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Epistemological orientations and evidence evaluation in undergraduates

Debra McGinnis*

Department of Psychology, Oakland University, Rochester, MI, USA

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ABSTRACT

Epistemological orientations and evidence evaluation abilities influence processes related to critical thinking and conclusion justification across various reasoning domains. Participants ($N = 500$) were presented with the Justifying Conclusions Inventory (JCI) enabling the identification of epistemological orientation groups. Cluster analysis identified four groups: Absolutists, Multiplists, Evaluativists, and Low Evaluativists. Participants also read research vignettes and responded to Research Evaluation Inventory (REI) questions addressing evidence evaluation processes related to skepticism. REI responses were significantly affected by epistemological orientation group, with Evaluativists demonstrating the most skepticism. Participants with the most education and those who had taken a methodology course also demonstrated greater skepticism. These results suggest the JCI is a defensible assay of global and domain-specific epistemic cognition. In addition, the findings herein elucidate characteristics of a transitional epistemic cognitive state which could be common in undergraduates.

1. Introduction

Cognitive scientists studying how people approach knowledge and knowing use the terms epistemic cognition, epistemological understanding, personal epistemology, epistemological beliefs, and epistemological orientations to describe these processes (Hofer & Pintrich, 1997; 2002; King & Kitchener, 1994, 2002, 2004; Kuhn, Cheney, & Weinstock, 2000). Epistemic cognition and epistemological understanding refer to thinking processes related to knowledge acquisition in a general sense, whereas personal epistemology, epistemological beliefs, and epistemological orientations refer to the varieties of epistemological beliefs and processes in individuals (Hofer and Pintrich, 1997). Included in all of these theoretical frameworks are taxonomies of beliefs or orientations related to the nature of knowledge (e.g., certainty) and how knowledge is justified (e.g., use of evidence; the role of authorities) (King and Kitchener, 1994). In short, an individual's epistemological orientation reflects his or her belief system about the nature of and acquisition of knowledge (Hofer and Pintrich, 2002; King & Kitchener, 2004). For example, an individual may believe there is one correct answer (a truth) and that this answer is known by certain individuals (e.g., parents, church leaders, and/or teachers).

King and Kitchener (1994) obtained evidence that epistemological orientation (EO) typically reflects one of three levels: pre-reflective, quasi-reflective, or reflective, and refer to their framework as "Reflective Judgment." Kuhn et al. (2000) later referred to these orientations as absolutists, multiplists, and evaluativists, respectively (Kuhn et al., 2000; Kuhn & Weinstock,

* Correspondence: Department of Psychology, Oakland University, Rochester, MI 48309.
E-mail address: mcginnis@oakland.edu

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2002)[1]. Individuals with an absolutist orientation focus on one conclusion and authority privilege to that conclusion (e.g., parents, teachers). Multiplists believe that there can be more than one conclusion; viewing various opinions as equally correct. Influencing the tendency to view all opinions as equally valid is the tendency to view different types of compelling evidence as equally valid. Of the three levels, evaluativists engage in the most sophisticated approach to evidence evaluation and logical analysis. Evaluativists have reasonably well-developed abilities pertaining to evidence evaluation (e.g., empirical evidence provides greater support for a conclusion than personal opinion). In addition, evaluativists embrace dispositions related to a more rigorous analysis of evidence and/or conclusions, including the willingness to revisit evidence and analytical processes at a later time even if that results in a revision of the conclusion. Cognitive scientists in this area have found empirical evidence suggesting that it is possible to identify the epistemological levels of individuals reliably, particularly within problem contexts (Hofer, 2004; Kuhn et al., 2000).

According to many theorists and scientists studying critical thinking, epistemic orientations and processes are crucial (Bromme, Pieschle, & Stahl, 2010; Dawson, 2008; Dwyer, Hogan & Stewart, 2014; King and Kitchener, 1994; Kuhn et al., 2000). Dwyer et al. (2014) proposed a framework integrating epistemological orientations, metacognition, and critical thinking, in which the inherent metacognitive nature of various processes related to critical thinking is clarified (also see Hogan, Dwyer, Harney, Noone, & Conway, 2015). In other words, attempts to produce a reasoned conclusion involves thinking about the nature of knowledge, evaluating potential justifications, and self-regulating one's thinking processes – all of which are metacognitive processes (also see: Bromme et al., 2010; Dawson, 2008; King and Kitchener, 1994; Kuhn et al., 2000). The metacognitive nature of epistemological processes related to critical thinking suggests that individuals may be aware of thinking propensities, thereby enabling researchers to use a variety of approaches to better understand what thinkers are doing mentally (Hofer, 2004).

The majority of studies addressing individual differences in epistemic cognition have used qualitative approaches, necessitating content analyses of responses to ill-defined problems (Baxter Magolda, 1992; King & Kitchener, 1994). Qualitative methodologies in this literature have met rigorous methodological standards resulting in empirical outcomes that can be highly regarded (Hofer and Pintrich, 1997). The development of inventories assessing epistemic cognition may contribute to empirical and theoretical progress that has already been demonstrated. DeBacker, Crowson, Beesley, Thoma and Hestevold (2008) examined the psychometric and content validity of three existing measures of epistemic beliefs and found problems with internal consistency and conceptual operationalization, suggesting that there is a need for instruments that are conceptually and psychometrically sound (also see Pintrich, 2002).

