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PERSONALITY AND INDIVIDUAL DIFFERENCES

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Interest and deprivation factors of epistemic curiosity

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Abstract

The extent to which two measures of epistemic curiosity (EC), the Epistemic Curiosity Scale (ECS; Litman & Spielberger, 2003) and the curiosity as a Feeling-of-Deprivation Scale (CFDS; Litman & Jimerson, 2004), differentiated between interest (I) and deprivation (D) type curiosity was examined in four studies. In studies 1 ($N = 725$) and 2 ($N = 658$), exploratory factor analyses of the ECS and CFDS subscales yielded two factors; the first (I-type) involved pleasure associated with discovering new ideas, while the second (D-type) emphasized spending time and effort to acquire a specific answer or solution. In study 3 ($N = 762$), confirmatory factor analysis demonstrated that a 2-factor model comprised of the I- and D-type curiosity items identified in study 2 had the best fit. In study 4 ($N = 515$), correlations between revised I- and D-type measures and different learning goals were evaluated. As hypothesized, the I-EC scale correlated with mastery-oriented learning, whereas the D-EC scale was related to failure-avoidance and success-orientation. The results suggest that I-EC is concerned with stimulating positive affect, diversive exploration, learning something completely new and mastery-oriented learning; D-EC involves the reduction of uncertainty, specific exploration, acquiring information that is missing from an existing knowledge-set and performance-oriented learning.

Keywords: Epistemic curiosity; I/D model; Diversive exploration; Specific exploration; Learning-achievement

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1. Introduction

Epistemic curiosity (EC) is the desire for knowledge that motivates individuals to learn new ideas, eliminate information-gaps, and solve intellectual problems (Berlyne, 1954; Loewenstein, 1994). Berlyne described EC as a uniquely human "drive to know" (1954, p. 187) that motivated inquisitiveness and experimentation, and that underlied intellectual development and scholarly achievement (Berlyne, 1966, 1971). Building on Berlyne's work, Litman and Spielberger (2003) theorized that individuals vary in terms of the frequency with which they experience and express EC. They conceptualize these dispositional tendencies as a personality trait associated with positive emotional-motivational states of interest and the intrinsic pleasure of learning. To assess individual differences in EC, Litman and Spielberger (2003) developed a 10-item Epistemic Curiosity Scale (ECS; α range = .82–.87), comprised two 5-item subscales (α range = .71–.81): The first, labeled Diversive-EC, measures interest in exploring unfamiliar topics in order to learn something new (e.g. "I enjoy exploring new ideas"); the second subscale, Specific-EC, inquires about enjoyment in solving problems and figuring out how things work (e.g. "When I am given a new kind of arithmetic problem, I enjoy imagining solutions"). The ECS is positively correlated with other measures of curiosity, and is found more strongly related to measures of cognitive activity than to measures of sensation seeking, providing evidence of convergent and discriminant validity, respectively (Collins, Litman, & Spielberger, 2004; Litman & Spielberger, 2003).

However, Litman and Jimerson (2004) observed that in Berlyne's (1954, 1963) original formulation of EC, unpleasant states of uncertainty from being deprived of information were considered more important for motivating knowledge seeking and intellectual achievement-striving than pleasurable states of interest. In Litman and Jimerson's (2004) view, interest (I) induction and deprivation (D) elimination reflect different types of curiosity that correspond to very different motives for acquiring new information: I-type curiosity involves the anticipated pleasure of new discoveries, whereas D-type curiosity is concerned with reducing uncertainty and eliminating undesirable states of ignorance. Accordingly, I- and D-type EC are theorized as corresponding to very different kinds of learning goals (Elliot, 1999): I-type EC is associated with acquiring knowledge simply for the intrinsic joy of it (i.e. mastery-oriented learning), whereas D-type EC is conceptualized as a "need to know", for which the correctness, accuracy, and relevance of the desired information to a specific unknown is of the utmost importance (i.e. performance-oriented learning). Moreover, D-type EC is conceptualized as an unsatisfied need-like state, and hypothesized to be a stronger motive for knowledge seeking than I-type EC (Litman, 2005). A consideration of how each type of curiosity relates to learning goals may be especially important, given that past research has shown that different motives for learning predict the degree of effort and persistence individuals apply to seeking new information (McGregor & Elliot, 1999) as well the valence of the emotional experiences that follow (Elliot, 1999; Elliot & Church, 1997).

