# CHARACTER STRENGTHS AND VIRTUES

## A HANDBOOK AND CLASSIFICATION

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# 5. CURIOSITY

[Interest, Novelty-Seeking, Openness to Experience]

■ *Maverick scientist John Lilly was a pioneer in electronics, biophysics, neurophysiology, psychology, and cybernetics. He was the world's leading authority on the effects of sensory deprivation and isolation on the human mind as well as intraspecies communication between humans and dolphins. What galvanizes someone to pursue expertise in such a wide range of disciplines? Although we can certainly point to Dr. Lilly's need for mastery, one of many traits differentiating him from his peers was his insatiable thirst for knowledge—his curiosity and interest in the world. Based on his own empirical research, cross-fertilized readings in Western science and Eastern religion, and personal explorations into altered states of consciousness via sensory deprivation tanks, psychotropic drugs, and Eastern mind–body practices, Dr. Lilly focused his life and career on exploring the seemingly limitless boundaries of consciousness. Lilly believed all human experiments must be initially conducted on oneself. The precarious nature of his self-experimentation, frequently entailing the use of LSD, ketamine, and the absence of personnel to monitor his physical safety, continued despite risks and losses to his professional career and personal life. Lilly believed the growth in knowledge outweighed the costs. Both intrepid and reckless, Lilly personified the character strength of curiosity (for details, see Jeffrey & Lilly, 1990; Lilly, 1972a, 1972b).* ■

## ■ Consensual Definition

Curiosity, interest, novelty-seeking, and openness to experience represent one's intrinsic desire for experience and knowledge. Curiosity involves the active recognition, pursuit, and regulation of one's experience in response to challenging opportunities. Although not all of us are as curious as John Lilly, curiosity

is ubiquitous, manifest in the mundane activities that make our daily lives more fulfilling:

- being absorbed in the plot of a movie
- completing a crossword puzzle without awareness of time passing
- opening and reading with eagerness a handwritten letter
- watching the flight of a seagull
- conversing with an intriguing stranger
- examining a picture of Siamese twins conjoined at the head
- pondering the aftermath of a date
- listening carefully to a new song on the radio

All individuals experience curiosity, but they differ in its depth and breadth, and in their threshold and willingness to experience it.

Despite overlap among curiosity, interest, novelty-seeking, and openness to experience, they can be hierarchically arranged. Curiosity and interest are sometimes used interchangeably. When individuals experience these positive emotional-motivational states, they initiate and sustain goal-directed behaviors in response to incentive cues. For example, someone at the beach notices a black suitcase floating in the ocean and decides to swim after it to determine its contents. Upon discovering it to be empty, her curiosity may dissipate. However, her curiosity may also increase in light of why the suitcase was in the ocean, what was in it, and whether its contents have washed ashore. Or perhaps not. The point is that individual differences in curiosity abound in terms of frequency, intensity, and duration of exploration.

Novelty-seeking reflects an individual's propensity for seeking novel and exciting experiences to elevate stimulation to an optimal level; this includes a willingness to endure high levels of risk (e.g., pain and injuries when rock climbing, rejection when meeting new people) to obtain the benefits of novelty. Although curiosity and novelty-seeking are both goal-oriented systems with a positive emotional core, curiosity seems broader in scope, encompassing both novelty-seeking (so-called diversive curiosity) and specific curiosity (increasing one's knowledge). In principle, novelty-seeking should have stronger associations with courage and sociability, and negative relationships with boredom and anxiety. In contrast, specific curiosity should have stronger links to openness to new values and ideas, a future orientation, and the frequency and enjoyment of problem solving.

Finally, openness to experience is a higher order personality dimension involving receptivity to novel fantasies, feelings, ideas, and values. Curiosity is a fundamental motivational component of all openness facets. Yet high openness also entails imaginative, artistic, and unconventional sensibilities neither necessary nor sufficient for curiosity per se. Similarly, individuals can be high in openness, expressing a willingness to understand themselves and be open-minded, yet reluctant to challenge and expand themselves. The experience of

curiosity is more of a mechanism of action (cognitively, emotionally, and/or behaviorally), whereas openness is more of a psychological predisposition. Although curiosity, novelty-seeking, and openness are all associated with a myriad of positive outcomes, novelty-seeking may also lead to negative outcomes if it results in illegal substance use, risky sexual behavior, and the like.

## ■ Theoretical Traditions

Throughout history, curiosity has been both lauded as a virtue and a source of creativity and denounced as hubris and vanity (Saint Augustine, 1943). Curiosity can certainly be dichotomized into unfavorable or favorable, given that peeping at bedroom windows is distinct from exploring exotic plants in a nature preserve. The present focus will be on the virtuous forms of curiosity.

William James (1890) called attention to "moral, intellectual, and aesthetic feelings" (p. 458) that are automatic pleasures in response to novel stimuli. James differentiated between two types of curiosity. The first entailed an emotional blend of excitement and anxiety with respect to exploring and enjoying novelty. The second was scientific curiosity or metaphysical wonder, evoked by "an inconsistency or a gap in . . . knowledge" (p. 429). This two-dimensional model, novelty-seeking and specific curiosity, recurs in the contemporary literature.

