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ABSTRACT

Spearman's notions of mental energy and mental span presage modern conceptions of attentional resources and working memory as fundamental to intelligence. Viewing attention as the conative directing of the intellect, as "the application of intellectual energy," Spearman's quantitative law of mental span deals with limits on the allocation of attention. Because attentional resources are salient in both historical and current conceptions of intelligence, the occurrence of multiple and alternative modes of attention complicates these theories. Moreover, such consistent individual differences in attentional mode have important implications for the theory and measurement of cognitive processing more generally. Specifically, two broad bipolar factors have been identified that contrast sharp-focus versus broad-focus scanning and signal versus information scanning. These stylistic factors are linked to personality and reflect not only the enhancement of information processing in the focus of attention, but also the possibility of parallel processing in the fringe invoking the potential need for active inhibition of distracting or competing processes--points that were also anticipated by Spearman. (Contains 63 references.) (Author)

RESEARCH REPORT

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HUMAN ABILITIES AND MODES OF ATTENTION: THE ISSUE OF STYLISTIC CONSISTENCIES IN COGNITION[1]

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Another important problem still unsettled is as to whether the conative influence [of attention] is always primarily enhansive, or can also be (directly) inhibitive. (Spearman, 1923, p. 136)

Intelligence and attention have been closely related concepts at least since the turn of the century. Indeed, "the pervasiveness of attention in cognition was accepted from the earliest days of psychology, and the term was used almost synonymously with cognition and consciousness" (Shiffrin, 1988, p. 739). Specifically, "*attention* has been used to refer to all those aspects of human cognition that the subject can control . . . , and to all aspects of cognition having to do with limited resources or capacity, and methods of dealing with such constraints" (p. 739). Early theorists of intelligence such as Spearman spoke of the sources and limits of attention in terms of mental energy and mental span, while modern cognitive theorists speak of mental effort and working-memory capacity. These continuities point to some enduring principles of cognition but are also open to some perennial problems posed by the occurrence of multiple and alternative modes of attention, such as broad versus narrow focussing and extensive versus concentrated scanning. That is, if intelligence and attention are intertwined and there are multiple modes or styles of attention, what are the implications for the conceptualization and measurement of intelligence?

Such stylistic modes of attention have long been discussed under the rubric of cognitive styles, or characteristic intraindividual patterns of abilities or cognitive controls (Broverman, 1960a, 1960b; Klein, 1958).

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Cognitive control is a term used in psychoanalytic ego psychology to refer to adaptive regulatory mechanisms for coping with environmental demands, in contradistinction to defense mechanisms for coping with anxiety and conflict. Cognitive styles are more general and comprise organizing as well as controlling functions (Messick, 1984).. Furthermore, attentional behavior provides fertile ground for identifying such stylistic consistencies. According to George Klein, Riley Gardner and their colleagues in 1959,

> when we view the workings of controls from the standpoint of the availability, mobilization, and deployment of attention, . . . the influence of cognitive controls is very much a matter of highlighting certain environmental features and reducing the effectiveness of others, [that is,] it is precisely in the regulation of attention that the influence of cognitive controls may be most apparent. (Gardner, Holzman, Klein, Linton, & Spence, 1959, p. 13)

Moreover, "studies of cognitive controls have suggested . . . that several relatively independent control principles determine different aspects of attention, and that no one control is dominant in all situations" (Gardner, Jackson, & Messick, 1960, p. 28).

Individual consistencies in attentional processes in perception and memory underlie dimensions of cognitive control at the first-order factor level; modal patterns of these control dimensions constitute higher-order factors of cognitive style (Messick, 1989). In particular, in addition to the cognitive styles of field independence versus field dependence and reflection versus impulsivity, which involve consistencies in attention deployment in field articulation and restructuring as well as in analytic versus holistic processing (Globerson & Zelniker, 1989; Witkin & Goodenough, 1981), two second-order bipolar factors have been identified that contrast sharp-focus versus broad-focus scanning and signal versus information scanning (Messick, 1989). These stylistic factors, which are operative in memory as well as perception and are differentially related to personality, will be discussed in more detail later.