In keeping with their theoretical view of D-type curiosity, Litman and Jimerson (2004) developed a 15-item Curiosity as a Feeling-of-Deprivation Scale (CFDS) (α range = .85–.88), which comprises three 5-item subscales (α range = .64–.78): The first measures a desire to reduce ignorance and increase Competence (CFD/C) (e.g. "I do not like not knowing things, so I try to learn new information about even the most complex topics."), the second assesses an Intolerance (CFD/I) for unsolved problems (e.g. "It really gets on my nerves when I know that Iam close to solving a puzzle, but still cannot figure it out."), and the third measures Persistence (CFD/P) when seeking answers or working on a problem (e.g. "I can spend hours on a single problem because I just cannot rest without knowing the answer"). Thus, quite different from the ECS, which emphasizes the *enjoyment* of learning something new, all of the CFDS items refer to being *bothered* by having insufficient information. However, while the affective tone of the CFDS items differ considerably from those of the ECS, in previous research these two EC instruments have been found very highly correlated with one another (r range = .68–.70) and have salient loadings on the same factor when analyzed with other curiosity scales (Litman & Jimerson, 2004; Litman & Silvia, 2006).

Nevertheless, despite the substantial overlap between the CFDS and ECS, some important differences have been found between these instruments as well. Consistent with the view that D-type EC involves some negative affectivity, the CFDS subscales are correlated positively with measures of anxiety, depression and anger, whereas the I-type ECS, which assesses only positive emotional experiences associated with curiosity, is negatively correlated or unrelated to these three measures (Collins et al., 2004; Litman & Jimerson, 2004; Litman & Silvia, 2006; Litman & Spielberger, 2003). Supportive of the hypothesis that D-type EC is a stronger motive for knowledge seeking, past research has shown that the CFDS is associated with both the arousal of higher levels of state-curiosity and a greater degree of information seeking behavior than the I-type ECS (Litman, Hutchins, & Russon, 2005). Additionally, the CFDS and ECS appear to be associated with different metacognitive knowing states ("tip-of-the-tongue" and "do not know", respectively), suggesting that different cognitive processes underlie each type of curiosity (Litman et al., 2005).

While previous research suggests that the ECS and CFDS assess qualitatively and quantitatively different experiences and expressions of EC, the substantial overlap between these instruments raises the question of whether these measures could be more clearly differentiated in terms of I- and D-type curiosity. Given evidence that distinguishing between I- and D-type EC may have important implications for understanding the emotions, cognitions, metacognitions, motives, and degree of effort people exert in seeking out new knowledge (e.g. Litman et al., 2005), it would be desirable to develop measures of I and D-type EC that are as differentiated as possible.

With the goal of determining whether more differentiated measures of I- and D-type EC might be developed, four studies were conducted: In studies 1 and 2, the dimensionality of the ECS and CFDS subscales was examined with exploratory factor analysis to identify the best and most differentiated components of I- and D-type EC. In study 3, confirmatory factor analyses were conducted to assess the fit of a revised I/D EC model. In study 4, relationships between revised I- and D-type EC measures and different learning goals (Elliot, 1999) were examined to assess their convergent and discriminant validity. As previously noted, Litman and Jimerson (2004) hypothesize that I-type EC is associated with the intrinsic pleasure of learning, which is a mastery-oriented learning goal, whereas D-type EC is hypothesized to involve seeking accurate knowledge capable of eliminating uncertainty, and wanting to reduce or avoid states of ignorance, which are performance-oriented learning goals (i.e. approach success and avoid failure, respectively).

2. Method

2.1. Participants

Participants were recruited from undergraduate psychology courses at a large Southeastern university. Data were collected with IRB approval for each study over the course of 10 consecutive academic semesters (i.e. fall, spring, and summer) between 2004 and 2007. Summary information for the participants in each study is reported in Table 1.

2.2. Instruments

The Epistemic Curiosity Questionnaire included the scale items from the 10-item ECS and the 15-item CFDS as previously described. Participants were instructed to report how they "generally feel" regarding each item statement by rating themselves on the following 4-point frequency scale: 1 = Almost Never, 2 = Sometimes, 3 = Often, 4 = Almost Always.

