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Measuring Epistemic Curiosity and Its Diversive and Specific Components

Jordan A. Litman
Department of Psychology
University of South Florida

Charles D. Spielberger
Center for Research in Behavioral Medicine and Health Psychology
University of South Florida

A questionnaire constructed to assess epistemic curiosity (EC) and perceptual curiosity (PC) curiosity was administered to 739 undergraduates (546 women, 193 men) ranging in age from 18 to 65. The study participants also responded to the trait anxiety, anger, depression, and curiosity scales of the State–Trait Personality Inventory (STPI; Spielberger et al., 1979) and selected subscales of the Sensation Seeking (SSS) and Novelty Experiencing (NES) scales. Factor analyses of the curiosity items with oblique rotation identified EC and PC factors with clear simple structure. Subsequent analyses of the EC items provided the basis for developing an EC scale, with Diversive and Specific Curiosity subscales. Moderately high correlations of the EC scale and subscales with other measures of curiosity provided strong evidence of convergent validity. Divergent validity was demonstrated by minimal correlations with trait anxiety and the sensation-seeking measures, and essentially zero correlations with the STPI trait anger and depression scales. Male participants had significantly higher scores on the EC scale and the NES External Cognition subscale (effect sizes of $r = .16$ and .21, respectively), indicating that they were more interested than female participants in solving problems and discovering how things work. Male participants also scored significantly higher than female participants on the SSS Thrill-and-Adventure and NES External Sensation subscales ($r = .14$ and .22, respectively), suggesting that they were more likely to engage in sensation-seeking activities.

Curiosity is broadly defined as a desire for acquiring new knowledge and new sensory experience that motivates exploratory behavior (Berlyne, 1949, 1950, 1954, 1960; James, 1890; Loewenstein, 1994; McDougall, 1921; Spielberger & Starr, 1994). Daniel Berlyne (1954), perhaps the most influential contributor to theory and research on exploratory behavior, differentiated between two types of curiosity, labeled *perceptual* and *epistemic*. Perceptual curiosity (PC), which Berlyne (1954) defined as "the curiosity which leads to increased perception of stimuli" (p. 180), was evoked in animals and humans by visual, auditory, or tactile stimulation. Epistemic curiosity (EC) was defined by Berlyne as a "drive to know" (p. 187) that was aroused by conceptual puzzles and gaps in knowledge.

Berlyne (1960) also distinguished between two types of exploratory behaviors, which he labeled *diversive* and *specific*. Diversive exploration was motivated by feelings of boredom or a desire for stimulus variation that directed animals and humans to "seek stimulation regardless of source or content" (p. 26). Specific exploration was motivated by curiosity and initiated a detailed investigation of novel stimuli to acquire new information. Visual inspection was considered by Berlyne (1957, 1958) to be a generic example of specific exploratory behavior motivated by PC, whereas specific epistemic exploratory behavior was "aimed not only at obtaining access to information-bearing stimulation capable of dispelling the uncertanties of the moment, but also at acquiring knowledge" (Berlyne, 1966, p. 31).

INDIVIDUAL DIFFERENCES IN CURIOSITY AND EXPLORATORY BEHAVIOR

To clarify the nature of curiosity as a psychological construct, it is essential to examine the emotional states that motivate exploratory behavior and to consider how individual

differences in curiosity as a personality trait influence exploration. Although Berlyne identified the general conditions that aroused curiosity as a motivational state, he did not address the potential importance of individual differences in curiosity as a personality trait. Personality research has traditionally focused on the assessment of individual differences in traits, such as anxiety and extraversion, and on how these traits predispose a person to experience and express corresponding emotional states. Emotional states may be conceptualized as internal emotional-motivational reactions that vary in intensity, whereas traits are relatively stable dispositional response tendencies that reflect the frequency for particular emotions to be experienced over time (Spielberger, 1975; Spielberger, Ritterband, Sydeman, Reheiser, & Unger, 1995).

In contrast to Berlyne's emphasis on curiosity as a motivational state that stimulates exploratory behavior, personality researchers have assessed individual differences in dispositional tendencies to engage in exploration. Influenced by Berlyne's conceptions of diversive and specific exploration, Day (1969) interpreted these types of exploratory behavior as reflecting two different curiosity traits. Consistent with Berlyne, Day theorized that specific curiosity involved being curious about a particular stimulus, and motivated specific exploratory behavior. However, whereas Berlyne assumed that diversive exploratory behavior was motivated by boredom, Day considered diversive exploration to be motivated by curiosity (i.e., being curious about a range of topics). The Ontario Test of Intrinsic Motivation (OTIM) was developed by Day (1969) to assess individual differences in diversive and specific curiosity.

Although no measures have been constructed with the explicit goal of assessing Berlyne's (9154) concepts of PC and EC, several scales have been developed to measure individual differences in theoretically related constructs, such as sensation seeking, novelty experiencing, and trait curiosity. Zuckerman's (1979) concept of *sensation seeking* differentiates seeking sensory stimulation from exploring new ideas. The Sensation Seeking Scale (SSS) was developed by Zuckerman to assess individual differences in the tendency to seek novel sensory stimulation by engaging in social exploratory behavior (Zuckerman, Kolin, Price, & Zoob, 1964). The Novelty Experiencing Scale (NES) was designed by Pearson (1970) to measure individual differences in the tendency to approach or avoid novel stimuli that activate sensory and cognitive processes.

The OTIM, NES, and SSS appear to assess individual differences in different aspects of exploratory behavior as relatively stable personality traits, but do not measure the intensity of the emotional states that motivate these behaviors. The State–Trait Curiosity Inventory (STCI) was developed to measure both the state (S) and trait (T) aspects of curiosity (Spielberger & Butler, 1971; Spielberger, Peters, & Frain, 1976). The STCI S–Curiosity scale was designed to assess the intensity of feelings of curiosity at a particular time; the STCI T–Curiosity scale assesses the frequency that individuals generally experience curiosity. Essentially the same definitions of state and trait curiosity guided the construction of the Melbourne Curiosity Inventory (MCI; Naylor, 1981). Factor analyses of responses to the STCI and MCI items have consistently identified independent state and trait curiosity factors, providing evidence that has been interpreted as demonstrating the importance of the state–trait distinction in the measurement of curiosity (Boyle, 1983, 1989, Olsen & Camp, 1984).

