information processing. Ideally, such evidence would emerge from finding that two groups of people perform a task equally well but nevertheless have distinct patterns of neural activity while performing it, which would show that they go about performing the task in different ways. Distinct patterns of neural activity can take two forms. First, individuals who rely on different cognitive styles might have activation in different networks of brain areas. Second, individuals who rely on different cognitive styles might have activation in similar networks, but each group would have more activation while performing a task that would best be performed using a nonpreferred cognitive style—which would suggest greater demand for attentional control.

Surprisingly, only a few studies have been based on such an experimental paradigm. One such study was reported by Gevins and Smith (2000), who examined differences between participants with verbal versus nonverbal cognitive styles. Gevins and Smith recoded electroencephalograms while the participants performed a spatial working memory task. Although the participants performed equivalently, those who relied on different styles recruited different brain regions when solving the task: Participants with a verbal cognitive style had more activation in the left parietal region, whereas participants with a nonverbal style had more activation in the right parietal region.

Motes, Malach, and Kozhevnikov (2008) performed functional magnetic resonance imaging (fMRI) while participants performed an object-mental-imagery task (which required visualized properties of objects, e.g., their shapes and colors) and found differences in activation for people who used different cognitive styles even though their behavioral performance was comparable. Specifically, "spatial visualizers," who reported a preference for processing information spatially (i.e., in terms of spatial relations and locations), had more bilateral neural activity in the lateral occipital complex (responsible for shape recognition) and right-lateralized neural activity in the dorsolateral prefrontal cortex than did "object visualizers," who preferred to process information visually (i.e., in terms of shape, color, and detail). The greater activation in the dorsolateral prefrontal cortex in spatial visualizers suggests that these people had a greater demand for task-specific resources and attentional control when performing a task that did not lend itself to their preferred cognitive style.

In a similar vein, Hedden, Ketay, Aron, Markus, and Gabrieli (2008) used fMRI to monitor brain activity while East Asians and Americans performed simple visual tasks in which they made absolute judgments (ignoring visual context) or relative judgments (taking visual context into account). Even though they performed comparably, East Asians and Americans had more activation in the frontal and parietal brain regions (known to be associated with attentional control) during culturally nonpreferred judgments than during culturally preferred judgments (e.g., taking context into account for East Asians, ignoring context for Americans).

Although more research of this type is necessary to support the conclusion, the results of these studies strongly suggest that cognitive style affects activation in task-specific and attentional neural networks, and also that tasks requiring a nonpreferred processing style engender an increased need for sustained attentional control. Furthermore, the research demonstrates that different cognitive styles are associated with different patterns of neural activity in the brain—which is itself evidence for the existence of cognitive styles.

Cognitive style as culturally sensitive individual differences in cognition

We next consider evidence from individual differences in cognition that are engendered by environmental factors.

Evidence from cultural psychology and neuroscience. A line of support for the present conception of cognitive styles as environmentally sensitive individual differences in cognition emerges from studies of the effects of culture on information processing. Most of these studies hinge on a salient difference between Western and Eastern cultures: Western cultures (the United States being a prime example) have an *individualist* orientation: The individual's interests are valued above those of the group. In contrast, Eastern cultures (China and Japan being prime examples) have a *collectivist* orientation: The group's interests are valued above those of the individual. If cognitive styles are in part adaptations to the social environment, then we would expect Westerners to perceive and conceive of information in a way that is adapted to an individualist orientation and Easterners, by contrast, to perceive and conceive of information in a way that is adapted to a collectivist orientation.

In fact, recent neuroimaging studies have provided evidence that people in collectivist cultures consider the surrounding context whereas people in individualist cultures focus on a single individual instance. Some studies have shown that East Asians attend to contextual information, whereas Westerners attend to focal objects, as reflected not only in their behavioral performance but also in activation of different neural networks in the brain while they perform relevant tasks (Chua, Boland, & Nisbett, 2005; Gutchess, Welsh, Boduroglu, & Park, 2006). Moreover, Goh et al. (2007) showed that elderly East Asians had a smaller adaptation response to the object compared with the background in the object areas of the brain than did elderly Westerners, which reflects culturally distinct patterns of information processing and malleability of perceptual processing as a result of differences in cultural exposure over time.

Furthermore, several studies have shown that members of Eastern cultures exhibit more holistic and field-dependent rather than analytic and field-independent perceptual styles (e.g., Miyamoto, Nisbett, & Masuda, 2006; Nisbett & Masuda, 2003). In particular, American participants made fewer mistakes on the rod-and-frame test than did Asian participants, indicating that they are less field dependent (Ji, Peng, & Nisbett, 2000). Furthermore, Kitayama, Duffy, Kawamura, and Larsen (2003) reported that North Americans were more accurate in an "absolute task" (drawing a line that was identical to a first line in absolute length), but Japanese people were more accurate in a "relative task" (drawing a line that was identical to the first line in relation to the surrounding frame). This finding suggests that the Japanese participants paid more attention to the frame (context) than did the North Americans, and thus exhibited more field dependence. Similarly, when presented with a change-of-blindness task, which requires participants to detect changes between two images, East Asians detected more changes in background context, whereas North Americans detected more changes in foreground objects (Nisbett & Masuda, 2003). Other studies showed that North Americans recognized previously seen objects in changed contexts better than did Asians, which reflects the North Americans' increased focus on the features of objects, independent of context (Chua et al., 2005).

Differences among members of different cultures have also been reported on tasks that require higher-order cognitive processing, such as categorization, reasoning, and decision making. Whereas American participants were more likely to group objects together if they belonged to a category defined by a simple rule (e.g., notebook–magazine), Chinese participants were found to be more likely to group together objects which shared a functional or contextual relationship (e.g., pencil–notebook; Ji, Nisbett, & Zhang, 2004). Similar, research with Russian participants (Luria, 1976) showed that they have a strong tendency to group objects according to their practical functions. Furthermore, research revealed that Westerners characterize the self as independent and self-focused, whereas East Asians emphasize interdependence and social context (Markus & Kitayama, 1991; Nisbett, Choi, Peng, & Norenzayan, 2001). Americans also believe that they have control over events to the extent that they often fail to distinguish between objectively controllable events and uncontrollable ones. In contrast, East Asians are not susceptible to this illusion (Glass & Singer, 1973), reflecting differences in the locus of processing.