The learning-achievement goal scale (Elliot & Church, 1997) is an 18-item instrument comprised three 6-item subscales that measure different achievement goals in relation to learning academic course material: (1) *mastery* ($\alpha = .89$), to attain a high level of understanding and competence for reasons of personal interest and enjoyment, (2) *performance-approach success* ($\alpha = .91$), to do well on tests of the material relative to an objective standard, and (3) *performance-avoid failure* ($\alpha = .77$), concerns about doing poorly on academic tests or appearing incompetent to others. Participants were asked to indicate how much each statement was true for them in relation to their college course material on a 1 to 4 point scale anchored by "very true" and "very false" for me. This scale was only administered in study 4.

2.3. Procedure

The questionnaires were administered to participants in large-group testing sessions. Approximately 30 min were required to participate. For each of the testing sessions, the experimenter introduced himself to the participants, indicated that the goals of the study were to learn about their feelings and attitudes, and informed them that additional information would be provided after they had participated.

Table 1
Summary data for participants in each study ($N = 2660$)

Study	*N*			Age		
	Total	Women	Men	Range	*M*	SD
1	725	531	194	18–47	20.37	5.70
2	658	520	138	18–55	23.55	7.61
3	762	571	191	18–49	22.41	6.45
4	515	415	100	18–40	20.16	4.23

3. Results

Means, standard deviations, and reliability indices for the ECS and CFDS measures are reported in Table 2 for studies 1–3.[1] With the exception of the CFD-C subscale for study 3, Alphas were acceptable for all of the scales ($\alpha \geqslant .70$); standard errors (SE) for the alphas were low (<.1). Alphas were somewhat lower for the subscales relative to the total scales, while SEs tended to be higher. Pearson product moment correlations between the ECS and CFDS measures for studies 1–3 are also reported in Table 2. Moderate to very strong positive correlations were found between the seven measures as would be expected given that these instruments all assess different components of EC. Also as expected, the correlations were especially strong between each total scale and its corresponding subscales.

3.1. Study 1 and study 2: differentiating between I- and D-type EC

In order to identify the aspects of the ECS and CFDS measures that were most differentiated in terms of I- and D-type EC, in study 1, responses to the five ECS and CFDS subscales were analyzed in an iterated principal axis factor analysis with oblique (promax) rotation, using the squared multiple correlation as the communality estimate (Russell, 2002). Consistent with expectations, the scree plot and parallel analysis of the eigenvalues (3.43, .31, .008, .005, .0001) indicated a two-factor solution should be extracted, for which loadings are reported in Table 3. As may be noted, the CFD-C and Specific-EC subscales did not differentiate between I- and D-type EC, given salient loadings of nearly equal magnitude on both factors. The CFD-I subscale also had salient loadings on both factors, although its dominant loading was on factor I. Only the CFD-P and Diversive-EC subscales had dominant loadings on a single factor, and no salient dual loadings, suggesting that these two subscales differentiated most between I- (factor I) and D-type (Factor II) EC; the inter-factor correlation was .66.

In study 2, a more detailed analysis of the 10 CFD-P and Diversive-EC subscale items was conducted to better evaluate what was distinctive about these two instruments; responses to these 10 items were submitted to an iterated principal axis factor analysis with promax rotation, using the squared multiple correlation as the communality estimate. The scree plot and parallel analysis of the eigenvalues (4.39, .97, .05, .03...) identified two factors, for which the loadings are reported in Table 4. Consistent with the analysis of the subscales, the Diversive-EC and CFD-P items formed two correlated factors ($r = .54$) with excellent simple structure. All five Diversive-EC items had dominant loadings on factor I (I-type) while the five CFD-P items had their dominant loadings on factor II (D-type); none of the items had any salient dual loadings.

It is informative to note differences in the content of the items with the highest loadings on each factor, as these items may be interpreted as the best measures of each factor's underlying construct. The item with the strongest loadings on the I-type factor, "I enjoy exploring new ideas" suggests that I-type EC is primarily concerned with the pursuit of a broad range of new information, and is an activity that is wholly enjoyable; this theme is echoed in the other Diversive-EC items as well. For the D-type factor the item "I can spend hours on a problem because I cannot

[1] Summary data for the revised EC measures used in study 4 are reported in the results section for this study.

