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Curiosity, Demand Characteristics, and the Tip-of-the-Tongue State

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Abstract

The tip-of-the-tongue (TOT) state is generally described as the feeling that one knows a target word and recall of this word is imminent, although the word is currently unrecallable. Research suggests participants' beliefs about their own knowledge affect the level and type of curiosity experienced while in a TOT state. This study examined the interaction between demand characteristics and specific types of curiosity experienced while in a TOT state. Demand characteristics were expected to affect the type of curiosity experienced, with participants in the high-demand group experiencing more negative forms of curiosity and the low-demand group experiencing more positive forms of curiosity. Participants in each demand condition completed a trivia task designed to elicit TOT states, a personality questionnaire, and a multiple-choice recognition task for the same trivia items from the first task. Overall, the low demand group experienced higher levels of curiosity for most feeling-of-knowing states and a more positive form of curiosity then the high demand group. Results are partially consistent with the approach-gradient theory of curiosity, but also indicate that demand characteristics may differentially affect the two types of curiosity examined.

Curiosity, Demand Characteristics, and the Tip-of-the-Tongue State

In general, people tend to think of memory and retrieval as all-or-nothing processes. Either a particular fact is in one's memory, or it is not; consequently, we can retrieve that fact, or we can not. But anyone who has ever experienced a tip-of-the-tongue state (and research indicates that most of us have), will know that memory does not always work this way. During a tip-of-the-tongue state, people are unable to recall a specific word, but feel sure that the word is in their memory and that it will come to them shortly. Recall feels imminent. Schwartz (1991) refers to tip-of-the-tongue research as both a "gold mine" and a "can of worms" in that it has the potential to offer unique insights to lexical retrieval and memory processes, but is also fraught with perplexities and inconsistencies (p. ix).

The tip-of-the-tongue phenomenon (referred to hereafter as TOT) is very common and possibly universal. According to survey data, most people report an average of one TOT experience per week (Brown, 1991). Additionally, researchers have found evidence for the existence of the TOT phenomenon in illiterate speakers (Brennen, Vikan, & Dybdahl, 2007) and in deaf cultures where it is referred to as the tip-of-the-fingers phenomenon (Thompson, Emmorey, & Gollan, 2005). The TOT phenomenon is even described in a remarkably similar way in different languages. In a survey of fluent, mostly native speakers of languages other than English, 45 of the 51 languages surveyed used some variation of the "tongue" metaphor to describe the feeling of not being able to retrieve a known word (Schwartz, 1991).

The TOT phenomenon can be defined as the experience of being temporarily unable to retrieve a known word (Abrams, Trunk, & Merrill, 2007). Unlike ordinary word retrieval failure, however, the TOT state often leaves people able to name some features of the target word (e.g., syntactic; semantic), although its precise phonological form is inaccessible. For

example, in a study by Ferrand (2001), French participants in a TOT state were able to correctly name the gender of the word (which they were unable to recall) 75%-80% of the time, even for nouns which had irregular gender forms. In contrast, Friedmann and Biran (2003) found that Hebrew speakers were unable to access the gender of nouns in a TOT state, possibly because Hebrew nouns can exist in a bare form in which gender is not made explicit. Hanley and Chapman (2008) found that participants were able to determine if a celebrity's name was two or three words long significantly more accurately than chance, even though they were unable to actually recall the name.

These studies support a two-stage model of word retrieval, with a meaning-based retrieval stage followed by a form-based retrieval stage (Gollan & Brown, 2006). According to this model, a TOT state occurs when an individual is able to successfully access the semantic meaning of a word but is unable to retrieve the form of the word. This inability may be caused by competition from phonologically or semantically related words (Abrams, Trunk, & Merrill 2007; Choi & Smith, 2005), by a lack of phonologically related words (Harley & Brown, 1998), by weaker activation levels of weaker memory traces (Burke, MacKay, Worthley & Wade, 1991), or it may be a form of metacognitive control (Schwartz, Travis, Castro & Smith, 2000). Many researchers are interested in TOT formation because they consider it a form of failed lexical retrieval which can be studied to gain insight into the general process of lexical retrieval.

