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The Latent Structure of Trait Curiosity: Evidence for Interest and Deprivation Curiosity Dimensions

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To evaluate Litman and Jimerson's (2004) Interest/Deprivation (I/D) model of curiosity, 355 students (269 women, 86 men) responded to 6 trait curiosity measures including the Curiosity/Interest in the World scale (C/IW; Peterson & Seligman, 2004), the Curiosity and Exploration Inventory (CEI; Kashdan, Rose, & Fincham, 2004), the Perceptual Curiosity scale (PC; Collins, Litman, & Spielberger, 2004), the Epistemic Curiosity scale (EC; Litman & Spielberger, 2003), and the Curiosity as a Feeling-of-Deprivation scales (CFD; Litman & Jimerson, 2004). Consistent with expectations, the results of confirmatory factor analyses demonstrated that the C/IW, CEI, PC, EC scales defined an Interest (I) curiosity factor, whereas the CFD scales formed a Deprivation (D) curiosity factor. However, as compared to the other interest-based curiosity measures, one of the EC subscales was found to be less differentiated from the CFD scales, presumably because these instruments assess overlapping aspects of Berlyne's (1954) concept of epistemic curiosity. The results of this study indicated that I and D curiosity are related but differentiated curiosity dimensions, providing evidence for the validity of the I/D model.

Curiosity, the desire for new knowledge or experience, is widely recognized as an important antecedent of exploration (Berlyne, 1960; Litman, 2005; Spielberger & Starr, 1994), intellectual enrichment (Hidi, 1990; Loewenstein, 1994), and the formation of enduring interests (Fink, 1994; Prenzel, 1992; Silvia, 2001, 2006). Like many other emotional-motivational constructs, early psychological accounts of curiosity have attributed its expression either to instinct (e.g., James, 1890/1950; McDougall, 1908/1960) or to innate needs (Murray, 1938). However, these purely descriptive models of curiosity were eventually overshadowed by a drive-based account that emerged in the 1950s during an explosion of research on exploratory behavior. Proponents of curiosity-drive theory hypothesized that when organisms encountered novel, complex, or ambiguous stimuli, they experienced unpleasant states of uncertainty and were motivated to acquire new information to reduce these states. Many studies have shown that exploration dropped off after new or unusual stimuli were examined, suggesting that curiosity had been satiated (Berlyne, 1954; Dember, 1956; Harlow, 1953). Although considerable evidence in support of curiosity-drive theory has been found, there has also been evidence that organisms voluntarily sought out curiosity-arousing stimuli when none were present (Butler, 1957; Fowler, 1965; Hebb, 1955). Curiosity-seeking behavior could not be easily explained in terms of drive (Walker, 1980).

By the 1960s, an alternate account of curiosity argued that animals and humans were motivated to maintain an optimal-level of arousal (Berlyne, 1967; Fiske & Maddi, 1961). According to the optimal arousal model, when organisms were overaroused (i.e., afraid), they would withdraw from stimuli; whereas if they were underaroused (i.e., bored), they would seek out and investigate curiosity-evoking stimuli to increase their arousal to an optimal level. Thus, contrary to the drive account, optimal arousal theorists assumed that exploratory behavior was aimed at the stimulation of curiosity rather that its satiation.

INDIVIDUAL DIFFERENCES IN CURIOSITY AS A PERSONALITY TRAIT

Because of an increasing recognition that what defines an "optimal" level of arousal may vary from person to person (e.g., Eysenck, 1967), the optimal-level model inspired a great deal of research on the assessment of differential tendencies to experience and express curiosity (Silvia, 2006, chap. 5). Scales developed to assess individual differences in curiosity have defined this construct as a major personality trait (Naylor, 1981; Spielberger, Peters, & Frain, 1976), an expression of intrinsic motivation or academic interest (Day, 1971; Maw, 1971; Vidler & Rawan, 1974), and as preferences for different kinds of novel stimulation (Pearson, 1970).

Although this wave of research on individual differences in curiosity was innovative, few of the curiosity scales that have been developed meet accepted standards for reliability and validity. In one study, Langevin (1971) found that many curiosity scales had reliability coefficients lower than .60; after factor analyzing these instruments, Langevin found that the first factor explained only about 20% of the common variance. Based on these findings, Langevin concluded that better measures of curiosity were needed. Boyle's (1983) critical review of curiosity assessment reached the same conclusion: Scales developed in future research needed to achieve higher psychometric standards. Loewenstein (1994) concurred with Langevin and Boyle but observed that interest in trait curiosity had dwindled since then.

NEW MEASURES OF TRAIT CURIOSITY

Although, as Loewenstein (1994) noted, there has been relatively little research on individual differences in curiosity during the previous two decades, the 21st century has seen a veritable renaissance in the study of trait curiosity. In just the last two years, several independent groups of researchers have endeavored to develop better instruments for assessing curiosity (Collins, Litman, & Spielberger, 2004; Kashdan, Rose, & Fincham, 2004; Litman & Jimerson, 2004; Litman & Spielberger, 2003; Peterson & Seligman, 2004). Most of these new measures follow in the theoretical footsteps of their predecessors and are rooted in the optimal arousal model; these scales assess curiosity as a positive, emotional-motivational system that energizes and directs novelty-seeking behaviors, with the ultimate goal of stimulating one's interest (Litman, 2005; Litman & Jimerson, 2004).