Although some cross-cultural psychologists (e.g., Ji et al., 2000; Varnum, Grossmann, Katunar, Nisbett, & Kitayama, 2009) have suggested that culture-sensitive individual differences could be reduced to one analytic/holistic dimension (e.g., a holistic person is also intuitive and field dependent), more thorough analysis of the reported culture-sensitive individual differences indicates that these individual differences operate at different levels of information processing (from perceptual to higher-order cognitive reasoning) and can been generally described as tendencies of East Asian people to (a) engage in context-dependent cognitive processes, whereas Westerners engage in context-independent cognitive processes (Goh et al., 2007; Miyamoto et al., 2006); (b) seek intuitive understanding through direct perception, whereas Westerners favor analysis and abstract principles (Nakamura, 1985; Varnum et al., 2009); (c) exhibit more external locus of control, in contrast to Westerners, who have a stronger internal locus (Glass & Singer, 1973; Nisbett et al., 2001); and (d) perceive and think about the environment more holistically and globally than Westerners, who tend to engage in more sequential processing (Goh et al., 2007). These tendencies strikingly resemble the cognitive families used by Nosal (1990) in the horizontal axis of his matrix of cognitive styles, which supports the idea that cognitive styles and culturally sensitive individual differences reported in cross-cultural psychology and neuroscience are the same construct.

Based on the reported cultural differences in cognition and their effects on the brain, researchers have concluded that culture influences perception and attention in fundamental ways (Nisbett et al., 2001) and that these cultural differences might represent culture-sensitive neural substrates of human cognition (Hedden et al., 2008). This idea resonates with earlier studies of Witkin and Goodenough (1977) and Witkin and Berry (1975), who argued that differences in style are related to differences in how attention is allocated to the perceptual field, which in turn result from differences in the requirements of social environments.

Evidence from differences among members of different professions. If the culture-sensitive differences in cognition reported by cross-cultural psychology and neuroscience indeed correspond to cognitive styles, we should be able to identify similar differences between members of different subcultures within a given culture—such as those that arise among members of different professions (see Blazhenkova & Kozhevnikov, 2012, for a review). In the following review, we focus on four dimensions described by cross-cultural psychology studies that reflect differences between Western and Asian populations: (a) context dependence versus independence, (b) analytic versus intuitive information processing, (c) internal versus external locus of control, and (d) global versus sequential information processing. We divide professions into three broad categories—visual and performing arts (e.g., visual art, design, film, and theater), natural science and technology (e.g., physics, computer science, and engineering), and humanities and social sciences (e.g., philosophy, history, linguistics, and journalism)—which reflect three different modes of information processing: visual-object, visual-spatial, and verbal, respectively.

Context independence versus context dependence. A large body of research demonstrates that field independence is related to a specialization in science: Scientists tend to be more field independent than professionals in the humanities and social sciences (Frank, 1986; Leo-Rhynie, 1985; Rai & Prakash, 1987; Sofman, Hajosy, & Vojtisek, 1976; Verma, 1984). For example, Rai and Prakash (1987) used the Embedded Figures Test to study the relationship between field-dependent and field-independent cognitive styles and choice of major, and found that people who use a field-independent cognitive style tend to choose a natural science major, whereas people who use a field-dependent cognitive style tend to choose majors in social science, teaching, and social work (see also Morgan, 1997). Field independence (as measured using the Embedded Figures Test) also has been found to predict entry into mathematics courses and is associated with achievement in mathematical disciplines (Vaidya & Chansky, 1980; Van Blerkon, 1988). Similarly, Leo-Rhynie (1985) found that students who take relatively many science courses are more field independent than students who take relatively many arts courses. Research has also shown that scientists are more field-independent than artists (e.g., Verma, 1984).

Nevertheless, despite the fact that scientists seem to be, as a group, higher in field independence than members of other professional groups, and higher than artists in particular, artists are higher in field independence than some other professional groups. The roots of this difference are evident even in childhood. For example, Jia, Jian-Nong, Hui-Bo, and Fu-Quan (2006) found that children enrolled in art classes score higher in field independence than children who were not enrolled in such classes. The same study also reported differences between groups with more versus less experience in art (Grade 3 art students had higher scores than Grade 1 art students), and concluded that increasing amounts of art education tend to foster field independence. Also, Leo-Rhynie (1985) demonstrated that field independence was related to academic success, regardless of whether students pursued arts- or science-intensive courses, and Fergusson (1992, 1993) reported that field-independence scores were correlated with artistic ability and grade point average.

In addition, Blazhenkova and Kozhevnikov (2010, 2012) interviewed members of various professions and found that scientists tend to be context independent not only in perception (as in the case of the field-independent/dependent style) but also at the higher levels of information processing (e.g., concept formation, problem solving, judgment). For example, scientists attempt to control for contextual confounds and rule out the influence of context during their professional problem solving. In contrast, the results of the interviews of artists indicate that visual artists may be able to allow or prevent context from leading their works at the highest levels of information processing: Visual artists report using the context as a source of inspiration and sometimes may change their work depending on the context, but they can also resist effects of context (Blazhenkova & Kozhevnikov, 2012).

In addition, the evidence from the qualitative interviews (Blazhenkova & Kozhevnikov, 2010) suggests that humanities professionals, as a group, may also have different attitudes toward context, depending on the goal of the task at hand and their specific field. In particular, more artistically oriented humanities professionals, such as creative writers, poets, and journalists, may exhibit greater context dependence, whereas more scientifically oriented humanities professionals, such as linguists, historians, and philosophers, seem to demonstrate greater context independence.

In summary, scientists are largely field independent and context independent, but field independence may be related to artistic specialization as well and is affected by an individual's level of experience.