This model of TOT formation, which is commonly referred to as the direct access model, relies on an implicit assumption about cognitive processes which Tulving named the doctrine of concordance (Tulving, 1989). According to this doctrine, there is a straightforward correlation between a given cognitive process, the observable behavior of a person, and their phenomenological experience of the behavior and/or cognitive process. Tulving challenged this

doctrine by claiming that underlying cognitive processes and the phenomenological experiences that accompany them are often distinct but related (based primarily on evidence dissociating retrieval from recollection). In other words, a model consistent with the doctrine of concordance would posit the existence of a single cognitive process which would lead to both the associated behavior and phenomenology. A model which was not consistent with the doctrine of concordance would suppose that there might be separate cognitive processes for some behavior and its phenomenology. In terms of TOT formation, a model adhering to the doctrine of concordance would expect both failed lexical retrieval (the behavior) and the experience of a TOT state (the phenomenology) to be caused by a single cognitive process.

The other main theory of TOT formation is an inferential model which arises out of Tulving's critique of the doctrine of concordance. Unlike the direct access model, which supposes that a single cognitive process accounts for both the behavior (failed lexical retrieval) and phenomenology of a TOT, the inferential model posits the existence of a separate process responsible for the phenomenology of the TOT state. According to the inferential model, people infer that they are experiencing a TOT state based on a variety of clues which inform them that the target information is likely to be in their memory. This process is presumed to be primarily unconscious (although the result, the experience of a TOT state, is a conscious one). Two possible types of clues that may lead people to infer that they are experiencing a TOT state are cue familiarity and the accessibility heuristic. According to the cue familiarity theory, TOTs occur as a result of a strong feeling of familiarity elicited by a familiar cue (Metcalfe, Schwartz, & Joaquim, 1993). For example, in one study participants were presented with word definitions and asked to provide the correct word for each definition. Koriat and Lieblich (1977) then analyzed these definitions along several dimensions and found that redundancy within the

definitions led to more TOT states. Thus aspects of a specific cue can play a role in TOT formation. According to the accessibility heuristic, the amount and intensity of information retrieved while attempting to recall a specific target plays a role in TOT formation (Schwartz & Smith, 1997). By using general knowledge questions for which there is no correct answer (e.g., what is the name of Mercury's moon?), Schwartz (1998) was able to induce illusory TOT states in an experiment. In other words, participants claimed to have memories of words which they had never actually learned based on a feeling-of-knowing created by the relationship between the false knowledge being tested (the name of Mercury's moon) with the participants' actual knowledge (of astronomy). These results are inconsistent with the doctrine of concordance in that the participants reported the phenomenological experience of a TOT in the absence of an actual failed lexical retrieval (given that the lexical target item did not actually exist) and support the inferential model in that participants seemed to rely on a feeling-of-knowing based on cue familiarity when reporting TOT states.

Interestingly, research has indicated that some aspects of the TOT phenomenon may be dependent on personality differences, which may be culturally or educationally based. Almost all research conducted on the TOT phenomenon has studied highly literate Western participants. In their work with illiterate speakers of the Mayan language of Q'eqchi', Brennen et al. (2007) found that, although most participants expressed some familiarity with the TOT phenomenon, only university level participants were able or willing to report any partial information about the target words. He speculates that this difference could be a result of varying levels of metacognitive attitude and epistemic curiosity. People with high metacognitive attitude "…savour their thoughts, wonder about the workings of their mind, and thereby find depth that others simply do not find" (p.168). Therefore, people with high metacognitive attitude are more

likely to experience TOTs because they have an introspective interest in word retrieval that those with lower metacognitive attitude lack. This conceptualization of metacognitive attitude is very similar to epistemic curiosity, which is defined as a measurable desire or drive for knowledge (Litman & Spielberger, 2003). As such, epistemic curiosity is thought to motivate inquisitiveness and experimentation, and underlie intellectual development and scholarly achievement (Litman, 2008). As a personality trait, epistemic curiosity is associated with the intrinsic pleasure of learning and positive emotional-motivational states of interest, and can vary across individuals.