As background for this discussion, we will first briefly examine some early views of mental energy and capacity in the interplay of attention and intelligence, especially the views of Spearman and Burt. These notions serve as counterpoint to more modern treatments in terms of the allocation of

attentional resources and the limits of working memory. Next, current conceptions of selective attention are summarized to illustrate the variety of processes of perceptual enhancement, filtering, and response inhibition that might exhibit consistent individual differences underlying, in various combinations, the observed dimensions of cognitive style. Special emphasis is placed on the neo-Piagetian theory of constructive operators proposed by Pascual-Leone (1969, 1989), which attempts to disentangle components of ability and capacity from the sources of style. In this context, the two styles of sharp- versus broad-focus scanning and signal versus information scanning are examined as performance variables as opposed to competence variables. It is noted, however, that such cognitive styles are not purely performance variables because they have implications not only for the expression of competence but also for its development. That is, styles influence the development of abilities and ability structures and hence bear on the conceptualization and measurement of intelligence.

A more straightforward way to motivate the ensuing discussion is as follows: Of the two bipolar second-order factors of scanning style recently identified, one of them -- namely, broad- versus sharp-focus scanning -- relates to attentional modes discussed by Spearman for deploying the mental energy underlying *g*. Hence, as background for interpreting this scanning style, we review Spearman's treatment of mental energy and mental span as determinants of both intelligence and attention, in relation to more current concepts of mental effort and working-memory capacity. The other bipolar scanning factor -- namely, signal versus information scanning -- relates to serial selective attention as opposed to simultaneous parallel processing. Hence, as background for interpreting this second scanning style, we review theories of selective attention (which also bear on broad- versus sharp-focus scanning), along with work on automatic versus controlled cognitive processing. Finally, because attentional styles and intellective abilities are each inferred from consistencies in task behavior, the distinction between performance and competence is examined. This provides a basis for characterizing styles both as performance variables contaminating the assessment of abilities and as competence variables influencing the nature of ability development.

ENERGY AND CAPACITY AS ENDURING CONCEPTS OF INTELLIGENCE AND ATTENTION

In interpreting his general factor of intelligence, or *g*, Spearman (1923, 1927) distinguishes between quantitative and qualitative aspects. On the quantitative side, *g* represents the amount of mental energy that an individual has available, the mobilization of which is closely linked to attention. For example, Spearman (1923, p. 162) discusses attention in terms of the conative directing of mental energy. When waxing metaphorical, he refers to the "focus" and the "fringe" of mental energy (Spearman, 1927, p. 344). He endorses Burt's (1940, p. 217) qualification that intelligence is not merely an effect of attention but rather that attention is an effect or symptom of intelligence. Finally, Spearman defines attention as "the application of intellectual energy" (Spearman & Wynn Jones, 1950, p.172).

One key aspect of mental energy is its transferability, that is, "it is some force capable of being transferred from one mental operation to another" (Spearman, 1927, p. 414). This concept of transferability remains an important feature of most, if not all, modern theories of human abilities as enabling variables (Messick, 1992). Furthermore, this mental energy is constrained for Spearman by a quantitative law of mental span that is a strong version of capacity limits, namely, "*every mind tends to keep its total simultaneous output constant in quantity, however varying in quality*" (p. 259). This law is explicitly discussed in terms of trade-offs in the distribution of attention as well as of competition among simultaneous cognitive activities for available attentional energy. Spearman even refers to "universal mental competition" in which simultaneous affective states compete with each other and with cognitive states for attentional energy; that is, affect can interfere with cognition and vice versa (Messick, 1987). Conation is also viewed as competitive with cognition and affect, but he is less clear as to whether one conation interferes with another.

Still on the quantitative side, Spearman (1927) identified two other general factors of perseveration and oscillation. The former is related to disposition rigidity and the marshalling of the will to overcome it (Cattell, 1946a, 1946b), and the latter is negatively related to "steadiness of character" (Spearman & Wynn Jones, 1950). Spearman (1927) held that the obverse of perseveration was cleverness or originality, but not simply

ideational fluency (Spearman & Wynn Jones, 1950). Guilford later showed that perseveration was opposed by measures of spontaneous flexibility or the divergent production of classes (Frick, Guilford, Christensen, & Merrifield, 1959). In terms of Spearman's quantitative formulation of intelligence, *g* represents the amount of mental energy, perseveration represents its inertia in shifting from one operation to another, and oscillation its facility of recuperation after mental effort.