Analytical versus intuitive information processing. Traditionally, science has been thought of as favoring analytic methods and art as favoring intuitive methods (Csikszentmihalyi, 1996; Gridley, 2006). Billington, Baron-Cohen, and Wheelwright (2007) found that the systemizing/empathizing (similar to analytic/intuitive; Baron-Cohen, 2002) cognitive style predicted entry into either the physical sciences or the humanities, respectively. Extremely high systematizing scores were seen in male scientists, and extremely low systemizing scores were seen in female humanities students, whereas the converse was true for empathizing scores. In addition, Zeyer (2010) found a positive correlation between motivation to learn science and the systemizing cognitive style, but no correlation between motivation to learn science and the empathizing style. Furthermore, Hudson (1968) reported differences between professionals in convergent/divergent cognitive styles (preferring more logic and formal materials vs. imagination): There were more convergers (3–4 per diverger) in the physical sciences, including mathematics, physics, and chemistry, and the opposite (3–4 divergers per converger) for humanities and art specializations (including arts, history, English literature, and modern languages); comparable percentages of divergers and convergers were found in biology, geography, and economics.

The data from a qualitative interview study, partially reported by Blazhenkova and Kozhevnikov (2010), provided further support for the above findings and indicated that, even at the highest levels of information processing, scientists tend to deal with information more analytically, whereas artists tend to deal with information more intuitively. Despite the reported differences between the analytical, rule-based approach style adopted by scientists and the intuitive style adopted by artists, substantial historical evidence suggests that intuition plays a major role in scientific work. For example, A. I. Miller (2000) described how different scientists may come to the same discovery using analytical or intuitive methods, which suggests that these methods may be equally important in science.

Blazhenkova and Kozhevnikov (2010) also found that humanities professionals employ either analytical or intuitive approaches, depending on their specialization and the task at hand. Overall, the differences between professionals in analytical versus intuitive processing indicate that, although visual artists typically appear to be intuitive and emotional and scientists typically appear to be rule driven and rational, the task sometimes may dictate the approach: When scientists engage in a scientific discovery, or artists engage in artistic creation, or writers write a poem, an intuitive approach might be equally employed by all.

Internal versus external locus of processing. Researchers have studied differences in locus of control among students who have different academic majors (Coperthwaite, 1994; Light, Purcell, & Martin, 1986). Overall, an internal locus of control has been found to be associated with interest and achievement in science (Scharmann, 1988) and interest in engineering (Alias, Akasah, & Kesot, 2012).

Based on extensive interviews, Blazhenkova and Kozhevnikov (2010) reported differences in locus of control among visual artists, scientists, and humanities professionals. Most visual artists described their work-related thoughts as spontaneous, uncontrolled, and outside of—or even against—their own conscious wills. They reported that inspiration could come to them almost constantly and could be triggered by life and work events, emotional experiences, and visual experiences. In contrast, scientists typically reported that they were in complete control of their ideas, in terms of both frequency/time of occurrence and content.

Holistic versus sequential information processing. Research findings suggest that visual artists are usually more skilled in the holistic processing of pictures than are scientists or humanities professionals (Blazhenkova & Kozhevnikov, 2009, 2010; Kozhevnikov, Kosslyn, & Shephard, 2005). Blazhenkova and Kozhevnikov (2010) reported that visual artists were more accurate in tasks tapping visual-object ability (recognizing the global shape of an object in a noisy picture), whereas scientists were better in tasks tapping sequential spatial transformations (e.g., mental paper folding). Other researchers have also reported that mathematically talented individuals have a more piecemeal, analytic style and experience less interference from distracters when attending to visual stimuli than do people who are not mathematically talented (Singh & O'Boyle, 2004).

Moreover, a number of studies (Blazhenkova & Kozhevnikov, 2010; Kozhevnikov et al., 2005) indicated that differences between visual artists and scientists along the sequential/holistic dimension not only appear at the perceptual level but extend to complex problem solving, such as abstract conceptual processing and approaches implemented in professional creative work. For example, Kozhevnikov et al. (2005) found that visual artists tend to interpret abstract kinematics graphs (position vs. time) as holistic pictorial illustrations of an objects' motion, and when describing the actual motion of the object depicted by a graph, they tend to use the global shape of the graph itself to describe the object's trajectory. In contrast, scientists interpret graphs as abstract representations, considering them part by part and analyzing the depicted motion in a stepwise fashion. Consistent with these findings, Blazhenkova and Kozhevnikov (2010) found that scientists and visual artists tend to implement similar sequential and holistic processing approaches, respectively, when interpreting abstract art. In contrast to the visual-spatial domain, in which a holistic approach hinders the processing of abstract visual-spatial information (e.g., in graphs), in the visual-object domain, visual artists benefited from employing a global-holistic approach when interpreting abstract art. As a result, visual artists provided more comprehensive and abstract interpretations of abstract art (for example, “crash and liberation, breakthrough and extreme tension,” as quoted in Blazhenkova & Kozhevnikov, 2010, p. 287) than did scientists or humanities professionals, who used a sequential approach and described abstract art pieces as conglomerations of local features without making sense of the whole (for example, “different colors: blue, black, red, yellow, white; sharp edges in red” or “some shapes, no order”; Blazhenkova & Kozhevnikov, 2010, pp. 287–288).

In conclusion, similarly to cross-cultural and neuroscience research, analysis of cognitive style differences among members of different professions suggests two important conclusions. First, differences are identified at different levels of information processing, and the same individual might exhibit different poles of the same cognitive style depending on the level of information processing (e.g., scientists who prefer an analytical style at lower levels of information processing might seek intuitive understanding at higher levels of information processing). Second, similar to members of different cultures, the differences among members of different professions can be described as differences in tendencies to (a) engage in context-dependent (humanities and social science professionals) or context-independent (scientists) processing (Frank, 1986; Leo-Rhynie, 1985; Rai & Prakash, 1987; Sofman et al., 1976; Verma, 1984); (b) seek intuitive understanding through direct perception (visual artists) or a more analytical, rule-based approach (scientists; Billington et al., 2007; Zeyer, 2010); (c) exhibit more external (visual artists) or internal (scientists) locus of control (Coperthwaite, 1994; Light et al., 1986); and, (d) perceive and think about the environment more holistically and globally (visual artists) or sequentially process it (scientists and humanities professionals; Blazhenkova & Kozhevnikov, 2010; Kozhevnikov et al., 2005).

