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Epistemic curiosity, feeling-of-knowing, and exploratory behaviour

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The present study investigated how knowledge-gaps, measured by feeling-of-knowing, and individual differences in epistemic curiosity contribute to the arousal of state curiosity and exploratory behaviour for 265 (210 women, 55 men) university students. Participants read 12 general knowledge questions, reported the answer was either known (''I Know''), on the tip-of-the-tongue (''TOT''), or unknown (''Don't Know''), and indicated how curious they were to see each answer, after which they could view any answers they wanted. Participants also responded to the Epistemic Curiosity (EC) and Curiosity as a Feeling-of-Deprivation (CFD) scales. ''TOT'' was associated with the smallest knowledge-gap, most curiosity and exploration, and feelings of uncertainty and tension as measured by the CFD scale. ''Don't Know'' corresponded with the largest knowledge-gap, less curiosity and exploration, and positive feelings of interest as measured by the EC scale. ''I Know'' states, which reflected the absence of a knowledge-gap, involved the least curiosity and exploration.

Epistemic curiosity reflects a desire for new information that motivates exploratory behaviour and knowledge acquisition (Berlyne, 1954). As an emotional-motivational state, epistemic curiosity is complex in that its arousal can involve positive feelings of interest associated with the anticipation of learning something new, as well as relatively unpleasant feelings of uncertainty due to a lack of knowledge (Litman & Jimerson, 2004). Epistemic curiosity states are aroused by novel questions, complex ideas, ambiguous statements, and unsolved problems, all of which may point to a ''gap'' in one's knowledge, and reveal a discrepancy between that which one knows and desires to know (Berlyne, 1954, 1960, 1966; Litman & Spielberger, 2003; Loewenstein, 1994). Thus, the purpose of epistemic curiosity is to motivate exploration aimed at

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resolving discrepancies in one's knowledge (Dember, 1960; Keller, Schneider, & Henderson, 1994; Loewenstein, 1994).

According to Loewenstein (1994; Loewenstein, Adler, Behrens, & Gillis, 1992), the perceived magnitude of a discrepancy between known and desired information is determined by making a *feeling-of-knowing* (FOK) judgement—a metacognitive evaluation of the extent of one's available knowledge (Brown & McNeill, 1966; Eysenck, 1979; Hart, 1965). Stronger FOK experiences result in smaller perceived discrepancies (knowledge-gaps) between known and unknown information, and correspond with feeling closer to possessing the desired knowledge (e.g., the answer to a question).

Typically, FOK is examined in relation to ''tip-of-the-tongue'' (''TOT'') states, which are considered to reflect either partial retrieval of a target word from memory or familiarity with a target's cue. An individual who experiences a ''TOT'' state might be able to produce the first letter of a target, or a highly associated word, while being unable to recall the desired target (see Koriat, 1998 for a discussion). Subjective experiences of ''TOT'' may vary in intensity, and have been described as feelings of ''tingling, torment, or turmoil'' (Schwartz, Travis, Castro, & Smith, 2000, p.19), accompanied by a sense that the target may pop into memory at any moment (Koriat & Lieblich, 1974; Nelson, Gerler, & Narens, 1984; Widner, Smith, & Graziano, 1996). In previous research, ''TOT'' intensity has correlated positively with recognition accuracy in subsequent memory tests, suggesting that individuals are at least somewhat aware of the unsuccessfully retrieved contents of their long-term memory (Kozlowski, 1977; Schwartz, et al., 2000).

Although the term ''feeling-of-knowing'' is used primarily to denote situations where individuals believe they possess knowledge, but cannot seem to fully retrieve it (i.e., ''TOT'' states), other knowledge states also appear to be determined based on similar metacognitive appraisals. When individuals conclude that they do not know (cannot even partially retrieve) the answer to a given question, they may reference a ''feeling-of-not-knowing'' (Glucksberg & McCloskey, 1981; Kohlers & Palef, 1976; Koriat & Lieblich, 1974). Likewise, when information appears to have been retrieved successfully from long-term memory, ''feelings-of-certainty''[1] are involved in judging whether it is accurate (Bacon et al., 1998; Murdock & Duffy, 1972). Thus, ''TOT'', knowing, and not knowing may be considered to reflect qualitatively distinctive FOK states that can vary in intensity.

Regarding the experience and expression of epistemic curiosity, Loewenstein (1994) predicts, somewhat counterintuitively, that when a discrepancy is

[1] Even when individuals report that they know an answer, such determinations are still subjective and may correspond with retrieval of the wrong target, erroneously believed to be correct (Koriat, 1998).

recognised between known and desired knowledge, FOK's that lead individuals to believe they have access to more information (smaller knowledge-gaps) will arouse more curiosity and stimulate more exploratory behaviour than perceptions of having less information (larger knowledge-gaps). These predictions are based on the approach-gradient principle of motivation (Miller, 1959), which holds that the intensity of motive states peaks as one approaches achievement of a goal—in this case, that of ''closing'' the knowledge-gap, and eliminating the discrepancy between known and desired information. Loewenstein (1994) suggests that the elimination of discrepancies in knowledge corresponds with an equivalent reduction in feelings of tension associated with uncertainty. Thus, Loewenstein (1994) considers knowledge-seeking to be energised more by uncertainty-reduction than by the anticipation of learning something interesting.

Loewenstein (1994) hypothesises that when individuals experience a ''TOT'' type of FOK state they will feel very close to resolving the discrepancy, state epistemic curiosity should approach its peak, and individuals will be more likely to engage in exploratory behaviour to obtain the desired knowledge. However, if individuals experience a ''feeling-of-not-knowing'', they will not feel close to discrepancy resolution, and less curiosity and exploration should follow. When the desired knowledge is believed to have been successfully retrieved, and there is no appreciable discrepancy in knowledge, Loewenstein (1994) predicts that little or no curiosity and exploration would follow.

In one study, Loewenstein et al. (1992) presented participants with a list of definitions (e.g., ''A monster, half bull, that was confined in a labyrinth'') and asked them to indicate whether they did or did not know the target word that corresponded with each definition. If they reported knowing the answer (''I Know'' FOK state), participants indicated how certain (an FOK intensity measure) they were of its accuracy. If they did not know the target word, participants were then asked if they were in a ''TOT'' FOK state, and to rate the intensity of their ''TOT''. To measure epistemic curiosity states, participants ranked each definition according to the order of their preference to learn the correct word.

As expected, Loewenstein et al. (1992) found that ''TOT'' states corresponded with more epistemic curiosity than ''Don't Know'' states, and ratings for the intensity of ''TOT'' correlated positively with curiosity rankings. When participants reported an ''I Know'' state, they experienced the least curiosity, while the associated FOK intensity ratings were negatively correlated with curiosity. Loewenstein et al.'s (1992) findings demonstrated that smaller knowledge-gaps, as measured by FOK states and intensity levels, were associated with more curiosity, and provided evidence supporting his approach-gradient theory.

While we were impressed with Loewenstein's theory and empirical findings, we note two important limitations to his research. First and foremost, Loewenstein et al.'s (1992) study only employed self-reports. They did not provide opportunities for their study participants to engage in any actual knowledge-seeking (e.g., look up target words), which is assumed to be the quintessential behavioural expression of epistemic curiosity[2] (Berlyne, 1954, 1960; Loewenstein, 1994; Litman & Spielberger, 2003). Thus, Loewenstein's (1994) hypotheses concerning the relationships among FOK, state curiosity, and exploratory behaviour remain untested.