Spearman (1927) also posited reciprocal attentional modes and considered the possibility of individual differences in each. He pointed out that mental energy, like physical energy, "has two dimensions, intensive and extensive; the clearness and speed of an operation may either attain to a high grade, or else cover a wide field; the 'attention' may be either concentrated or else diffused" (p. 260). Furthermore, he acknowledged the similarity of this contrast to Meumann's attention-types, which pit a concentrating or fixating mode of attention against a diffusive or fluctuating mode. However, from analyses of concentrated attention on isolated tasks performed successively versus diffused attention on dual tasks performed simultaneously, Spearman concluded that these do not form separate factors but, rather, represent intensive and extensive aspects of *g*.

In contrast, Burt (1949) reported a bipolar factor of fixating versus diffusive attention that was related to both perseveration and emotional stability. Although Burt felt that this factor should probably be regarded as temperamental rather than cognitive, he noted its similarity to Spearman's descriptions of the typical perseverator versus oscillator, thereby linking Spearman's additional general factors of perseveration and oscillation to attentional modes. Indeed, such a possibility was also alluded to by Spearman (1927) as a way that "wheels into general line the prolific suggestions of Meumann" (p. 292). As we shall see, Meumann's attention-types and Burt' bipolar attention factor presage our stylistic dimension of sharp- versus broad-focus scanning, which is also related to measures of rigidity and temperament.

On the qualitative side, *g* entails a combination of noegenetic processes with abstractness (Spearman & Wynn Jones, 1950, p. 190). The noegenetic processes of awareness of experience, eductio of relations, and eduction of correlates underscore the centrality of reasoning in intelligence and continue

to be essential in theories of fluid intelligence from Cattell (1971) to Sternberg (1985). Spearman (1927, p. 214) views abstraction as the "climax of eduction." By cognizing mental content apart from its context, abstraction greatly facilitates "transfer of ability from the simpler situations to the more complicated ones" (p. 215-216). Despite the broad range of application deriving from this fluid transferability of reasoning or noegenetic processes, the concept of attention is often assumed to be broader than the concept of intelligence because attentional resources are used in non-intellective information-processing tasks such as signal detection (e.g., Hunt, 1980). However, with Spearman's embracing of awareness of experience as an intellective process, the margins are, at the very least, fuzzy and disputable.

The issues of mental energy and capacity endure in present-day cognitive psychology but with different terminology. By and large, one currently hears little about mental energy as such but, rather, about attention being a heightened state of arousal (Moray, 1969; Posner, 1975) or entailing mental effort (Hasher & Zacks, 1979; Kahneman, 1973). A refreshing exception is Earl Hunt's (1980) contention that the allocation of attentional resources provides the common thread accounting for the ubiquitous positive correlations (or positive manifold) among different cognitive tests: Hunt concludes that studies of dual-task interference "support the argument that there is a pervasive 'mental energy' that underlies a wide variety of cognitive tasks" (p. 470).

Similarly, one hears little nowadays about general mental capacity as such but, rather, about the limitations on working memory resulting in a restricted pool of attentional resources available for cognitive processing. These constraints may take the form, for example, of competition for representation in working memory (Anderson, 1983), competition for limited-capacity processing channels (Broadbent, 1957, 1958), or modulation of processing in otherwise automatic pathways (Cohen, Dunbar, & McClelland, 1990). This allusion to automatic pathways alerts us to the possibility of automatic processes that do not require attention for their execution and that, in effect, represent additional resources beyond working memory. The distinction between automatic and controlled processes will be discussed in connection with our subsequent brief review of theories of selective attention.

The prospect of additional automatic-processing resources also broaches the more general issue of whether there is a single pool of shared central resources to meet the processing needs of the entire mental system as opposed to multiple resource pools. Proposed alternatives include Howard Gardner's (1983) eschewal of a central pool in favor of separate resources for each of his modular intelligences and Kahneman's (1973) view of a central resource combined with multiple satellite resources (which are concerned, for example, with motor movements and perceptual mechanisms).

Some evidence bearing on this issue of the centrality or specificity of working-memory resources emerges in a factor-analytic study by Kyllonen and Christal (1990). This study primarily addresses the relationship between reasoning ability and working-memory capacity or, in Spearman's terms, the relation between the qualitative and quantitative aspects of intelligence. Kyllonen and Christal (1990) administered several tests of reasoning ability along with tasks designed according to Baddeley's (1986, pp. 34-35) definition of working-memory capacity, in that the tasks "require the simultaneous processing and storage of information" and "measure various contents." They isolated a general working-memory factor cutting across a variety of processing codes and input modalities, which is counter to the notion that working-memory capacity is process- or domain-specific but does not rule out the possibility of additional subsidiary resources.