MEASUREMENT OF PC AND EC

Measures of curiosity, novelty experiencing, and sensation seeking share a common theme in that they assess tendencies to engage in exploratory behavior (Voss & Keller, 1983). However, these measures differ greatly on their relative emphasis in seeking either sensory stimulation or knowledge and information. Spielberger and Starr (1994) factor-analyzed the scale and subscale scores of the curiosity, sensation-seeking, and novelty experiencing measures that were previously described, and found two strong factors that they labeled "Information Seeking" and "Experience Seeking." The STCI and MCI T–Curiosity scales, the OTIM Specific Curiosity subscale, and the NES Internal and External Cognition subscales had the strongest loadings on the Information Seeking factor. The Experience Seeking factor was defined by strong loadings of the SSS Experience Seeking and NES External Sensation subscales, and by small to moderate loadings of the SSS Thrill-and-Adventure (TAS) and OTIM Diversive Curiosity subscales. Spielberger and Starr (1994) concluded that the Information Seeking factor was consistent with Berlyne's concept of EC because it encompassed "the internal, cognitive components of curiosity that are most directly measured by information seeking scales" (p. 240). Their Experience Seeking factor appeared to be related primarily to sensation seeking and diversive exploration, as these concepts were defined, respectively, by Zuckerman (1979) and Day (1969).

In reviewing the item content of the scales that loaded on Spielberger and Starr's (1994) Information and Experience Seeking (ES) factors, Collins (1996) observed that none of these scales appeared to assess individual differences in PC, which, according to Berlyne (1954), motivates exploratory behaviors such as visual investigation and inspection by touch. Guided by Berlyne's concept of PC, Collins constructed a 16-item scale to assess individual differences in this construct. Factor analyses of responses to the 16 PC items identified two factors, which were labeled *diversive PC* and *specific PC*. Diversive PC involved general exploration of one's surroundings (sample item: "I like to discover new places to go"). Specific PC was related to detailed inspection of a particular stimulus (sample item: "When I see a new fabric, I like to touch and feel it").

Collins (1996) administered his 16-item PC scale to university students, along with measures of trait curiosity, novelty experiencing, sensation seeking, and a questionnaire developed to assess how often the respondents engaged in perceptual exploratory behaviors. The PC scale correlated positively and substantially with the STCI T–Curiosity scale (*Mdn r* = .545), and moderately with the NES External Sensation and the SSS Thrill-and-Adventure and Experience Seeking subscales (*Mdn r* = .405). Consistent with Berlyne's concept of PC, these findings indicated that the PC scale assesses both seeking information and sensory experience.

The finding that the PC scale correlated substantially with the STCI T–Curiosity scale raises questions about what the T–Curiosity scale actually measures. Although Spielberger and Starr (1994) assumed that this scale assessed individual differences in Berlyne's concept of EC, Collins's (1996) findings suggested there are at least two plausible alternative explanations: (a) The STCI T–Curiosity scale measures both EC and PC, which cannot be meaningfully differentiated as independent curiosity constructs; or (b) the T–Curiosity scale does not measure either EC or PC, but may assess internal processes that are common to more than one aspect of a multifaceted personality construct, of which EC and PC are dimensions.

Because scales have not been previously developed with the explicit goal of measuring Berlyne's concepts of PC and EC, it is unknown whether individual differences in these two constructs can be meaningfully differentiated and how EC might be related to T–Curiosity. If EC and PC can be meaningfully differentiated, and an EC scale can be constructed, this would provide greater precision in the measurement of individual differences in curiosity as a multidimensional personality trait. A valid and reliable EC measure would also enable us to learn more about how people differ in the tendency to seek out opportunities for learning new ideas and obtaining perceptual stimulation.

The major goal of this study was to determine whether EC could be identified as a meaningful personality construct, which can be differentiated from PC. A second goal was to develop a scale for assessing individual difference in EC and to evaluate the internal consistency of this scale, and its relationship to PC, T–Curiosity, sensation seeking, and other personality traits. If EC can be meaningfully differentiated from PC and a scale can be constructed to assess the EC construct, the factor structure of this measure will be evaluated to determine if diversive and specific EC components can be identified.

METHOD

Participants

The study participants consisted of 739 university students (546 women, 193 men) recruited from introductory and upper level undergraduate psychology courses at a large urban university, who ranged in age from 18 to 65 ($M = 23.64$; $SD = 7.47$). The sample consisted of approximately equal numbers of students who entered the university as freshmen or in their junior year as community college transfers. All students received extra credit toward their final grade for research participation.

Instruments

Each participant responded to a battery of four psychometric tests that were given in the following order: (a) the curiosity questionnaire, (b) the trait scales of the State–Trait Personality Inventory, (c) the Internal and External Cognition and External Sensation subscales of the NES, and (d) the TAS and ES subscales of the SSS. The order of presentation was determined by the importance of the measure in relation to the goals of the study, and similarities in the scale instructions and rating procedures for each measure. The four measures are briefly described here.

Curiosity questionnaire. This questionnaire consisted of 16 PC items developed by Collins (1996) and 40 items constructed to assess individual differences in EC as these constructs were defined by Berlyne (1954). Each PC and EC item was rated on the same scale used to evaluate individual differences in personality traits in previous research (Spielberger, 1983, 1988). In responding to each curiosity item, the participants were instructed to report how they "generally feel" on a 4-point scale ranging from 1 (*almost never*), 2 (*sometimes*), 3 (*often*), to 4 (*almost always*).