Second, Loewenstein (1994; Loewenstein et al., 1992) dismissed, and consequently did not investigate, the role of individual differences in tendencies to experience epistemic curiosity as a personality trait. According to the state-trait theory of emotion and personality, individuals characterised by high levels of a particular trait will experience the corresponding emotional-motivational state with greater intensity as compared to those who are low in the trait under similar conditions (Spielberger, 1972; Spielberger, Ritterband, Sydeman, Reheiser, & Unger, 1995). Thus, in studying the factors that are implicated in the arousal of epistemic curiosity, a consideration of individual differences in personality is important, as trait epistemic curiosity is theorised to influence the arousal of the corresponding emotional-motivational states that energise exploration (Litman & Spielberger, 2003; Peters, 1978; Spielberger, Peters, & Frain, 1976; Spielberger & Starr, 1994).

Building on state-trait theory, Litman and Jimerson (2004) theorise that there are also individual differences in the kinds of emotions people experience when their curiosity is aroused, which can reflect pleasurable feelings of interest and also unpleasant experiences of uncertainty. As Loewenstein (1994) suggests that exploratory behaviour is more strongly motivated when curiosity primarily reflects the latter case, the role of individual differences in the qualitative experience of curiosity is also an important consideration in research on the arousal of epistemic curiosity states.

The major goal of the present study was to further investigate the hypothesised relationships between FOK and epistemic curiosity states, and between these variables and actual exploratory behaviour. In keeping with the first goal, we also assessed whether different feelings-of-knowing were associated with varying degrees of actual knowing. A second major goal was to investigate the role of individual differences in both the intensity and affective experience of epistemic curiosity.

We presented our study participants with 12 general knowledge questions, each of which could be answered with a single word, and evaluated the intensity

[2] It is interesting to note that while there have been many studies of visual or manipulative forms of exploration, such as inspection of shapes or patter (Berlyne, 1957, 1958) or the operation of puzzles (e.g., Henderson & Moore, 1979), there has been surprisingly little research on exploratory behaviour in which the specific goal was to acquire new knowledge. Notable exceptions include Lowry and Johnson (1981) who provided students with opportunities to freely engage in library research in order to learn more about controversial topics, and Peters (1978) who assessed question-asking behaviour by students in a classroom when confronted by either a ''threatening'' or ''non-threatening'' instructor.

of FOK for three different types of FOK states. Participants reported that the target word was either known (''I Know''), on the tip-of-the-tongue (''TOT''), or unknown (''Don't Know''). After reporting on their type and intensity of FOK for each item, the participants then indicated how curious they were to learn the corresponding answer. Shortly thereafter, participants were given opportunities to engage in free epistemic exploratory behaviour, and were able to find out the correct answer to any question that they wanted. Participants also responded to two scales that assessed individual differences in tendencies to experience epistemic curiosity as feelings of either ''interest'' or ''uncertainty''.

Based on previous FOK research (e.g., Bacon et al., 1998; Brown & McNeil, 1966; Glucksberg & McCloskey, 1981), we predicted that the most accurate memory would be associated with ''I Know'', followed by ''TOT'' and ''Don't Know'' states, and anticipated that FOK intensity would be positively related with memory-accuracy for each FOK state. We also expected that participants would experience more intense FOKs for ''I Know'' and ''TOT'' states as compared to ''Don't Know'' states.

In keeping with Loewenstein's (1994) approach-gradient theory of epistemic curiosity, we hypothesised that the highest state curiosity would correspond with ''TOT'', intermediate curiosity would be aroused when the answer was not known, and the least curiosity would accompany knowing the answer. We expected a corresponding pattern for the degree of exploratory behaviour exhibited by participants for these three FOK states. We predicted that FOK intensity and epistemic curiosity states would correlate positively for ''TOT'' and ''Don't Know'', but negatively for ''I Know'' state intensity.

Consistent with state-trait theory (Spielberger, 1972; Spielberger et al., 1995), scores for the trait epistemic curiosity measures were expected to be positively correlated with the arousal of curiosity states across the three types of FOK. However, in accordance with Loewenstein (1994), we anticipated that the most exploratory behaviour would be associated with curiosity states that primarily reflected feelings of uncertainty and tension. To evaluate the complex relationships between epistemic curiosity traits and states, FOK, and exploratory behaviour, several models were tested using path analysis. Also in keeping with state-trait theory, we expected that both curiosity traits and FOK would be directly related to the arousal of state curiosity, and that state curiosity would have a direct effect on exploratory behaviour.

METHOD

Participants

The participants were 265 students (210 women, 55 men) recruited from undergraduate psychology courses at a large urban university, ranging in age from 18 to 40 ($M = 20.97$; $SD = 5.10$). Participants received extra credit toward their final grade in one psychology course for taking part in this study.

Instruments and materials

All participants responded to (1) a general knowledge questionnaire designed to assess FOK and epistemic curiosity states; (2) a curiosity-trait questionnaire; and (3) a set of exploratory behaviour materials. A number of participants were selected at random to also receive a recognition-memory test. Each instrument or set of materials is described below.

General knowledge questionnaire. This questionnaire was comprised of 12 items that were selected from a database of 300 general knowledge questions, for which normative data on recall accuracy is known (Nelson & Narens, 1980). Each item was a question that could be answered with one word (e.g., Q: ''What is the last name of the man who began the reformation in Germany?'' A: ''Luther''). To ensure a range of FOK responses, the 12 general knowledge questions varied by normative probability (p) of correct recall and subject matter, by which the order of item presentation was counterbalanced. Mean p recall across items ranged from .078 to .837, and topics included history, literature, and science. Participants were given a separate sheet of paper on which to write down the answers they reported knowing.

Participants' metacognitive judgements of knowing the answers to the 12 general knowledge questions were assessed using two complementary methods: For each item, the participants first indicated their type of FOK state, by reporting either ''I don't know the answer'', ''The answer is on the tip-of-my-tongue'', or ''I know the answer''. If participants reported that they knew the word, they were asked to write down the correct answer. Each FOK state was considered to reflect a qualitatively distinctive experience, and hypothesised to correspond with subjective judgements of failed (''Don't Know''), incomplete (''TOT''), or successful (''I Know'') retrieval of the target. Similar methods have been used in previous research for differentiating between ''TOT'' states and other knowledge states (Brown & McNeil, 1966; Koriat & Lieblich, 1974; Loewenstein et al., 1992).

Next, participants reported the intensity of their FOK's. For ''I Know'' states, participants were asked to indicate how confident they were that the answer they gave was correct. For both ''TOT'' and ''Don't know'' states, participants were asked to indicate how confident they were that they could identify the correct answer in a multiple choice test. All FOK intensity (confidence) ratings were made on a 5-point likert-type scale anchored by ''not at all confident'' and ''very confident''. Similar measures of FOK intensity have been used in previous research labelled variously as ''confidence'', ''certainty'', or ''prediction of knowing'' (Bradley, 1981; Freedman & Landauer, 1966; Libert & Nelson, 1998; Loewenstein et al., 1992). In order to assess the intensity of epistemic curiosity states aroused by each item, the participants were asked to indicate how curious they were to see the answer to each question on a 4-point likert-type scale with ‘‘not at all curious’’ and ‘‘very curious’’ as the anchors.

Recognition-memory test. For this instrument, the general knowledge items from the questionnaire were readministered, with answer alternatives presented in a multiple choice format. Plausible alternatives were provided as distractors for each general knowledge item, for example, ‘‘What is the name of the brightest star, excluding the sun? (a) Polaris, (b) Sirius, (c) Cassiopeia, (d) Orion’’, and the position of the correct answer was varied for each question.