Kyllonen and Christal (1990) also conclude that reasoning ability and working-memory capacity, being correlated in the .80s, are closely related but not identical. Reasoning ability was more highly correlated with general knowledge, while working-memory capacity was more highly correlated with information-processing speed. The title and tenor of their paper favor the conclusion that individual differences in reasoning ability reflect little more than differences in working-memory capacity. This implies a causal connection from working memory to reasoning ability, which is fundamentally different from Spearman's more unitary view that reasoning or noegenetic processing is the qualitative aspect and mental span the quantitative aspect of one-and-the-same *g*. However, Kyllonen and Christal (1990) do allow the contrary causal hypothesis that "working-memory capacity is primarily determined by individual differences in reasoning ability" (p. 428). This latter formulation is consistent with Burt's (1940) appraisal mentioned

earlier that attention is an effect or symptom of intelligence rather than the other way around.

Next we consider some of the processes of selective attention that might underlie, in distinctive combinations, the observed individual differences in attentional mode. Before doing this, however, I cannot resist noting that this sketchy review of energy and capacity in mental functioning, if nothing else, should serve to titillate all of the nothing-new-under-the-sun buffs and old-wine-in-new-bottles buffs.

ENHANCEMENT AND INHIBITION IN SELECTIVE ATTENTION

Almost all theories of selective attention incorporate some notion of capacity or resource limitations. Almost all theories also recognize that, in complex tasks such as reading or typing, many of the operations occur in concert so that much of the processing likely takes place in parallel outside the normal control of attention. As a consequence, most theories distinguish between controlled or attentional processes (which are voluntary, relatively slow, and require attention for their execution) and automatic or inattentive processes (which are fast and do not require attention).

More specifically,

> the automatic processes . . . do not much partake of capacity limitations: They can operate in parallel with certain other automatic and attentive processes without loss and without interference with those other processes. The attentive processes are limited in capacity and tend to interfere with one another, often leading them to be used successively. (Shiffrin, 1988, p. 764)

This dichotomy between controlled and automatic processes is convenient for discussion but simplistic in application because processes vary in degree of automaticity as a function of relative strength related to practice (Cohen, Dunbar, & McClelland, 1990). There is also evidence that automatic and controlled processes operate concurrently and interactively at most stages of processing (Shiffrin, 1988). A further complication is that attention itself can be automatized, as when attention is drawn by targets. Hence, the presentation of targets will elicit attention, utilizing attentional resources

and interfering with other ongoing processes requiring attention (Shiffrin & Schneider, 1977).

A common view of perceptual processing involves some automatic or parallel processing of primitive stimulus features at an early preattentive stage, followed by a rather strict selective filter that allows only stimuli relevant to a designated "channel" to pass through for further processing (Broadbent, 1957, 1958). However, this bottleneck theory of perception was modified to an attenuation theory by Treisman (1960, 1969) when it became clear that the selective filter served to reduce the signal-to-noise ratio of unattended messages rather than blocking them completely. Thus, the attended channel would receive full or enhanced processing while other channels received attenuated processing. Treisman uses a metaphor of an "attention window" having an aperture of variable size that can be adjusted to select a small or large group of adjacent items for enhanced processing (e.g., Treisman, 1990).

A similar and popular metaphor likening attention to a spotlight beam has a long and checkered history. When applied to perusal of internal fields of memory or imagining, the metaphor usually invokes the "mind's eye" (e.g., Kosslyn, 1987). For example, William James (1890) discussed attention in terms of the "span of consciousness" and spoke of the "ideational excitement of the center" compared to the marginal region. More pointedly, Hernández-Peón (1964) compared attention

> to a beam of light in which the central brilliant part represents the focus surrounded by a less intense fringe. Only the items located in the focus of attention are distinctly perceived whereas we are less aware of the objects located in the fringe of attention. (p. 167)

However, this rudimentary version has to be elaborated and modified to accommodate new findings and changing theories. For example, the focus of the beam is to be characterized by detailed information extraction rather than just high acuity or sensory resolving power (Eriksen & Hoffman, 1973). Furthermore, the span or bandwidth of the attentional beam is variable; it can be either wide or narrow, which affects the range of stimuli processed holistically (Humphreys, 1981). Moreover, the spotlight needs some mechanism for switching between two processes, one being diffuse with parallel

processing of multiple items of information and the other more concentrated with serial processing of separate items (Jonides, 1983).