Greene, Torney-Purta and Azvedo (2010) developed a 13-item quantitative instrument that addresses epistemic cognition in two domains, math and history. Their instrument asks participants ($N = 740$; middle school to graduate school) to indicate their level of agreement with statements reflecting various forms of justification (authority, personal opinion, and facts that are certain and unchangeable), producing scores reflecting justification propensities. Greene et al. (2010) obtained evidence for the psychometric integrity of their questionnaire, demonstrating the utility of a quantitative approach when used in a specific content domain (also see Sosu, 2013).

The present study addresses the need for a quantitative instrument assessing global epistemological orientations. The inventory developed and tested herein, the Justifying Conclusions Inventory (JCI), was designed to address a range of epistemological tendencies characteristic of absolutism, multiplism, and evaluativism, such as the use (or non-use) of evidence, the relevance of evidence, the process of reasoning with evidence, and justification propensities. Scores on JCI subscales were used to categorize undergraduates as to epistemological orientation. It was hypothesized that third-year and fourth-year undergraduates would be more likely than first-year or second-year students to be classified into one of the more sophisticated epistemological orientation groups, although there should be undergraduates who are more or less sophisticated regardless of their academic standing. Using the JCI to group individuals into epistemological orientations facilitates the identification of individual differences in students at similar educational levels as well as across educational levels.

Post-secondary educational experiences, broadly speaking, may promote epistemological development, continuing cognitive development that begins in childhood and adolescence (Hofer, 2004; King & Kitchener, 1994; Kuhn, 1991; Perry, 1970; Valanides and Angeli, 2005). Post-secondary course content often showcases discipline-specific epistemologies, with an emphasis on why particular justifications are valued over others, potentially contributing to epistemological development. Furthermore, students who enroll in methodology courses are explicitly exposed to knowledge acquisition strategies that produce the most valued knowledge in a particular discipline which may promote development more specifically (Hofer, 2004; Angeli & Valanides, 2009). Dampening these conclusions somewhat is the evidence that epistemological development may be gradual or uneven for some proportion of students, suggesting that the overall linear relationship between epistemological orientations and education may be noisy (Greene et al., 2010; Hammer & Elby, 2002; Hofer, 2004; King and Kitchener, 2004; Kuhn et al., 2000; Rodriguez and Cano, 2006).

[1] Kuhn et al. (2000) also included a stage referred to as "realist" in which the knower perceives a one-to-one correspondence between the external world and knowledge. This overlaps the earliest stage of King & Kitchener (1994)King & Kitchener's (1994) framework (stage 1 of the pre-reflective level) and is most typical of children. This stage is less relevant herein because the current endeavor pertains to epistemic cognition in individuals over the age of 18. However, it should be noted that some researchers argue that naïve beliefs consistent with realist perspectives may be present in adults in particular contexts, (see for example Bromme et al., 2010).

To evaluate the influence of research methodology exposure on epistemological orientations, the goals of the current study include comparing students exposed to a research methodology course to those who had not been exposed. It was hypothesized that students exposed to research methodology course content would be more likely to be classified into one of the two most sophisticated EO groups (Evaluativists or Multiplists). Utilizing two samples of undergraduates (Exposure, No-Exposure) enabled the examination of the influence of specific training in research methodology on epistemological development.

To examine epistemological orientations in a scientific context, participants were asked to evaluate a research vignette and to answer questions presented in a Research Evaluation Inventory (REI). The vignette presented a description of a study on extrasensory perception: a topic chosen because it would be more familiar than other research topics, and because such a topic is known to be questionable, and therefore it should elicit reactions related to epistemological orientations. The Research Evaluation Inventory (REI) included questions addressing the validity of the source, the quality of experimental design, and whether one should just believe these claims or use evaluative processes,. It was hypothesized that participants in more sophisticated EO subgroups and participants in the exposure group would evaluate the research vignette most critically. Including evidence evaluation in a scientific context enabled the exploration of domain-specific epistemic cognition relevant to the JCI (Muis, Bendixen, & Haerle, 2006; Sosu, 2013). If the JCI results in EO groupings with participants differing in critical thinking skills relevant to a specific content domain (in this case within a research evaluation domain), then REI subscale scores should differ across EO groups. For example, individuals who lean toward absolutism may consider print material from a range of publications as authoritative, resulting in Absolutists having higher REI subscale scores for overall credibility and source credibility. Conversely, Evaluativists should have lower REI subscale scores for overall credibility and source credibility, reflecting skepticism of unknown sources and skepticism of questionable conclusions. Hence, it is hypothesized that REI means will differ systematically across EO groups, providing evidence that the JCI is a defensible assay of epistemic cognition in a specific sense, as well as in a general manner.

To summarize, the goals of the present study were (1) to examine the utility of the Justifying Conclusions Inventory as a means to obtain epistemological subscale scores and to classify undergraduates into epistemological orientation groups; (2) to explore the influence of two types of educational variables (educational level and research methodology course participation) on epistemological orientation as reflected by JCI scores and epistemological orientation groups; and (3) to explore the influence of epistemological orientation groups on evidence evaluation processes specific to a research vignette (REI subscale scores).