Curiosity-trait questionnaire. This questionnaire consisted of the 10-item Epistemic Curiosity scale (EC; Litman & Spielberger, 2003) and the 15-item Curiosity as a Feeling-of-Deprivation scale (CFD; Litman & Jimerson, 2004). The EC scale was specifically designed to measure individual differences in Berlyne’s (1954) concept of epistemic curiosity, and emphasises pleasurable feelings of interest and joy associated with learning (e.g., ‘‘I enjoy learning about subjects that are unfamiliar to me’’), whereas the CFD scale appears to measure aspects of Berlyne’s construct that involve relatively unpleasant feelings of uncertainty and tension that motivate ardent knowledge seeking (e.g., ‘‘I’m uncomfortable when I don’t understand an idea or concept, and will try hard to make sense of it’’).

In responding to each curiosity-trait item, which were presented in a mixed order, the participants were instructed to report how they ‘‘generally feel’’ by rating themselves on the following 4-point frequency scale: 1= Almost Never, 2= Sometimes, 3= Often, 4= Almost Always. This rating scale has been used extensively to evaluate individual differences in curiosity and other personality traits (Spielberger, 1979, 1983, 1988; Spielberger, Peters, & Frain, 1976). In previous research, the alpha coefficients for the EC and CFD scales were satisfactory, ranging between .82 and .85 (Collins, Litman, & Spielberger, 2004; Litman, 2000; Litman & Jimerson, 2004; Litman & Spielberger, 2003).

Exploratory behaviour materials. These materials consisted of a bundle of sealed business card-sized envelopes, which were rubber-banded together. On the outside of each envelope, a general knowledge question was printed, exactly as it appeared in the questionnaire. Inside each envelope, the correct answer to the corresponding question was printed on a slip of card paper.

General procedure

The questionnaires and other materials were administered in group-testing sessions. At the beginning of the testing session, the experimenter introduced himself to the participants, explained that the goals of the study were to learn about the feelings, attitudes, and general knowledge of college students, and that additional information about the study would be provided later. The participants were informed that the study would be conducted in two phases: (1) Personality Assessment; and (2) General Knowledge Assessment. During each phase they would be given a questionnaire booklet, and other materials as needed. Participants were asked to raise their hands after they finished responding to each questionnaire or set of materials, or if they had questions at any time during the study, and an experimenter would come over to provide assistance. The order that the two phases were carried out was counterbalanced over testing sessions. Specific procedures associated with each of these two phases are described below.

Personality assessment

During this phase, the participants were given the curiosity-trait questionnaire, with the following instructions: ''A number of statements that people use to describe themselves are given below. Read each statement and then indicate how you *generally* feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer that seems to describe how you *generally* feel''.

General knowledge assessment

For this phase, participants were first given the general knowledge questionnaire, which was used for assessing FOK and epistemic curiosity states. The following instructions were printed on the questionnaire cover sheet:

> We are interested in your feelings about knowing the answers to questions. Please read each of the following questions and decide whether (a) you know the answer, (b) the answer is on the tip-of-the-tongue or, (c) you do not know the answer. After you choose *one* of these alternatives, you will also be asked to indicate your degree of confidence, using a 5-point scale. Be sure that the confidence rating that you give corresponds to the alternative that you have already indicated. We are not interested in your accuracy, and these questions do not constitute an intelligence test. Work at your own pace, but do not spend too much time deciding on your responses.

Following these general instructions, a second set of instructions was provided, which was parallel those on the cover sheet, but also included a detailed definition of each FOK state.

> After you have read each question, you will be asked to indicate one of the following responses: (a) *I know the answer.* The 'I know' response indicates that you feel that you have reported the correct answer above. If you feel that you know the answer, you should also write the answer down on the separate sheet of paper that was given to you. If you feel that you have written down the correct answer,

indicate how confident you feel that the answer you gave is the correct one. (b) *The answer is on the tip-of-my-tongue, but I can't think of the exact word.* The 'tip-of-the-tongue' response indicates that you feel that you know the correct answer, even though you cannot remember the exact word that corresponds with the answer at the moment. If you feel that the correct answer is on the tip-of-your-tongue, indicate how confident you feel that you could pick out the correct answer if you saw it on a multiple-choice test. (c) *I don't know the answer.* The 'I don't know' response indicates that you feel that you do not know the correct answer. If you feel that you don't know the answer, how confident you feel that you could pick out the correct answer if you saw it on a multiple-choice test.

After reading these instructions, the questionnaire began on the following page. Each page of the booklet was reserved for a single general knowledge item, for which the question was printed in bold at the top of the page (e.g., ''What is the name of Socrates' most famous student?''), and the FOK and curiosity measures were presented below. After reporting their FOK state and intensity (confidence), participants were then asked to indicate how curious they were to see the correct answer.

Once a participant completed responding to the general knowledge questions, his or her materials were collected, and the participant was given either the recognition-memory test or an instruction sheet with the exploratory behaviour materials.

A subsample of 60 participants was randomly selected to receive the recognition-memory test, which had the following instructions: ''For each of the following questions choose the correct answer. If you aren't certain, make your best guess''. Once the participant finished, the test was collected, and he or she was given the exploratory behaviour materials. The exploratory behaviour materials (envelopes) were set face down in front of the participant, who was directed to carefully read the following instructions before proceeding:

Inside each envelope there is an answer to one of the general knowledge questions that you were previously asked. You are free to open any of the envelopes that you wish, but you should only open the envelopes that relate to those questions for which you genuinely want to see the answers. Feel free to look in one, some, all, or none of the envelopes. You are not required to open any of the envelopes, and whether you open an envelope is entirely your choice. There is no time limit, and you may take all of the time that you wish. To open an envelope, simply break the red seal. Inside each envelope, there is a slip of card paper. On that slip of paper is the answer that corresponds with the question printed on the envelope. When you have finished with the envelopes, please raise your hand, and the experimenter will come over and collect your materials.

Approximately 30–45 minutes were required to respond to the questionnaire instruments and exploratory behaviour materials. Once a participant had finished taking part in the study, all remaining materials were collected, and an educational debriefing form with references for relevant scholarly work on curiosity and feeling-of-knowing was provided. Participants were asked to not discuss the study with other students and thanked for taking part in the study.

RESULTS

The results are divided into four sections. In the first section, the criterion validity of the three types of FOK states is evaluated to determine whether FOK intensity (confidence) ratings and memory accuracy varied by FOK state as expected. In the second section, the hypothesised relationships between FOK, state epistemic curiosity, and exploratory behaviour is investigated. In the third section, the correlations between epistemic curiosity traits and states, FOK, and exploration will be examined, and specific predictions concerning the nature of these relationships will be evaluated with path analysis.

Criterion validity of FOK states

Summary statistics for the intensity of FOK states and free-recall accuracy indices for ''I Know'' states during the general knowledge questionnaire phase are reported in Table 1 for the sample of 265 participants. A repeated measures ANOVA indicated that intensity levels differed significantly due to the type of FOK state, $F(2, 528) = 1193.32$, $p < .001$; all mean differences were significant, as indicated by Tukey tests. These findings suggested that more intense FOK's were associated with knowledge-gaps that were perceived as smaller and highest when no gap was perceived at all. An analysis of the effect sizes of these differences (Cohen's *d*) indicated there was a large effect ($d > 0.80$) for the ''Don't Know''/''I Know'' and ''Don't Know''/''TOT'' differences, but only a small effect was found for the ''TOT''/''I Know difference ($d = 0.28$). The

TABLE 1
Summary statistics for intensity of FOK states and free-recall accuracy indices for "I Know" states ($N = 265$)

		FOK state		
		''Don't Know''	*''TOT''*	*''I Know''*
FOK intensity	M^1	1.95^a	3.56^b	3.72^c
	SD	0.64	0.83	0.30
	α	.52	.54	.52
				$p(\text{recall})^2 = .75$ Point biserial $r = .40$***

[1] Refers to the proportion of answers that were accurately recalled while reading the general knowledge item questionnaire.
[2] Means with different superscripts are significantly different from one another ($p < .05$).
*** $p < .001$.

alphas for FOK intensity ratings were low (M $\alpha = 0.537$), suggesting that the intensity of FOK states varied considerably across general knowledge items.