Influenced by Darwin, James observed that attention is a limited resource and that individuals tend to focus on stimuli fostering excitement or personal meaning. In evolutionary terms, attraction to novel stimuli is adaptive because it increases knowledge, but the fear of novelty is also adaptive because the unknown may be dangerous. Thus, curiosity is inextricably bound to anxiety and approach–avoidance conflicts. Individuals with a strong endowment of curiosity proffer a specific advantage in life because attention is more fluid, and novel ideas, objects, and relationships can be found, enjoyed, explored, and integrated into an expanding self. In principle, these aspects of curiosity aid survival—for example, finding plants with medicinal properties, increasing social resources, discovering new habitats.

A proliferation of drive theories appeared in the mid-20th century to explain what makes people curious. Early experimental psychologists found rats that would explore unfamiliar wings of mazes and engage in play in the absence of drive satiation (Krechevsky, 1937). These findings led them to define curiosity itself as a homeostatic drive in the same vein as hunger, thirst, and sex. However, proposing that curiosity is an instinctual drive remains nonfalsifiable because other motivational or cognitive processes responsible for exploration are always present.

The demise of the homeostatic drive model led to a lengthy theoretical debate on whether curiosity and exploration were (a) internally driven by the desire to avoid boredom and monotony (H. Fowler, 1965) or (b) externally

driven by the lure of novel, complex, or ambiguous stimuli (Berlyne, 1967). Numerous studies and interpretations support these ostensibly opposed positions (Voss & Keller, 1983). More important, the theoretical conflict between these models created an impasse that blocked further study. Both positions have merit, as long as we posit multiple pathways to the evocation and satiation of curiosity. However, attributing curiosity solely to internally or externally generated sources does little to explain its properties, how it is elicited, why the same activity can generate intense curiosity in some but not others, and how it develops.

Also absent from these drive theories is the notion that one's curiosity and exploratory behaviors partly depend on outcome expectancies like risk appraisal and the depth of one's knowledge. Unadulterated novelty is exceedingly rare, with individuals relating most novel stimuli to what they know, expect, and can categorize. Curiosity cannot be divorced from what is remembered, and so cognitive theories of curiosity began to be proposed.

These cognitive models focus on how one's curiosity involves a desire to make sense of the world and to feel competent in recognizing violations of mental representations (Deci, 1975; Kagan, 1972). Consider the interest most of us would experience when meeting a nuclear physicist with a penchant for heavy metal rock music. These models propose that individuals are motivated to resolve incongruity by the search for an optimal "correspondence between expectancy and perception" (Hebb, 1949, p. 149). The cognitive process theory posits that curiosity is a function of assimilating and accommodating novel stimuli into one's schematic framework of the self and the world (Beswick, 1971). Greater curiosity emerges from difficulties integrating information into one's schematic framework, sensitivities to discrepancies in the environment, and comfort with the anxiety-provoking nature of conceptual conflicts. This model leads to a rich avenue of untested and falsifiable hypotheses, although cognitive models have yet to account for the fact that knowledge fuels rather than quells curiosity. They also fail to account for the relationships between intelligence and curiosity. Finally, most cognitive models posit that individuals want to resolve curiosity, implying that curiosity is somehow aversive, an assumption at odds with the everyday experience of any engrossed reader, moviegoer, scientist, or parent of an infant—all can readily attest that curiosity is a positive, rewarding state.

More recent theories depict curiosity as a multifaceted system evoking a wide range of human emotions, cognitions, and behaviors that can be satiated by a variety of sensory and cognitive channels (Boyle, 1989; Langevin, 1971). Spearheaded by the work of Daniel Berlyne (1962), curiosity and exploratory tendencies have been segmented into novelty-seeking (diversive curiosity) and specific curiosity, thereby influencing large bodies of disparate research.

Novelty-seeking is best described as an emotional-motivational state facilitating the search for stimulation occasioned by novelty, complexity, uncertainty, or conflict, irrespective of specific questions or problems. According to work

led by Zuckerman (1994) and his colleagues, individuals appear to differ in their desire for experience seeking, thrill and adventure seeking, boredom susceptibility, and willingness to take risks to obtain novelty.

Specific curiosity is best described as an orientation toward investigating specific objects, events, and problems to understand them better and be challenged by them. An extensive body of research has been devoted to individual differences in specific curiosity (Cacioppo, Petty, Feinstein, & Jarvis, 1996). These two curiosity dimensions appear to be complementary in that novelty-seeking readily leads to stimulus encounters resulting in specific problems fueling specific curiosity behaviors. Individuals differ as to whether they pursue and enjoy complex cognitive activities or are relieved to avoid cognitively taxing curiosity experiences. Those who enjoy complex cognitive activities experience a wide range of positive subjective experiences and demonstrate virtuous attributes (Cacioppo et al., 1996).