The purpose of my study is to further examine the relationship between epistemic curiosity (a specific aspect of metacognitive attitude) and the tip-of-the-tongue (TOT) state. Previous research suggests that participants' beliefs about their own knowledge affect the level and type of curiosity they experience for a variety of feeling-of-knowing states (Litman, Hutchins & Russon, 2005). In a study by Litman et al. (2005), participants were presented with a set of general knowledge trivia questions and then asked to indicate their feeling-of-knowing state (FOK) by reporting either "I know the answer", "The answer is on the tip-of-my-tongue", or "I don't know the answer". After that participants reported how confident they were in their answer and how curious they were to see the answer to each question (a measure of state-curiosity). All participants also completed a curiosity-trait questionnaire designed to assess their level of Epistemic Curiosity (pleasurable feelings of interest and enjoyment in learning) and Curiosity as a Feeling-of-Deprivation (unpleasant feelings of uncertainty and tension, which motivate knowledge-seeking). According to state trait theories of emotion and personality, people with higher levels of a particular personality trait experience the corresponding emotional trait more strongly (at a greater intensity) than those with lower levels of the particular trait. The

dual measurement of both state and trait curiosity thus allows for both an examination of individual differences and a subtle way to distinguish between different types of curiosity. A subsample of the participants also completed a multiple-choice recognition-memory task in which the general knowledge trivia questions were presented a second time, this time in multiple-choice format.

Litman et al. (2005) found that the participants' self-reported FOK judgments for trivia items were positively correlated with their self-reported levels of state curiosity (how curious they were to see the answer to specific items). TOT states were characterized by both the highest FOK confidence ratings (not including items for which participants were able to report the answers) and the highest levels of curiosity, but TOT states did not yield significantly greater recall on the forced-choice recognition-memory task than Don't Know (DK) states. This result indicates that participants' beliefs about their own knowledge were not accurate predictors of performance on a memory task, or in other words, feeling-of-knowing did not correspond to actual knowing. This correlation between FOK and curiosity supports the approach-gradient theory of motivation, which predicts that the intensity of a motivational state peaks as one approaches the achievement of a goal. In this case, curiosity is the state which peaks as one approaches the goal of retrieving the target information, thereby "closing" the knowledge-gap.

Additionally, the different types of trait curiosity corresponded to different FOK judgments. Trait levels of Epistemic Curiosity (EC), the more positive form of curiosity, were positively correlated to state curiosity levels for Don't Know states, whereas Curiosity as a Feeling-of-Deprivation (CFD), the more negative form of curiosity, correlated with state curiosity levels for TOT states (Litman, Hutchins & Russon, 2005). This is especially interesting in light of the results which found no actual difference between TOT and Don't Know states in

terms of performance on a recognition task. Therefore the difference in the types of curiosity experienced by participants was related to participants' perceptions of their own knowledge rather than their actual knowledge.

Other research has found that situational factors, such as certain types of social pressure, can affect TOT rates. One type of social pressure, referred to as demand characteristics in the literature, can be defined as the assumed degree of pressure felt by the participants to answer experimenter-provided general knowledge questions. Such demand characteristics influence the number of TOT states reported by participants, with high-demand conditions yielding higher TOT rates (Widner, Smith & Graziano, 1996). In this study, participants were told that other people found a set of general knowledge trivia questions either very difficult to answer (low-demand condition; LD) or relatively easy to answer (high-demand condition; HD). In fact, all of the trivia questions were moderately difficult to answer. In the first experiment, the trivia questions were presented to participants on a computer screen in the presence of a researcher to whom they reported their answers and whether or not they were experiencing a TOT state. It was assumed that informing participants that the questions were difficult would place less demand on them because they would feel less pressure to perform well in front of the researcher than if they had been informed that the questions were relatively easy. Participants reported significantly more TOT states in the high-demand condition than in the low-demand condition, but there were no differences in accuracy (on a multiple-choice task involving the same set of trivia questions) for the reported TOT states across demand condition. The second experiment was identical to the first except that participants were now asked to report feeling-of-knowing (FOK) states instead of TOT states. The authors defined FOK states as follows: "If you feel you know the answer to a presented question but can't remember it at the moment, and you feel that

you could identify the correct answer from a list of similar words, if shown to you at a later point in time, then you are in a feeling-of-knowing state." Based on this definition, the primary difference between a FOK and TOT is the lack of a feeling of imminent recall. Surprisingly, unlike TOT states, neither the frequency nor accuracy of FOK states was affected by the demand manipulation. The authors hypothesize that this is because the demand characteristics primarily affect the imminency component of the TOT state rather than the familiarity component, but also indicate that more research is needed to flesh out the effect of the demand manipulation. According to the approach-gradient theory of curiosity, this demand manipulation should affect the level of curiosity felt by participants because of its effect on the perceived imminence of the recall of a target word.