The content of the 16 PC items inquired about interest in exploring novel, complex, or ambiguous perceptual stimuli (e.g., "I like to listen to new and unusual kinds of music"; "When I hear a strange sound, I usually try to find out what caused it"). The alpha coefficient for the PC scale was .85 for men and .87 for women (Collins, 1996). Consistent with Berlyne's conception of EC, the content of the 40 EC items inquired about interest in acquiring new knowledge (e.g., "learning about," "finding out") and in cognitively processing information (e.g., "thinking," "imagining") related to novel, complex, or ambiguous stimuli. Fourteen of the 40 EC items were adapted from existing curiosity measures (Day, 1969; Lehrissey-McCombs, 1971; Pearson, 1970); 26 EC items were especially constructed for this study based on Berlyne's theoretical conception of EC. The procedures for constructing the 40 EC items are reported in greater detail by Litman (1998).

STPI. The State–Trait Personality Inventory (STPI; Spielberger et al., 1979) consists of eight 10-item scales for measuring state and trait anxiety, anger, depression, and curiosity. The STPI state scales assess the intensity of these emotional states at a particular moment; the STPI trait scales measure how often each emotional state is generally experi-

enced. Only the STPI trait scales were included in this study. Participants respond to the STPI trait items by reporting how often they experienced the personality characteristics that each item described by rating themselves on the same 4-point frequency scale that was used with the curiosity questionnaire. All four STPI trait scales exhibited good reliability in previous research, with alpha coefficients ranging from .80 to .96 (Spielberger et al., 1979).

NES. The NES was designed to measure the tendency to approach (like) or to avoid (dislike) novel stimuli, using a forced-choice preference format (Pearson, 1970). The four 20-item NES subscales are: (a) External Sensation, (b) Internal Sensation, (c) External Cognition, and (d) Internal Cognition. Kuder–Richardson indexes for each subscale range from .76 to .87 (Pearson, 1970). The Internal and External Cognition subscales were included in this study as additional measures of EC; the External Sensation subscale provided an additional measure of sensation seeking. Given that the Internal Sensation subscale did not appear to be related to the constructs under investigation, this scale was not administered.

SSS. The SSS was developed to assess individual differences in the tendency to seek novel sensory stimulation by engaging in social exploratory behavior. Four major sensation-seeking dimensions are assessed by 10-item subscales: (a) TAS, (b) ES, (c) Disinhibition (Dis), and (d) Boredom Susceptibility (BS). In responding to the SSS, participants reported which of two statements best describes their "likes or feelings." The internal consistency reliability of the total scores on the SSS scale range from .83 to .86 (Zuckerman et al., 1964). A retest stability coefficient of .94 for the SSS Total scores was reported by Starr (1992). The range of internal consistency reliabilities for each SSS subscale are as follows: (a) TAS: .77 to .82, (b) ES: .65 to .67, (c) Dis: .74 to .78, and (d) BS: .56 to .59 (Zuckerman et al., 1964). Because the Dis and BS items were not directly related to seeking novel sensory stimulation, only the TAS and ES subscales were included in this study.

Procedure

The Curiosity Questionnaire, STPI trait scales, and the NES and SSS subscales were administered in group testing sessions to undergraduate university students. At the beginning of the testing session, the experimenter introduced himself and handed out the packet of questionnaires to the participants, who were informed that the goals of the study were to learn about the feelings and attitudes of college students. The participants were also informed that additional information about the study would be made available to them after they responded to the questionnaires and were asked not to discuss the study with other students. Approximately 30 to 40 min was required to complete the curiosity questionnaire and respond to the STPI, SSS, and NES scales and subscales.

RESULTS

Principle axis factor analyses of responses to the 56 curiosity items were computed separately for women and men. Three criteria were employed to determine the optimal number of factors to extract: (a) Eigenvalues greater than one, (b) Cattell's (1957) scree test, and (c) the psychological meaningfulness of the extracted factors (Coovert & McNelis, 1988). The eigenvalues criterion suggested six possible factors for women (15.9, 1.9, 1.5, 1.4, 1.3, 1.0) and seven for men (13.8, 2.6, 2.0, 1.5, 1.4, 1.3, 1.1). However, a visual scan of the scree plots suggested that only two or, at most, three factors should be extracted for both sexes. Based on the scree criterion and the hypothesis that meaningful EC and PC factors could be identified, two- and three-factor principle axis solutions were examined in separate analyses for women and men.

The results of the two-factor principal axis solutions of responses to the 56 curiosity items are reported in Table 1. Before rotation, all but 1 of the 40 EC items had dominant salient loadings of .30 or greater on the first factor for both women and men. Of the 16 PC items, 10 had dominant salient loadings for both sexes on the first factor. Only 1 EC and 3 PC items had dominant loadings for either women or men on the second factor, which could not be meaningfully interpreted. In the three-factor solutions, none of the 56 items had a salient loading on the third factor for either sex. Thus, before rotation one strong curiosity factor and only a relatively weak uninterpretable second factor were identified. These findings provided evidence that curiosity is a relatively homogeneous personality construct.

In the two-factor solutions for women and men with oblique (promax) rotation, which are also reported in Table 1, the first factor was defined by 28 of the 40 EC items with dominant salient loadings for both sexes. Twelve of the 16 PC items had dominant loadings on the second factor for both sexes. These two substantially correlated factors ($r = .59$ for women; .55 for men) had good simple structure, suggesting that the underlying curiosity construct was comprised of two meaningful dimensions defined, respectively, by items with content that was consistent with Berlyne's concepts of EC and PC. In the three-factor solutions with oblique rotation, the first two factors were similar to those in the two-factor solutions. As the third factor was defined by different items for women and men, had relatively few items with salient loadings, and was difficult to interpret, the three-factor solution was not considered further.