Echoing early evolutionary models, Spielberger and Starr's (1994) optimal stimulation/dual process theory posits that the pursuit of optimal subjective experiences entails curiosity and anxiety. When curiosity is stronger than anxiety, individuals explore their environment (diversive curiosity). When anxiety is stronger than curiosity, individuals tend to disengage from goals to reduce stimulation to a more manageable level. Optimal stimulation purportedly consists of subjective pleasantness and challenge, accentuated with mild anxiety. Information-seeking behaviors (specific curiosity) are activated to reduce some of the initial uncertainty arising from novel activities, sustaining more moderate, optimal levels of stimulation. State curiosity is a function of individual differences in stimulation thresholds. Although Spielberger developed an assessment battery to measure anxiety and curiosity, researchers tend to focus exclusively on curiosity or anxiety, not both. Surprisingly, the basic tenets of this model have undergone few empirical tests (Kashdan, 2002; Peters, 1978). However, the results of these studies support this framework as a link between fundamental appetitive and aversive processes.

Despite the longevity of the two-factor diversive-specific model of curiosity, aside from factor analyses of self-report instruments, there is a general absence of substantiating evidence. Contemporary researchers tend to focus on either diversive, specific, or general curiosity, leading to three ostensibly isolated bodies of research. Additionally, the most extensive work in the field is on openness to experience, one of the Big Five core personality traits (McCrae & Costa, 1997a). Openness has been conceptualized as the receptivity to and need for experience, as well as related values, imagination, and artistic sensibilities. In light of all the work on different facets of curiosity, it is surprising that the majority of work is minimally represented, if not ignored, in literature reviews (Loewenstein, 1994; Spielberger & Starr, 1994). Future work must explore the differential correlates and predictive utility of these curiosity constructs, thereby testing the viability of multidimensional models.

Based on early work on cognitive development, the personal growth facilitation model of curiosity posits that recognizing and pursuing novelty, uncertainty, and challenge is the foundation for enhancing personal and interpersonal capital (Kashdan, Rose, & Fincham, 2002). The reciprocally driven process includes (a) greater allocation of attention and energy to recognizing and pursuing cues of novelty and challenge, (b) cognitive evaluation and behavioral exploration of challenging activities, (c) deep absorption in these activities, and (d) integration of curiosity experiences by assimilation or accommodation. The process of generating, sustaining, and integrating curiosity experiences is tantamount to expanding personal resources. The two essential components of curiosity posited by this model, appetitive exploration and flowlike task absorption, served as the basis for the trait and state Curiosity and Exploration Inventories. Despite preliminary support for appetitive motivational processes linking curiosity to an expansion in interpersonal resources, the basic mechanisms need further empirical study.

Experiencing curiosity evokes positive affect, motivating individuals to seek new experiences and reinforcing their exploration (Ainley, 1998; Kashdan & Roberts, 2002, in press). Feelings of competence and control resulting from integrating novel experiences engender further positive affect (R. M. Ryan & Frederick, 1997). Thus, curiosity begets further curiosity. This relationship is even more pronounced as one becomes cognizant of information that can reduce meaningful gaps in knowledge. A profitable direction for future research includes understanding the causal directions of these positive feedback loops.

Individuals have idiosyncratic hierarchies wherein certain activities and stimulation sources are more appealing than others—music, movies, celebrity gossip, scientific breakthroughs. Besides perceived desirability, one's level of curiosity is likely to be a function of the fit between thinking styles and novelty sources; for example, introverts are less likely than extroverts to ask questions in school. Although early educational research provides some evidence for this thesis (Beswick & Tallmadge, 1971), much remains to be learned about individual differences and contextual factors that moderate curiosity and its desirable consequences. Why might one identical twin be drawn to the study of economics and the other to clinical psychology?

One psychological context with a profound effect on curiosity is the state of boredom. When bored, highly curious individuals are oriented to finding novelty and are sensitive to environmental nuances that can increase arousal. Boredom foreshadows impulsive and delinquent behaviors (Zuckerman, 1999). However, the right temperamental combinations can alternatively lead to blocks in productivity and creativity. When activities are perceived as boring but meaningful, individuals deploy strategies to enhance interest and sustain effort toward goals (Sansone, Weir, Harpster, & Morgan, 1992). High-curious individuals are probably more likely than low-curious individuals to be able to generate interest in activities that are meaningful or unavoidable.

## Measures

Coincidental with the proliferation of theoretical models, a number of self-report questionnaires have been developed to measure individual differences in curiosity. There also exist indices of novel behavior that can be used to assess state curiosity. These assessment strategies show a range of construct validity. Most measures address isolated lower order factors of curiosity such as general curiosity, novelty-seeking, specific curiosity, academic curiosity, scientific curiosity, and, to measure perceptual curiosity, the duration of focused attention to common versus irregular and ambiguous figures. The most widely used measures are described in Table 5.1.

Many self-report measures lack adequate psychometric properties (alphas less than .60; Langevin, 1971). In contrast, the widely used State–Trait Curiosity Inventory (STCI; Spielberger, 1979) and nearly identical Melbourne Curiosity Inventory (MCI; Naylor, 1981) are composed of transparent items—for example, "I am curious"—with high item homogeneity resulting from redundancy. Indeed, the original items for the STCI and MCI tapping antagonistic states of boredom and anxiety were dropped due to their orthogonal relationships with curiosity items. Naylor (1981) defended these actions by stating, "It was decided to concentrate on the development of a curiosity scale without the concern for balance since this seemed to create more problems than it was intended to solve" (p. 174). Given the existence of multidimensional models of curiosity, and strong empirical relations between cognitive ability and curiosity, one wonders what exactly these scales are measuring. Sometimes they are simply labeled as information-seeking or specific curiosity scales (Spielberger & Starr, 1994).