Table 2
Means, standard deviations, reliability indices, and correlations[a] among the ECS and CFDS measures for study 1 ($N = 725$), study 2 ($N = 658$), and study 3 ($N = 762$)[b]

	M (SD)	α (SE$_\alpha$)	95% CI$_\alpha$	Pearson's r					
				1	2	3	4	5	6
1. ECS	29.79 (7.14)	.87 (.007)	.86–.89						
	32.43 (7.43)	.88 (.007)	.87–.90						
	27.27 (5.57)	.84 (.008)	.82–.85						
2. Diversive-EC	15.93 (3.76)	.82 (.010)	.80–.85	.90					
	17.21 (3.84)	.84 (.010)	.82–.86	.91					
	14.58 (3.05)	.78 (.012)	.76–.81	.89					
3. Specific-EC	13.87 (4.07)	.79 (.005)	.77–.81	.92	.66				
	15.22 (4.27)	.81 (.005)	.79–.83	.93	.68				
	12.69 (3.15)	.72 (.016)	.69–.75	.90	.61				
4. CFDS	43.66 (10.57)	.91 (.013)	.90–.92	.80	.71	.75			
	46.99 (10.67)	.91 (.015)	.90–.91	.78	.71	.72			
	39.46 (7.60)	.86 (.021)	.84–.87	.73	.65	.66			
5. CFD-C	15.35 (3.71)	.77 (.013)	.74–.80	.77	.72	.68	.89		
	16.41 (3.74)	.75 (.015)	.72–.78	.74	.71	.66	.89		
	14.22 (2.75)	.64 (.021)	.59–.68	.68	.67	.56	.80		
6. CFD-I	15.49 (3.86)	.78 (.012)	.76–.81	.74	.67	.68	.90	.72	
	16.80 (3.81)	.77 (.014)	.74–.80	.72	.68	.65	.91	.75	
	13.92 (2.92)	.70 (.017)	.66–.73	.55	.49	.50	.83	.51	
7. CFD-P	12.82 (4.23)	.84 (.009)	.83–.86	.65	.52	.66	.90	.68	.71
	13.78 (4.27)	.85 (.009)	.84–.87	.65	.54	.65	.90	.69	.73
	11.32 (3.42)	.81 (.011)	.79–.83	.61	.50	.60	.87	.54	.58

[a] $r \geqslant .16$ are significant, $p < .05$.
[b] For each scale, 1st row = Sample 1, 2nd row = Sample 2.

Table 3
Rotated factor loadings[a] for the five ECS and CFDS subscales ($N = 725$)

	I	II
CFD-P	**.92**	−.03
CFD-I	**.57**	**.35**
Specific-EC	**.47**	**.41**
Diversive-EC	−.01	**.92**
CFD/C	**.45**	**.49**

Salient loadings are in bold.
[a] Each loading is listed in the descending order of magnitude for its dominant factor.

rest without knowing the answer" had the strongest loading, suggesting that D-type EC is most concerned with finding missing pieces of information that may be added to an existing knowledge base. Moreover, this item refers to a bothersome preoccupation with obtaining missing information that precludes involvement in other activities. This item also suggests a willingness to invest

Table 4
Rotated factor loadings[a] for CFD-P and Diversive-EC items ($N = 658$)

	I	II
Enjoy exploring new ideas	**.82**	−.10
Enjoy learning about subjects that are unfamiliar to me	**.78**	.06
Find it fascinating to learn new information	**.78**	.04
Learn something new, like to find out more about it	**.69**	.10
Enjoy discussing abstract concepts	**.45**	.11
Hours on a problem because I cannot rest without answer	−.11	**.87**
Conceptual problems keep me awake thinking about solutions	−.04	**.68**
Frustrated if I cannot figure out problem, so I work even harder	.16	**.68**
Work like a fiend at problems that I feel must be solved	.13	**.65**
Brood for a long time to solve problem	.17	**.63**

Salient loadings are in bold.
[a] Loadings are listed in the descending order of magnitude for the dominant factor.

time and effort in order to obtain missing information. These themes are also expressed by the other CFD-P items; it may be noted that the investment of time or effort is not implied by any of the Diversive-EC items.