2. Method

2.1. Participants

A total of 500 young adults participated: 158 first-year students (31.6%); 94 second-year (18.8%), 140 third-year (28%), 104 fourth-year (20.8%), and 4 who had graduated (0.8%). There were 368 women (73.6%) and 132 men (26.4%). Participants received partial course credit in one of several Psychology courses. Nearly half of the students were enrolled in an Introductory Psychology Course ($N = 230$, 46.1%), all of whom reported that they had not completed a research methodology course ("no exposure" group). The remaining students were either upper-division students who had completed a research methodology course or students who were currently enrolled in a research methodology course, but beyond the middle of the semester ($N = 270$, 53.9%). Because relevant scientific ideas may be more salient cognitively when students are concurrently enrolled in a methodology course, it seemed reasonable to include presently-enrolled participants in the "exposure" group. The breakdown of education year by exposure to a methodology course was: first year (147 no, 11 yes); second year (47 no, 47 yes); third year (24 no, 116 yes); and fourth year (11 no, 93 yes), and for graduates (1 no, 3 yes). For all analyses, the graduates and fourth year students were combined.

2.2. Materials

2.2.1. Justifying conclusions inventory (JCI)

The JCI includes statements pertaining to epistemological dispositions related to evidence use, relevance, evaluation and re-evaluation; knowledge and/or conclusion source and certainty; as well as to subjective and objective processes. Participants were asked to use a six-point Likert scale to rate their agreement with each statement (1 = *disagree absolutely*; 6 = *agree absolutely*).

2.2.2. Pilot studies

Two pilot studies preceded the data reported herein. In Pilot Study I, 291 undergraduate native English-speaking participants responded to a 100-item inventory based conceptually on characteristics of the seven stage model proposed by King and Kitchener (1994). Factor analysis (principle components, varimax rotation) was conducted. First, items with factor loadings below .3 were deleted, and the analysis reconducted. This process was repeated until all primary factor loadings exceeded .3. In the next analysis, all items loading alone or items loading with one other item in an uninterpretable fashion were deleted. Next, cross-loaded items and items with loadings under .45 were removed, resulting in 37 items and a three factor solution (absolutist, multiplist, evaluativist). The 37-item instrument was pilot-tested in the second pilot study. In

Pilot Study II, 112 undergraduate native English-speaking participants were recruited. Data reduction proceeded as described above for Pilot Study I, resulting in a 23-item instrument which is used in the current study. The 23-item JCI is provided in Appendix A in its entirety.

2.2.3. Research vignettes

A vignette describing a telepathy experiment was developed for use in this research. Vignette content (extrasensory perception) was chosen because it should be perceived as questionable scientifically by the majority of students, thereby triggering evidence evaluation processes. The vignette accurately reflected the information in the Introductory Psychology textbook used in all of the Introductory Psychology courses at the university from which participants were drawn. To investigate the role of source, one vignette included the source as New Age Studies; and the second listed the source as Scientific Studies. In all other ways, the research vignettes were identical. Participants were randomly assigned to research vignette source conditions (New Age Studies, Scientific Studies), and were blind as to the manipulation. The vignette by education year was: first year (86 new age, 72 science); second year (50 new age, 44 science); third year (65 new age, 75 science); fourth year (51 new age, 53 science) and graduates (1 new age, 3 science). Appendix B presents the vignette in its entirety.

2.2.4. Research evaluation inventory (REI)

The 18-item REI was developed specifically to ascertain reactions to the research vignette. More specifically, the REI solicits responses to statements about the overall credibility of the claims about telepathy; the credibility of the source (either New Age Studies or Scientific Studies); and whether respondents utilized intuitive strategies when evaluating the research vignette. Participants were asked to use a six-point Likert scale to rate their agreement with each statement (1 = *disagree absolutely*; 6 = *agree absolutely*). The REI is presented in its entirety in Appendix C.

2.2.5. Procedure

After informed consent procedures, participants read the research vignette silently. Then they were asked to respond to the REI, a background questionnaire, and the JCI.

3. Results

3.1. Principle component analysis of JCI and REI scores

Significance levels were set at .05 for all analyses. There were six missing responses out of 11,022 responses (or .05%) for the JCI, and 20 out of 9,018 (or 0.22%) for the REI: reflecting low rates of missing data. Each missing datum was replaced with the overall mean for the non-missing responses. Principal Component Analysis (PCA) was used to identify a smaller set of conceptually-meaningful factors for each inventory.

3.2. Justifying conclusions inventory (JCI)

Correlational analysis using Bartlett's test of sphericity was significant, χ^2 (253) = 3788.68, $p < .001$, suggesting that all of the correlations were sufficiently large for PCA. In addition, the KMO test for sampling adequacy was .874, with values greater than .60 considered adequate for PCA, as this reflects small partial correlations overall. Four of the 23 items loaded on two factors (JCI-3 JCI-9, JCI-13, and JCI-22). These were removed and the analysis re-conducted. The scree plot suggested three factors, all of which had eigenvalues greater than 1.0. These three factors were retained, and explained 50.7% of the variance in JCI item scores. The conceptual content of the JCI items loading on each factor corresponded conceptually to three epistemological orientations: (1) Absolutism (19.4% of the variance); (b) Multiplism (15.0%); and (c) Evaluativism (16.2%). Table 1 provides the factor loadings for the three-factor solution. Cronbach's α reliabilities for the subscales were .86 for Absolutism; .77 for Multiplism; and .78 for Evaluativism. Subscale scores for each participant were computed.