A major limitation of many self-report measures is that they rely on items pertaining to specific objects and events such as interest in schoolwork, museums, computers, drug use, or surfing (H. I. Day, 1971; Kreitler, Kreitler, & Zigler, 1974; Litman & Spielberger, 2003; Zuckerman, Eysenck, & Eysenck, 1978). Clearly, nonrandom error accounts for some of the explanatory power of these measures. Greater curiosity will be ascribed to individuals with the best match between personal preferences and domain-specific items (Loewenstein, 1994). For example, cultural differences would be artificially inflated if Americans were interested in different activities than Europeans and these various activities were represented by scale items. Despite this limitation, the Sensation-Seeking Scale—Form V (SSS-V; Zuckerman et al., 1978) is the most widely used measure of novelty-seeking. Factor analyses have found that novelty-seeking and information-seeking/specific curiosity fall out separate dimensions (Langevin, 1971; Spielberger & Starr, 1994). The four subscales of the SSS-V appear to measure diversive curiosity. However, the construct of diversive curiosity is broader than a "willingness to take physical, social, legal, and financial risks for the sake of such experiences" (Zuckerman, 1994, p. 27). Some individuals prefer novel

TABLE 5.1 *Measures of Curiosity and Related Constructs*

*State-Trait Curiosity Inventory* (STCI)

Spielberger (1979)

Self-report questionnaire composed of 10 face-valid items reflecting global interest and wonder

- Internal reliability (alpha coefficients): ~.95 for trait scale; ~.94 for state scale
- Test–retest reliability: not available
- Construct validity: correlates –.08 –.35 with SSS-V subscales; ~.40 with openness to experience, locus of control, optimism, and self-esteem; and ~–.40 with negative affect

*Sensation-Seeking Scale–Form V* (SSS-V)

Zuckerman et al. (1978)

Self-report questionnaire composed of 40 items addressing thrill and adventure seeking, experience seeking, disinhibition, and boredom susceptibility

- Internal reliability (alpha coefficients): .56 –.82 for separate scales; ~.85 for total score
- Test–retest reliability: .89 for 3 weeks; .75 for 6–8 months
- Construct validity: correlates ~–.45 with anhedonia scales; –.54 with arousal avoidance; ~.30 with divergent thinking tests; and .25 with Need for Cognition Scale

*Need for Cognition Scale* (NCS)

Cacioppo & Petty (1982)

Self-report questionnaire composed of 34 items addressing the degree to which individuals enjoy and engage in thinking and solving complex problems

- Internal reliability (alpha coefficients): ~.90
- Test–retest reliability: .88 for 7 weeks; .66 for 8 months
- Construct validity: correlates ~.60 with curiosity scales; ~–.30 with measures of dogmatism and discomfort with ambiguity; and ~.40 with achievement tests

*Openness to Experience Scale of the NEO-PI-R*

Costa & McCrae (1992)

Self-report questionnaire composed of 48 items reflecting a broad orientation to being high in imagination, aesthetic appreciation, intellectual curiosity, and open-mindedness

- Internal reliability (alpha coefficients): .81
- Test–retest reliability: .68 –.79 for different facets over 6-year interval
- Construct validity: correlates ~.40 with indices of curiosity, novelty-seeking, cognitive flexibility, divergent thinking, and creativity

*Curiosity and Exploration Inventory—Trait and State Versions* (CEI)

Kashdan & Roberts (in press)

Self-report questionnaire composed of 7 items addressing appetitive strivings for novel and challenging activities and the propensity to be deeply absorbed in activities

- Internal reliability (alpha coefficients): .63–.74 for separate scales; ~.76 for total score
- Test–retest reliability: ~.80 for separate dimensions and total score for 1 month
- Construct validity: correlates ~.40 with indices of curiosity, novelty-seeking, positive affect, and appetitive motivation; ~–.40 with boredom proneness and social anxiety

and challenging experiences that are absent of danger, like viewing stars through a telescope. In creating the Impulsive Sensation-Seeking Scale, Zuckerman, Kuhlman, Joireman, Teta, and Kraft (1993) eliminated all domain-specific items, acknowledging this potential confound in prior incarnations of the SSS.

Two other well-established curiosity-relevant measures are the Need for Cognition Scale (NCS; Cacioppo & Petty, 1982) and the Openness to Experience Scale (Costa & McCrae, 1992). Each of these measures has been refined and well validated. The NCS, which is best conceptualized as a lower order factor of curiosity, appears to assess individual differences in specific curiosity or the tolerance and enjoyment of effortful thinking. The construct of openness is a broad dimension of personality, subsuming "vivid fantasy, artistic sensitivity, depth of feeling, behavioral flexibility, intellectual curiosity, and unconventional attitudes" (McCrae, 1996, p. 323), demonstrating positive influences on social attitudes (e.g., prejudice), relationships, and creativity. However, as a means of further understanding the role of curiosity in generating growth, openness may be less valuable than other facets of curiosity (i.e., sensation-seeking, need for cognition, state curiosity). The specific role of curiosity as an emotional-motivational component of openness will need to be further validated.