A zoom-lens version has also been proposed having a reciprocal relation between resolving power for discerning information and the size or bandwidth of the field of view (Eriksen & Yeh, 1985). This is reminiscent of Spearman's (1927) trade-off mentioned earlier between "a high grade" and "a wide field" of mental energy. In a two-process zoom-lens version, the narrow focus would process separate items of information serially with high resolving power, while the wide focus would process multiple items in parallel with attenuated resolving power. As will be discussed later, within the limits of available attentional resources or mental energy, the degree of enhancement or resolving power might also be treated as an independently varying process. Furthermore, the enhancement yielded by the attentional beam may be integrative, providing "the 'glue' which integrates the initially separable features into unitary objects" (Treisman & Gelade, 1980, p. 98) and facilitating the structural analysis of their relationships (Treisman, 1990).

The spotlight metaphor also suggests that the direction of the attentional beam both illuminates the targeted area and withdraws illumination from other areas. Do the selectivity effects derive primarily from facilitation or from suppression, that is, from enhanced processing in the attended area or from attenuated processing in the unattended areas, or both? A developing consensus indicates that attentional selectivity derives from some form of signal enhancement rather than solely from noise suppression or filtering (Eriksen & Hoffman, 1974). Furthermore, there is evidence both for perceptual filtering prior to verbal analysis of distractor material and for response suppression after verbal analysis (Greenwald, 1972). Target enhancement appears to go hand in hand with active inhibition of distractors, but this facilitation and inhibition are separate processes that may be independent yet often work in tandem (Posner & Snyder, 1975; Neumann & DeSchepper, 1991). In sum, "it may be that objects presented in regions of nonfocus will be processed automatically and hence will generate encodings that must be inhibited in order to carry out the requirements of the main task" (Shiffrin, 1988, p. 785).

The facilitative, inhibitory, and integrative aspects of attention are explicitly treated by Pascual-Leone (1969,1989) as separate processes, each of

which exhibits consistent individual differences. In his theory of constructive operators, Pascual-Leone posits a mental energizing or excitatory component and a mental interruption or inhibitory component. The former is referred to as mental attention or mental energy and is quantified as M-capacity or M-power. M-capacity is the maximum number of schemes a person is capable of activating at any one time, schemes being internal representations of task-relevant information. Pascual-Leone distinguishes structural M-capacity or M-reserve, which is all the capacity a person possesses, from functional M-capacity, which is the amount actually used in the mental activity. M-reserve is tantamount to working-memory capacity and corresponds to Spearman's mental span and his quantitative aspect of *g*. Functional M-capacity is typically lower than M-reserve, affording some leeway within those limits for effortful boosting of attentional resources to enhance processing. The inhibitory or I-component provides for separately varying mechanisms or processes of interruption to suppress distracting or misleading schemes.

The M- and I-processes "together constitute the so-called 'beam' of mental attention. The mental energy boosts the activation of relevant schemes to be attended while mental interrupt inhibits those task-irrelevant schemes to which the subject does not intend to attend -- thus creating the sharp 'edge' of the 'light' of consciousness which is experienced phenomenologically" (Pascual-Leone, 1989, p. 45). Pascual-Leone also posits an F-factor for gestalt field effects, which contribute to the integrative nature of attention, for example, by synthesizing stimulus features for object identification as well as categorization and by facilitating figure-ground organization. "By forcing a gestaltist structuring of the . . . activated schemes the F-factor brings about the closing that completes the effect of an attentional flashlight 'beam'" (p, 61).

However, sometimes the F-factor yields compelling configurations that are perceptually misleading with respect to task demands, as in Witkin's embedded-figures and rod-and-frame tests. In the former, a simple figure must be isolated from overlapping configurations of which it is a part, and in the latter a luminous rod surrounded by a luminous tilted frame is to be set to the true vertical in an otherwise darkened room (Witkin & Goodenough, 1981). Thus, respondents are faced with a conflict between the effects of the F-

factor and task requirements to overcome the misleading features, that is, to utilize M- and I-resources for restructuring. Ability or competence contributes to task performance in terms of individual differences in M-power. Cognitive styles contribute in terms of consistent strategic differences in mobilizing and allocating M- and I-resources.