Previous research thus indicates that participants' beliefs about their own knowledge affect the level and type of curiosity they experience while in a TOT state (Litman, Hutchins & Russon, 2005). The differences in curiosity levels are explained by the approach gradient theory which expects that curiosity will be more intense for target items which feel closer to being recalled. Thus TOT states yield higher curiosity levels than DK states. The differences in curiosity type (positive or negative) are linked to the different recall states. DK states were associated with positive forms of curiosity and TOT states were associated with more negative forms of curiosity. This difference is explained by the approach gradient theory in that larger perceived knowledge gaps (as in a DK state) are associated with less intense and more positive forms of curiosity and smaller knowledge gaps (as in a TOT state) are associated with more intense and more negative forms of curiosity. Research also indicates that putting higher demand on participants to answer trivia questions causes them to report experiencing more TOT states, possibly by affecting the imminency component of the TOT state (Widner, Smith &

Graziano, 1996). This study is an examination of the effects of the demand manipulation on curiosity and the TOT state. According to the approach gradient theory, people in the high demand condition should experience higher levels of curiosity because of the demand manipulation's effect on the imminency component of TOT states. Demand characteristics are also predicted to have an effect on the types of curiosity experienced while in various states. Since demand characteristics seem to affect the feeling of imminence associated with the TOT state, participants in the high-demand group are expected to experience more negative forms of curiosity (uncertainty and tension) and participants in the low-demand group are expected to experience more positive forms of curiosity (interest in learning).

Method

Participants

Eighty undergraduate Macalester students between the ages of 18 and 23 participated in this study. Participants were recruited from Introductory Psychology courses and Cognitive Psychology courses. Participants enrolled in Introductory Psychology received course credit for participating. All other participants were entered into a prize lottery in exchange for participating.

Materials

All materials for this experiment were presented on a PC computer using E-Prime software. The instructions for this experiment presented participants with a specific definition of the TOT state and created certain demand characteristics. Participants were presented with Brown and McNeill's (1966) description of the TOT state which explains: "If you are unable to think of the word but feel sure that you know it and that it is on the verge of coming back to you then you are in a TOT state." As in Widner, Smith, and Graziano (1996), demand characteristics

were adjusted by presenting participants with statements embedded within the experiment's instructions. In the low-demand condition, the instructions contained the statement: "In this experiment you will be presented with a number of questions that should be quite difficult to answer. In fact, approximately 95% of the students who have already participated in this experiment had great difficulty in answering them." In the high-demand condition, the instructions contained the statement: "In this experiment you will be presented with a number of questions that should be quite easy to answer. In fact, approximately 95% of the students who have already participated in this experiment had little difficulty in answering them."

For this experiment, TOT states were elicited using 37 items drawn from Nelson and Narens (1980) list of 300 questions. Each item consisted of a question with a one word answer (e.g., "What is the last name of the author who wrote "Brothers Karamazov"?" with the answer being "Dostoyevsky"). To make both demand conditions believable, questions with varied normative probability of recall were chosen (mean *p* recall ranged from 0.019 to 0.778) and question topics were varied, including history, literature, and general knowledge items. Questions for which males and females had reliably different recall probabilities were avoided. For the recognition-memory task, multiple choice options for these trivia items were presented along with the questions. For each question, one correct answer was presented along with three plausible distractors, for example, "What is the last name of the author who wrote "Brothers Karamazov"? (a) Gogol, (b) Nabokov, (c) Tolstoy, (d) Dostoyevsky". The position of the correct answer varied for each question.

The Epistemic Curiosity (EC) stimuli consisted of 10 items drawn from Litman and Spielberger's EC questionnaire (Litman & Spielberger, 2003). These items are all statements designed to measure participants' curiosity; for example, "When I come across a word I don't

know, I look up its meaning." This EC scale has been shown to have high reliability ($\alpha = .85$ for women and $\alpha = .81$ for men), and also significant positive correlations with a Perceptual Curiosity scale ($r = .57$, $p < .001$) and the STPI Trait Curiosity scale ($r = .61$, $p < .001$), thus providing evidence for its convergent validity (Litman & Spielberger, 2003).

The Curiosity as Feeling-of-Deprivation (CFD) stimuli consisted of 15 items drawn from Litman and Jimerson's CFD questionnaire (2004). These items are all statements designed to measure participants' curiosity; for example, "It bothers me if I don't know a word, so I will look up the meaning." Where the EC scale is correlated with mastery-oriented learning, the CFD scale is more closely related to failure-avoidance and success-orientation (Litman, 2008).