TABLE 1
Principal Axis Factor Loadings for 56 Curiosity Items (40 EC, 16 PC) Before and After Oblique Rotation

			Unrotated				*Rotated*			
			Factor 1		*Factor 2*		*Factor 1*		*Factor 2*	
Item No.[a]	*Item Type*	*Item Statement*[b]	*W*	*M*	*W*	*M*	*W*	*M*	*W*	*M*
40	EC	Complex problem/discovering a solution	–.44	.79	.80	–.15	–.29	.64	.52	–.31
30	EC	Simple explanations of/leave a lot of questions	.57	.59	–.29	–.24	.72	.66	–.15	–.04
29	EC	Complicated machinery/l ask how it works	.55	.46	–.26	–.25	.67	.58	–.13	–.10
49	EC	New solutions to difficult problems brings pleasure	.62	.57	–.20	–.30	.66	.69	–.03	–.11
18	EC	I am interested in discovering how things work	.66	.47	–.15	–.28	.65	.60	.04	–.13
23	EC	Theory/like to test it out	.62	.54	–.14	–.07	.62	.46	.03	.14
39	EC	Turning new ideas over/think about in different ways	.66	.61	–.12	–.17	.62	.60	.07	.05
48	EC	Learn something new/like to find out more about it	.70	.70	–.08	–.06	.61	.57	.14	.21
16	EC	Thinking about different/answers to same question	.64	.57	–.12	–.13	.60	.53	.07	.08
37	EC	Fascinating to learn new information	.65	.62	–.10	–.18	.60	.62	.10	.04
36	EC	Read something which puzzles me/keep reading it until I understand	.52	.56	–.20	–.17	.59	.57	–.07	.03
24	EC	Interesting to think about contradicting ideas	.65	.65	–.09	.02	.59	.45	.10	.27
47	EC	New ideas excite my imagination	.74	.63	–.02	–.16	.59	.61	.22	.07
43	EC	Hypothetical situation/like to think about what might happen	.58	.51	–.14	–.07	.58	.43	.02	.13
5	EC	Discussing abstract concepts	.61	.62	–.10	–.04	.57	.48	.08	.20
3	EC	Incomplete puzzle/try and imagine the final solution	.52	.48	–.17	–.10	.56	.45	–.03	.07
52	EC	Someone answers a question of mine/find myself even more inquisitive	.60	.62	–.10	–.02	.56	.46	.08	.23
19	EC	It excites me to have a new idea that leads to even more new ideas	.66	.66	–.05	–.24	.55	.71	.16	–.01
34	EC	I would like to understand how complicated things like computers work	.47	.46	–.18	–.28	.54	.60	–.06	–.13
28	EC	New kind of arithmetic problem/I enjoy imagining solutions	.38	.37	–.23	–.26	.52	.51	–.15	–.15
32	EC	I would enjoy discussing theories about existence with a philosopher	.62	.55	–.04	–.07	.51	.46	.15	.14
8	EC	Thinking over new ideas and concepts is fun	.65	.59	–.01	–.15	.51	.57	.20	.07
45	EC	I enjoy exploring new ideas	.69	.70	.02	–.14	.50	.64	.26	.12
53	EC	Someone says something ambiguous to me/want an explanation	.49	.44	–.12	–.02	.49	(.29)	.02	.15
38	EC	Learning about subjects which are unfamiliar to me	.67	.62	.03	–.14	.49	.58	.26	.09
46	EC	I am interested in how different people would react during a crisis	.57	.48	–.05	.29	.48	.07	.13	.52
4	EC	Something unexpected happens/figure out what/caused it	.50	.41	–.04	.06	.48	(.24)	.06	.23
27	EC	I like to read any magazine that reports new scientific discoveries	.54	.50	–.06	.16	.47	.51	.11	.02
55	EC	Riddle/interested in trying to solve it	.46	.37	–.12	–.17	.47	.43	.01	–.04
51	EC	I enjoy trying to figure out what led up to important historical events	.54	.54	–.04	.01	.43	.37	.17	.2
37	EC	Word I don't know/look up the meaning	.47	.46	–.06	–.02	.42	.36	.08	.16
11	EC	I like to/figure out people's motives/behavior seems unusual	.47	.52	.01	.08	.36	.30	.16	.30
35	EC	Imagine what people are thinking from/their faces	.48	.45	.03	.31	.34	.03	.19	.53
21	EC	I enjoy trying to understand my feelings	.41	.39	0.00	.25	.31	.05	.13	.44
14	EC	Interested in reading about periods of history that are unfamiliar to me	.48	.40	.06	.02	.31	(.28)	.23	.18
10	EC	I like to imagine how a story will end before it's over	.39	.30	.01	.01	(.29)	(.20)	.14	.13
15	PC	See a vocal group perform/associate the different voice types	.37	.31	.04	.26	(.25)	–.03	.16	.42
2	EC	When I have a strange dream/I wonder about what it means	.33	.27	.03	.37	(.22)	–.16	.15	.53
9	PC	I like to discover new places to go	.40	.52	.49	.29	–.18	.11	.72	.53
1	PC	I like to travel to places I have never been to before	.25	.46	.46	.36	–.26	–.05	.64	.57
17	PC	I like visiting art galleries and art museums	.50	.53	.37	.29	.03	.10	.61	.54

(continued)

TABLE 1 (Continued)