The intent of this brief review of theory and research on selective attention was to expose the rich array of process variables from cognitive psychology that might exhibit consistent individual differences, thereby potentially contributing to stylistic dimensions of attention deployment. We have seen that individual differences might occur independently in facilitative, inhibitory, and integrative processes of attention; in the width or narrowness of the attentional focus; in the degree of resolving power for information extraction; in the extent to which resolving power and bandwidth are reciprocal; and, in the tendency for attentional processes to occur serially over successive items of information or in parallel over multiple items simultaneously.

Varied as these possibilities are, they do not exhaust the multiplicity of individual differences in attentional behavior observed in studies of eye movements, memory retrieval, and perceptual task performance. For example, we must refine the distinction between intensity and extensity of attention in terms of focussing versus nonfocussing and scanning versus nonscanning. Focussing versus nonfocussing refers to the width of the attentional beam and to its two reciprocal tendencies: That is, as the beam widens, it may become relatively diffuse and unfocussed with attenuated processing, or it may become more integrative of multiple items and relationships through parallel processing. Extensive versus limited scanning refers to the movement of the beam, whatever its size and intensity.

As a consequence, there is more than one kind of broad as well as of narrow attention (Wachtel, 1967). Broad attention can refer either to extensive scanning of the stimulus field or else to perusal with a broad attentional bandwidth, which might be either unfocussed or integrative. The extensive scanning may be marked by high scatter or dispersion of attentional fixations or by large jumps from one fixation to the next, or both (Luborsky, Blinder, & Schimek, 1965). Furthermore, extensive scanning may reflect unsystematic or anxious roaming of the stimulus field, systematic or planful

coverage, or flexibly controlled deployment of attention to multiple information sources.

In contrast, narrow attention can refer either to limited scanning of the stimulus field or else to perusal with a narrow attentional bandwidth. The narrow attentional beam may represent enhanced perception of successive details or selective perception that reduces responsiveness to compelling irrelevancies, or both. The limited scanning may be marked by low scatter of fixations or by small track lengths between fixations, or both. Furthermore, limited scanning may reflect meticulous or repeated examination of details, cautious adherence to central or salient features, or defensive avoidance of the threatening or unknown.

Whether the scanning is extensive or limited with either broad or narrow bandwidth, the attentional behavior may in addition exhibit consistent individual differences in speed. Moreover, rapid scanning as well as slow scanning may be in the service of precision and comprehensiveness. On the other hand, either may instead be reflective of defensiveness, the slow scanner avoiding attention to potentially threatening aspects of the field by only hesitantly venturing to look around and the fast scanner distracting attention from potential threats by looking rapidly everywhere (Luborsky, et al., 1965). Finally, all of these aspects of attention, in whatever combination, may apply not only to external perceptual fields but also to perusal of internal fields of memory, meaning, and knowledge.

SHARP- VERSUS BROAD-FOCUS AND SERIAL VERSUS PARALLEL SCANNING

Let us now turn to the two attentional modes or cognitive styles of sharp- versus broad-focus scanning and signal versus information scanning that emerged as second-order factors in separate analyses of male and female samples (Messick, 1989). Although these two second-order dimensions appear to be comparable in the two sexes, the contributing first-order structures as well as some personality correlates are divergent, suggesting differential underlying dynamics as a function of gender.

In addition to marker tests for verbal and quantitative ability, the battery included measures of perceptual speed and closure, breadth of categorizing, inkblot perception, and a variety of personality scales.

Measures were also included for facility in detecting stimuli or stimulus classes both in unorganized or randomly structured fields (such as locating four-letter words in arrays of letters, or finding misspelled words or words containing the letter "a" in long lists of words) as well as in organized fields (such as finding a simple pattern embedded in a complex figure or locating faces camouflaged in pictorial scenes). Many of the tests were scored not only for the number of correct responses but also for the number of wrong and omitted responses.

In the variety of search tasks employed, the signals ranged in specificity from a unique target (such as the letter "a" or a standard pattern) to instances of a circumscribed class (such as four-letter words, round things, or blue things) to instances of more open classes (such as faces or misspelled words). Given that scanning propensities may be reflected in memory retrieval as well as in perceptual search -- that is, in the manner in which internal fields of memory, meaning, and knowledge are surveyed -- measures were also included for remoteness of word association as well as for fluency in ideational production of class instances.