Procedures

Participants were randomly assigned to either the high or low demand group. Participants were presented with the informed consent form and asked to indicate their consent by signing the form. Participants then completed the experiment, with a researcher present in the room the entire time.

Participants first completed the trivia portion of the experiment. The instructions for this section of the experiment gave the participants Brown and McNeill's (1966) definition of a TOT state and contained either the high or low demand statement about the alleged difficulty of the trivia items. During the trivia portion of the experiment, participants were presented with the 37 trivia questions drawn from Nelson and Narens (1980) in random order. Participants recorded their responses on the computer by either typing in an answer or a question mark (to indicate that they did not know the answer). After responding to each question, participants were asked if they experienced a TOT for that question (and responded with either a "Y" for yes or an "N" for no), and then asked to indicate on a 4-point likert-type scale how curious they were to see the

answer to that particular question (the scale anchors were “not at all curious” and “very curious”).

After completing the trivia portion of the experiment, participants responded to the two curiosity scales. The EC and CFD stimuli lists were combined and presented one item at a time in random order. Participants were instructed to report how they “generally feel” for each statement. The response scale for each item ranged from 1 (*almost never*), 2 (*sometimes*), 3 (*often*), to 4 (*almost always*) (Litman & Spielberger, 2003; Litman & Jimerson, 2004).

After completing the curiosity trait assessments, participants were given a forced-choice recognition-memory test on the same trivia questions which they encountered in the first portion of the experiment. Participants were not told in advance that this would be a part of the experiment to avoid influencing their answers during the first trivia section. The recognition trivia questions were again presented one at a time in random order, but this time accompanied by the four multiple choice options. Participants were forced to choose one answer for every trivia question and were instructed to guess if they were unsure of the correct answer. At the end of this section, participants were debriefed and thanked for participating.

Results

The data from the first trivia portion of the experiment consisted of the participant’s answer to each trivia question (either an answer or a question mark indicating that they did not know the answer), their response to the question asking if they had experienced a TOT state (either yes or no), and their response to the state curiosity question (which could range from 1 to 4 with larger numbers indicating higher levels of curiosity). Responses for each trivia question were coded as belonging to one of four categories: Know (K), Don’t Know (DK), Resolved-TOT (RTOT), or Unresolved-TOT (URTOT). When a participant was able to correctly answer a

trivia question and did not report a TOT state, this was considered "Know" state. Conversely, when a participant was not able to correctly answer a trivia question and did not report a TOT state, this was considered a "Don't Know" state. When a participant was able to correctly answer a trivia question after having been in a TOT state, this was considered a Resolved-TOT state, and when a participant was not able to correctly answer a trivia question after having been in a TOT state, this was considered an Unresolved-TOT state. Each trivia question and state curiosity response was coded as belonging to one of these four states. The personality trait data consisted of an average score for each participant for each type of curiosity (Epistemic Curiosity and Curiosity as a Feeling-of-Deprivation). The data from the recognition portion of the experiment consisted of participant's responses to each multiple-choice trivia question. These responses were then coded for accuracy. Results reported as significant had associated *p*-values of less than .05.

Scores for the two personality trait measures and overall recognition accuracy were compared across demand condition to ensure that the two groups did not differ in terms of personality or general knowledge. Mean scores for the trait curiosity measures are presented in Table 1. There were no significant differences between participants in the High and Low Demand conditions for either of the personality trait measures (EC: $p > .40$; CFD: $p > .40$). There was also no significant difference between the two conditions in terms of overall performance on the multiple-choice trivia task ($p > .40$). Thus group assignment appears to be sufficiently random in terms of curiosity and general knowledge.

Average curiosity responses for each participant for each state (RTOT, URTOT, DK and K) were calculated and compared across demand conditions. Based on the approach-gradient theory of curiosity, I predicted that participants in a URTOT state would report the highest levels

of curiosity, followed by the DK state and then K and RTOT states (which should elicit comparable levels of curiosity). The approach-gradient theory would also predict that participants in the High Demand condition would experience higher levels of curiosity compared to those in the Low Demand condition. Figure 2 contains mean curiosity levels divided by state and demand condition. Overall, participants reported higher levels of curiosity in the low demand condition compared to the high demand condition. This difference was significant for K states ($F(1,68) = 9.186$, $p = .003$) and RTOT states ($F(1,70) = 7.689$, $p = .007$), marginally significant for URTOT states ($F(1,78) = 3.891$, $p = .052$), and not significant for DK states ($F(1,78) = 1.297$, $p = .258$). Tukey's HSD was used to compare average curiosity responses across state (RTOT, URTOT, DK and K) and collapsed across demand condition (see Table 2 for homogenous subsets). Curiosity levels between all states varied significantly except between DK and RTOT states.