Peterson and Seligman's (2004) 10-item Curiosity/Interest in the World (C/IW) scale of the Values in Action Inventory of Strengths conceptualizes curiosity as a global, positive trait that involves tendencies to find all manner of subjects interesting (e.g., "I can find something of interest in any situation") and to enjoy exploration and subsequent discovery (e.g., "I really enjoy learning about other countries and cultures"). The C/IW scale is modestly correlated with educational level (r = .19), substantially correlated with openness (r = .73), and uncorrelated with social desirability. Alphas ranging from .70 to .83 have been reported for the C/IW (Peterson & Seligman, 2004; Seligman, 2005).

A second recently developed general, positive trait measure of curiosity is the Curiosity and Exploration Inventory (CEI; Kashdan et al., 2004), a seven-item scale that emphasizes the role of curiosity as a facilitator of personal-growth (Kashdan, 2002, 2004). The CEI consists of a four-item subscale that assesses interest in Exploration (CEI–E) of new things (e.g., "Everywhere I go, I am out looking for new things or experiences") and a three-item subscale that measures levels of Absorption (CEI–A) when engaged in curiosity arousing activities (e.g., "When I am actively interested in something, it takes a great deal to interrupt me"). Kashdan et al. reported that both CEI subscales correlated positively with other measures of trait curiosity (M r = .57), intrinsic motivation (M r = .61), openness to experience (M r = .50), and experience seeking (M r = .37). Based on partial correlations, the CEI–E subscale was uniquely related to need for cognition (M partial r = .39), appetitive motivation (M partial r = .23), and psychological well-being (M partial r = .27), whereas the CEI–A correlated with disinhibition (partial r = .25) and boredom proneness (partial r = .21). Alphas for the total CEI scale range from .72 to .80 and .63 to .64 for the subscales (Kashdan et al., 2004).

Whereas the C/IW and CEI scales both assess curiosity as a global positive trait, the Epistemic Curiosity (EC; Litman & Spielberger, 2003) and Perceptual Curiosity (PC; Collins et al., 2004) scales measure different facets of trait curiosity based on Berlyne's (1960) theoretical view that different types of curiosity are aroused by opportunities for new knowledge or sensory information, respectively (see Silvia, 2006, chap. 3). The 10-item EC scale is comprised of a 5-item Diversive subscale (EC/D), which involves taking interest in exploring unfamiliar topics to learn something new (e.g., "I enjoy discussing abstract concepts"), and a 5-item Specific subscale (EC/S) that inquires about how much people enjoy solving problems or figuring out how things work (e.g., "When I am given a new kind of arithmetic problem, I enjoy imagining solutions"). The PC scale is also comprised of two 5-item subscales; the Diversive subscale (PC/D) assesses interest in exploring new places and seeking a broad range of sensory stimulation (e.g., "I enjoy visiting art galleries and art museums"), whereas the Specific subscale (PC/S) inquires about examining a particular stimulus (e.g., "When I see a new fabric, I like to touch and feel it").

The EC scale and subscales correlate strongly with measures of interest in cognitive activity (M r = .48) but have much weaker correlations with sensation seeking (M r = .21). In contrast, the PC measures are moderately correlated with sensation seeking (M r = .35) but have somewhat lesser relationships with cognitive interests (M r = .24). The EC and PC scales are positively correlated with each other (M r = .53) and with other measures of curiosity (M r = .54). The EC/D subscale was more highly correlated with Pearson's (1970) Internal Cognition scale (partial $r_{EC/D}$ = .47, partial $r_{EC/S}$ = .06), which involves enjoying the development of new ideas, whereas the EC/S subscale correlated more highly with

Pearson's External Cognition scale (partial $r_{EC/D}$ = .18, partial $r_{EC/S}$ = .49), which measures interest in discovering how things work. However, in previous research with the PC scale, the degree of differentiation between the PC/D and PC/S subscales on the basis of correlations with other measures has been less clear (Collins et al., 2004; Litman & Spielberger, 2003). Alpha coefficients that have been reported for the EC and PC total scales range between .82 and .87 and between .71 and .81 for the subscales (Collins et al., 2004; Litman, Hutchins, & Russon, 2005; Litman & Jimerson, 2004; Litman & Spielberger, 2003).

THE DISTINCTION BETWEEN CURIOSITY AS A "FEELING-OF-INTEREST" AND "FEELING-OF-DEPRIVATION": THE INTEREST/DEPRIVATION (I/D) MODEL OF CURIOSITY

All four of the aforementioned curiosity scales are grounded in the optimal-level of arousal model, for which its proponents view exploratory behavior as being directed toward the induction of curiosity and the stimulation of interest. This theory may be contrasted with the curiosity-drive account, which identifies the reduction of curiosity and elimination of uncertainty as the goals of exploration. Although curiosity induction remains the dominant theoretical model in contemporary curiosity research, curiosity-reduction models have received renewed consideration as well, primarily inspired by the theoretical work of Loewenstein (1994).