Shorter versions of novelty-seeking, curiosity, and openness scales have been created and validated. Child versions of novelty-seeking and openness scales have also been created, and the simple wording of the STCI makes it appropriate for younger populations.

More recently, we have the Curiosity and Exploration Inventory (CEI), a brief seven-item measure comprising exploration (appetitive strivings for novelty and challenge) and flow (deep absorption in activities); initial analyses found no evidence for differential diversive and specific curiosity factors (Kashdan & Roberts, in press). The CEI has good psychometric properties and construct validity. Upon controlling for the overlapping construct of trait-positive affect, the CEI demonstrates unique relationships with appetitive motivational constructs.

There is a long history of experimental and naturalistic studies on the contextual and individual difference factors influencing state and trait curiosity (for a review of visual paradigm studies, see Voss & Keller, 1983). To assess child curiosity, studies have had teachers, peers, and independent observers rate curiosity using Likert scales with behavioral referents (for innovative tasks and reliable indices, see Alberti & Witryol, 1994; Coie, 1974). For instance, teachers were asked to rank-order children in curiosity using the following definition: (a) reacts positively to new or strange stimuli in the environment by exploring/manipulating them, (b) indicates a desire to better understand themselves and/or the environment, (c) visually searches for novelty, and (d) long-standing engagement with stimuli to increase understanding (Coie, 1974).

To assess specific curiosity, Loewenstein, Adler, Behrens, and Gillis (1992) used a set of innovative perceptual and epistemic tasks testing the following predictions: (a) The more information obtained in an area that closes a gap in

knowledge, the greater one's curiosity will be to understand the rest, and (b) the more meaningful the domain of information, the greater one's curiosity. In one experiment, participants were seated with a series of upside-down body part photographs constituting a person. Participants were randomly shown a specific number of body parts. After successively turning over the appropriate photographs, participants were asked to guess the age of the person. As outcome measures, they were asked three curiosity-related questions: How curious are you in knowing the person's actual age, how curious are you in seeing all the photographs, and is it worth 50 cents to see all the photographs?

Interpersonal curiosity has been assessed with a reciprocal self-disclosure task wherein individuals take turns asking and answering questions that escalate in personal and emotional intensity, mimicking the process of intimacy development (Kashdan & Roberts, in press). Cognitive and behavioral indices of curiosity can include the direction and intensity of attentional resources, facial expressions of interest, and responsiveness during the interaction.

For these and other curiosity paradigms, construct validity will need to be demonstrated. Because these studies assess short-term curiosity, future work needs to assess idiosyncratic interest in the novel topics, objects, or activities under study. Similarly, anxiety levels (e.g., children differ in their perception of teacher threat) and individual thinking styles (e.g., introvert vs. extrovert) may influence the manifestation of curiosity. To improve the reliability of findings, multimethod approaches are necessary. Most important, baseline measures of curiosity and anxiety are not uniformly reported, raising the question of whether curiosity is evoked by experimental stimuli. Because curiosity is a transient state and participants may be curious about curiosity studies, baseline data should be obtained as a context for understanding within-person curiosity changes.

## ■ Correlates and Consequences

Curiosity, novelty-seeking, and openness to experience are all associated with desirable psychosocial outcomes. This includes general positive affect, willingness to challenge stereotypes, creativity, preference for challenge in work and play, perceived control, and negative relationships with perceived stress and boredom (Cacioppo et al., 1996; McCrae & Costa, 1997a; Zuckerman, 1994). The emotional-motivational state of curiosity appears to fuel positive emotions such as excitement, enjoyment, and attentiveness (Ainley, 1998; Kashdan & Roberts, 2002, in press), facilitating complex decision making (Kreitler et al., 1974) and goal perseverance (Sansone & Smith, 2000). In a longitudinal study of 7th- to 11th-grade students, "students designated as being interested in the broad domain of learning reported their school experience as more satisfying (positive affect), as being important to their future (opportunity), having good relation-

ships with teachers, and having a sense that they would succeed (achievement)" (Ainley, 1998, p. 264). When the school environment was perceived as unthreatening, college students with high trait curiosity asked nearly five times as many questions as students with low trait curiosity (Peters, 1978).

Meta-analyses show that curiosity accounts for approximately 10% of the variance in academic learning and performance (Schiefele, Krapp, & Winteler, 1992) and 36% of the variance in self-selected career choices (Lent, Brown, & Hackett, 1994). Greater curiosity-related behaviors and cognitions are consistently associated with greater learning, engagement, and performance in academic settings (e.g., Harackiewicz, Barron, Tauer, & Elliot, 2002) and work organizations (e.g., Reio & Wiswell, 2000). For clients being treated for physical and psychological conditions, greater intrinsic motivation for treatment goals predicted greater adherence and better outcomes (e.g., R. M. Ryan, Plant, & O'Malley, 1995; G. C. Williams, Gagne, Ryan, & Deci, 2002).