The proportion of answers correctly recalled, *p*(recall), when participants indicated an ''I Know'' FOK state is reported in the bottom right corner of Table 1; the correlation between the intensity of ''I Know'' states and *p*(recall) are reported here as well. ''I Know'' states were associated with a *p*(recall) of .75, while the associated intensity levels were moderately positively correlated (r = .40) with accurately recalled answers. These findings provided evidence that ''I Know'' states were positively associated with actual knowing, and that accuracy was improved when FOK's were more intense.

Recognition accuracy indices for FOK states and FOK intensity are reported in Table 2 for the subsample of 60 participants (43 women, 17 men) who received the memory test.[3] In order to estimate the overall magnitude of the relationship between FOK states and recognition accuracy, the Goodman-Kruskal gamma coefficient, which is an index of association for data in ordered tables, was computed (for a detailed discussion of the appropriateness of gamma, see Nelson, 1984). To evaluate whether individual FOK states were related to different retrieval outcomes, the proportion of correctly recognised answers associated with each type of FOK state was also computed, as were Point-biserial correlations between intensity levels and correctly recognised answers for each FOK state.

The moderately strong gamma coefficient of .43 provided evidence that individuals were generally metacognitively aware of whether they did or did not know something. As hypothesised, the highest proportion of correctly recognised answers was associated with ''I Know'' FOK states, while the lowest proportion corresponded with ''Don't Know'' states. However, as may be noted in Table 2, there was essentially no difference in accuracy between ''TOT'' and ''Don't Know'' states, which was unexpected. Small positive correlations were found between FOK intensity and recognition accuracy for ''I Know'' (r = .24; M = 4.23; SD = 1.00) and ''TOT'' (r = .14; M = 3.65; SD = 0.95) FOK states. Interestingly, FOK intensity ratings were uncorrelated with accurate recognition for ''Don't Know'' states (r = .07; M = 1.81; SD = 0.93). These findings indicated that participants were somewhat more aware of the extent of their knowledge when they felt that they had either partially or fully retrieved an answer. These findings for both the total sample and the subsample provided evidence of criterion validity for the FOK states that was generally consistent with expectations.

[3] As previously noted, the 60 participants who were given the recognition-memory test did so after responding to the general knowledge questionnaire and without any forewarning. Therefore, taking the memory test could not have influenced their responses to any of the items found within this questionnaire, and data from these 60 participants were included in all subsequent analyses of state epistemic curiosity.

TABLE 2
Recognition accuracy indices for FOK states and intensity ($n = 60$)

FOK state	*p(recognised)*[1]	*Point-biserial r with FOK intensity*
"*Don't Know*"	.51	.07
"*TOT*"	.52	.14*
"*I Know*"	.79	.24***
	Gamma = .43***	Overall = .26***

[1] Refers to the proportion of answers that were accurately recognised during the memory test.
rbp = point-biserial correlation.
* $p < .05$; *** $p < .001$.

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In order to determine whether the intensity of epistemic curiosity states varied due to the type of FOK, a repeated measures ANOVA was computed for the total sample of 265 participants. As hypothesised, FOK states were significantly associated with the intensity of state epistemic curiosity, $F(2, 528) = 113.14$, $p < .001$). Means and alpha coefficients for state curiosity associated with each FOK state are reported in Table 3, for which mean differences were analysed with Tukey tests. The highest curiosity states were associated with "TOT", while curiosity states were of an intermediate intensity for "Don't Know" and lowest for "I Know" states. Large effects ($d > 0.80$) were found for the "I Know"/"TOT" and the "Don't Know"/"TOT" difference, while a small effect was found for the "I Know"/"Don't Know" difference ($d = 0.23$). The alphas for the measures of state curiosity associated with each type of FOK were somewhat low but acceptable ($M\ \alpha = .726$), especially considering that these were based on responses to a heterogeneous set of general knowledge questions, rather than responses to items that assessed a single construct (Nunnally, 1967, 1978).

The proportion of answers examined during the exploratory behaviour phase associated with each FOK state is also reported in Table 3 for the total sample.[4] As expected, "TOT" FOK states were associated with the most exploratory behaviour, followed by "Don't Know", while participants engaged in the least exploratory behaviour when they experienced "I Know" states. These differences in exploratory behavior were significant, as indicated by a chi-square test,

[4] Because the exploratory behaviour of those participants who were given the recognition-memory test might have been influenced by taking the test, their behaviour was compared with the rest of the sample using a chi-square test. As no significant difference was found, the data for these two groups were combined.

TABLE 3
Summary statistics of state epistemic curiosity and exploratory behaviour associated with each FOK state (N = 265)

		FOK state		
		''Don't Know''	*''TOT''*	*''I Know''*
State epistemic curiosity	M^1	2.79[a]	3.43[b]	2.59[c]
	SD	0.80	0.63	0.91
	α	.81	.67	.71
	p(explore)[2]	.63	.79	.52

[1] Means with different superscripts are significantly different from one another (p < .05).
[2] Refers to the proportion of answers that were examined during the exploratory behaviour phase.

$\chi^2(2) = 153.23$, $p < .001$. Although ''I Know'' states were associated with the least exploration relative to other FOK states, it is interesting to note that a substantial degree of exploration was still exhibited even when participants believed that the answer was already known.

Evaluating the relationships between epistemic curiosity traits and states, FOK, and exploratory behaviour. Correlations between state epistemic curiosity, FOK intensity, and exploratory behaviour for each type of FOK state are reported in Table 4. Small positive correlations (M r = .21) were found between state curiosity and intensity levels for ''Don't Know'' and ''TOT'' states. By contrast, state curiosity was negatively correlated with ''I Know'' states ($r = -.14$). Thus, as expected, when individuals determined that they had failed or only partially succeeded in producing an answer, more intense FOKs corresponded with somewhat greater state curiosity. However, when participants believed that they had successfully retrieved the desired information, stronger FOKs tended to attenuate curiosity reactions.

Small to moderate positive correlations (M r = .355) were found between state epistemic curiosity and exploratory behaviour for ''Don't Know'' and ''I Know'' FOK states. Although state curiosity also correlated positively with exploration for ''TOT'' FOKs, the magnitude was very small (r = .12). While these findings indicated that more intense curiosity states corresponded with more exploratory behaviour, the small relationship between these variables for ''TOT'' states was unexpected. Upon further inspection of the data, it was revealed that over 85% of the ''TOT'' state curiosity ratings were 3 or 4; as noted previously, the maximum possible state curiosity rating was a 4. While this finding indicated that, as hypothesised, ''TOT'' states aroused very intense levels of state curiosity, it also suggested that the likert-type scale used in the present study was too restrictive, resulting in a ceiling effect that attenuated the correlation between ''TOT'' and curiosity.