3.3. Research evaluation inventory (REI)

Correlational analysis using Bartlett's test of sphericity was significant, χ^2 (91) = 2221.99, $p < .001$, suggesting that all of the correlations were sufficiently large for PCA. In addition, the KMO test for sampling adequacy was .869, with values greater than .60 considered adequate for PCA. The scree plot suggested two factors, both of which had eigenvalues greater than 1.0. A third factor had an eigenvalue of nearly 1.0 (0.98) so PCA was re-conducted specifying three factors. These three factors were retained, explaining 63.4% of the variance in REI scores. Items with loadings below .50 were eliminated, resulting in a conceptually-meaningful factor structure. Conceptually, these factors corresponded to (1) Agreement: agreement with the conclusion (27.1% of the variance); (2) Source: journal source credibility (18.0%); and (3) Intuition: intuitive processes (sensing that something is accurate rather than using a rational approach) (18.0%). Table 2 provides the factor loadings for the three-factor solution. Cronbach α reliabilities for the subscales were .88 for Agreement; .71 for Source; and .64 for Intuition. REI subscale scores were computed.

Table 1
Justifying conclusions inventory factor loadings.

	Absolutism	Evaluatism	Multiplism
JCI-4	.80		
JCI-10	.80		
JCI-1	.77		
JCI-7	.74		
JCI-16	.70		
JCI-23	.70		
JCI-17		.71	
JCI-2		.65	
JCI-5		.65	
JCI-8		.64	
JCI-14		.63	
JCI-20		.62	
JCI-11		.61	
JCI-18			.77
JCI-6			.69
JCI-19			.69
JCI-15			.67
JCI-21			.62
JCI-12			.61
α	.86	.78	.77

Table 2
Research evaluation inventory factor loadings.

	Agreement	Source	Intuition
REI-12	.84		
REI-6 (reverse)	.80		
REI-17	.79		
REI-1	.76		
REI-8		.87	
REI-14		.85	
REI-11		.54	
REI-5			.78
REI-10			.60
REI-15			.56
REI-4			.56
α	.88	.71	.64

3.4. Epistemological orientations: cluster and discriminant analysis

Cluster analysis was used to identify subgroups presenting different configurations across the JCI subscales (Absolutism, Multiplism, and Evaluativism). For example, one group could be characterized by high evaluativism scores, with low scores on both absolutism and multiplism. *K*-means cluster analysis produces groupings that maximize the distances among cluster centers, resulting in statistically homogeneous groups (Hair and Black, 2000). JCI subscales were standardized prior to cluster analysis. The average distance from cluster centers was 1.07, with a range of 0.10 to 4.27. Of the 500 cases, 19 (about 3.8%) differed from their cluster center by two standard deviations, and these were removed before proceeding.

The cluster analysis yielded four epistemological orientations: Absolutism, Multiplism, Evaluativism, and Low-Evaluativism. The first group included individuals who tended to rate absolutism items the highest ($N = 76$; cluster center for Absolutism = 1.60), with lower scores for Multiplism and Evaluativism (−0.12, −0.21, respectively). The second group included individuals who favored Multiplism ($N = 103$; cluster center for Multiplism 1.29), with lower scores for Absolutism and Evaluativism (−0.73, 0.42, respectively). The third group included individuals who favored Evaluativism ($N = 142$; cluster center for Evaluativism = .85), with lower scores for Absolutism and Multiplism (−0.45, −0.62, respectively). The fourth group included individuals with the lowest Evaluativism scores ($N = 160$; -1.01 for Evaluativism) with a near-zero cluster center for Absolutism and below zero cluster center for Multiplism (0.11, −0.22, respectively). This fourth group may reflect a transition phase wherein Absolutist perspectives are being questioned, but Multiplist and Evaluativist perspectives are not embraced. The data herein suggest that the transitional group were unlikely to endorse items reflecting evaluativism (the cluster center for Evaluativism was about one standard deviation below the mean), rather than just being confused by them.

Discriminant analysis was used to examine the integrity of the epistemological orientation cluster groupings. Discriminant analysis resulted in three significant functions. The first accounted for 50.1% of the variance, with a canonical correlation of .808. The second accounted for 30.5% of the variance, with a canonical correlation of .730. And the third accounted for 19.4% of the variance, with a canonical correlation of .648. The large correlations for each of the three functions reflect the robustness of using the three subscales to discriminate among epistemological orientations. The first function was associated

Table 3
JCI Subscale Descriptives across Epistemological Orientation Groups.

JCI subscales	Epistemological orientation group				ANOVA	
	Absolutists $N = 75$	Multiplists $N = 101$	Evaluativists $N = 139$	Low evaluativists $N = 160$	$F(3, 471)$	η^2
Z-Abs	$1.611_a(0.61)$	$-0.720_a(0.65)$	$-0.448_a(0.66)$	$0.109_a(0.65)$	220.1	0.584
Abs	$3.804_a(0.56)$	$1.675_a(0.59)$	$1.923_a(0.60)$	$2.432_a(0.60)$		
Z-Mult	$-0.100_a(0.88)$	$1.290_a(0.66)$	$-0.635_a(0.73)$	$-0.218_a(0.66)$	150.27	0.489
Mult	$3.618_a(0.74)$	$4.782_a(0.55)$	$3.170_a(0.61)$	$3.519_a(0.55)$		
Z-Eval	$-0.019_a(0.78)$	$0.430_a(0.71)$	$0.866_a(0.54)$	$-1.014_a(0.57)$	239.87	0.604
Eval	$4.974_a(0.46)$	$5.236_a(0.41)$	$5.491_a(0.32)$	$4.392_a(0.34)$		

Note: $N = 475$. Each row includes a mean based on the standardized subscale scores (e.g., Z-abs) and a mean based on the raw subscale scores (e.g., Abs). Standard deviations are in parentheses. All of the E.O. pairwise comparisons were significant at $p < .001$.

with sizable correlation coefficients for Absolutism and Evaluativism: $r = -.667$, $r = .719$, respectively; the second function was associated with a large negative correlation coefficient for Multiplism: $r = -.714$; and the third function was associated with a large positive correlation coefficient for Multiplism, $r = 718$.