3.2. Study 3: testing the construct validity of the revised I/D EC model

The results of study 1 and 2 point to a revised I/D EC model comprised of the 5 Diversive-EC items and the 5 CFD-P items. In order to assess the relative fit of this revised I/D EC model, responses to the ECS and CFDS items were submitted to confirmatory factor analysis using maximum likelihood estimation. Two sets of models were tested; the first was comprised all 25 ECS and CFDS items; the second set included only the five Diversive-EC and five CFD-P items identified as the most differentiated measures of I and D-type EC. For the first set, the first model tested was a 1-factor curiosity model designed to evaluate whether the 25 ECS and CFDS items were more appropriately conceptualized as indicators of a unitary EC construct. The second model tested was a 2-factor I/D model of correlated I-type (10 ECS items) and D-type (15 CFDS items) factors, while the third model of the first set specified five correlated 5-item factors made up of the two ECS and three CFDS subscales. For the second set, two models were tested: The first was a 10-item 1-factor model and the second was a 10-item 2-factor model comprised correlated I-type (5 Diversive-EC items) and D-type (5 CFD-P items) factors.

Several goodness of fit (GOF) indices were examined, including chi-square, comparative fit index (CFI), non-normed fit index (NNFI), McDonald's centrality fit index (MFI), and root mean square error of approximation (RMSEA). To compare nested models, the parsimony fit index (PFI) was examined. In order to compare non-nested models the expected cross-validation index (ECVI) was evaluated. In determining model fitness, although a non-significant chi-square is desirable, smaller values still indicate superior fit when significant (James, Mulaik, & Brett, 1982). Hu and Bentler (1999) suggest that MFI $\geqslant .90$ and CFI and NNFI $\geqslant .95$ indicate very close fit, while values close to.90 are acceptable (Raykov, 1998). Hu and Bentler (1999) suggest RMSEA $\leqslant .06$ indicates close fit, although Browne and Cudeck (1992) consider $\leqslant .08$ acceptable.

For PFI, James et al. (1982) suggest that values >.50 are acceptable, with higher values being desirable. For ECVI, lower values indicate superior fit (Hatcher, 1994).

GOF indices for each analysis are reported in Table 5; chi-squares were significant for all five models. For Set 1 (25 items), none of the GOF indices for the 1-factor model (1A) indicated good fit. The 2-factor I/D model (1B) also had poor fit, although it was improved over the 1-factor model as evidenced by a significantly smaller chi-square (χ^2dif. = 200.47(1), $p < .001$) and higher PFI. The 5-factor I/D model (1C) also had poor fit, although it was generally superior to the other two models of the first set, as evidenced by a significantly lower chi-square than the 2-factor model (χ^2dif. = 428.57(9), $p < .001$), marginally acceptable CFI, adequate RMSEA, and higher PFI. For Set 2 (10 items), the 1-factor model (2A) had very poor fit, while fit for the 2-factor I/D model (2B) was generally excellent; CFI, NNFI were >.95, MFI was >.90 and RMSEA was <.06.

Additionally, the 2-factor model (2B) had a significantly lower chi-square (χ^2dif. = 401.48(1), $p < .001$) and a higher PFI than the 1-factor model. In comparing relative fit across all models, the 10-item 2-factor I/D model had the lowest ECVI, indicative of the best fit overall. Estimates for the inter-factor correlation, factor loadings, and error path coefficients for the 10-item 2-factor I/D model (2B) are presented in Fig. 1. The two EC factors were highly correlated ($r = .60$); all factor loadings were very strong and significant ($p < .001$), ranging from .58 to .76.

3.3. Study 4: I- and D-type EC and their relationships with learning-achievement goals

Partial correlations were computed between the revised I- and D-type EC scales and three learning-achievement goals: mastery (M), performance-approach success (PAS), and performance-avoid failure (PAF), which are reported in Table 6. Consistent with expectations, the I-type EC scale was strongly correlated with M, was uncorrelated with PAS, and had a small negative correlation with PAF. Also consistent with expectations, the D-type EC scale was positively related to both PAS and PAF, and had a weaker relationship than I-type EC with M. These results support the hypothesis that I-type EC involves intrinsic interest in learning whereas D-type EC reflects a desire for accurate knowledge and involves concerns about reducing one's ignorance. The I-type EC scale ($M = 14.6$, SD = 3.31) and the D-type EC scale ($M = 12.90$,

Table 5
Goodness of fit (GOF) Indices for five epistemic curiosity models for ($N = 762$)