TABLE 4
Correlations between state epistemic curiosity, FOK intensity, exploratory behaviour, and measures of trait epistemic curiosity associated with each FOK state (N = 265)

	State epistemic curiosity			*FOK intensity*			*Exploratory behaviour*		
	''Don't Know''	*''TOT''*	*''I Know''*	*''Don't Know''*	*''TOT''*	*''I Know''*	*''Don't Know''*	*''TOT''*	*''I Know''*
FOK intensity	**.26**	**.16**	−**.14**						
Exploratory Behaviour	**.41**	**.12**	**.30**	**17**	.04	−**.22**			
CFD scale	**.14**	**.25**	.01	.06	**.14**	.00	.09	.03	.03
EC scale	**.23**	**.12**	.01	.07	**.17**	.02	.10	−.02	.01

Note: Significant correlations are in bold. $r \geq .12 = p < .05$; $r \geq .16 = p < .01$; $r \geq .20 = p < .001$

FOK intensity and exploratory behaviour were positively correlated for ‘‘Don’t Know’’ FOK states, but negatively for ‘‘I Know’’ FOK’s. Finding that these correlations were in the same direction as those found between state curiosity and exploration is consistent with the fundamental assumption that the formation of FOK judgements and the arousal of curiosity are related internal processes, which are both implicated in the motivation of exploratory behaviour. However, in the light of these findings, the absence of a significant positive correlation between these variables for ‘‘TOT’’ states was difficult to interpret.

The correlations among the measures of state epistemic curiosity, FOK intensity, and exploratory behaviour suggested that when individuals felt they had experienced failed or partial information retrieval, stronger FOKs were associated with more intense state curiosity reactions and more exploratory behaviour. However, when individuals felt that their retrieval attempt was successful, weaker FOKs were associated with more state curiosity and exploration. These findings were generally consistent with Loewenstein’s (1994) approach-gradient view of epistemic curiosity.

Correlations of the EC and CFD scales with state epistemic curiosity, FOK intensity, and exploratory behaviour are also reported in Table 4 for each type of FOK state. Given that the likert-type state curiosity measure was relatively ‘‘affect free’’, information about the nature of the specific emotions that were experienced when curiosity was aroused (e.g., ‘‘interest’’ or ‘‘uncertainty’’) could be inferred based on the correlations between state curiosity and the two trait epistemic curiosity scales. Along similar lines of reasoning, the size of these correlations indicated the extent to which the intensity of epistemic curiosity states was influenced by individual differences in personality as measured by the two trait scales.

As would be expected, the EC ($M = 26.83$; $SD = 5.46$; $\alpha = .82$) and CFD ($M = 38.01$; $SD = 7.30$; $\alpha = .83$) scales correlated very highly and positively with each other ($r = .70$); collapsing across FOK types, the EC and CFD scales were about equally associated with curiosity states ($M\ r$ = EC .135; $M\ r$ CFD = .138). However, as may be noted in Table 4, the two curiosity scales correlated quite differently with state curiosity depending on the type of FOK. For ‘‘Don’t Know’’ FOKs, the EC scale, was correlated almost twice as highly with curiosity states ($r = .23$) as compared to the CFD scale ($r = .14$). By contrast, for ‘‘TOT’’, the CFD scale correlated twice as strongly with state curiosity ($r = .25$) as compared to the EC scale ($r = .12$). The difference between these correlations was marginally significant for ‘‘Don’t Know’’, $t(262) = -1.93$; $p < .06$, and significant for ‘‘TOT’’ states, $t(262) = 2.81$; $p < .01$). Unexpectedly, when participants reported ‘‘I Know’’, neither of the two trait scales correlated with epistemic curiosity states.

These findings suggested that when participants’ retrieval efforts had failed, state epistemic curiosity was somewhat more associated with tendencies to experience feelings of interest and joy in anticipation of learning something new. By contrast, partial retrieval outcomes involved curiosity states that reflected tendencies to feel uncertainty and tension when lacking information. Finding that CFD scale scores were more highly related to ''TOT'' states is also consistent with the ''tingling'' and ''turmoil'' that is characteristic of this type of FOK. However, it should be noted that while the correlations found between epistemic curiosity states and traits for ''Don't Know'' and ''TOT'' states were significant and in the expected direction, the magnitude of these correlations indicated that the arousal of curiosity was only modestly influenced by individual differences in personality. Because no significant correlations were found between curiosity states and traits when participants reported ''I Know'' the answer, the nature of the emotions that were experienced is unclear.

The CFD and EC scales were uncorrelated with FOK intensity for ''Don't Know'' and ''I Know'' types of FOK states, but correlated significantly and positively with the FOK intensity associated with ''TOT'' states. This finding suggested that individual differences in trait curiosity may bias feelings about the content of one's memory when one believes that information is on the tip of his or her tongue. Given that FOK states may be conceptualised as memory appraisals that are emotional in nature, this finding is not inconsistent with state-trait theory, and is particularly interesting, considering that ''TOT'' states were not found to be very good predictors of actual knowing in the present study. The two trait curiosity scales were essentially uncorrelated with the degree of exploratory behaviour exhibited.

The correlations among the measures of epistemic curiosity traits and states, FOK intensity, and exploratory behaviour were generally consistent with state-trait theory, and suggested that individual differences in personality traits are associated with differential tendencies to experience corresponding emotional states when information retrieval fails or is only partially successful, while the arousal of such states was related to engaging in subsequent exploratory behaviour for all three FOK states.

To further evaluate the complex relationships among trait and state epistemic curiosity, FOK intensity and exploratory behaviour, path analyses were conducted. In keeping with the state-trait theory of emotion and personality, we presumed a linear, nonrecursive relationship among these variables, conceptualised as a kind of ''chain reaction'', such that trait variables were hypothesised to directly exert their influences on state variables, which in turn would have a direct effect on behaviour.[5] Guided by this theoretical view, and Loewenstein's (1994) approach-gradient theory of curiosity, we hypothesised

[5] We recognise that it is inappropriate to infer causality, given the correlational design of the present study. Our use of language that implies ''cause and effect'' is meant to be taken entirely within the context of our theoretical orientation regarding epistemic curiosity traits and states, FOK, and exploration.

that the arousal of epistemic curiosity states was directly influenced by FOK intensity and by individual differences in trait epistemic curiosity, as measured by the EC and CFD scales. We further hypothesised that exploratory behaviour was directly influenced by the intensity of state curiosity. Thus, state curiosity was considered to be a mediator variable that linked trait epistemic curiosity and FOK intensity to exploration.

Four indices of fit were considered in evaluating these path models: chi-square, the comparative fit index (CFI), the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and the root-mean-square residual (RMR). In interpreting these fit indices, one would hope to find chi-squares that are not significant, CFIs, GFIs, and AGFIs approaching .90 or greater, and RMRs less than .05, which are indicative of acceptable model fit (Byrne, 1998; Schumaker & Lomax, 1996).