Loewenstein (1994) observed that curiosity is stimulated only in circumstances when individuals lack information—that is, when people recognize a discrepancy between what they know and what they would like to know (cf. Berlyne, 1957). Because curiosity always involves a knowledge-deficit, Loewenstein suggested that it is more meaningful to describe curiosity as a feeling of informational deprivation that people are motivated to eliminate. Although Loewenstein recognized that people may also search for information because they expect it to stimulate their interest, he considered information seeking to be motivated more by the displeasure associated with ignorance or uncertainty than by the anticipated pleasure that may accompany the acquisition of new knowledge.

Building on Loewenstein's (1994) theoretical views, Litman and Jimerson (2004) proposed that curiosity as a feeling-of-interest is aroused when individuals do not consider themselves to be lacking knowledge per se but rather feel that it would be enjoyable to discover something new such as an amusing anecdote or entertaining story (Silvia, 2005). In contrast, curiosity as a feeling-of-deprivation is stimulated when people feel they are lacking substantive and meaningful information such as the answer to a complex question, a valuable fact, or solution to a tough problem. Acquiring such information may enhance one's feelings of competence or improve one's understanding of something, whereas its lack is perceived as contributing to one's ignorance and uncertainty.

In keeping with the I/D model of curiosity, curiosity as a feeling-of-interest may be thought of as a "take it or leave it" attitude toward new information for which its stimulation, even if unsatisfied, can be pleasurable. Curiosity as a feeling-of-deprivation, on the other hand, may be equated with a "need to know," which involves somewhat unpleasant feelings of tension or frustration until it is satisfied (Litman, 2005). Because of this important qualitative difference, Litman and Jimerson (2004) hypothesized that deprivation-based curiosity is a stronger motive for information seeking than interest-based curiosity and should correspond with more exploratory behavior.

To assess curiosity as a feeling-of-deprivation (CFD), Litman and Jimerson (2004) developed a 15-item CFD scale comprised of three 5-item subscales: The first subscale measures a need to increase feelings of Competence (CFD/C) by acquiring new knowledge (e.g., "It bothers me if I come across a word that I don't know, so I will look up its meaning in a dictionary"), the second assesses an Intolerance (CFD/I) for seemingly unsolvable problems (e.g., "I have a hard time accepting that some mysteries just can't be solved"), and the third measures Persistence (CFD/P) in trying to solve a problem or gather information (e.g., "I can spend hours on a single problem because I just can't rest without knowing the answer"). Litman & Jimerson reported an alpha of .84 for the total CFD scale; alphas were lower for the brief subscales, ranging from .64 to .78.

Litman and Jimerson (2004) found that the CFD scale and subscales had moderately strong positive correlations (*M r* = .45) with measures of interest-type curiosity (i.e., the EC, PC, and Trait Curiosity scales). Interestingly, the CFD scales correlated especially highly with the EC scale (*M r* = .62), presumably because both the CFD and EC scale items refer to gaining new knowledge and solving problems and thus are both measuring different aspects of Berlyne's (1954) concept of epistemic curiosity. In addition, the persistence and intolerance aspects of the curiosity as a feeling-of-deprivation construct (i.e., the CFD/P and CFD/I subscales, respectively) had small but significant positive correlations with trait measures of anxiety and depression (*M r* = .11) and somewhat stronger correlations with trait anger (*M r* = .25). In contrast, all three interest-type scales were either unrelated or negatively correlated with these three measures of negative affect. These findings are consistent with the view that curiosity as a feeling-of-deprivation reflects a desire for new information but also involves a mild degree of negative affectivity.

Litman et al. (2005) recently demonstrated that for answers to a series general knowledge questions, scores on trait measures of both curiosity as a feeling-of-interest and as a feeling-of-deprivation were positively related to reported levels of state curiosity on a likert-type scale, which in turn were related to the degree of information-seeking behavior exhibited. However, path analyses indicated that these relationships depended on participants' prior knowledge. When participants reported they did not know the answer, state curiosity to learn it was associated with the interest-based EC scale ($\beta_{EC} = .24$, $p < .001$) but not with the CFD scale ($\beta_{CFD} = -.04$, *ns*). However, when participants indicated that the answer was on the "tip of the tongue," the CFD scale predicted the intensity of curiosity states ($\beta_{CFD} = .33$, $p < .001$), whereas the EC scale was unrelated ($\beta_{EC} = -.14$, *ns*). Moreover, as compared to when curiosity states were correlated to the EC scale, when curiosity states were associated with the CFD scale, they were more intense ($d > .80$) and also corresponded with 16% more information-seeking behavior, which is consistent with the assertion that curiosity as a feeling-of-deprivation reflects a more powerful motive to acquire knowledge than curiosity as a feeling-of-interest.

To determine whether measures of curiosity as a feeling-of-interest and curiosity as a feeling-of-deprivation represent meaningfully differentiated dimensions, Litman and Jimerson (2004) submitted the CFD, EC, and PC total scales and the Trait Curiosity scale from the State Trait Personality Inventory (Spielberger, 1979) to confirmatory factor analysis. The EC, PC, and Trait Curiosity scales defined a feeling-of-interest curiosity factor, and the three CFD subscales defined its own eponymous factor. The hypothesized I/D bifactor model had acceptable fit, but overall fit was improved by allowing the EC scale to load on both the Interest (I) and Deprivation (D) factors. This finding suggested that curiosity as a feeling-of-interest and feeling-of-deprivation are distinctive dimensions of curiosity but that the EC and CFD scales are less differentiated because both instruments explicitly inquire about feelings of curiosity aroused by opportunities to acquire new knowledge, and thus, both scales measure epistemic curiosity. However, these instruments differ in that the EC scale emphasizes the fun of learning something new, whereas the CFD scale items refer to feelings of dissatisfaction related to not knowing.