A concerted effort was made to differentiate between two possible modes of attention, namely, serial scanning for signal detection and parallel-process scanning that apprehends incidental information in the field. This was attempted using perceptual search tasks in which the respondent was required to find stimuli or signals embedded in meaningfully organized visual fields -- for example, to locate faces camouflaged in pictorial scenes. Two scores were obtained, one for the number of good or keyed hidden faces located and another for the number of areas circled that did not contain a keyed face, that is, the number of "fabulated" faces (Smith & Klein, 1953).

The distinction here is between good form appropriateness as opposed to poor form appropriateness of figures identified as "faces," a distinction supported by confirming loadings for inkblot measures of form appropriateness and form definiteness on the same factors. Upon completion of the search task, the stimulus materials were removed, and the respondents were then asked specific questions about the content of the pictorial scenes. Persons who take in incidental information about the field in the process of scanning could thus be differentiated from those whose attention is apparently limited selectively to detecting the hidden signals.

Also pertinent to the distinction between signal and information scanning is the Stroop Color-Word Test, which taps susceptibility to cognitive interference or degree of responsiveness to compelling irrelevant stimuli (MacLeod, 1991). The Stroop task consists of color names printed in differently colored inks; respondents must name the ink colors as quickly as possible and not read the words. Resistance to color-word interference is thought to be a function of two processes: one is selective deployment of attention successively to the appropriate aspects of the stimulus and the response, namely, to the color of the ink and its corresponding color name; the other is flexible control of both inhibition and facilitation of response in dealing with successive color-word stimuli, that is, active inhibition of the printed color name and simultaneous (or successive) facilitation of the name of the contrasting colored ink in which it is printed (Gardner, et al., 1959; Klein, 1964; Rand, Wapner, Werner, & McFarland, 1963). There are consistent individual differences in each process as well as in the relative balance with which they occur in concert; in the extreme, some individuals may rely on only one or the other.

The conjecture here is that those individuals who rely relatively more on the first process of selective attention on the Stroop test would also tend to deploy selective attention serially as a strategy (or perhaps a style) of signal detection. In contrast, those tending toward parallel processing would automatically develop multiple encodings of incidental information, some of which (like the color words on the Stroop test) interfere with task performance and need to be actively inhibited, thereby leading these parallel processors to rely relatively more on the second Stroop process of response inhibition and flexible control.

Indeed, two of the first-order factors in our scanning study were consistent with this view: One involved signal scanning for both unique targets via perceptual search and class instances via memory search; the other involved information scanning, with loadings for incidental knowledge of the pictorial scenes as well as other tasks facilitated by multiple encodings. Furthermore, the Stroop interference score loaded substantially on both factors, which is consistent with the view that signal scanning implicates one of the two Stroop processes (namely, serial selective attention) while information scanning implicates the other (namely, active inhibition of the

intrusive effects of parallel processing). These two first-order factors were negatively correlated and, along with some other first-order factors, generated a bipolar second-order dimension of signal versus information scanning that is reflective, as we have seen, of serial versus parallel processing.

The structure just described was for the male sample. In the female sample, the corresponding bipolar second-order factor is quite comparable, with similar tests loading it in a hierarchical analysis, but the contributing first-order factors were somewhat different. For example, the Stroop interference score loads only the signal-scanning factor in the female sample, which suggests that females either rely primarily on selective attention in Stroop test performance or else use both selective attention and response inhibition in relative balance.

The other bipolar second-order factor is interpretable as sharp- versus broad-focus scanning in both male and female samples. At the test level, one of the major contrasts is between finding good faces in pictorial scenes as opposed to having such a broad view of faces that many fabulated versions are accepted. In males, the broad bandwidth appears to involve attenuated processing because several wrong and omits scores on closure tests load in this direction, as do measures of rigidity and authoritarianism. The first-order factors loading in the broad bandwidth direction involve quick closure via broad estimation, which is facilitative on tasks where approximations are adaptive but in other instances also carries the maladaptive baggage of premature closure. Hence, this cognitive style might be better characterized for males as sharp- versus loose-focus scanning or focussed versus unfocussed scanning.

In contrast, the broad bandwidth pole in females appears more integrative: It was negatively correlated with rigidity and authoritarianism and positively correlated with self-sufficiency and affective interests. These correlates suggest that this factor might be better characterized for females by something like tight- versus open-focus scanning. Another difference between males and females is that all but one first-order factor for females cut across both perception and memory, whereas for males there are separate factors for scanning external perceptual fields and internal memory fields, mediated by the isolation of affect.