Classifying cases according to the discriminant functions resulted in 98.8% consistency, validating the integrity of the cluster results. Six cases out of 481 were misclassified (1 Absolutism; 1 Multiplism; 2 Evaluativism; and 2 Low Evaluativism). These misclassified cases were excluded from subsequent analyses resulting in epistemological orientation groupings that were as orthogonal as possible, yielding a well-discriminated sample of 475 out of the original 500. Of the 475 participants, 15.8% ($N = 75$) were classified as Absolutists, 21.3% ($N = 101$), as Multiplists, 29.3% ($N = 139$) as Evaluativists, and 33.7% as Low Evaluativists ($N = 160$).

Z-score means and ANOVA statistics for mean comparisons are provided in Table 3. The 75 participants categorized as Absolutists tended to have subscale scores near the middle of the scale rather than at the high end, suggesting that these participants should not be viewed as solidly Absolutist, but rather as leaning toward absolutism more than other participants. The 160 participants classified as Low Evaluativists had low scores on Evaluativism (compared to other participants) and were near the mean for Absolutism, suggesting that the Low Evaluativist Transition participants were somewhat absolutist, but clearly not endorsing evaluativist perspectives. Potential explanations for this outcome are provided later in the discussion section.

3.5. Epistemological orientations, education, and methodology course exposure

Education was scored as a categorical variable reflecting current educational level: first-year through fourth-year. The chi-square statistic for education and EO groups was significant, χ^2 (9, $N = 475$) = 19.28, $p = .023$. These results suggest that as educational level increased, the trend toward Evaluativism increased, with these trends most noteworthy in fourth-year students: 9.7% were Absolutists, 21.4% were Multiplists, and 37.9% were Evaluativists. In contrast, 21.5% of the first-year students were Absolutists, 18.1% were Multiplists, and 25.5% were Evaluativists. Also noteworthy is the substantial decline in absolutists from the second to the third year (from 22.2% to 9.8%). Overall, the association of EO and education levels suggests that absolutism is at its peak in first-year students, multiplism is at its peak in third-year students, and evaluativism is at its peak in fourth-year students. About a third of each of the groups (first-year, third-year, and fourth-year) was classified as Low Evaluativists, with the possibility that this group reflects students in transition who may not fully embrace or understand the more sophisticated perspective. Indices of effect sizes for these tests (chi-square) reflect small to medium effect sizes (Cramer's $\nu = .11$, df-smaller = 3). Row and column statistics are provided in Table 4.

The association of exposure and epistemological orientation was also significant, χ^2 (3, $N = 475$) = 14.43, $p = .002$. Proportionally, the quantity of Absolutists in the exposure group was small: 10.9% compared to 21.7% in the No-Exposure group. The quantity of Multiplists in the Exposure group exceeded the quantity in the No-Exposure group (25.2%, 16.6%, respectively), with this trend repeating for Evaluativists (31.8%, 25.5%). Indices of effect sizes for these chi-square tests reflect small to medium effect sizes ($\phi = .17$, df-smaller = 1). This outcome suggests that exposure to scientific methodologies influences epistemological development. Row and column statistics are provided in Table 4.

3.6. Research evaluation inventory (REI) analyses – vignette type

The effects of the three independent variables (research vignette, research methods course exposure, and epistemological orientation) on REI subscale scores (agreement, source, and intuition) were examined using a 2 (research vignette: science, new age) × 2 (exposure: yes, no) × 4 (epistemological orientations: absolutist, multiplist, evaluativist, and low-evaluativists) ANOVA. A main effect of vignette type on the REI subscale journal source was obtained, $F(1, 473) = 16.65$, $p < .001$, $\eta^2 = .034$. Participants who read "science" vignettes rated items related to source credibility highest, providing confirmation that the source manipulation had its intended effect. Participants were unaware of this manipulation, so none of the participants were asked to evaluate if a different source would have resulted in more or less source credibility. Table 5 includes the means and post-hoc comparisons.

Table 4
Epistemological orientations across year and research methodology course exposure.

University year *N* = 475	Abs 75	Mult 101	Eval 139	Low-Ev 160	χ^2 (3)	ϕ
First	32	27	38	52	9.42*	0.26
N = 149	21.5%	18.1%	25.5%	34.9%		
Second	20	15	23	32	6.80	0.28
N = 90	22.2%	16.7%	25.6%	35.6%		
Third	13	37	39	44	17.23***	0.36
N = 133	9.8%	27.8%	29.3%	33.1%		
Fourth	10	22	39	32	18.52***	0.42
N = 103	9.7%	21.4%	37.9%	31.1%		
Research methodology exposure			*N* = 475			
Yes	28	65	82	83	30.71***	0.35
N = 258	10.9%	25.2%	31.8%	32.2%		
No	47	36	57	77	16.79***	0.28
N = 217	21.7%	16.6%	26.3%	35.5%		

Note: Row percentages = EO cases per row variable. χ^2 values in the sixth column reflect model fitting using EO frequencies in each row. The goodness of fit statistic for Education and EO was χ^2 (9, *N* = 475) = 19.28, *p* = .023; and for Methodology Course Exposure and EO, χ^2 (3, *N* = 475) = 14.43, *p* = .002. All expected cell frequencies were greater than 5. *$p < .05$, ***$p < .001$

Table 5
REI Subscale Descriptive and ANOVA Statistics.