Item No.[a]	Item Type	Item Statement[b]	Unrotated				Rotated			
			Factor 1		Factor 2		Factor 1		Factor 2	
			W	M	W	M	W	M	W	M
12	PC	Rather visit a park I have never been/than one I know well	.32	.30	.33	.19	–.07	.03	.50	.33
50	PC	Saw a cave/want to explore the inside of it	.50	.43	–.09	.17	.00	.15	.49	.36
33	PC	Enjoy viewing an art display/many interpretations of a single theme	.59	.54	.22	.30	.23	.10	.46	.56
25	PC	I like to listen to new and unusual kinds of music	.48	.24	.25	.35	.12	–.16	.46	.50
13	PC	Hear something rustling in the grass/see what it is	.38	.41	.26	–.05	.03	.35	.44	.10
6	PC	I like exploring my surroundings	.53	.49	.22	.20	.20	.16	.44	.42
54	PC	Smell something new/find out what the odor is coming from	.48	.39	.23	.25	.14	.05	.43	.44
44	EC	Look at a work of art/wonder what inspired the artist	.53	.53	.21	.27	.20	.12	.43	.52
20	PC	Hear a strange sound/try to find out what caused it	.41	.46	.23	–.08	.09	.41	.42	.09
56	EC	I would like to learn more about other cultures	.47	.49	.21	.22	.16	.14	.40	.45
41	PC	I enjoy trying different kinds of ethnic foods	.35	.28	.24	.32	.03	–.10	.40	.47
31	PC	I enjoy walking through interesting buildings	.59	.51	.13	.22	.32	.16	.35	.45
26	PC	Hear a musical instrument/I like to see it	.54	.38	.14	.24	.27	.04	.35	.42
22	PC	When I see a new fabric/I like to touch and feel it	.44	.31	.14	.37	.20	–.13	.32	.54
42	EC	See an advertisement without a caption/wonder about what it means	.42	.35	.08	.11	(.24)	.15	.24	(.26)
		Eigenvalues	15.9	13.8	1.97	2.6	14.9	12.6	10.6	9.7
		Common variance	.60	.44	.07	.08				

Note. $N = 739$ (546 women, 193 men). Factor loadings ≥ .30 are underlined. Dominant rotated factor loadings < .30 are reported parenthetically. EC = epistemic curiosity; PC = perceptual curiosity.

[a]Ordinal position of an item within the questionnaire. [b]Listed in descending order of magnitude of the dominant loadings for women on each rotated factor.

Identifying Diversive and Specific Components of EC

In previous research, Collins (1996) identified two components of PC that were considered to reflect diversive and specific types of exploratory behavior (Berlyne, 1960, 1966; Day, 1969). To determine whether diversive and specific components of EC could also be identified, the 28 items with dominant salient loadings on the EC factor for both sexes, and no salient dual loadings, were selected to form a preliminary EC scale. Responses to these items were further evaluated in separate principal axis factor analyses for women and men. Eigenvalues for men (9.4, 1.4, 0.83, 0.66, 0.57) identified one strong factor and a second weaker factor. For women, the eigenvalues (10.5, 0.93, 0.62, 0.55, 0.48) indicated a single strong factor and a marginal second factor. However, examination of the scree plots suggested that two factors could be extracted for both sexes.

The results of the two-factor principal axis factor analyses are reported in Table 2 for women and men, before and after oblique (promax) rotation. Before rotation, 27 of the 28 EC items had dominant loadings of .40 or greater on the first factor for both sexes, providing strong evidence of an underlying EC dimension. After oblique rotation, 14 items had dominant salient loadings on the first factor for both sexes and 6 items had dominant loadings on the second factor; of these 20 items, none had any salient dual loadings. The content of the items with the highest loadings on the first factor described seeking new information (e.g., 45, "I enjoy exploring new ideas"). The items with the strongest loadings on the second factor had content that involved obtaining knowledge about a specific topic (e.g., 29, "When I see a complicated piece of machinery, I like to ask someone how it works"). Thus, with oblique rotation, the two factors reflected Diversive and Specific components of EC, which corresponded to the two factors that Collins (1996) found for PC.

The next step in the data analyses was to select the best items to form an EC scale, with subscales for measuring Diversive (EC/D) and Specific (EC/S) EC. Items with the strongest loadings on the first (Diversive) and second (Specific) curiosity factors, and no salient dual loadings for either sex, were identified. The content of the six items that had consistently high dominant loadings of .40 or greater on the second factor (Items 3, 18, 28, 29, 34, 55) were examined first. Item 34 ("I would like to understand how complicated things like computers work") was eliminated because its content was considered redundant with Item 29 ("If I see a complicated piece of machinery, I like to ask someone how it works"), which had better psychometric properties. The remaining five items were retained for the EC/S subscale.

Eleven of the 14 items with dominant loadings for both sexes on the diversive EC factor, listed above the dotted line in Table 2, had loadings of .50 or greater and no salient dual loadings. Item 32 ("I would enjoy discussing theories about

TABLE 2
Principal Axis Factor Loadings for 28 EC Items Before and After Oblique Rotation

Item No.[a]	Item Statement[b]	Unrotated				Rotated			
		Factor 1		Factor 2		Factor 1 EC/D		Factor 2 EC/S	
		W	M	W	M	W	M	W	M
47	New ideas excite my imagination	.74	.66	–.28	–.26	.83	.74	–.06	–.08
45	Enjoy exploring new ideas	.70	.72	–.25	–.29	.77	.82	–.05	–.10
38	Learning about subjects which are unfamiliar	.66	.65	–.24	–.03	.74	.52	–.05	.18
37	Fascinating to learn new information	.67	.65	–.18	–.04	.67	.54	.03	.18
8	Thinking over new ideas and concepts is fun	.66	.61	–.18	–.16	.66	.62	.03	.02
39	Find myself turning new ideas over/think about them	.69	.64	–.15	–.13	.65	.61	.08	.07
19	Excites me to have a new idea that leads to even more	.67	.71	–.14	–.06	.63	.60	.08	.17
32	Discussing theories with a philosopher	.61	.57	–.14	–.28	.59	.70	.06	–.14
48	Learn something new/like to find out more about it	.71	.70	–.06	–.11	.57	.65	.20	.10
24	Find it interesting to think about contradicting ideas	.64	.63	–.09	–.11	.56	.59	.13	.08
5	Discussing abstract concepts	.62	.62	–.07	–.25	.52	.71	.14	–.08
43	Hypothetical situation/think about what might happen	.55	.51	–.05	–.18	.45	.56	.14	–.03
16	Thinking about different answers to same question	.66	.57	–.05	.13	.44	.32	.28	.34
52	Someone answers a question/even more inquisitive	.59	.60	.04	–.01	.42	.48	.22	.18
51	Figure out what led up to important historical events	.52	.50	–.03	–.05	.40	.44	.15	.11
23	Theory about something/like to test it out	.64	.55	.06	–.03	(.39)	.45	.32	.15
49	Discovering new solutions to problems brings pleasure	.64	.62	.09	–.01	(.36)	.49	.35	.19
7	See a word I don't know/like to look up the meaning	.46	.46	.03	–.06	(.29)	.41	.22	.08
29	Complicated piece of machinery/ask how it works	.58	.48	.44	.58	–.07	–.16	.77	.83
28	Arithmetic problem/enjoy imagining solutions	.43	.41	.38	.36	–.11	–.01	.64	.55
34	Like to understand how complicated things work	.50	.50	.24	.41	.09	.02	.49	.64
3	Incomplete puzzle/try and imagine the final solution	.53	.48	.23	.24	.13	.15	.49	.43
18	Interested in discovering how things work	.68	.50	.12	.40	.29	.03	.48	.62
40	Complex problem/interested in discovering a solution	.68	.60	.12	.05	(.35)	.42	.41	.26
55	Riddle/interested in trying to solve it	.46	.40	.18	.23	.14	.10	.40	.40
30	Simple explanations leave a lot of questions	.60	.63	.11	.09	.32	.41	(.36)	.31
27	Read magazine that reports new scientific discoveries	.54	.52	.12	.24	.25	.19	(.36)	.45
36	Something puzzles me/keep reading until I understand	.53	.59	.08	–.06	.29	.12	(.30)	.51
	Eigenvalues	10.5	9.4	.93	1.4	9.7	8.8	5.6	6.0
	Common Variance	.72	.60	.06	.09				