To determine whether epistemic curiosity states mediated the relationships between scores on the three initial variables (the CFD and EC scales, and FOK intensity) and the outcome variable (exploratory behaviour), evidence of meeting two criteria were taken into consideration: (1) Finding significant paths from the initial variables to the hypothesised mediator (state curiosity); and (2) finding a significant path from the mediator to the outcome variable while controlling the initial variables (Collins, Graham, & Flaherty, 1998; Kenny, Kashy, & Bolger, 1998; Shrout & Bolger, 2002; MacKinnon, 2000).[6]

The path diagram for the ''Don't Know'' model is presented in Figure 1. Most of the fit-indices suggested that the model fit was very good: $\chi^2(3) = 1.883$, n.s.; CFI = 1.00; GFI = .997; AGFI = .985; RMR = .068. As indicated by significant path coefficients, the arousal of state curiosity was positively influenced by FOK intensity ($t = 4.21$; $p < .01$) and by scores on the EC scale ($t = 2.93$; $p < .05$). However, the influence of the CFD scale was not significant ($t = -0.53$; n.s.). These findings provided additional evidence that when participants were in a ''Don't Know'' FOK state, the emotional experience of curiosity was primarily associated with feelings of interest and enjoyment, which was heightened by more intense FOK experiences. Epistemic curiosity states positively influenced exploratory behaviour ($t = 7.30$; $p < .001$), and was the only

[6] We feel it is important to point out that even though the CFD and EC scales were essentially uncorrelated with exploratory behaviour, as may be noted in Table 4, a correlation between initial and outcome variables is not required to demonstrate mediation, although this is a popularly cited prerequisite condition that was proposed by Baron and Kenny (1986). More recent treatments of mediation (e.g., Kenny et al., 1998) have amended this requirement, and have noted a number of examples in which a mediator is present, even when there is no observed relationship between the ''IV'' and ''DV''. We agree with the view espoused by Collins et al. (1998), who regard mediated processes to reflect ''chain reactions'', such that an initial variable influences a mediator variable, which in turn influences an outcome (for a related view, see also Kline, 1998). Collins et al.'s (1998) perspective on mediated effects is particularly relevant to the state-trait theory of emotion and personality, which guided the development of the models that were analysed in the present study.

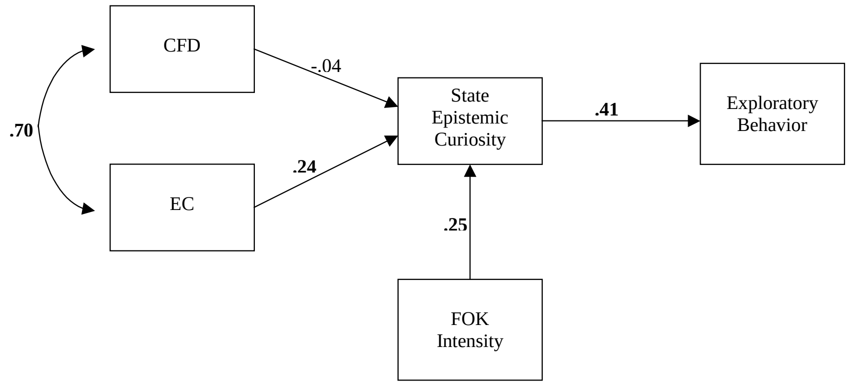

Figure 1. Path diagram for the model of ''Don't Know'' FOK states (N = 265). (Significant coefficients are in bold)

significant effect after evaluating the direct effects of the initial variables in a separate path analysis (p = .392; SE = .052; t = 6.60, p < .001). These results provided evidence that the relationship between trait epistemic curiosity, as reflected in feelings of interest, FOK intensity, and exploratory behaviour was mediated by state curiosity.

The path diagram for the ''TOT'' FOK state model is presented in Figure 2, for which the fit was excellent: $\chi^2(3)$ = .863, n.s.; CFI = 1.00; GFI = .998; AGFI = .993; RMR = .015. Both FOK intensity (t = 2.33; p < .05) and individual differences in CFD (t = 3.93; p < .01) had a direct effect on state curiosity. However, the effect of EC scale scores on curiosity states was not significant (t = $-$1.03; n.s.). These findings provided further evidence that when participants were in a ''TOT'' state, the arousal of curiosity involved feeling deprived of knowledge, and involved experiences of tension and uncertainty, which were enhanced by stronger FOKs. As expected, exploratory behaviour was directly influenced by epistemic curiosity states (t = 2.03; p < .05). After controlling for the other variables in a separate analysis, this effect remained marginally significant (p = .11; SE = .024; t = 1.91, p < .06). Taken together, the results of these analyses were generally consistent with the hypothesis that the relationship between trait curiosity, FOK intensity, and exploratory behaviour was mediated by epistemic curiosity states.

Given that significant correlations were found between CFD and EC scale scores and FOK intensity, as may be noted in Table 4, we also examined an alternate ''TOT'' model to evaluate the intriguing possibility that individual differences in trait curiosity also had an effect on FOK intensity. Although this alternate model was not explicitly hypothesised, it was also not inconsistent with the previously described theoretical views concerning traits, states, and

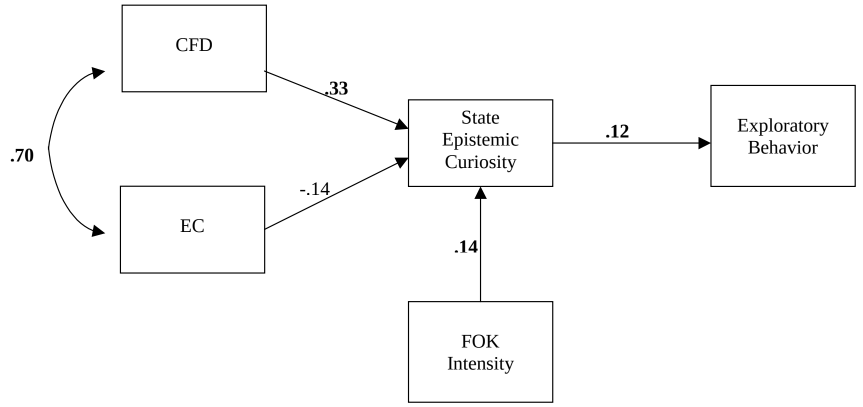

Figure 2. Path diagram for the model of ''TOT'' FOK states (N = 265). (Significant coefficients are in bold.)

behaviours. This alternate model was identical to the initial model, except that two additional paths were estimated that led from the two trait curiosity measures to FOK intensity. The results of the path analysis for this alternate model indicated that neither new path was statistically significant, while all other model statistics corroborated with those of the hypothesised model.

In testing the model of ''I Know'' FOK states, the inclusion of the EC and CFD scales was untenable from the outset given that both of these scales correlated zero with the curiosity states for this type of FOK. Thus, a simpler model containing only FOK intensity, state curiosity, and exploratory behaviour was examined for ''I Know'' states, in which state curiosity was hypothesised to mediate the relationship between FOK intensity and exploratory behaviour. Fit-indices for the ''I Know'' FOK path model were not indicative of a good fit: $\chi^2(1) = 9.79$, $p < .001$; CFI = .763; GFI = .976; AGFI = .857; RMR = .074, suggesting that the path coefficients for this model could not be meaningfully interpreted.

DISCUSSION

The major goals of the present study were to investigate the relationships between state and trait epistemic curiosity, FOK, and exploratory behaviour. As hypothesised, the greatest state curiosity and exploration was associated with ''TOT'' states, an intermediate level of curiosity and exploration followed ''Don't Know'' states, and the least curiosity and exploration accompanied reports of ''I Know'' the answer. These findings indicated that smaller perceived knowledge-gaps were associated with more curiosity and exploratory behaviour, which was highly consistent with Loewenstein's (1994) approach-gradient theory of epistemic curiosity.