Vignette type	*N*	REI subscales					
		Agreement M	SD	Journal source M	SD	Intuition M	SD
Science	238	2.66	1.16	3.60	0.94	2.45	0.77
New Age	237	2.76	1.12	3.24	0.98	2.47	0.82
ANOVA		n.s.		$F(1, 473) = 16.65^{***}$		n.s.	
η^2				.034			
Exposure							
Methods – no	217	2.93	1.13	3.63	0.81	2.56	0.76
Methods – yes	258	2.53	1.11	3.24	1.06	2.37	0.81
ANOVA		$F(1, 473) = 14.43^{***}$		$F(1, 473) = 19.41^{****}$		$F(1, 473) = 6.81^{**}$	
η^2		.030		.040		.015	
Epistemological Orientation Group							
Absolutists	75	2.88	1.05	3.65_a	0.83	2.67_{ab}	0.86
Multiplists	101	2.68	1.21	3.50	1.06	2.38_a 0.81	
Evaluativists	139	2.53	1.15	3.20_a	1.12	2.26_{bc}	0.77
Low Evaluativists	160	2.82	1.04	3.44	0.80	2.57_c	0.74
ANOVA		n.s.		$F(3, 471) = 3.94^{**}$		$F(3,471) = 6.15^{***}$	
η^2				.024		.038	

Note: *N* = 475 for all analyses. Matching subscripts indicate significant post-hoc pairwise mean differences between epistemological orientations.

3.7. Research evaluation inventory (REI) analyses – methodology exposure

The independent variable, research methodology exposure, had a significant effect on all three subscales (agreement, source, and intuition), providing evidence that research methodology course exposure affected evidence-evaluation processes, F (1, 473) = 14.43, $p < .001$, $\eta^2 = .030$; F (1, 473) = 19.41, $p < .001$, $\eta^2 = .040$; and F (1, 473) = 6.81, $p < .01$, $\eta^2 = .015$, respectively. Compared to students who had not been exposed to a methodology course, students who had been exposed had lower scores for REI items reflecting agreement with the conclusions presented in the vignette; lower scores for the credibility of the journal source; and lower scores for items reflecting the use of intuitive or subjective processes while evaluating the vignette. Table 5 includes the means and post-hoc comparisons.

The interaction of EO and Exposure for the dependent variable source was nearly significant, F (3, 467) = 2.50, $p = .059$, $\eta^2 = .016$. The highest source rating means, $M = 3.92$, SD = 0.90, corresponded to no-exposure multiplists ($N = 36$); and the lowest source rating mean, $M = 2.97$, $SD = 1.20$, corresponded to exposure evaluativists ($N = 82$). This finding suggests that no-exposure multiplists were the least likely to view the source with skepticism, an outcome that is consistent with a defining characteristic of multiplist orientations: valuing multiple sources as reliable. This EO exposure interaction, while not quite statistically significant, does reflect a trend consistent with the main effects of EO and Exposure on evidence evaluation reported above. The remaining interactions were not statistically significant.

3.8. Research evaluation inventory (REI) analyses – epistemological orientation

Main effects of EO on REI subscales journal source and intuition were also observed, $F(3, 471) = 3.94$, $p < .01$, $\eta^2 = .024$; $F(3, 471) = 6.15$, $p < .001$, $\eta^2 = .038$. Participants in the evaluativist group were more likely to be skeptical of the journal source and less likely to endorse REI items reflecting intuitive processes compared to the other EO groups. Post-hoc mean difference analyses revealed that the differences between evaluativist and absolutist for two subscales (source, intuition) were significant, with absolutist means exceeding evaluativist means. The post-hoc REI intuition subscale differences between evaluativists and low-evaluativists were also significant, with low-evaluativist means greater than evaluativist means. Hence, REI means for the absolutist group reflected the least skepticism and the most endorsement of intuitive processes, whereas REI means for the evaluativist group reflected greater levels of skepticism and reduced endorsement of statements reflecting intuitive processes. These effects provide convergent validity for EO groupings. The only caveat herein is that the effect sizes obtained were small to medium for this set of analyses. Statistical quantities for these analyses are provided in Table 5.

3.9. Controlling for Education and Age

To examine the possibility that education alone (rather than research methodology exposure) influenced REI scores, ANOVAs were re-conducted, with education level as a covariate. After controlling for the effects of education level, analyses with REI agreement and REI source as the dependent variables remained significant: $F(1, 472) = 6.71$, $p = .01$; and $F(1, 472) = 5.62$, $p = .05$, respectively. Hence, course exposure may facilitate the development of research evaluation abilities beyond the influence of undergraduate education.

4. Discussion

Exploring the utility of the Justifying Conclusions Inventory (JCI) as a self-report tool for identifying epistemological orientations in undergraduates was among the goals for the present study. Factor analysis of the JCI suggested a three-factor solution, resulting in three subscales corresponding to absolutist, multiplist, and evaluativist factors. The use of cluster analysis and discriminant analysis yielded three participant subgroups corresponding to high absolutism, high multiplism, and high evaluativism. A fourth group, possibly a transitional phase, consisted of participants who scored low on evaluativism relative to the other groups.