We cannot say whether these scientists and artists developed these styles as a consequence of working in a domain or whether they were inclined toward these styles initially, which in turn led them to become involved in a domain. But in either case, members of different professions exhibited differences in patterns of cognitive processing similar to those found among members of different cultures in cross-cultural psychology and neuroscience. The findings support the conclusions that culture-sensitive individual differences identified by cross-cultural psychology and neuroscience can be identified not only within cultures but also within subcultures, such as educational and professional specializations. Moreover, the data from members of different professions undermines attempts to reduce the range of cognitive-style dimensions to a single analytic/intuitive dimension, as suggested by some researchers in cross-cultural psychology (Ji et al., 2000; Varnum et al., 2009) and in business and management (Hayes & Allinson, 1994). As we noted, visual artists often adopt a holistic and intuitive style but not necessarily a field-dependent style. In contrast, scientists often adopt a sequential style of information processing and, at the same time, an intuitive cognitive style.

Toward an Integrated Approach to Cognitive Style

Based on our review, in this section we propose a new conceptualization of cognitive style and discuss its key characteristics across different fields.

Toward a new characterization of cognitive style

The construct of cognitive style initially referred to environmentally sensitive individual differences in cognition that help one to adapt to the environment. This conceptualization of cognitive style was lost during research in the 1950s, but it was reintroduced in applied fields in 1970s, and has recently re-emerged in cross-cultural neuroscience as “culture-sensitive individual differences in cognition.”

According to this conceptualization, cognitive style represents adaptation to the external world that develops through interaction with the surrounding environment on the basis of specific cognitive abilities and personality traits. The environment consists of several layers that present different sorts of influences; they range from the microsystem (i.e., the immediate environment—e.g., school and family) to the macrosystem (e.g., institutional patterns of culture, including the economy, customs, and bodies of knowledge; Bronfenbrenner, 1994). Several environmental layers of particular interest to research on cognitive style are illustrated in Figure 3.

The first environmental layer represents the individual’s immediate familial and physical environment, studied by early cognitive style researchers (e.g., Witkin et al., 1954); this layer especially influences early cognitive development and reinforces certain innate characteristics while suppressing others. The process is similar to what has been described by Buss and Greling (1999) as an

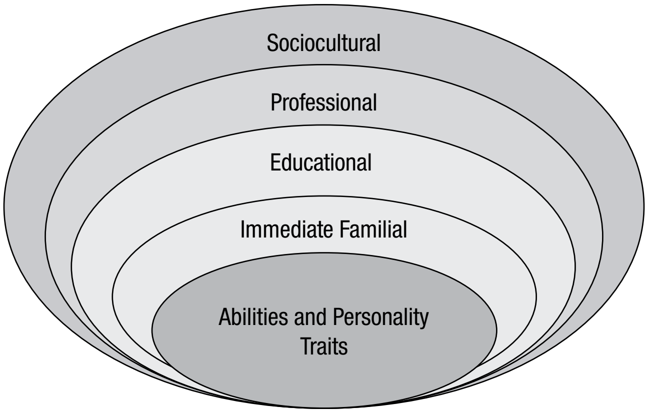

Fig. 3. Factors affecting cognitive-style formation. Adapted from "Cognitive Style," by M. Kozhevnikov, 2013, in D. Reisberg (Ed.), *Oxford Handbook of Cognitive Psychology* (pp. 842–855), p. 852. Copyright 2013 by Oxford University Press. Adapted with permission.

individual's being channeled into alternative strategies as a result of influences of different early environmental events. However, these styles are not set in stone, and they might be further modified at the educational layer, which is of primary interest of educational researchers (e.g., Entwistle & Ramsden, 1983; Frank, 1986; Riding & Rayner, 1998; Saracho, 1997; Vermunt, 1998); this layer represents influences of different educational systems and social groups on an individual's patterns of information processing. The next layer, which is of primary interest in the field of business and management (e.g., Agor, 1989; Hayes & Allinson, 1998), reflects professional, media, and personal interactions with peers that sharpen ways of thinking and make them more distinct. Surrounding all of these layers is the final, cultural layer, of interest to cultural psychologists and neuroscientists (Kember, Jenkins, & Ng, 2003; Mitchell, Xu, Jin, Patten, & Gouldsborough, 2009; Mitsis & Foley, 2009; Varnum, Grossmann, Kitayama, & Nisbett, 2010); this cultural layer reflects mental, behavioral, and cognitive-processing patterns common to a specific cultural group. Although the layers are presented separately in Figure 3, they are not separate but interwoven, "as in a single knitted coat with different types of thread" (Signorini, Wiesemes, & Murphy, 2009, p. 258), and together they shape the habitual patterns of cognitive processing that constitute a cognitive style.

Thus, in contrast to basic processing capacities, intelligence, or personality traits, a cognitive style arises from an adaptive system of interacting processes that are shaped by, and respond to meet, requirements of the external environment. Intelligence, for example, is generally characterized as the ability to understand complex material and solve complex problems relatively quickly; the nature of intelligence does not change when a person is confronted with a new environment. In contrast, cognitive styles grow out of an adaptive system that emerges from interactions among individual differences in basic processes, while environmental influences and sociocultural environments engender particular habitual approaches to processing. For instance, strong abstract logical reasoning or spatial-visualization abilities may lead to an interest in mathematics and science, and if the immediate environment is conducive to learning math and sciences, a person might develop a set of particular cognitive styles (e.g., field independent, analytic). Furthermore, the person then might invest a great amount of time and effort in looking for educational and professional environments that support his or her interests in learning mathematics and sciences, further reinforcing the development of these styles. In this way, cognitive style is an adaptive system that moderates the effects of both an individual's predispositions and the external environment.

Toward an integrated taxonomy of cognitive style

Although many types of cognitive styles have been proposed, we claim that all of them are adaptations to the environment. If this is true, we should be able to identify different sorts of adaptations to the environment—which can provide one basis for beginning to systematize the range of cognitive styles.