As predicted, greater recognition memory reflected ''I Know'' states as compared to the other two FOKs. However, ''TOT'' did not correspond with better memory than ''Don't Know'' states, which was unexpected. The intensity of FOK states correlated positively with recognition for ''TOT'' and ''I Know'' states, as anticipated, although ''Don't Know'' FOK intensity and accuracy were unrelated. As hypothesised, participants experienced the most intense FOKs when they were in an ''I Know'' state, followed by ''TOT'', and ''Don't Know''. Moreover, ''TOT'' intensities were closer in magnitude to those reported for ''I Know'' than for ''Don't Know''. While these findings were generally consistent with the hypothesised qualitative differences among these FOK states, they also suggest that the *beliefs* individuals had about the extent of their knowledge was more relevant to the arousal of curiosity than the *actual* extent of their knowledge. Moreover, these findings indicate that the degree of dissociation between feelings-of-knowing and actual knowing may have been influenced by the ability to successfully retrieve a target from long-term memory, which is consistent with previous research (Koriat, 1988).

As expected, state epistemic curiosity ratings correlated positively with exploratory behaviour for all three FOK states. Also as expected, positive correlations were found between FOK intensity and state curiosity for ''TOT'' and ''Don't Know'', while a negative correlation was found with intensity for ''I Know'' states. However, contrary to predictions, trait epistemic curiosity scores, as measured by the EC and CFD scales, only correlated significantly with state curiosity for ''TOT and ''Don't Know'' states. Consistent with these findings, the results of the path analyses provided evidence that the influences of personality and FOK intensity on exploratory behaviour were mediated by curiosity states when information was either not known or partially known.

The EC scale correlated more highly with state curiosity for ''Don't Know'' states, whereas the CFD scale was more strongly related to curiosity states related to ''TOT''. Although these effects were rather modest, they suggest that the affective experiences associated with the arousal of curiosity depend on, at least to some extent, the perceived magnitude of the knowledge-gap. These findings, which were corroborated by the results of the path analyses, suggested that when participants felt more distant from the desired knowledge, curiosity was both less intense and also involved more positive emotions; when they felt closer to figuring out the knowledge, curiosity was more intense, but also less pleasant. These findings suggest that exploration is more strongly motivated when the goal is to reduce feelings of uncertainty rather than to increase feelings of interest, as hypothesised by Loewenstein (1994).

The lack of any correlations between the EC and CFD scales and ''I Know'' curiosity states offers few clues regarding the affective experiences associated with its arousal. Moreover, the poor fit of the relevant path model raises questions about the processes that underlie the arousal of curiosity states associated with target retrieval. One logical interpretation is that when participants felt they knew the answer, they simply wanted to check some of their answers for correctness. Given that the items comprising the EC and CFD scales specifically enquire about a desire for learning new knowledge, this interpretation makes sense—after all, if the answer was already known, there would be little new information to gain, except as pertains to the confirmation of accuracy. While such a motive may be labelled ''curiosity'', it clearly differs in its goal from the curiosity associated with a desire for intellectual enrichment, and may reflect the distinction between setting performance-oriented and learning-oriented goals (Elliot & Dweck, 1988).

However, the aforementioned conclusions on the types of emotional experiences associated with state curiosity are necessarily tentative, given the relatively small relationships that were found for the EC and CFD scales with curiosity states, and the very high overlap between these trait epistemic curiosity measures. In order to gain a clearer understanding of whether the affective experience of curiosity differs meaningfully for ''TOT'' and ''Don't Know'' FOKs, it will be important in future research to examine other indices of emotion, such as facial expression or heart rate (Izard, 1990; Langsdorf, Izard, & Rayias, 1983; Reeve, 1993; Reeve & Nix, 1997).[7] In future research it will also be important to examine the relationships among curiosity states, FOK, and exploration when individuals are exposed to other situations that involve epistemic curiosity, such as understanding complex ideas, figuring out the meaning of ambiguous statements, or solving logical problems.

In summary, the findings of the present study demonstrated that the magnitude of perceived knowledge-gaps, as measured by FOK, and trait epistemic curiosity both contribute to the arousal of curiosity states to motivate exploratory behaviour when information is believed to be either unknown or only partially known. ''TOT'' states were associated with the smallest knowledge-gap, most intense curiosity, most exploration, and relatively unpleasant feelings of tension and uncertainty. ''Don't Know'' states involved the largest knowledge-gap, less curiosity and exploration, and positive feelings of interest and enjoyment. ''I Know'' states reflected the absence of an appreciable knowledge-gap and were associated with the least curiosity and exploration.

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[7] Similarly, self-report measures of depression and anxiety also tend to be very highly correlated with one another (Beck, Steer, & Garbin; 1988; Gotlib & Crane, 1989; Spielberger, Ritterband, & Reheiser, 2003), but correspond with meaningfully different cognitions and metacognitions (Beck, 1971; Beck & Clark, 1988; Papageorgiou & Wells, 1999) and patterns of physiological reactivity (Clark & Watson, 1991a, 1991b) despite their substantial overlap.

REFERENCES

Bacon, E., Danion, J., Kauffmann-Muller, F., Schelstraete, M., Bruant, A., Sellal, F., & Grange, D. (1998). Confidence level and feeling of knowing for episodic and semantic memory: An investigation of lorazepam effects on metamemory. *Psychopharmacology*, *138*, 318–325.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, *51*, 1173–1182.

Beck, A. T. (1971). Cognition, affect, and psychopathology. *Archives of General Psychiatry*, *24*, 495–500.

Beck, A. T., & Clark, D. A. (1988). Anxiety and depression: An information processing perspective. *Anxiety Research*, *1*, 23–36.

Beck, A. T., Steer, R. A., & Garbin, M. G. (1988). Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*, *8*, 77–100.

Berlyne, D. E. (1954). A theory of human curiosity. *British Journal of Psychology*, *45*, 180–191.

Berlyne, D.E. (1957). Determinants of human perceptual curiosity. *Journal of Experimental Psychology*, *53*, 399–404.

Berlyne, D.E. (1958). The influence of complexity and novelty in visual figures on orienting responses. *Journal of Experimental Psychology*, *55*, 289–296.

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity.* New York: McGraw-Hill.

Berlyne, D. E. (1966). Curiosity and exploration. *Science*, *153*, July, 25–33.

Bradley, J. V. (1981). Overconfidence in ignorant experts. *Bulletin of the Psychonomic Society*, *17*, 82–84.

Brown, R., & McNeill, D. (1966). The ''tip-of-the-tongue'' phenomenon. *Journal of Verbal Learning and Verbal Behavior*, *5*, 325–337.

Byrne, B. M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming.* Mahwah, NJ: Erlbaum.

Clark, L. A., & Watson, D. (1991a). Theoretical and empirical issues in differentiating depression from anxiety. In J. Becker & A. Klienman (Eds.), *Psychosocial aspects of depression* (pp. 39–65). Hillsdale, NJ: Erlbaum.

Clark, L. A., & Watson, D. (1991b). Tripartite model of anxiety and depression: Evidence and taxonomic implication. *Journal of Abnormal Psychology*, *100*, 316–336.

Collins, L. M., Graham, J. W., & Flaherty, B. P. (1998). An alternative framework for defining mediation. *Multivariate Behavioral Research*, *33*, 295–312.

Collins, R. P., Litman, J. A., & Spielberger, C. D. (2004). The measurement of perceptual curiosity. *Personality and Individual Differences*, *36*, 1127–1141.

Dember, W. (1960). *The psychology of perception.* New York: Henry Holt & Co.

Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality & Social Psychology*, *54*, 5–12.

Eysenck M. W. (1979). The feeling of knowing a word's meaning. *British Journal of Psychology*, *70*, 243–251.

Freedman, J. L., & Landauer, T. K. (1966). Retrieval of long-term memory: ''Tip-of-the-tongue'' phenomenon. *Psychonomic Science*, *4*, 309–310.