4.1. Epistemological Orientations and Education Variables

Consistent with the hypothesized outcome, participants with higher levels of education, as well as students who had been exposed to a research methodology course, were more likely to belong to more sophisticated epistemological orientation groups (Multiplists and Evaluativists). Theoretically, these associations demonstrate that education facilitates the development of epistemic cognition in undergraduates, with training in research methodology facilitating development above and beyond development possible without methodological training.

4.2. Epistemological Orientations and Research Evaluation

Research Evaluation Inventory (REI) subscales differed significantly across epistemological orientation groups. Compared to Absolutists, Evaluativists were more likely to endorse items reflecting skepticism about the journal source and less likely to endorse items reflecting intuitive processes. Evaluativists were also less likely to endorse intuitive process items compared to Low Evaluativists; and Multiplists were less likely to endorse these items compared to Absolutists. Taken together, these results suggest that the JCI may have utility in *specific* reasoning or thinking contexts, as well as more globally.

4.3. Transitional Phase of Epistemological Development

The quantity of Low Evaluativist participants (about a third) suggests that transitioning to more sophisticated epistemological orientations may be less linear or more gradual for some individuals. It is also noteworthy theoretically that the process of transition may include skepticism about knowledge acquisition tendencies characteristic of more sophisticated perspectives (as indicated by low evaluatism in transition participants). As such, the data herein are consistent with research and theory challenging the progressive nature of epistemological development; suggesting that there may be individual differences in rates of epistemological development (Bromme et al., 2010; Greene et al., 2010; Hammer and Elby, 2002; Hofer, 2004; King and Kitchener, 2004; Kuhn et al., 2000). Developing a greater understanding of epistemological development, as well as characteristics of any transitional phases, will necessitate longitudinal approaches. Possible trajectories for transitional thinkers include: (1) gradually embracing more sophisticated perspectives; (2) struggling to become comfortable with more sophisticated epistemological perspectives; or (3) regressing to earlier perspectives until they become more comfortable cognitively with these new perspectives.

Grappling with epistemological orientations should be a relatively common undergraduate characteristic. However, the timing of epistemological development should vary across individuals depending on various factors not measured in this

study, including the quality of prior educational experiences, differences in cognitive and metacognitive abilities, and motivation. In addition, Rodriguez and Cano (2006) found that learning styles (e.g., simplistic reproductive; meaning-derivative) are related to epistemological sophistication, making it conceivable that some undergraduates are wrestling with shifts in approaches to knowledge acquisition due to maturation in learning approaches and epistemological orientations Together, these findings provides insight into why it may have been difficult to *categorize* undergraduates into epistemological orientation groups in earlier studies, and why *tracking* epistemological development in this age group empirically may be particularly challenging. Hence, increased sensitivity to transitional sub-groups and covariates such as learning styles should be a goal of future studies in this area of research, particularly when undergraduates comprise samples of interest.

4.4. Limitations

A limitation of the present study was the use of both inventories in the same study. It was necessary to use a within-subject design to examine the influence of epistemological orientation on research evaluation abilities. A pre-screening approach could be used in future studies in an effort to control potential bias that could arise from using the JCI with a second instrument designed to assess epistemological orientations or other aspects of critical thinking in a specific context or domain. A second limitation pertains to JCI cross-validation with indirect methods (education, research methodology exposure, and research evaluation responses). However, the consistency of results across variables, and across hypothesized outcomes, provides a reasonable amount of support for the validity of this inventory. A future study could include an evaluation of an ill-defined problem in an effort to explore the correlation between self-reported epistemological orientations and epistemic cognition in action.

5. Conclusions

The results of the present study substantiate the utility of the JCI as a tool to assess Absolutism, Multiplism, and Evaluativism in undergraduates. Cross-validation with cognitive processes associated with the evaluation of a scientific vignette supports this claim. In addition, the findings reported herein suggest that undergraduates may not transition quickly and unambiguously to more advanced epistemic cognitive levels, but that about a third may be questioning previous perspectives while simultaneously experiencing skepticism about more sophisticated approaches. This finding may reflect characteristics common in undergraduate samples, given that undergraduates may be experiencing epistemic development due to curricular or course emphases fostering epistemic development. For students who begin post-secondary study with absolutist leanings, the process of development may include the experience of dissonance as new ways of thinking clash with older ones. A study that includes non-students has the potential to shed light on whether post-secondary students are more likely to be in the midst of changing epistemological orientations.

Future research using the JCI could also include samples of (a) high school students; (b) undergraduates who clearly identify as one particular major (e.g., Psychology, Chemistry, English, etc.); and (c) middle-age and older adults, in an effort to examine the impact of life stage, disciplinary orientations, and/or past experiences on epistemic development. Research using quantitative instruments to assess epistemological orientations and factors associated with epistemological development has the potential to facilitate a deeper understanding of epistemological development in adults, augmenting the existing literature on epistemic cognition and critical thinking.

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Appendix A. Justifying Conclusions Inventory

Sometimes people have problems understanding certain issues and determining which conclusion is the most acceptable or correct. For example, the following issues have been subject to a great deal of debate: whether chemical additives are harmful or safe; whether the social security system should be changed or not; and whether the death penalty should be legal or not. The statements below pertain to these kinds of debatable issues. Please think of these kinds of issues as you respond to these statements. You have as long as you need to read each statement and to respond. Please take your time and read each statement carefully so that each response accurately reflects your thoughts. Please use this 1–6 scale to indicate how much you agree with each statement below.