Note. $n = 546$ (women); $n = 193$ (men). Factor loadings ≥ .40 are underlined. Dominant rotated factor loadings < .40 are reported parenthetically. EC = epistemic curiosity.

[a]Ordinal position of an item within the questionnaire. [b]Listed in descending order of magnitude of the dominant loadings for women on each rotated factor.

existence with a philosopher") was eliminated because the event that it described was considered unrealistic. Item 24 was eliminated because of possible ambiguity in the meaning of "contradicting ideas." Of the remaining 9 items, "new ideas" was mentioned in the wording of 5 items (Items 8, 19, 39, 45, 47). It was considered desirable to have an equal number of items for measuring each EC component; thus, only Item 45 was retained because it emphasized intellectual exploration, which was considered to be highly relevant to the concept of EC, and had very strong factor loadings for both sexes. The five items retained for the EC/D subscale (Items 5, 37, 38, 45, 48) were combined with the five EC/S items (Items 3, 18, 28, 29, 55) to form the EC scale.

The factor structure of the resulting 10-item EC scale was examined, in separate principal axis factor analyses for women and men before and after oblique rotation, for which the results are reported in Table 3. Before rotation, all 10 items had dominant salient loadings of .40 or greater on the first factor for both sexes, and minimal loadings on the second factor, providing clear evidence of a single very strong underlying EC dimension. After rotation, the five EC/D items had dominant loadings on the first factor for both sexes and the five EC/S items had dominant loadings on the second factor; none of these items had salient dual loadings. The correlations between the two EC factors were .59 for women and .54 for men.

Psychometric Properties and Construct Validity of the EC Scale and Subscales

The means, standard deviations, Cronbach alpha reliability coefficients, and *t* tests of gender differences for the EC scale and the Diversive (EC/D) and Specific (EC/S) subscales are reported in Table 4 for women and men. The correlations of gender with the EC scale and each subscale, which provide an index of effect size for the gender differences, are also reported in Table 4. The alpha coefficients were .80 or greater for the EC scale and EC/D subscale, and somewhat lower for the EC/S subscale (.75 for women, .71 for men). The *t* tests for gender differences indicated that men scored signifi-

TABLE 3
Principal Axis Factor Loadings for the 10 EC Scale Items That Comprise the EC/D and EC/S Subscales Before and After Oblique Rotation

Item No.[a]	Item Statement[b]	Unrotated				Rotated			
		Factor 1		Factor 2		Factor 1 EC/D		Factor 2 EC/S	
		W	M	W	M	W	M	W	M
38	Enjoy learning about subjects which are unfamiliar	.68	.62	–.34	–.24	.80	.66	–.08	–.01
37	Fascinating to learn new information	.68	.66	–.32	–.25	.78	.69	–.05	.02
45	Enjoy exploring new ideas	.66	.67	–.16	–.28	.60	.73	.12	.01
48	Learn something new/like to find out more	.69	.66	–.12	–.21	.58	.65	.19	.06
5	Enjoy discussing abstract concepts	.56	.55	–.03	–.20	(.39)	.58	.22	.02
29	See a complicated piece of machinery/ask someone how it works	.61	.55	.33	.42	.05	–.03	.67	.70
28	New kind of arithmetic problem/enjoy imagining solutions	.46	.40	.33	.33	–.08	.06	.63	.58
3	Incomplete puzzle/try and imagine the final solution	.54	.51	.25	.22	.09	–.04	.54	.54
18	Interested in discovering how things work	.69	.53	.11	.31	.33	.14	.44	.47
55	Riddle/interested in trying to solve it	.48	.44	.16	.24	.14	.07	.40	.47
	Eigenvalues	3.7	3.2	.60	.80	3.0	3.1	1.5	1.4
	Common variance	.81	.71	.13	.17				

Note. $n = 546$ (women); $n = 193$ (men). Factor loadings ≥ .40 are underlined. Dominant rotated factor loadings < .40 are reported parenthetically. EC = epistemic curiosity; EC/D = Diversive; EC/S = Specific.
[a]Ordinal position of an item within the questionnaire. [b]Listed in descending order of magnitude of the dominant loadings for females on each rotated factor.