As for interpersonal relationships, both trait and state curiosity predict positive subjective experiences and interpersonal closeness as rated by self and interaction partners, above and beyond other affect and motivational variables (Kashdan & Roberts, 2002, in press; Kashdan et al., 2002). Highly curious individuals experience greater intimacy with novel interaction partners as a function of directing attention and capitalizing on positive qualities of partners and conversations and self-generating interest and fun during interactions (Kashdan et al., 2002). Based on these findings, it seems reasonable to conclude that curiosity facilitates appetitive behaviors leading to positive development. Future work might continue to explore the operating mechanisms linking curiosity to desirable outcomes in various life domains.

In a provocative 5-year follow-up study of a geriatric sample, after controlling for age, education, and health variables, initial levels of state and trait curiosity were significantly greater in survivors than in those who died (Swan & Carmelli, 1996). Despite the need for replication, the data advocate research to better understand pathways by which curiosity may influence subjective well-being and mortality rates.

As for unique associations, trait openness, general curiosity, and specific curiosity are positively associated with intelligence, problem-solving ability, autonomy, self-esteem, and subjective well-being (Cacioppo et al., 1996; Kashdan et al., 2002; Marshall, Wortman, Vickers, Kusulas, & Hervig, 1994; McCrae, 1993–1994). Novelty-seeking has been shown to be associated with some less than desirable outcomes such as impulsivity, fascination with violent and sexual events, and antagonism/anger expressiveness (Aluja-Fabregat, 2000; Zuckerman, 1994). High novelty-seeking, in conjunction with low conscientiousness, may lead to the pursuit of short-term gratification at the expense of future negative consequences. High novelty-seeking children overly exposed to mass media violence may be more susceptible to increases in their own violent behavior. High novelty-seeking individuals who engage in impulsive delinquent activities (i.e.,

drugs, promiscuous sex, stealing) and associate with like-minded peers may be more susceptible to adjudicated criminal lifestyles. Whether high novelty-seeking is satiated by illicit or licit means is likely to be a function of parent–child relations, self-esteem, and opportunities to engage in challenging activities that satisfy one's needs for competence, mastery, and personal meaning. However, research in this important area is sorely lacking.

## ■ Development

Although different cultural rules are likely to influence its manifestation, signs of curiosity emerge in infancy (Izard, 1977). Interest–excitement is an innate, transcultural emotional phenomenon (Silvia, in press). Upon being elicited by the appearance of new or salient stimuli, corresponding responses include physiological arousal, subjective pleasure, and behavioral exploration of the environment (choreographing vocalization, motor action, thinking). In infants, curiosity manifests as visual searching for novelty and engagement with desired stimuli. Essentially, curiosity is activated by person–environment interactions. Infant temperament and the curiosity and fear evoked by the environment begin to set the stage for whether novel stimuli are categorized as dangerous or reinforcing (M. Schulman, 2002). Characteristics of trait behavioral inhibition, a predisposition to fear and withdraw from novel settings, people, and objects, begin to manifest and solidify as early as 21 months of age (Kagan, 1989). Social situations, being inherently ambiguous and complex, provide an important context for eliciting curiosity. Behaviorally inhibited children may experience not only greater distress and impairment than their more approach-oriented peers but also less positive affect and self-expansion opportunities that stem from exploring, understanding, and strengthening bonds with unfamiliar people and objects (Garcia-Coll, Kagan, & Reznick, 1984; Reznick et al., 1986).

Individual differences in curiosity are likely to dovetail with the development of internalized templates in the first years of life about caregivers as a source of security and reliability and the self as being worthy and lovable (Bowlby, 1988). Those children who deem caregivers as more nurturing and autonomy granting are better equipped to regulate the inherent anxiety of novelty, thereby leading them to be more open to new experiences and mastery over developmental tasks (McCrae & Costa, 1988). Contemporary models of attachment have found that adults develop attachment styles and that the level of perceived security in close relationships is associated with greater curiosity behaviors (Mikulincer, 1997). This research bodes well for curiosity interventions, as future studies can test whether young children deprived of positive parent–child relationships can rekindle the curiosity, exploration, and growth opportunities missing during formative years. As for working models of the self, research needs to account for the roles of self-esteem, hope,

and other positive traits as potential determinants of the human motive to maximize pleasure and experience curiosity.

Although longitudinal studies comparing children and adults are lacking, it appears that diversive, specific, and epistemic curiosity all appear to remain quite stable across the life span (Cacioppo et al., 1996; Spielberger, 1979). As for novelty-seeking, it can be confidently stated that thrill and adventure seeking, disinhibition, and a susceptibility to boredom all tend to decline with advancing age (Giambra, Camp, & Grodsky, 1992; Zuckerman et al., 1978). This is not surprising, as the willingness to take personal risks for novelty can be expected to decline as a result of new reasons for longevity (e.g., grandchildren).