GOF Index	Models[a]				
	1A	1B	1C	2A	2B
χ^2(dif.)[b]	1473.21 (275)	1272.74 (13)	844.17 (265)	520.51 (35)	119.03 (34)
CFI	.831	.836	.905	.802	.965
NNFI	.832	.820	.892	.746	.954
MFI	.761	.519	.684	.733	.947
RMSEA [95% CI]	.076 [.072–.080]	.069 [.065–.073]	.053 [.049–.057]	.133 [.123-.144]	.056 [.045–.068]
PFI	.705	.731	.766	.616	.720
ECVI [95% CI]	2.07 [1.92–2.24]	1.81 [1.67–1.96]	1.27 [1.16–1.39]	.720 [.630–.821]	.208 [.170–.256]

[a] *Notes:* 1A = 1-Factor 25-item curiosity model, 1B = 2-Factor 25-item I/D model, 1C = 5-factor 25-item I/D subscale model, 2A = 1-Factor 10-item curiosity model, 2B = 2-Factor 10-item I/D model.
[b] Chi-square statistics are significant ($p < .001$).

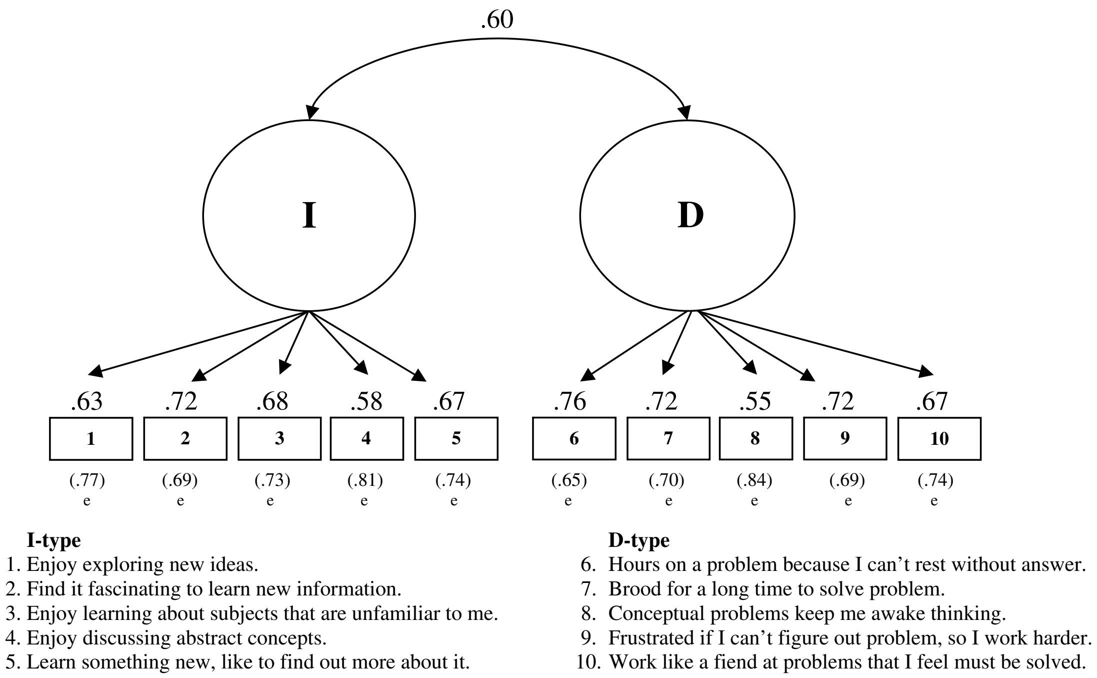

Fig. 1. Diagram of the 10-item 2-factor I/D EC model ($N = 762$).

Table 6
Partial correlations[a] between the 5-item I-type and 5-item D-type epistemic curiosity measures and learning-achievement motives($N = 515$)

	M(SD)	α	I	D
Mastery	18.99 (3.28)	.81	.45	.17
Performance-approach success	17.64 (3.87)	.83	.04	.24
Performance-avoid failure	18.80 (3.54)	.75	−.16	.32

[a] For pr's $\geqslant .17$, $p < .001$.