GOAL OF THIS STUDY

Although Litman and Jimerson (2004) found that trait measures of curiosity as a feeling-of-interest and curiosity as a feeling-of-deprivation are strongly correlated, they also found that the two constructs can be differentiated with confirmatory factor analysis. However, an independent verification of the I/D two-factor model has not yet been conducted. Such verification is important because all of the measures used in the past analyses have been developed by the same group of investigators (e.g., Collins et al., 2004; Litman & Spielberger, 2003) and have been founded on similar conceptual models of motivation (see Spielberger & Starr, 1994). Evidence for the I/D distinction with a different set of measures founded on diverse theoretical orientations would provide more compelling evidence for our expected latent structure of trait curiosity. Thus, our major goal of this study was to conduct a further assessment of the dimensionality of trait curiosity, specifically among scales that have emerged in the current wave of research. In keeping with this goal, we also evaluated the internal-consistency reliability of these instruments.

METHOD

Participants

The participants were 355 students (269 women, 86 men) ranging in age from 18 to 43 years ($M = 19.9$, $SD = 3.75$) who we recruited from general psychology courses at the University of North Carolina at Greensboro. All participants received course credit for taking part in this study. The sample was approximately 66% White, 29% African American, and 5% other ethnicities.

Instruments and Procedures

We administered the C/IW, CEI, EC, PC, and CFD scales and subscales as previously described to participants in large-group sessions. To simplify the response procedures, all participants responded to these instruments on a 5-point Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). We collected data over three consecutive semesters.

RESULTS

Means and standard deviations for scores on the curiosity scales and subscales are reported in Table 1. Alpha coefficients, including standard errors and 95% confidence intervals (CI) for alpha,[1] mean interitem correlations, and mean corrected item-total (CIT) correlations for these instruments are also reported in Table 1. As no gender differences were found for any of the scale or subscale scores, these statistics are based on the total sample. Alphas for all of the total scales were generally acceptable ($\alpha \geq .75$), with the exception of the CEI. Although alphas were generally lower for most of the subscales, the mean interitem correlations, which ranged from .27 to .41, were as high as or even higher than those for the total scales. This finding suggested that the lower magnitude of alpha found for the

[1]For a recent and highly detailed discussion of how to compute and interpret the standard error and 95% CI of alpha, see Duhachek and Iacobucci (2004).

TABLE 1
Means, Standard Deviations, Internal Consistency Reliability Indexes, and Pearson Product–Moment Correlations Among Curiosity Measures

	M	*SD*	α	SE_α	95% CI_α	*M* Interitem *r*	*M* CIT	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1. C/IW	3.70	.49	.76	.019	.72 to .80	.25	.43													
2. CEI	3.58	.53	.69	.025	.65 to .74	.26	.41	.42												
3. CEI–E	3.68	.59	.62	.033	.55 to .68	.29	.40	.40	.86											
4. CEI–A	3.44	.70	.59	.037	.51 to .66	.32	.40	.30	.81	.41										
5. PC	3.66	.56	.75	.020	.71 to .78	.24	.41	.38	.55	.55	.36									
6. PC/D	3.58	.66	.63	.030	.58 to .69	.28	.41	.27	.41	.39	.28	.86								
7. PC/S	3.74	.65	.64	.030	.58 to .70	.27	.40	.39	.55	.56	.34	.86	.49							
8. EC	3.57	.54	.79	.017	.76 to .83	.25	.45	.42	.58	.60	.36	.68	.57	.60						
9. EC/D	3.75	.59	.72	.023	.67 to .77	.37	.50	.51	.59	.62	.34	.69	.52	.68	.82					
10. EC/S	3.39	.69	.68	.026	.63 to .73	.31	.44	.23	.41	.42	.27	.48	.45	.37	.87	.43				
11. CFD	3.40	.63	.88	.009	.86 to .90	.32	.53	.24	.53	.49	.40	.46	.39	.41	.59	.48	.52			
12. CFD–C	3.56	.66	.64	.029	.59 to .70	.27	.40	.32	.49	.50	.32	.41	.31	.40	.56	.49	.46	.85		
13. CFD–I	3.67	.64	.71	.024	.66 to .75	.33	.47	.20	.48	.43	.37	.47	.42	.40	.50	.44	.41	.87	.64	
14. CFD–P	2.98	.85	.78	.017	.75 to .81	.41	.56	.14	.44	.38	.36	.35	.31	.29	.50	.35	.49	.90	.64	.69

Note. N=355. rs > .14 are significant $p < .01$. CIT = corrected item-total correlations; C/IW = Curiosity/Interest about the World scale; CEI = Curiosity and Exploration Inventory; E = Exploration scale; A = Absorption scale; PC = Perceptual Curiosity scale; D = Diversive subscale; EC = Epistemic Curiosity scale; S = Specific subscale; CFD = Curiosity as a Feeling-of-Deprivation scale; C = Competence subscale; I = Intolerance subscale; P = Persistence subscale.

subscales was due in part to the smaller number of items that comprised these measures rather than a lack of internal consistency (Clark & Watson, 1995; Cortina, 1993). However, the lower bound for the 95% CIs of alpha indicated that reliability for nearly all of the measures could stand to be improved. Standard errors for the alphas were generally quite low (< .1), suggesting that the items comprising each instrument were relatively homogeneous (Duhachek & Iacobucci, 2004); standard errors tended to be somewhat higher for subscales relative to their total scales, again due primarily to their smaller number of items (Duhachek & Iacobucci, 2004).