By invoking process concepts such as inhibition as well as aspects of personality such as rigidity and orientation toward affect in the interpretation of these stylistic attentional modes, we hark back once again to Spearman's fertile conjectures. In speaking of the conative control of attention, he noted that

> another important problem still unsettled is as to whether the conative influence is always primarily enhansive, or can also be (directly) inhibitive. Yet another moot point is as to whether not only conation, but also affection, possesses such immediate influence in the regulating of cognitive intensity. (Spearman, 1923, p. 136)

STYLE IN THE EXPRESSION AND DEVELOPMENT OF COMPETENCE

Given the close association historically between intelligence and attention, it is important to explore potential relationships between human abilities and such stylistic attentional modes as sharp- versus broad-focus scanning and signal versus information scanning. These and other cognitive styles, such as field independence versus field dependence and reflection versus impulsivity, reflect consistent individual differences in the manner or form of cognition as distinct from the content or level of cognition (Messick, 1984). As such, cognitive styles are often viewed as ***performance*** variables rather than ***competence*** variables (Globerson, 1989; Neimark, 1981).

From this perspective, cognitive styles reflect not competence per se but, rather, the utilization of competence, that is, they moderate access to competence as well as its strategic deployment in meeting task requirements (Neimark, 1985). Indeed, Pascual-Leone's (1969) theory of constructive operators is tantamount to a performance model overlaid on the competence model of Piaget. His M-power, along with operators for content knowledge (C) and procedural learning (L), represent competence; his I- and F-factors, along with operators for affect and motivation (A) as well as for biases and beliefs (B), relate to performance.

As a case in point, Neimark (1981) argues that low success rates of field-dependent persons on Piaget's formal operational tasks, which by their nature are ambiguous and unstructured, do not reflect deficiencies in formal thinking but rather a performance artifact due to misleading field effects.

Others who agree with the performance-artifact explanation emphasize differences in strategy or cue selection as well as the propensity of field-dependents to underutilize their repertoire of executive planning schemes (Globerson, 1989; Linn, 1978; Pascual-Leone & de Ribaupierre, 1979).

However, because competence is inferred from task performance in the assessment of human abilities and because styles influence performance apart from competence, the effects of styles constitute contaminants in the assessment of abilities. Somehow styles and abilities need to be disentangled to improve the valid measurement of each. This might be accomplished, for example, by developing refined task materials and experimental controls, convergent and discriminant evidence via multitrait-multimethod designs, effective factor-analytic techniques, and style-appropriate training of strategy selection and use so as to reveal competence optimally.

Nevertheless, separating the contributions of styles from abilities in performance appears to be both difficult and daunting. This is so because their interplay occurs not only at the level of outcomes but also at the level of processes. Stylistic attentional modes influence the nature and quality of stimulus information available for thinking and problem solving (Zelniker, 1989), thereby affecting not just the manner but the material of cognition. These style-based differences in the substance of cognition shape the nature of ability and knowledge structures that are formed as well as their higher-order organization. Thus, cognitive styles are both performance and competence variables combined: Styles influence not only the utilization of cognitive structures but also their development (Brodzinsky, 1985; Messick, 1984, 1987). Once again, however, this is not a new perspective. In 1960, as an instance, Riley Gardner and his colleagues interpreted their factor-analytic results linking cognitive controls and intellective abilities on the same factors in these words:

> It seems possible that . . . mutual 'feedback' . . . occurs in the developmental emergence of cognitive controls and abilities. For example, generalized facility in selective attention may provide a necessary condition for the differentiation of several linked abilities. . . . [In turn] specific abilities may contribute to the differentiation of the control. (Gardner et al., 1960, p. 117).

Hence, stylistic modes of attention, by influencing both the expression and the development of competence, pose both a problem and a challenge for the theory and measurement of human abilities. Stylistic consistencies in cognition pose a problem precisely because they bear on both performance and competence. As performance variables their contaminating effects must be taken into account in the measurement of abilities. As competence variables their role in the development and structuring of abilities and knowledge requires an intricate theoretical rationale relating intelligence and personality. Finally, as bridging variables between cognition and personality, styles offer a challenge because stylistic self-consistency may afford an elucidative purview for addressing both the richness and the individuality of human intellect.

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