Disagree Absolutely 1	Disagree Moderately 2	Disagree Slightly 3	Agree Slightly 4	Agree Moderately 5	Agree Absolutely 6

1. Most debatable issues have one correct conclusion, even though it seems that they do not.
2. Evidence must be evaluated to determine if it is really relevant to the issue under consideration.
3. Usually there is not a person who is right and one who is wrong. They each have their own truths so their conclusions are equally valid.
4. Most debatable issues have one right conclusion.
5. Reasonable thinking about debatable issues requires that we are willing to evaluate our own reasoning processes relevant to the issue.
6. If I have one conclusion and someone else holds a different conclusion, both conclusions are equally accurate.
7. For most debatable issues, there is a right position and a wrong position.
8. Understanding debatable issues is an ongoing process requiring the evaluation of new evidence.
9. Because drawing conclusions is based on our own personal perceptions, it is not possible to determine if one conclusion is better than others.
10. Debatable issues are associated with one correct conclusion, even though I may not know what that conclusion is.
11. Conclusions are compelling if they are supported by solid reasoning about the most relevant evidence.
12. Deciding among conclusions is unnecessary because everyone has a right to their opinion.
13. Each person has his or her own truth and beliefs, so there can be more than one acceptable conclusion to a debatable issue.
14. Drawing a conclusion about a debatable issue involves reasoning about why one conclusion is well supported and others are not.
15. Disagreements about debatable issues are really unnecessary because every person's opinion should be viewed as accurate.
16. Most issues are not truly debatable: there is one correct answer.
17. Determining the best conclusion requires the critical evaluation of all of the relevant evidence.
18. Because people have a right to their opinion, there is more than one conclusion that is correct.
19. Each person sees the issues in his or her own unique way, so there is often more than one acceptable conclusion to a debatable issue.
20. Drawing a solid conclusion about a debatable issue involves determining which evidence provides the best support for that conclusion.
21. If someone else has come to a conclusion that differs from my conclusion, and he or she can justify their conclusion, then we are both right.
22. The best conclusion reflects the most compelling understanding of an issue given the relevant evidence.
23. There is one correct conclusion to issues, and other conclusions are wrong.

Note: Absolutist = 1, 4, 7, 10, 16, 23. Multiplist = 6, 12, 15, 18, 19, 21. Evaluativist = 2, 5, 8, 11, 14, 17, 20.

Appendix B. Research Vignette

Please read the summary provided below. This summary (abstract) describes an experiment. After you read this summary, please turn the page and respond to the questions pertaining to this summary. Please feel free to take your time and think carefully about each of your responses.

Abstract from Dansk, J. & Jones, M. (2002). *(Source Manipulation)**, 24, 132–145.

Telepathy is a type of extrasensory perception or ESP. Telepathy refers to the ability to perceive thoughts from other people without using any of the five senses. This study used the Ganzfeld procedure to examine the validity of telepathy. In this procedure, participants sat in a relaxed position listening to white noise through headphones with their eyes completely covered. Because sensory stimuli were masked, this procedure is thought to create a telepathic-receptive state of consciousness. The sender sat in a room some distance from the receiver and never interacted with the participant (the receiver). At a predetermined time, the sender viewed a target picture randomly-selected from a set of four pictures. As she viewed the picture, the sender focused on sending thoughts to the receiver. Ten minutes after the end of this session, the receiver rated the target picture as well as three other pictures. Across ten trials, the ratings for the target picture (the one the sender was looking at) were significantly greater than the ratings for the non-target picture. These results suggest that information had been transmitted telepathically to the receiver, and add to evidence supporting telepathic transmission under experimental conditions.

*Source was either New Age Studies or Scientific Studies.

Appendix C. Research Evaluation Inventory

This questionnaire presents questions relating to the research article that you read. Please answer each question as honestly as you can. Please use this 1–6 scale to indicate how much you agree with each statement below.

Disagree Absolutely	Disagree Moderately	Disagree Slightly	Agree Slightly	Agree Moderately	Agree Absolutely
1	2	3	4	5	6

1. This article increased my belief in the accuracy of claims about telepathy.
2. For topics like telepathy, I rely on my own views when I draw conclusions.
3. The experiment described in this article is well-conducted.
4. My personal experiences are consistent with the research presented in this article.
5. People who do not believe in telepathy are closed-minded.
6. This article had no effect on belief in telepathy.
7. It is not logical to claim that telepathy exists.
8. This research was published in a reputable source.
9. Scientific evidence is not useful when evaluating claims about telepathy.
10. The claims made by people who have had telepathic experiences are likely to be accurate.
11. The experiment described in this article is well-designed.
12. This article increased my belief in telepathy.
13. It is necessary to keep an open-mind when evaluating evidence about telepathy.
14. The journal publishing this research is well-respected scientifically.
15. Because it is easy to conceive that telepathy exists, claims about telepathy are accurate.

16. Scientific experiments can help people determine if telepathy exists.
17. This article increased my belief in paranormal phenomenon (i.e., telepathy, clairvoyance, spirits, psychic energy, auras, etc.)
18. My religious beliefs do NOT have an impact on how I view the research in this article.

Note: Agreement = 1, 6 (reverse), 12, 17. Source = 8, 11, 14. Intuition = 4, 5 (reverse), 10, 15.

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