Overall, CITs for all of the curiosity scales were moderately strong ($M \geq .40$). However, several scales had at least one item with a very low CIT correlation (< .30), the removal of which would have slightly increased alpha. Two C/IW items, one that referred to "boredom" and one that referred to "learning about other cultures" had very low CITs with the remaining items. One EC/S item that referred to solving "arithmetic problems" had a low CIT correlation with the other EC scale items but acceptable CIT properties with the remaining items of its subscale. One CEI–E item, "I am *not* the type of person who probes deeply into new situations or things," had low CITs with both the items of the total scale and the corresponding subscale. Pearson product–moment correlations among the curiosity measures are also reported in Table 1. Overall, the small to moderately strong positive correlations among the curiosity scales provided generally good evidence of convergent validity and suggested that all of these instruments assessed overlapping constructs.

Latent Structure of Curiosity Scales

In keeping with Litman and Jimerson's (2004) I/D model, we expected that the C/IW, CEI, PC, and EC scales and subscales would form an I-curiosity factor, and the three CFD measures would form a D-curiosity factor. Although we expected the scales to form meaningfully distinct factors due to differences in the affective nature of the constructs they assessed, we also expected the factors to be positively correlated given that both forms of curiosity are theorized to motivate information-seeking behavior. We further anticipated potentially greater overlap for the EC scales with the D-curiosity factor, given that the CFD scales (our primary measures of the D factor) and the EC scales both assess Berlyne's (1954) concept of epistemic curiosity.

Guided by the previously mentioned considerations, we developed several theoretically structured models of the Interest- and Deprivation-based curiosity scales that had been included in this study. To ensure there was a minimally sufficient number of indicators for the D-curiosity construct, we included the three CFD subscales in all analyses (Comrey & Lee, 1992; Gorsuch, 1988; Kline, 1998; MacCallum & Austin, 2000; Spector, 1992). Because the number of variables entered into a factor analysis may affect its overall fit (Kenney & McCoach, 2003), we conducted separate analyses with two sets of measures. Set 1 was comprised of the CFD subscales; the C/IW scale; and total scores for the CEI, PC, and EC scales. Set 2 included the CFD subscales, the C/IW scale, and the six subscale scores for the remaining instruments.

For both sets of measures, the first model was a one-factor curiosity model with paths to each of the scales; we tested this model to determine whether the curiosity instruments were more appropriately conceptualized as a comprising a unitary curiosity construct as compared to the hypothesized bifactor I/D model. The second model we tested was structured in accordance with basic tenets of the I/D theory (Litman & Jimerson, 2004) such that I and D curiosity represented distinct but correlated factors. We also tested several bifactor I/D models that addressed the complex relationship between the EC and CFD scales based on the theoretical view that the these instruments are less differentiated from each other because each measures different aspects of epistemic curiosity.

To assess the fit of these various curiosity models, we submitted scores on the two sets of scales to confirmatory factor analyses using maximum likelihood estimation (Olsson, Foss, Troye, & Howell, 2000). We conducted all analyses on the covariance matrix using the PROC CALIS procedure (SAS Institute, Inc., 1996) of SAS Version 8.2. We examined several goodness-of-fit (GOF) indexes including chi-square, comparative fit index (CFI), nonnormed fit index (NNFI), McDonald's (1989) centrality fit index (MFI), and root mean square error of approximation (RMSEA). To compare nested models with similar fit, we examined the parsimony fit index (PFI); to compare the relative fitness of nonnested models, we examined the expected cross-validation index (ECVI).

Although nonsignificant chi-square is desirable, values can become inflated with large sample sizes and thus reject models that are otherwise valid. However, chi-square is useful for comparing nested models because smaller chi-squares indicate superior fit (Hatcher, 1994; James, Mulaik, & Brett, 1982; Raykov, 1998; Russell, 2002). Hu and Bentler (1999) suggested that values for MFI ≥ .90 and CFI and NNFI ≥ .95 indicate very close fit, whereas values approaching .90 are acceptable, especially for relatively new models (MacCallum & Hong, 1997; Raykov, 1998; Stevens, 1996). Hu and Bentler (1999) suggested a RMSEA ≤06 for close fit; Browne and Cudeck (1992) recommended a somewhat less stringent criterion of ≤08 as acceptable. For PFI, Mulaik et al. (1989) suggested that values > .50 are acceptable, with higher values being desirable. For ECVI, lower values indicate better fit (Hatcher, 1994).