TABLE 4
Means, Standard Deviations, Cronbach's α, *t* Tests of Gender Differences, and Correlations With Gender for the EC Scale, and the EC/D and EC/S Subscales, and All Other Measures of Curiosity, Sensation Seeking, and the STPI Trait Scales

Scale			Women	Men	t Test	r
Epistemic curiosity	EC	*M*	27.59	29.67	4.69*	.16
		SD	5.66	5.19		
		α	.85	.81		
	EC/D	*M*	15.17	15.67	2.07	.07
		SD	2.93	3.03		
		α	.81	.80		
	EC/S	*M*	12.42	14.00	5.85*	.21
		SD	3.32	3.12		
		α	.75	.71		
Other curiosity measures	Perceptual Curiosity	*M*	46.79	45.68	1.71	.11
		SD	8.20	7.54		
		α	.85	.82		
	Trait Curiosity	*M*	30.21	29.97	0.51	.02
		SD	4.62	4.31		
		α	.81	.76		
	NES Internal Cognition	*M*	21.30	21.47	0.73	.06
		SD	3.99	3.95		
		α	.85	.83		
	NES External Cognition	*M*	10.75	12.33	3.76*	.14
		SD	4.61	5.14		
		α	.83	.84		
Sensation Seeking measures	NES External Sensation	*M*	11.80	14.02	5.95*	.22
		SD	4.33	4.46		
		α	.82	.84		
	SSS Thrill & Adventure	*M*	8.98	10.21	3.82*	.14
		SD	3.91	3.73		
		α	.75	.74		
	SSS Experience Seeking	*M*	7.77	8.26	1.86	.07
		SD	3.01	3.10		
		α	.45	.42		

(continued)

TABLE 4 Continued

Scale			Women	Men	t Test	r
STPI Trait measures	Trait Anxiety	*M*	21.08	20.52	0.21	.04
		SD	5.58	5.11		
		α	.85	.82		
	Trait Anger	*M*	21.30	21.47	0.73	.01
		SD	6.07	6.01		
		α	.86	.85		
	Trait Depression	*M*	17.17	17.08	0.84	.00
		SD	5.54	5.47		
		α	.90	.90		

Note. *n* = 546 (women); n = 193 (men). EC = epistemic curiosity; EC/D = diversive; EC/S = specific; NES = Novelty Experiencing sclaes; SSS = Sensation Seeking scale; STPI = State–Trait Personality Inventory.
*$p < .001$.

cantly higher than women on the EC scale, due primarily to their higher scores on the EC/S subscale. However, the effect size for these differences based on the correlations of gender with the EC scales was relatively small.

Means, standard deviations, alpha coefficients, *t* tests of gender differences, and correlations of gender with the other four curiosity scales, the sensation-seeking scales, and the other personality measures are also reported in Table 4. The internal consistency for these measures was satisfactory (*Mdn* α = .825), with the exception of the SSS ES subscale for which the alphas were less than .50. Although men scored significantly higher than women on the NES EC, ES, and SSS TAS subscales, the effect size for these differences were quite small, as may be noted in Table 4. No other gender differences were found for these measures.

Although significant gender differences were found for the EC scale and the EC/S subscale, given the small effect size for these differences, and the finding that the factor patterns of the items comprising the EC scales were essentially the same for women and men (see Table 3), these scales were considered to have similar meaning for both sexes. Therefore, in examining the relationships among these measures, the data for women and men were combined. The Pearson product–moment correlations computed between the EC scale and the EC/D and EC/S subscales and between these scales and the other curiosity, sensation-seeking, and personality measures for the combined sample are reported in Table 5. Given the overlap of items, the very strong correlations of the EC scale with the EC/D and EC/S subscales were expected. However, the moderate correlation of .56 between the EC/D and EC/S subscales was consistent with the hypothesis that these two subscales assessed substantially related, but meaningfully different, components of an underlying EC dimension.

The significant positive correlations (*Mdn r* = .54) of the EC scale and both subscales with the PC and STPI Trait Curiosity scales and the NES Internal and External Cognition subscales provide evidence of convergent validity. Examining the correlations of the EC/D and EC/S subscales with the other four curiosity measures revealed an interesting pattern of findings. The correlations of the EC/D subscale with the PC scale and Trait Curiosity scale and the NES Internal Cognition subscale were all higher than the corresponding correlations of the EC/S subscale with these measures, as indicated by significant *t* tests ($p < .001$) of the differences between these correlations. In contrast, the EC/S subscale correlated significantly more highly ($p < .001$) with the NES External Cognition subscale than with the other three curiosity measures.

Small but statistically significant positive correlations were also found between the EC scale and subscales with the three sensation-seeking measures, suggesting that EC overlaps, at least to some extent, with seeking sensory stimulation. The correlation of the EC/D subscale with the SSS Experience Seeking subscale was somewhat higher than the correlations of the EC scale and subscales with the other sensation-seeking measures. Consistent with previous findings (Spielberger & Starr, 1994), small but significant negative correlations were found between the EC scale and both subscales with trait anxiety. The correlations of the EC scale and subscales with the anger and depression measures were essentially zero, which provides evidence of divergent validity.

DISCUSSION

A major goal of this study was to determine if EC and PC could be differentiated from each other as meaningful dimensions of a multifaceted personality construct. A pool of 56 curiosity items (40 EC, 16 PC) was administered to 739 undergraduate students (546 women, 193 men) along with other curiosity, sensation-seeking, and personality measures. Factor analyses of responses to these items for both women and men identified one strong curiosity factor before rotation. With oblique rotation, two substantially correlated curiosity factors were identified for both sexes, defined by items with content corresponding to Berlyne's concepts of EC and PC. The results of the factor analyses, before and after rotation, provide evidence of a single curiosity construct, with two major dimensions.