Gotlib, I. H., & Crane, D. B. (1989). Self-report assessment of depression and anxiety. In P.C. Kendall, & D. Watson (Eds.), *Anxiety and depression: Distinctive and overlapping features. Personality, psychopathology, and psychotherapy* (pp. 131–169). San Diego: Academic Press.

Glucksberg, S., & McCloskey, M. (1981). Decisions about ignorance: Knowing that you don't know. *Journal of Experimental Psychology*, *7*, 311–325.

Hart, J. T. (1965). Memory and the feeling-of-knowing experience. *Journal of Educational Psychology*, *56*, 208–216.

Henderson, B., & Moore, S. G. (1979). Measuring exploratory behavior in young children: A factor-analytic study. *Developmental Psychology*, *15*, 113–119.

Izard, C. E. (1990). Facial expressions and the regulation of emotions. *Journal of Personality and Social Psychology*, *58*, 487–498.

Keller, H., Schneider, K., & Henderson, B. (1994). Preface: The study of exploration. In H. Keller, K. Schneider, & B. Henderson (Eds.) *Curiosity and exploration* (pp. 199–212). Berlin: Springer.

Kenny, D. A., Kashy, D. A., & Bolger, N. (1998). Data analysis in social psychology. In D. Gilbert, S. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (2nd ed.), (Vol. 1, pp. 233–265). Boston, MA: McGraw-Hill.

Kline, R. B. (1998). *Principles and practice of structural equation modeling*. New York: Guilford Press.

Kohlers, P. A., & Palef, S. R. (1976). Knowing not. *Memory and Cognition*, *4*, 553–558.

Koriat, A. (1998). Metamemory: The feeling of knowing and its vagaries. In M. Sabourin & F. Craik (Eds.), *Advances in psychological science: Vol. 2. Biological and cognitive aspects* (pp. 461–479). Hove, UK: Psychology Press.

Koriat, A., & Lieblich, I. (1974). What does a person in a ''TOT'' state know that a person in a ''don't know'' state doesn't know? *Memory and Cognition*, *2*, 647–655.

Kozlowski, L. (1977). Effects of distorted auditory and of rhyming cues on retrieval of tip-of-the-tongue words by poets and nonpoets. *Memory and Cognition*, *5*, 477–481.

Langsdorf, P., Izard, C. E., & Rayias, M. (1983). Interest expression, visual fixation, and heart rate changes in 2- and 8-month-old infants. *Developmental Psychology*, *19*, 375–386.

Libert, T. W., & Nelson, D. L. (1998). The roles of cue and target familiarity in making feeling of knowing judgments. *American Journal of Psychology*, *111*, 63–75.

Litman, J. A. (2000). *Construct and predictive validity of measures of epistemic and perceptual curiosity*. Unpublished doctoral dissertation, University of South Florida, Tampa.

Litman, J. A., & Jimerson, T. L. (2004). Curiosity as a feeling-of-deprivation. *Journal of Personality Assessment*, *82*, 147–157.

Litman, J. A., & Spielberger, C. D. (2003). Measuring epistemic curiosity and its diversive and specific components. *Journal of Personality Assessment*, *80*, 75–86.

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

Loewenstein, G., Adler, D., Behrens, D., & Gillis, J. (1992). *Why Pandora opened the box: Curiosity as a desire for missing information*. Unpublished manuscript, Department of Social and Decision Sciences, Carnegie Mellon University, Pittsburgh, PA.

Lowry, N., & Johnson, D. (1981). Effects of controversy on epistemic curiosity, achievement and attitudes. *Journal of Social Psychology*, *115*, 31–43.

MacKinnon, D. P. (2000). Contrasts in multiple mediator models. In J. S. Rose, L. Chassin, C. C. Presson, & S. J. Sherman (Eds.), *Multivariate applications in substance use research* (pp. 141–160). Mahwah, NJ: Erlbaum.

Miller, N. A. (1959). Liberalization of basic S-R concepts: Extensions to conflict behavior, motivation, and social learning. In S. Koch (Ed.), *Psychology: The study of a science* (pp. 196–292).

Murdock, B. B., Jr., & Duffy, P. O. (1972). Strength theory and recognition memory. *Journal of Experimental Psychology*, *94*, 284–290.

Nelson, T. O. (1984). A comparison of current measures of the accuracy of feeling-of-knowing prediction. *Psychological Bulletin*, *95*, 109–133.

Nelson, T. O., Gerler, D., & Narens, L. (1984). Accuracy of feeling-of-knowing judgments for predicting perceptual identification and recall. *Journal of Experimental Psychology. General*, *113*, 282–300.

Nelson, T. O., & Narens, L. (1980). Norms of 300 general-information questions: Accuracy of recall, latency of recall, and feeling-of-knowing ratings. *Journal of Learning and Verbal Behavior*, *19*, 338–368.

Papageorgiou, C., & Wells, A. (1999). Process and meta-cognitive dimensions of depressive and anxious thoughts and relationships with emotional intensity. *Clinical Psychology and Psychotherapy*, *6*, 156–162.

Peters, R. A. (1978). Effects of anxiety, curiosity, and perceived instructor threat on student verbal behavior in the college classroom. *Journal of Educational Psychology*, *70*, 388–395.

Reeve, J. (1993). The face of interest. *Motivation and Emotion*, *17*, 353–375.

Reeve, J., & Nix, G. (1993). Expressing intrinsic motivation through acts of exploration and facial displays of interest. *Motivation and Emotion*, *21*, 237–250.

Schumaker, R. E., & Lomax, R. G. (1996). *A beginner's guide to structural equation modeling.* Mahwah, NJ: Erlbaum.

Schwartz, B. L., Travis, D. M., Castro, A. M., & Smith, S. M. (2000). The phenomenology of real and illusory tip-of-the-tongue states. *Memory and Cognition*, *28*, 18–27.

Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, *7*, 422–445.

Spielberger, C. D. (1972). Anxiety as an emotional state. In C.D. Spielberger (Ed.), *Anxiety: Current trends in theory and research* (pp. 23–49). New York: Academic Press.

Spielberger, C. D. (1979). *Preliminary manual for the state-trait personality inventory.* Unpublished manual, University of South Florida, Tampa, FL.

Spielberger, C. D. (1983). *Manual for the state-trait anxiety inventory (Form Y).* Palo Alto, CA: Consulting Psychologists Press.

Spielberger, C. D. (1988). *Professional manual for the state-trait anger expression inventory (STAXI)* (Research ed.). Tampa, FL: Psychological Assessment Resources, Inc. (PAR).

Spielberger, C. D., Peters, R. A., & Frain, F. (1976). *The state-trait curiosity inventory.* Unpublished manual, University of South Florida, Tampa, FL.

Spielberger, C. D., Ritterband, L. M., & Reheiser, E. C. (2003). The nature and measurement of depression. *International Journal of Clinical and Health Psychology*, *3*, 209–234.

Spielberger, C. D., Ritterband, L. M., Sydeman, S. J., Reheiser, E.C., & Unger, K. K. (1995). Assessment of emotional states and personality traits: Measuring psychological vital signs. In J. N. Butcher (Ed.), *Clinical personality assessment: Practical approaches* (pp. 42–57). Oxford, UK: Oxford University Press.

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

Widner Jr., R. L., Smith, S. M., & Graziano, W. G. (1996). The effects of demand characteristics on the reporting of tip-of-the-tongue and feeling-of-knowing states. *American Journal of Psychology*, *4*, 525–538.