We conducted separate confirmatory analyses for each set of scales. GOF indexes for each analysis are reported in Table 2. For Set 1, the basic bifactor I/D model consisted of a D-curiosity factor with paths leading to the three CFD subscales and an I-curiosity factor with paths to the C/IW, CEI, PC, and EC scales. An alternate Set 1 I/D model specified the EC scale to load as a complex indicator on both the I- and D-curiosity factors. For Set 2, the basic I/D model included an I-curiosity factor comprised of the C/IW scale and the six positive trait curiosity subscales and a D-curiosity factor defined by the three CFD subscales. In the first variant model, the EC/D subscale was specified as a complex indicator; in the second variant, EC/S was complex; and in the third, both the EC/D and EC/S subscales were complex indicators. We conducted these iterations of complex loadings for the EC subscales to determine whether the overlap between the epistemic curiosity measures was due primarily to only one of the subscales, a possibility that had not been previously investigated.

As shown in Table 2, chi-squares were significant for all eight models ($p < .001$). For Set 1, none of the GOF indices for the one-factor model (1A) indicated a good fit. With the exception of RMSEA, the basic bifactor I/D model (1B) had generally good fit and was clearly superior to the one-factor model. The complex model (1C) in which the EC scale was allowed to load on both factors had about the same fit as the standard bifactor model, but the loading for the EC scale on the D-curiosity factor was not significant, which indicated that the model was untenable.

For Set 2, the one-factor model (2A) had very poor fit, whereas fit for the bi-factor model (2B) was much better, although not ideal. For the complex-indicator models, the first model (2C, EC/D as complex) was marginally better than the standard bifactor I/D model. For the remaining two alternate models (2D, EC/S as complex and 2E, both EC/D and EC/S as complex, respectively), CFI and NNFI were adequate (> .90), but MFI and RMSEA for each of these models was less than desirable. In comparing the relative fit among the Set 2 models, the standard bifactor model (2B) fit better than the one-dimensional model (2A), $\chi^2(1, N = 355) = 192.39$, $p < .001$. All three alternate models fit slightly better than the basic I/D model. Although the EC/D and EC/S as complex indicator model (2E) had the best fit among the three alternates, the loading for the EC/D subscale on the D factor was not significant, and therefore, this model was untenable. Of the remaining two alternate Set 2 models that were tenable, fit was better for the second alternate (2D, EC/S as complex; PFI = .676) than for the first (2C, EC/D as complex; PFI = .665).

Of the models that were tenable, the Set 1 standard bifactor model (1B; ECVI = .274) had the best overall fit, followed by the Set 2 EC/S as complex indicator model (2D; ECVI = .477). These findings indicated that I and D forms of curiosity are differentiated but that the EC/S subscale assessed aspects of epistemic curiosity that were less distinct from those aspects assessed by the CFD scales as compared to the other interest-based curiosity measures.

Estimates for the interfactor correlation, factor loadings, and error path coefficients for the scale Set 1 I/D standard bifactor model (1B) are presented in Figure 1; this informa-

TABLE 2
Confirmatory Factor Analysis GOF Indexes for Various I/D Models

	Set 1			*Set 2*				
GOF Index	*1A*	*1B*	*1C*	*2A*	*2B*	*2C*	*2D*	*2E*
$\chi^2(df)$	206.77(14)	65.83(13)	63.78(12)	342.42(35)	150.03(34)	144.01(33)	122.36(33)	120.02(32)
CFI	0.831	0.953	0.955	0.796	0.923	0.926	0.941	0.941
NNFI	0.832	0.954	0.920	0.737	0.898	0.899	0.919	0.912
MFI	0.761	0.927	0.929	0.647	0.848	0.855	0.880	0.882
RMSEA	0.197	0.107	0.111	0.158	0.098	0.098	0.087	0.086
PFI	0.548	0.584	0.540	0.606	0.683	0.665	0.676	0.656
ECVI	0.669	0.274	0.274	1.090	0.549	0.538	0.477	0.476

Note. $N = 355$. All chi-square statistics are significant, $p < .001$. GOF = goodess-of-fit; I/D = interest/deprivation; Set 1 = model includes total scales for Interest measures; Set 2 = model includes subscales for Interest measures; both include the three Curiosity As a Feeling-of-Deprivation Scales; 1A = one-factor model; 1B = two-factor I/D model; 1C = two-factor model with Epistemic Curiosity (EC) Scale as complex indicator; 2A = one-factor model; 2B = two-factor model I/D model; 2C = two-factor model with EC Diversive subscale (EC/D) as complex indicator; 2D = two-factor model with EC Specific subscale (EC/S) as complex indicator; 2E = two-factor model with EC/D and EC/S as complex indicators; CFI = comparative fit index; NNFI = nonnormed fit index; MFI = McDonald's centrality fit index; RMSEA = root mean square error of approximation; PFI = parsimony fit index; ECVI = expected cross-validation index.

tion is presented in Figure 2 for the Set 2 EC/S complex indicator model (2D). In both models, the two factors were very highly correlated (Set 1 $r = .72$; Set 2 $r = .64$), suggesting that interest and deprivation curiosity are substantially related yet distinct aspects of curiosity as hypothesized. For both models, all factor loadings were significant ($p < .01$), ranging from .49 to .86 for Set 1 and from .29 to .85 for Set 2.[2]

DISCUSSION

Our major goal of this study was to evaluate the latent structure of recently developed curiosity scales and subscales—including the C/IW, CEI, EC, PC, and CFD scales—in light of Litman and Jimerson's (2004) I/D model of curiosity. In keeping with this goal, we also evaluated the psychometric properties of each instrument. With the exception of the CEI, all of the total scales exhibited generally acceptable internal consistency; alphas for the subscales were considerably lower due at least in part to their brevity, as they had similar mean interitem correlations. All of the curiosity scales were positively correlated with one another, which provided evidence of convergent validity for these instruments.