There is no neurobiological work on curiosity per se, but there is extensive work on the related positive biobehavioral approach system (BAS; Depue, 1996). The BAS is characterized by a strong sensitivity to incentive cues in the environment that facilitate positive emotional experiences (Carver & White, 1994). In modeling the structural framework of the BAS, curiosity is included as one of the processes mediating relations between initial reward cues and goal-directed approach behaviors (Depue, 1996). On the neurological level, evidence finds greater dopamine activity to coincide with positive affective responses (i.e., interest, curiosity) to rewarding stimuli (see review in Depue & Collins, 1999). Second, individual differences in trait measures of the BAS and positive affect are more strongly related to resting left prefrontal cortex asymmetry than other stable brain wave patterns (Sutton & Davidson, 1997). These provocative findings imply that the BAS (and trait curiosity) may be partially hardwired. Neurological (e.g., dopamine release), emotional-motivational, and behavioral BAS components are proposed to work in synchrony to meet the goals of maximizing pleasure. One limitation of this model is the proposed directionality of these components. Complex reciprocal relationships can be expected, including the interactive role of other relevant traits like anxiety sensitivity, which are unlikely to be as simple as the hierarchical structures being espoused. Exploring the interplay of various BAS components has vast potential for enhancing our understanding of the biopsychosocial underpinnings of curiosity.

Gene-linkage studies have shown that novelty-seeking is associated with the D4 dopamine receptor gene in animals (D4DR; Dulawa, Grandy, Low, Paulus, & Mark, 1999) and humans (Benjamin, Ebstein, & Belmaker, 1997). Despite some replication failures, at least four studies have confirmed this relationship (Ebstein & Belmaker, 1997). Additional support stems from work finding the D4DR to be a genetic marker for attention-deficit/hyperactivity disorder (ADHD; Sunohara et al., 2000). On a continuum ranging from behavioral inhibition to impulsivity problems, ADHD is an extreme manifestation of novelty-seeking. Nonetheless, single genetic markers for broad personality constructs are rare. There is merit in exploring genes that interact with D4DR to influence novelty-seeking. Knowledge of the genetic loci of novelty-seeking can improve our understanding of its developmental trajectory and how genetic predis-

positions interact with environmental choices, like the selection of peers and careers.

Twin studies have estimated the genetic and environmental influences on openness to experience (Bergeman et al., 1993). According to Loehlin (1992), 43% of the variance is explained by genetic influences (a conservative estimate that assumes multiple gene interactions). This figure is greater than the genetic influences for other Big Five personality traits. For openness, there was negligible evidence for the influence of shared rearing environments (6%), with the remaining variation likely to be proportioned among unshared environments, gene–environment interactions, and method error. The strong genetic component of openness may be due to the evolutionary survival value of curiosity/openness, the neurological underpinnings of the BAS, or the strong association between openness and intelligence (itself a highly heritable characteristic; McCrae & Costa, 1997a). Regardless, high heritability coefficients do not imply that traits are immutable. The 51% of unexplained variance in openness suggests that curiosity may be amenable to intervention. It remains to be seen whether biological and genetic influences differ among curiosity dimensions.

## ■ Enabling and Inhibiting Factors

In his seminal work, Berlyne (1960) argued that an individual's interest in something is a function of inherent novelty, complexity, uncertainty, and conflict. There appears to be a point of diminishing returns wherein stimuli can become too confusing or ambiguous to be rewarding. Experimental studies have found that acquiring specific knowledge evokes curiosity, the desire for further information, and upward spirals among these constructs (Loewenstein et al., 1992). The experience of competence- or mastery-based rewards also encourages future curiosity.

Consider individuals who begin to take tennis lessons and upon learning how to swing the racket, shift their feet across the court and use torque motion to hit with more speed and precision; they become more interested in playing again, more cognizant of advanced techniques to be learned (e.g., hitting with topspin), and more interested in expanding their competence. Levels of curiosity are a function of the perceived probability that specific knowledge is attainable (probability) and the perceived probability that one's personal resources can be expanded upon integrating new knowledge (desirability). Factors that affect probability and desirability can be expected to encourage or thwart curiosity. Curiosity can be thwarted by a failure to appreciate what one does not know (Loewenstein et al., 1992). Impediments may include overconfidence, dogmatism, low cognitive resources to process stimuli, and pathological conditions such as narcissism, psychopathy, and schizophrenia.

As for other factors interfering with curiosity and exploration, experimental studies have found anxiety to inhibit curiosity and exploration in interpersonal interactions (Kashdan & Roberts, in press), classroom settings (Peters, 1978), and voluntary interest in playing with puzzles (Plant & Ryan, 1985). Social interaction anxiety (e.g., fear of meeting new people, initiating conversations) has also demonstrated unique, negative relationships with curiosity (Kashdan, 2002). Furthermore, states of excessive self-focused attention appear to interfere with curiosity (Rodrigue, Olson, & Markley, 1987) and exploration of the environment (Plant & Ryan, 1985). This work fits with attentional capacity models positing that individuals have limited resources at any one time, and that excessive self-absorption interferes with the ability to recognize and attend to rewarding features of the environment.

Beliefs that one can act volitionally in a situation (autonomy) robustly facilitate curiosity in various tasks, settings, and domains (Deci & Ryan, 2000). A large body of research shows that internal pressures such as guilt and fear, external pressures such as threats and punishment, and tangible external rewards diminish curiosity for specific tasks. There is also evidence of dynamic, reciprocal relationships between high levels of curiosity and greater competence-related beliefs (e.g., Tracey, 2002) and feelings of belongingness and closeness to others (Mikulincer, 1997).