As discussed earlier, most of the previous attempts to systematize cognitive styles have been focused either on specifying different cognitive-style families or on producing a hierarchical organization of cognitive styles of the same style family. In the first case, researchers attempted to identify orthogonal style families, irreducible to each other, such as wholistic/analytic and verbalizer/imager (Riding & Cheema, 1991), concrete/abstract and sequential/random (Gregorc, 1979, 1982), or concrete experience/abstract conceptualization and reflective observation/active experimentation (Kolb, 1984). These taxonomies typically specified only two orthogonal cognitive-style families, which were chosen somewhat arbitrarily—and each ignored important distinctions drawn by the others. In the second case, researchers attempted to position similar styles (usually analytic/intuitive) into different levels of hierarchy, depending on the level of processing they recruit. A. Miller's (1987) model of cognitive style is one such example.

Integrating these earlier attempts in order to develop a framework of cognitive styles, and based particularly on Nosal's approach, we propose that cognitive style can be represented by a matrix. The vertical axis of this matrix represents levels of information processing, and the horizontal axis represents distinct cognitive-style families. Each of these cognitive-style families represents a way of adapting to the external environment. We use four levels of information processing (perception, concept formation, higher-order cognitive processing, and metacognitive processing) and four empirically determined, orthogonal cognitive-style families (context-dependency vs. independency, rule-based vs. intuitive processing, internal vs. external locus of control, and integration vs. compartmentalization).

Figure 4 represents our attempt to position the most commonly used 19 style dimensions identified in cognitive-style research into this matrix (the circles represent traditional cognitive styles, whereas rectangles represent learning and decision-making styles). The levels of information processing are conventional, but it would be worth pausing for a moment to review the horizontal axis, which represents distinct families of styles corresponding to different types of adaptations.

Context dependence versus independence describes the tendency to perceive events as separate versus inseparable from their physical, temporal, or even semantic contexts. For example, on the perceptual level, this family includes the field-dependence/independence dimension. We also included in the same cell of the matrix such styles as field articulation (element/form articulation), which refers to the articulation of discrete elements or large figural forms against a patterned background (Messick & Fritzky, 1963). At a higher level of cognitive processing, we positioned the adaptor/innovator style (Kirton, 1976), which reflects a tendency to prefer to accept generally recognized policies (context dependent) versus to question accepted solutions or policies and propose doing things differently (context independent), as well as Gregorc's (1979, 1982, 1984) abstract/concrete style dimension which reflects the tendency to understand abstract ideas, qualities, and concepts (independently of context) versus process concrete information (constrained by context). We placed the mobility/fixity style at the metacognitive level because it