Given the finding that EC could be meaningfully differentiated from PC, 28 items with dominant salient loadings on the EC factor for both sexes and no salient dual loadings were selected to form a preliminary scale for measuring individual differences in EC as a personality trait. Because previous research demonstrated that PC consisted of diversive and specific components (Collins, 1996), the EC items were factored to determine if similar components of EC could also be identified. Before rotation, all but one of the EC items had dominant salient loadings on a single factor for both sexes and no dual loadings, demonstrating a strong underlying EC factor. After rotation, two distinct factors emerged for both sexes. Consistent with the concepts of diversive and specific curiosity (Berlyne, 1954; Collins, 1996; Day, 1969), the items with strong loadings on the first factor described seeking a broad range of new information, whereas the second factor was defined by items that described interest in learning detailed knowledge about a specific topic.

On the basis of factor loadings and item content, the 5 best diversive (EC/D) and specific (EC/S) items were selected to form the EC scale. Factor analyses before rotation indicated that all 10 of these EC items had dominant salient loadings on a single factor for both women and men. After rotation, for both men and women, the 5 EC/D items had dominant loadings on the first factor and the 5 EC/S items had dominant loadings on the second factor, with perfect simple structure, providing evidence of a strong underlying EC dimension with diversive and specific components. These findings were also generally consistent with previous research by Langevin (1971) and Ainley (1987), who suggested that curiosity may be directed toward a range of diverse topics (breadth), or narrowly focused on a specific topic (depth).

The analyses of gender differences indicated that men scored significantly higher than women on the EC scale, due primarily to their higher scores on the EC/S subscale. Although the effect size for these differences was relatively small, it is interesting to note that men scored significantly higher than women on three of the five EC/S items in separate *t* tests of gender differences (18: "I am interested in discovering how things work"; 28: "When I am given a new kind of arithmetic problem, I enjoy imagining solutions,"; 29: "When I see a complicated piece of machinery, I like to ask someone how it works"). Men also scored higher than women on the NES External Cognition subscale, which assesses individual differences in one's preference for figuring out how things work. These findings suggested that men are more likely than women to develop interests in arithmetic and working with mechanical devices.

Moderately high positive correlations of the EC scale and subscales with the other four curiosity measures demonstrated meaningful convergent validity. It is interesting to note that the EC/D subscale correlated more highly with the NES Internal Cognition subscale, whereas the EC/S subscale was most highly correlated with the NES External Cognition subscale. According to Pearson (1970), the Internal Cognition subscale assesses tendencies to enjoy the development of new ideas, whereas the External Cognition subscale measures interest in discovering how things work. Thus, diversive EC appears to be more related to exploring unfamiliar topics in order to learn something new (i.e., developing ideas), whereas specific EC is more directly related to obtaining information needed to solve a particular problem (i.e., how something works).

Positive correlations of the EC scale and subscales with the sensation-seeking measures were small in magnitude, but statistically significant. These findings suggest that the EC construct was relatively independent of sensation seeking, which is consistent with Zuckerman's (1979) view that sensation seeking was unrelated to the pursuit of knowledge. However, the finding that these correlations were significant suggested that EC, at least to some extent, involves

TABLE 5
Pearson Product–Moment Correlations for the EC Scale and Subscales With Other Measures of Curiosity, Sensation Seeking, and STPI Trait Scales

		EC	*EC/D*	*EC/S*
Epistemic	EC/D	.87*		
Curiosity	EC/S	.90*	.56*	
Other curiosity measures	Perceptual Curiosity	.57*	.56*	.46*
	Trait Curiosity	.61*	.63*	.46*
	NES Internal Cognition	.48*	.52*	.34*
	NES External Cognition	.56*	.41*	.57*
Sensation Seeking measures	NES External Sensation	.20*	.14*	.21*
	SSS Thrill & Adventure	.20*	.17*	.20*
	SSS Experience Seeking	.27*	.31*	.19*
STPI Trait measures	Trait Anxiety	–.17*	–.15*	–.15*
	Trait Anger	.04	.03	.04
	Trait Depression	–.09	–.09	–.07

Note. $n = 546$ (women); $n = 193$ (men). EC = epistemic curiosity; EC/D = diversive; EC/S = specific; NES = Novelty Experiencing scales; SSS = Sensation Seeking scale; STPI = State–Trait Personality Inventory.
*$p < .001$.

seeking sensory stimulation. The small negative correlations of the EC scale and subscales with the STPI Trait Anxiety scale were consistent with previous research, suggesting that higher levels of anxiety tend to inhibit curiosity (Spielberger & Starr, 1994). Essentially zero correlations of the EC scale and subscales with the STPI Trait Anger and Depression scales indicated that EC was unrelated to either angry or depressive feelings, providing evidence of divergent validity.

In conclusion, the findings of this study demonstrated that it is meaningful to conceptualize curiosity as a multifaceted personality trait, with PC and EC as two distinctive though substantially correlated dimensions. The scale developed in this study to assess individual differences in EC was comprised of items that described interest in exploring new ideas, discovering solutions to novel problems, and figuring out how things work. The findings of this study also identified two components of EC, which were related to diversive and specific exploratory behavior as these concepts were originally conceptualized by Berlyne (1960, 1966) and Day (1969). Moderately high correlations of the EC scale with the other curiosity measures demonstrated convergent validity. Divergent validity was evidenced by essentially zero correlations with anger and depression, and minimal relationships with sensation seeking and anxiety.

In future research, it will be important to determine whether scores on the EC scale and subscales predict individual differences in relevant exploratory behaviors, such as asking questions or solving problems, which are activities that have consequences for intellectual enrichment and growth. Given that the EC scale and subscales are designed to assess individual differences in different forms of knowledge seeking, another important direction for future research will be to examine the relationship of these scales with other measures that involve seeking intellectual stimulation, such as the Ideas and Fantasy facets of McRae and Costa's (1989, 1999) Openness-to-Experience factor, and the inquisitive–uninquisitve facet of Goldberg's Intellect/Openness dimension (Goldberg, 1992; Hofstee, de Radd, & Goldberg, 1992).

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Jordan A. Litman
Department of Psychology
University of South Florida
Tampa, FL 33620–8200
E-mail: jlitman@luna.cas.usf.edu

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