Although there is considerable overlap between I and D curiosity, the results of this study provide further evidence that these constructs correspond to differentiated dimensions; in two confirmatory factor analyses, bifactor I/D models always fit the data significantly better than a corresponding one-factor model. Although the strong correlation between I and D curiosity raises some questions about the practical meaningfulness the distinction, it is important to note that measures of the two dimensions appear to have different correlates (Litman, 2005; Litman & Jimerson, 2004), have been found differentially associated with specific metacognitive states, and are also associated with different degrees of exploratory behavior (Litman et al., 2005). Similarly, scores on measures of anxiety and depression are also substantially correlated (Beck, Steer, & Garbin; 1988; Gotlib & Crane, 1989; Spielberger, Ritterband, & Reheiser, 2003) but are associated with meaningfully different metacognitions (Beck, 1971; Beck & Clark, 1988; Papageorgiou & Wells, 1999) and reactions (Clark & Watson, 1991a, 1991b). Nevertheless, clearly much more research will be necessary to establish that I and D curiosity are indeed meaningfully distinct constructs.

Given that all three CFD subscales inquire about seeking knowledge, an alternate interpretation of the two factors is that they better reflect epistemic curiosity and general curiosity rather than interest and deprivation. However, finding that the EC total scale and EC/D subscale only loaded on the I-type curiosity factor suggests that this explanation is unsatisfactory. On the other hand, given that the EC/S scale had significant loadings on *both* the I and D factors suggests that better differentiated measures of the I and D aspects of epistemic curiosity are needed. Moreover, given that the EC and CFD scale reliabilities were somewhat lower than would be desirable and that overall model fit was adequate but not excellent, it is evident that further refinement of both the EC and CFD scales as measures of either epistemic curiosity or I and D types of curiosity, respectively, will be needed and that a more careful consideration of the nature of epistemic curiosity is required.

[2]Although revision of the scales included in this study was not one of our aims, we also reran these analyses with the weaker items deleted from the scales to see whether it affected fit. Fit indexes were quite similar, and the loadings were virtually unchanged.

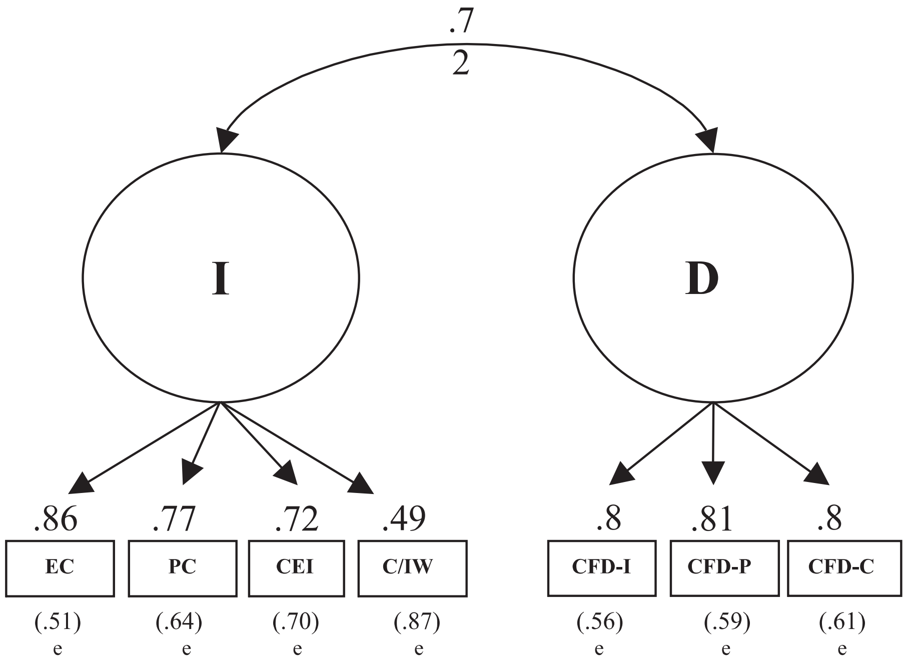

FIGURE 1 Model 1B: Standardized factor loadings and error path coefficients for the Interest (I) Deprivation (D) bifactor model ($N = 355$). All factor loadings are significant at $p < .001$. EC = Epistemic Curiosity scale; PC = Perceptual Curiosity scale; CEI = Curiosity and Exploration Inventory; C/IW = Curiosity/Interest About the World scale; CFD = Curiosity as a Feeling-of-Deprivation scales; CFD–I = Intolerance subscale; CFD–P = CFD Persistence subscale; CFD–C = CFD Competence subscale.