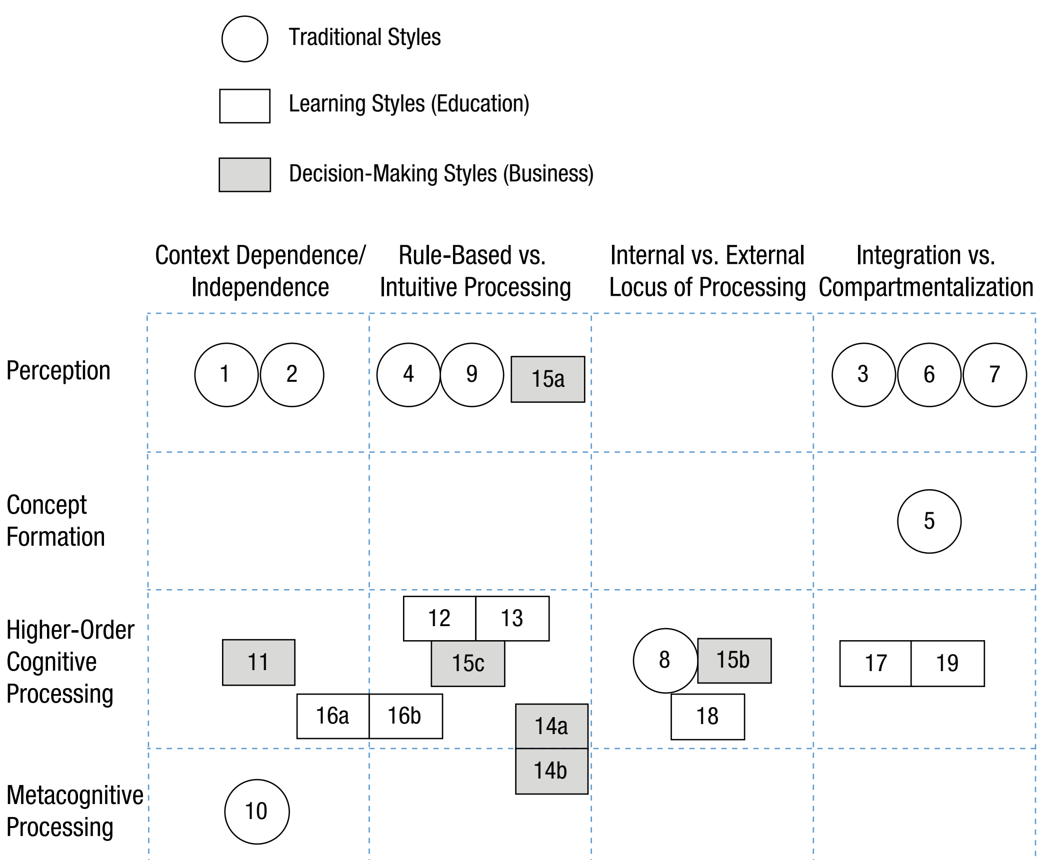

Fig. 4. Cognitive-style matrix representing the most common traditional and applied styles. 1 = field-dependence/independence (Witkin et al., 1954); 2 = field articulation (Messick & Fritzky, 1963); 3 = leveling/sharpening (G. S. Klein, 1951); 4 = range of scanning (Gardner, Holzman, Klein, Linton, & Spence, 1959); 5 = breadth of categorization (Gardner et al., 1959); 6 = tolerance for unrealistic experience (G. S. Klein & Schlesinger, 1951); 7 = holist/serialist (Pask, 1972); 8 = locus of control (Rotter, 1966); 9 = reflexivity/impulsivity (Kagan, 1966); 10 = mobility/fixity (Witkin, Dyk, Faterson, Goodenough, & Karp, 1962); 11 = adaptor/innovator (Kirton, 1976); 12 = convergent/divergent (Kolb, 1984); 13 = rational/experiential (Epstein, Norris, & Pacini, 1995); 14a = analytical/intuitive style dimension (Agor, 1984, 1989; Hodgkinson & Sadler-Smith, 2003); 14b = integrated or high-analytical/high-intuitive style dimension (Agor, 1984, 1989; Hodgkinson & Sadler-Smith, 2003); 15a = Myers-Briggs Type Indicator (MBTI) sensing/intuition dimension (Myers, 1976); 15b = MBTI introversion/extraversion dimension (Myers, 1976); 15c = MBTI thinking/feeling dimension (Myers, 1976); 16a = Gregorc's abstract/concrete dimension (Gregorc, 1979, 1982, 1984); 16b = Gregorc's ordering dimension (Gregorc, 1979, 1982, 1984); 17 = deep/surface approaches (Biggs, 1987; Entwistle & Ramsden, 1983; Vermunt, 1994); 18 = extrinsic/intrinsic motivation (Biggs, 1987); 19 = tolerance for ambiguity (Kirton, 2004; Wilkinson, 2006).

characterizes the degree of self-regulation required in a given situation versus consistency of cognitive functioning; this style was originally introduced by Witkin et al. (1962) in relation to the field-dependency/independency dimension.

Rule-based versus intuitive processing describes an individual's tendency toward directed (driven by rules, analytic) versus aleatoric (driven by salient characteristics or relying on heuristic evidence) information scanning. The dimension that specifies an extensive versus limited range of scanning (Gardner, 1953) is positioned at the perceptual level; it refers to a preference for attending (via top-down processing) solely to a narrow range of relevant information versus attending (via bottom-up processing) to many facets of the environment, including those that may not be relevant. We also positioned here the MBTI sensing/intuition dimension, which refers to the tendency to pay attention to actual facts and details versus impressions. At the higher-order levels of information processing, we positioned such applied styles such as convergent/divergent (Kolb, 1984), rational/experiential (Epstein et al., 1995), intuition/analysis (Agor, 1984, 1989; Allinson & Hayes, 1996), MBTI thinking/feeling (Myers, 1976), and Gregorc's ordering dimension (Gregorc, 1979, 1982, 1984). All of these styles have one pole that reflects a rule-driven (rational, analytic, convergent) approach that relies on reason and logic and another pole that reflects an intuitive (divergent, experiential) approach that relies primarily on experiential heuristic evidence and involves sensitivity to one's own and others' thoughts. At the highest metacognitive level, we positioned Agor's (1984, 1989) integrated style dimension and the Cognitive Style Index high-analytical/high-intuitive style (the Hodgkinson & Sadler-Smith, 2003, version), which reflects an advanced managerial style that allows individuals to self-regulate the tendency to use analytical versus intuitive approaches, depending on the situation.

Locus of processing (internal vs. external) represents a tendency to locate control of information processing outside of (external locus) or within (internal locus) oneself. At the higher-order cognitive-processing level, internal versus external locus of control (Rotter, 1966) reflects the tendency to perceive one's influence on the environment versus the tendency to perceive events as happening outside of one's realm of influence. We also positioned here extrinsic/intrinsic style (Biggs, 1987) and the MBTI extraversion/introversion style dimensions.

Compartmentalization versus integration represents a tendency to prefer a compartmentalized, sequential versus an integrative, holistic approach to information processing. This dimension taps such cognitive styles as global/local (Kimchi, 1992), or holism/serialism (Pask, 1972), which reflect a tendency to process information as discrete global units (at the integration end of the dimension) versus as sequences of parts. We also included here leveling/sharpening (G. S. Klein, 1951) at the perceptual level and the breadth-of-categorization style (Gardner et al., 1959) at the conceptual level. These styles reflect the degree to which people are impelled to act upon or ignore differences; acting upon differences reflects an integrative approach, whereas ignoring differences reflects a more compartmentalized approach. The applied styles included at the higher-order cognitive-processing level are deep versus surface approaches to learning (Biggs, 1987; Entwistle & Ramsden, 1983; Vermunt, 1994), which reflect approaches to learning that require understanding the big picture versus remembering separate facts, as well as tolerance for ambiguity (Kirton, 2004; Wilkinson, 2006).

The proposed taxonomy does not present a final or complete classification of styles but, rather, is a work in progress to be further developed. For instance, such styles as visualizer/verbalizer (Paivio, 1971), or its updated version of object/spatial/verbal learners (Kozhevnikov, Hegarty, & Mayer, 2002; Kozhevnikov et al., 2005), are not easy to position in the matrix. Various possibilities can be explored for incorporating such dimensions, such as adding a new cognitive-style family (vertical dimension) in the matrix that reflects preference to process information in a particular modality or considering these styles as a part of the integration/compartmentalization (holistic vs. sequential processing) cognitive-style family. Future research should specify the precise number of cognitive-style families, which could be identified via factor analysis of the known cognitive styles while controlling for the specific level of information processing.

This matrix approach invites the mapping of cognitive styles onto information-processing theories in detail, given that it is grounded in the fundamental distinctions that arise from such theories. But much more than that, it provides a clear categorization of different types of styles from applied fields and eliminates the confusing labeling of styles. In the concluding section of this article, we show how this approach can help us understand the roles of cognitive styles in applied fields.

General Conclusions and Applications to Applied Fields

Research on cognitive style in psychology and cross-cultural neuroscience, on learning styles in education, and on decision styles in business and management are all addressing the same phenomena: the range of possible types of processing that can help individuals to adapt to physical and sociocultural events and circumstances. The present article suggests that cognitive style represents environmentally sensitive individual differences in cognition. Different sociocultural practices and beliefs engender divergent cognitive styles, which may direct a person to foreground an object versus the background, to focus on external versus internal criteria, or to process the global visual image versus its local properties. Cognitive styles affect not only higher-order cognitive processing but also perception and attention, and they are, in turn, reflected in neural activity. What we perceive, attend to, and remember is determined not only by perceptual or working memory capacities but also by top-down influences—and cognitive styles can exert such top-down influences.