SD = 3.35) had acceptable internal consistency (I-type: $\alpha = .82$; SE $\alpha = .013$; 95% CI = .79–.84; D-type: $\alpha = .76$; SE $\alpha = .016$; 95% CI = .73–.79) and were moderately positively correlated ($r = .47$); the three learning goal measures also had adequate internal consistency ($\alpha \geqslant .75$), and small to moderate positive correlations with each other, especially the PAS and PAF ($r_{\mathrm{MPAS}} = .37$; $r_{\mathrm{MPAF}} = .14$; $r_{\mathrm{PASPAF}} = .45$).

4. Discussion

The major goal of the present study was to examine the dimensionality of two overlapping EC measures, the ECS and CFDS, which were designed to assess I- and D-type curiosity, respectively. An exploratory factor analysis of the ECS and CFDS subscales demonstrated that the CFD-P and Diversive-EC measures were the most differentiated in terms of I- and D-type curiosity.

The 10 items that comprised the Diversive-EC and CFD-P subscales were factored, and consistent with the analysis of the subscales, two correlated I- and D-type EC factors emerged with excellent simple structure. A series of confirmatory factor analyses indicated that a 2-factor I/D model comprised the 5-item Diversive-EC and 5-item CFD-P items had the best overall fit of several competing models that were tested. Not surprisingly, although the two factors of the revised I/D EC model were better differentiated than those of the original model, they were still strongly correlated due to the fact that both factors assess different aspects of an underlying EC construct.

In reviewing the items that defined each factor, the I-type EC factor emphasized the fun of learning a broad range of new ideas, whereas the D-type EC factor was primarily concerned with finding solutions to specific problems. These findings raise the question of whether the two factors are more accurately conceptualized as *diversive* and *specific* exploration rather than I- and D-type curiosity, respectively. Berlyne (1963) and Day (1971) both suggested that desiring a broad range of new information, which is suggested by the Diversive-EC items, motivates diversive exploration, whereas seeking information about one particular source, as addressed by the CFD-P items, manifests in specific exploration.[2]

While there is a certain appeal to interpreting the emergent factors as diversive and specific, there are several reasons why this explanation is less satisfactory than I and D. First, the Specific-EC subscale, like CFD-P, also inquires about solving specific problems, but had loadings of nearly equal magnitude on both factors in the analysis of the subscales. Second, the CFD-C subscale, like Diversive-EC, emphasizes broadly seeking knowledge, and it too had loadings of nearly equal magnitude on both factors. These findings suggest that *both* the mitigating circumstances (i.e. diversive information seeking vs. solving specific problems) and the corresponding affective experiences (i.e. enjoyment vs. tension) are relevant to the distinction between I- and D-type EC. Moreover, the I-type EC scale was found more highly related to mastery learning goals whereas the D-type EC measure was primarily associated with concerns about performance, both to approach success as well as avoid failure. Past research has shown that mastery-oriented goals are associated with intrinsic motivation (Elliot & Church, 1997), which is highly consistent with the concept of I-type EC. Past research has also shown that performance-approach related goals are associated with effort and persistence in studying (McGregor & Elliot, 1999) while performance-avoidant goals are related to negative affective conditions such as worry and anxiety (Elliot, 1999), both of which are very consistent with the concept of D-type curiosity. Taken together, these results suggest that the concepts of I- and D-type curiosity encompass and extend beyond those of diversive and specific exploration, as well as elucidate the nature of these constructs.

The results of the present study help to clarify the differences between I-type and D-type EC. I-type EC appears to be concerned with adding new ideas or concepts to one's repertoire, motivates diversive exploration, and involves feelings of enjoyment associated with wanting to improve intellectual mastery. D-type EC reflects an unsatisfied need-like state that energizes specific exploration aimed at solving problems, and is associated with setting performance-oriented learning goals. It will be important in future research to conduct further investigation of the range of situations, cognitions, metacognitions, feelings, behaviors that are differentially associated with I- or

[2] Factor analytic research by Langevin (1971) and Ainley (1987) has also suggested that curiosity may be directed towards a range of diverse topics (breadth), or narrowly focused on a specific topic (depth).

D-type EC. Another important direction for future research will be to further examine the relationships between I- and D-type EC, learning goals, and learning outcomes. Accordingly, it will be worthwhile to investigate the underpinnings of I- and D-type curiosity, such as individual differences in appetitive responses to knowledge (Litman, 2005), which may have consequences for their differential development.

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