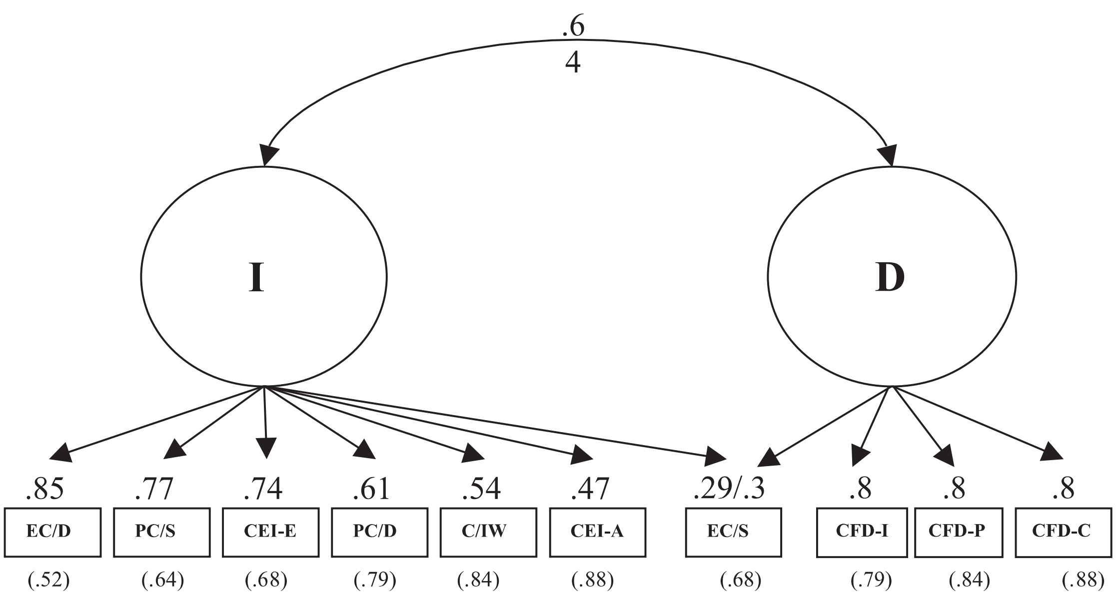

FIGURE 2 Model 2D: Standardized factor loadings and error path coefficients for the Interest (D) Deprivation (D) bifactor model with EC/S as a complex indicator (N = 355). All factor loadings are significant at $p < .001$. EC = Epistemic Curiosity scale; PC = Perceptual Curiosity scale; PC/S = PC Specific subscale; CEI = Curiosity and Exploration Inventory; PC/D = PC Diversive subscale; C/IW = Curiosity/Interest About the World scale; CEI–A = CEI–Absorption scale; EC/S = EC Specific subscale; CFD = Curiosity as a Feeling-of-Deprivation scales; CFD–I = CFD–Intolerance subscale; CFD–P = CFD–Persistence subscale; CFD–C = CFD Competence subscale.

Berlyne's (1954) concept of epistemic curiosity, defined as a desire for new knowledge, has been associated with both the reduction of unpleasant states of uncertainty (e.g., Berlyne, 1954, 1960; Lowenstein, 1994) as well as the delighted joy of learning (e.g., Day, 1971; Spielberger & Starr, 1994), which is highly consistent with Litman and Jimerson's (2004) I/D view of curiosity. Whereas the CFD scale and subscales appear to measure aspects of epistemic curiosity associated with uncertainty reduction (i.e., D-type curiosity), the EC scale and subscales were developed explicitly to assess epistemic curiosity as a "joy of leaning" (i.e., I-type curiosity).

Learning new conceptual knowledge is assessed by the EC/D subscale (e.g., "I find it fascinating to learn new information"; "I enjoy exploring new ideas"), whereas the EC/S subscale emphasizes seeking knowledge to solve problems (e.g., "When someone asks me a riddle, I am interested in trying to solve it"; "If I am given an incomplete puzzle, I like to try and imagine the final solution"). Even though the EC/S items do not refer to having thoughts or feelings related to experiences of tension, one possible reason for the pattern of loadings found in this study for the EC subscales is that problem-solving situations are intrinsically more likely to stimulate CFD-type reactions in individuals. Efforts to solve problems always involve the potential for failure and therefore some potential for experiences of negative affectivity (e.g., frustration). By contrast, learning or discussing new ideas may not have the same built-in potential for frustration or tension that might come from a failed attempt to solve a puzzle or figure out how something works.

Although the results of this study are generally consistent with previous research findings (Litman & Jimerson, 2004), several limitations are apparent. For one, the final structure of any factor analysis is necessarily a consequence of the scales that are included in that analysis. Had a different set of measures been included in this study, it is possible I and D would not have formed differentiated factors; therefore, it will be important to investigate the factor structure of a larger array of curiosity (and noncuriosity) scales in future research. Another limitation is that the use of the common rating scale among the measures might have inflated the correlations over what would be expected with the standard scales, which will be important to take into consideration in future research. Finally, a major limitation of this study is that the findings are based on responses from only a single sample comprised entirely of college students; students typically have greater information-seeking resources available to them than nonstudents, which means their thoughts and feelings regarding the acquisition of information may differ from those of nonstudents. Data from additional samples and from more a diverse group would have been a valuable addition to our study. In future research, it will be important to examine the factor structure of I-type and D-type measures with new and more varied groups.

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