Cognitive style is a uniquely human characteristic. Other animals are born in a particular environment and bound to specific environmental conditions, and therefore they typically exhibit numerous fixed behavioral patterns that result from evolution by natural selection. In contrast, humans are much less restricted by fixed innate mechanisms that evolved to function in specific environmental conditions. This places more importance on the role of postnatal development, which is largely based on social interactions, concept acquisition, and cultural means of learning, and takes place in ever-expanding and changing environments throughout the life span (Kozhevnikov, 2013). Thus, the inborn capacities of humans can be expressed and developed in a wide range of ways. Indeed, evidence from neuroscience indicates that neurogenesis and neural plasticity are affected by social environments (e.g., Lu et al., 2003), and research in evolutionary genetics consistently supports the coevolution of genes, cognition, and culture (see Li, 2003, for a review).

Because cognitive style emerges from an interactive system, it is not surprising that it is correlated with certain predispositions, such as basic cognitive abilities and personality traits. Therefore, conducting numerous correlational studies between styles and other individual-difference variables (as it is currently done in the education and business literatures) is unlikely to reveal the nature of cognitive styles. To provide more support for conceptualizing cognitive style as adaptive systems, of particular interest would be longitudinal studies that focus on how groups of people develop specific cognitive styles when they are immersed in different learning or sociocultural environments and how moving among different sociocultural environments leads individuals to adapt their cognitive-style profiles. If members of such groups have comparable intellectual abilities and personality traits but develop different cognitive styles, this would allow us to distinguish clearly between the concept of cognitive styles and more fixed traits.

Neuroimaging studies aimed at understanding how our physical and sociocultural environments shape our neural activity are also an important step in this direction. Although researchers in cultural neuroscience have conducted several studies along these lines, these studies have largely been limited to the effect of global culture. In this respect, researchers in education and in business and management could help cognitive psychology and neuroscience to bridge the nature of cognitive style to environmental demands, such as those of instructional and workplace situations. Future research along these lines may reveal a degree of sociocultural shaping not only of higher-order cognitive functioning but also of attention and perception; these differences, in turn, may be reflected in specific differences in neural activity. Such sociocultural shaping may be substantially greater than what has so far been assumed in the psychological literature.

We have also found that the various styles from disparate disciplines can be organized into a unifying taxonomy, which is informed by contemporary cognitive psychology and neuroscience. This conclusion is important in part because one of the most serious criticisms of the construct of cognitive style has been its numerous dimensions, which seem to be impossible to unite or systematize. The taxonomy of cognitive style we propose organizes style dimensions into a matrix, with the vertical axis representing levels of information processing and the horizontal axis representing orthogonal cognitive-style families, each of which is an adaptive system. We based this taxonomy on the empirical literature and basic distinctions from cognitive psychology and neuroscience. It comprises a finite number of adaptive systems (horizontal axis) that give rise to different cognitive styles; and each adaptive system can operate at different levels of information processing (vertical axis).

The proposed taxonomy is useful not only as a way to organize styles but also as a way to identify opportunities for additional research. First, it allows us to integrate all the well-documented cognitive, learning, personality, and decision-making styles. All of these style types—proposed in traditional cognitive-style research, in education, and in business and management—correspond to different adaptive systems that draw on different levels of information processing. As Figure 4 shows, traditional cognitive styles operate mostly at the perceptual level of information processing, whereas learning styles in education operate at the higher-order level of cognitive processing. Decision-making style, in contrast, occupies mostly the rule-based/intuitive cognitive-style family and operates at different levels of information processing. Second, the taxonomy provides a framework for detecting gaps in the ranges and types of cognitive styles, which can lead us to identify yet-unknown cognitive-style dimensions (e.g., there are many missing cells at the level of concept formation). Third, the taxonomy presents a way to unify disparate applied disciplines in their approaches and assessments of cognitive style, as well as contributing to developments within the fields of cognitive and cultural psychology by providing an organizing framework for organizing and predicting different dimensions of environmentally sensitive individual differences in cognition.

Finally, we have demonstrated that the present approach can illuminate the use of cognitive style in applied disciplines, particularly in education and in business and management. As our review suggests, there is a need for the applied fields to revise their style assessments. Current research in applied fields has limitations: It tends to focus on one particular cognitive-style family (or even on a single cell of the matrix) or combines two or more cognitive-style families with other variables that have no relation to styles (as happens in education). The present approach implies that researchers in business and management should also assess individuals on cognitive-style families beyond the analytical/intuitive dimension. Similarly, in the field of education, the taxonomy can help to separate cognitive style from nonstylistic dimensions and suggest which styles can sensibly be combined in one instrument.

Furthermore, the taxonomy can help teachers and managers assess which cognitive style or styles are required to perform a specific task well, which can lead to programs to train individuals to apply that style or styles. As our matrix approach suggests, there may be a fundamental problem with the matching hypothesis in education or the person-fit hypothesis in business and management. Not only is any given person characterized by many cognitive styles, but different styles will match specific types of material used for specific purposes. That is, for any given teaching goal, the relevant styles may vary along both the vertical and horizontal axes of our matrix. The challenge for educators may well be in identifying which styles matter most, and in which contexts.

In taking these ideas forward, our matrix approach leads us to the following proposal: We must begin by performing a task analysis to identify which aspects of the task are the *rate-limiting steps*. By analogy, when typing, the rate-limiting step is the ease of executing rapid finger movements, not the strength of the finger presses; in contrast, when opening the lid of a jar, the strength of the twisting movement is the rate-limiting step, not the programming of the sequence of grasping the lid and then twisting (see Kosslyn et al., 2004). One key to matching is to identify the rate-limiting types of information processing, which are the source of difficulties for students. This exercise will isolate a column in the matrix corresponding to the level of information processing. Following this, the specific nature of the task will direct one to the appropriate row or rows, allowing one to isolate the cognitive-style dimension or dimensions that are potentially relevant to the task.

Thus, to match style to the task, teachers must engage in a three-phase process: First, they must analyze the task and identify the aspects of learning that will prove challenging to the students. Second, they must identify which cognitive styles can be used effectively for that task and material. In many cases, more than one family of styles can be employed, although some may be more effective than others. Third, they must determine which methods can be used to present the material that will play to the relevant styles, and then they must be prepared to present the material using the various viable methods.