## ■ Gender, Cross-National, and Cross-Cultural Aspects

Gender differences are notably absent in general and specific curiosity as well as openness. Men do tend to report greater novelty-seeking than women on the Thrill and Adventure Seeking (TAS) and Disinhibition (DIS) subscales of the SSS-V (Zuckerman et al., 1978). The TAS assesses preferences for specific dangerous activities such as surfing and rock climbing, and the DIS assesses lack of social and sexual constraints. Gender differences may be a function of gender role orientations rather than biological differences.

A critical deficiency in the curiosity literature is its failure to investigate ethnic differences. European Americans tend to report greater novelty-seeking than African Americans on the TAS subscale (Zuckerman, 1994). However, cross-national differences in novelty-seeking may be an artifact of the domain-specific items of the SSS-V. The specific activities targeted in the TAS such as skiing and surfing are unlikely to be equally accessible or reinforcing in different ethnic and socioeconomic samples. This problem can be resolved by using measures of curiosity that assess more than the willingness to engage in dangerous and risky activities. Cross-cultural differences would be best studied by measures that are not tied to domain-specific European American activities.

Evidence for cross-cultural convergence has been demonstrated for general curiosity (Ben-Zur & Zeidner, 1988), novelty-seeking (Zuckerman et al., 1978), epistemic curiosity (Verplanken, 1991), openness to experience (McCrae, 1996), and their correlates (e.g., political values, education level). However, most of these studies have compared the United States with Canada, England, the Netherlands, Israel, Spain, Australia, and New Zealand, which have comparable political infrastructures and societal values. More work is needed on comparisons between individualistic and collectivist societies.

## ■ Deliberate Interventions

Studies have shown that specific facets of environments (e.g., perceived threat, autonomy supportive) and activities (e.g., competitiveness, meaningfulness) influence state curiosity (Silvia, in press). Yet how malleable is enduring curiosity? What are the roles of cognitive abilities and intelligences? With the advent of measurement advances, the next step is to design and test interventions to cultivate curiosity in meaningful contexts (academic, social, work, leisure). Optimal psychological states arise from experiences where one's skills are perfectly balanced with immediate challenges, entailing intrinsic motivation and absorption (i.e., curiosity) and feelings of perceived control (Csikszentmihalyi, 1990). Curiosity interventions will need to address age differences and moderators of outcomes (i.e., identifiers of subgroups with particularly good or poor responses) and to assess immediate gains as well as the more distal consequences.

Curiosity is fueled by both increased knowledge and awareness of knowledge gaps in areas that are personally meaningful and engaging. Despite the absence of research on interventions, it can be interesting to speculate on ideas. Candidates for intervention modules include increasing mindfulness of what is known and unknown, facilitating autonomy and competence experiences, and setting up mentor relationships in personally meaningful domains. It can be hypothesized that more open-ended learning experiences such as creating ice cream to learn physics or taking a yoga class to learn the anatomy of different muscle groups may not only increase momentary curiosity but create enduring curiosity. The pursuit of activities that foster curiosity and learning may be an adaptive coping mechanism to deal with emotional and social distress (e.g., midnight basketball leagues for poverty-stricken inner-city youth, teaching chess or checkers to psychiatric inpatients with high cognitive functioning) and a means to perpetuate opportunities for positive experiences (e.g., writing journals as an avocation and potential career). The potential resilience afforded by cultivating curiosity-enriching experiences, and the promotion of virtuous cycles, is an open forum for future basic and applied research.

## What Is Not Known?

There are a number of potentially fruitful areas for future research:

- What are the causal pathways leading from curiosity to personal growth?
- What pathways lead to the development of licit versus illicit means of satiating curiosity?
- Does the exploratory behavior of children and adolescents create more enriched environments amplifying cognitive, interpersonal, and intrapersonal development?
- What are the familial and developmental antecedents to curiosity (e.g., parental child-rearing characteristics, crystallizing experiences, cognitive ability, other traits, peer relations)? What is their association with curiosity and exploration across the life span?
- What are the outcomes of individuals with differential curiosity profiles, such as strong curiosity in one versus many domains?
- Can dispositional curiosity be cultivated? What are the best strategies, and what are the most suitable contexts for intervention?

## Must-Read Articles and Books

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin, 119*, 197–253.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: HarperCollins.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*, 75–98.

McCrae, R. R., & Costa, P. T. (1997). Conceptions and correlates of openness to experience. In R. Hogan, J. Johnson, & S. Briggs (Eds.), *Handbook of personality psychology* (pp. 825–847). San Diego, CA: Academic Press.

Sansone, C., & Smith, J. L. (2000). Interest and self-regulation: The relation between having to and wanting to. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 341–372). San Diego, CA: Academic Press.

Silvia, P. J. (in press). *The psychology of interest.* New York: Oxford University Press.

Spielberger, C. D., & Starr, L. M. (1994). Curiosity and exploratory behavior. In H. F. O'Neil & M. Drillings (Eds.), *Motivation: Theory and research* (pp. 221–243). Hillsdale, NJ: Erlbaum.

Voss, H., & Keller, H. (1983). *Curiosity and exploration: Theories and results.* New York: Academic Press.