For instance, when a physics teacher asks students to understand the meaning of kinematics graphs, she or he needs to understand first that the rate-limiting step is spatial processing at a higher-order information-processing level, and that the most appropriate style required for teaching this type of material is a higher-order spatial style (Blazhenkova & Kozhevnikov, 2010; Kozhevnikov et al., 2002). Furthermore, the teacher should understand that although they are not optimal, some students may try to use analytic or verbal strategies to interpret kinematics graphs, and some students (object visualizers with high object but low spatial ability) will be able to easily understand the material only in this way (Kozhevnikov et al., 2002)—but they will be prone to certain types of errors, and the teacher should be ready to correct such errors. (Attempting to present object visualizers with pictorial illustrations that would match their style would be inadvisable, because object imagery actually impairs the understanding of graphs; Hegarty & Kozhevnikov, 1999.)

Furthermore, as noted, educational and business research is moving beyond the matching hypothesis or person-interaction fit, respectively, and is focusing more on the development of style flexibility. Educational research suggests that instructors should address both student variations in cognitive-style flexibility and the potential of the learning environment to reinforce style flexibility in learners. However, it is also essential to help students understand the range of possible styles they can attempt to use. The use of a reflective and critical approach, whereby instructors are encouraged to consider how their approach to planning could assist or restrict student learning and to consider alternative learning and teaching approaches to assist style flexibility within their students to encourage independence and not dependence on a particular mode of delivery, has been advocated in education (Evans & Waring, 2009, in press). If teachers want to develop style flexibility in their students, something like the taxonomy of cognitive styles we offer is necessary to identify the range of the appropriate cognitive styles, as well as those that might be particularly useful for a given situation.

Overall, the present article suggests that cognitive style has a place in, and should be integrated into, mainstream cognitive psychology and neuroscience. Not only will such integration benefit applied fields, but it also could provide a coherent framework for understanding individual differences in cognition more broadly. We hope that the proposed cognitive-style framework will aid research and the application of cognitive style across different disciplines and will lead to new insights into individual differences in cognitive functioning more generally.

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The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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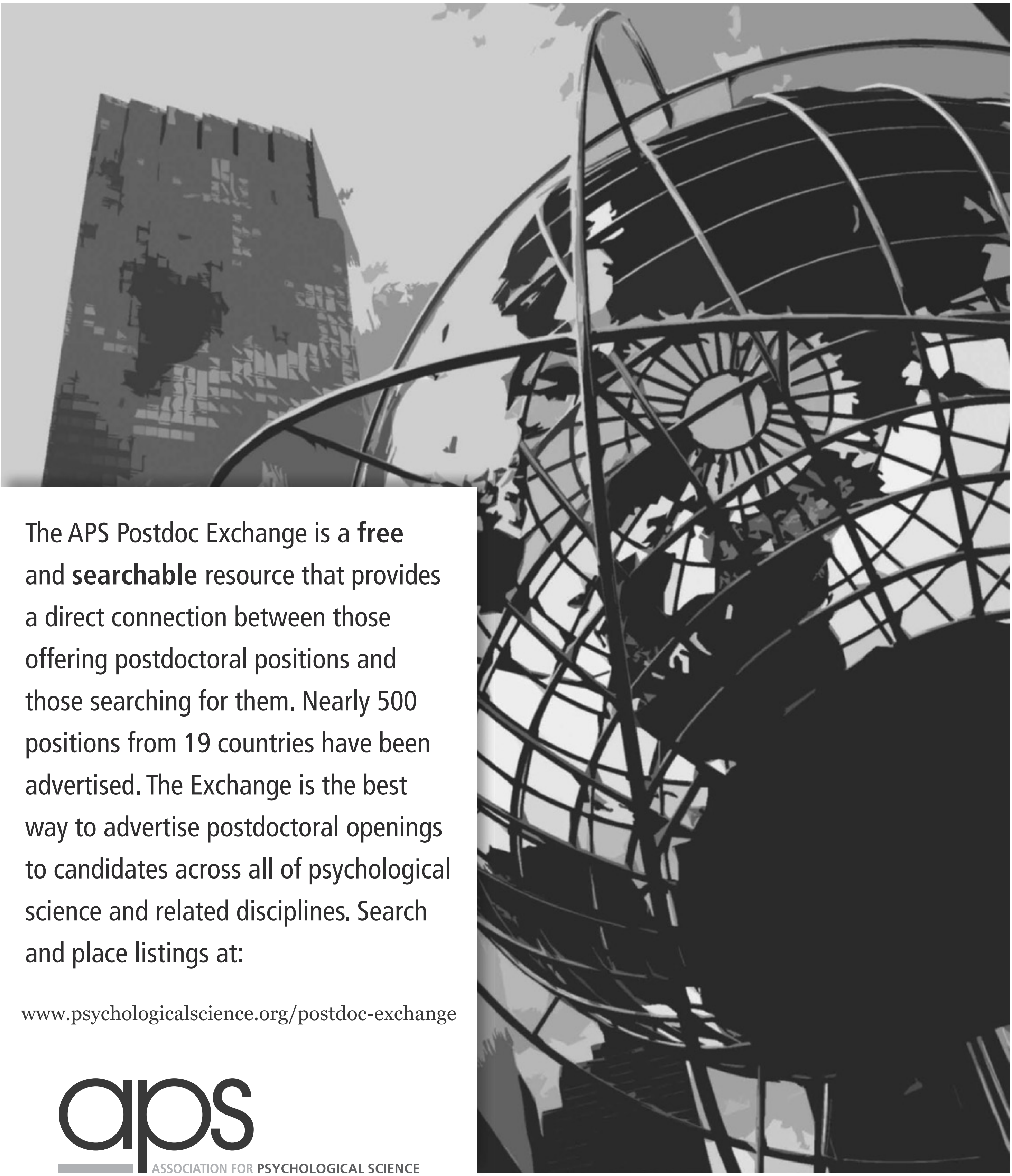

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