Demand characteristics were predicted to affect the type of curiosity experienced with participants in the high-demand condition experiencing more negative forms of curiosity (CFD) and participants in the low-demand condition experiencing more positive forms of curiosity (EC). Only URTOT and DK state curiosity levels were investigated since previous research indicates that these are the feeling-of-knowing states for which state curiosity is related to trait curiosity (Litman et al., 2005). Correlations between personality trait measures of curiosity and state measures of curiosity were calculated, and Fisher's *z'* transformation was used to compare correlation coefficients. Correlations between EC and CFD trait curiosity measures and state curiosity measures for URTOT and DK states are presented in Table 3 and correlation comparisons for URTOT states are presented in Table 4. There were no significant correlations

between CFD trait curiosity and URTOT state curiosity in either demand condition. The difference between these two correlations was also not significant. There was a significant correlation between EC trait curiosity and URTOT state curiosity in the low demand condition, but not in the high demand condition. The difference between these two correlations was approaching significance (z' = 1.57, p = .1164). There were no significant correlations between either type of trait curiosity and DK state curiosity for either demand condition, nor were the differences between any of the DK correlations significant. As expected, there was also a significant correlation between the two measures of trait curiosity in both conditions (HD: r = .335, p = .035; LD: r = .598, p < .001). Unexpectedly, the difference between these two correlations was approaching significance (z' = 1.47, p = .141).

A review of the literature on these curiosity scales yielded an alternate way of measuring these two types of curiosity in a way which further differentiates between the two scales. Litman (2008) performed a factor analysis of the EC and CFD scales and selected, for each scale, the five items with the highest loadings. These new scales were relabeled as measuring the Interest (I-EC) and Deprivation (D-EC) factors of Epistemic Curiosity.[1] I-EC is associated with acquiring knowledge simply for the pleasure of doing so (mastery-oriented learning) whereas D-EC is associated with an unsatisfied need-like state in which the correctness, accuracy, and relevance of the unknown information is vitally important (performance-oriented learning). The new I-EC scale corresponds to the previous EC scale and the D-EC scale corresponds to the CFD scale. Using participants' responses to the EC and CFD scales, I was able to calculate their average scores for the new I-EC and D-EC scales. Correlations between the old and new

[1] The use of the term "Epistemic Curiosity" is somewhat inconsistent across papers. Up to this point, the term has been used in this paper to describe a specific form of curiosity which involves pleasurable feelings of interest and enjoyment in learning. Epistemic curiosity in the Litman (2008) paper is used to describe the broader category of curiosity underlying both the previous EC and CFD scales.

curiosity scales were calculated to validate the relationships between the two sets of scales (see Table 5). As would be expected, all four curiosity scales are significantly correlated with each other. But the correlation between the EC and CFD scales is significantly stronger than the correlation between the I-EC and D-EC scales when the two correlations are compared using Fisher's *z'* transformation ($z' = 2.18$, $p = 0.0293$). Moreover, the correlations between the new and old curiosity scales are numerically (although not significantly) different in the desired directions (the correlation between EC and D-EC is smaller than the correlation between EC and CFD, and the correlation between CFD and I-EC is smaller than the correlation between CFD and EC).

As before, correlations between these new personality trait measures of curiosity and state measures of curiosity were calculated, and Fisher's *z'* transformation was used to compare correlation coefficients. Correlations between I-EC and D-EC trait curiosity measures and state curiosity measures for URTOT and DK states are presented in Table 6. The pattern of results is largely the same as those obtained using the less differentiated curiosity scales, with the exception of the correlation between state curiosity experienced while in a DK state and I-EC trait curiosity in the low demand condition (which is now significant).

Average accuracy scores on the multiple-choice recognition task were calculated for each participant for each state (RTOT, URTOT, DK and K) and compared across states. There were no significant differences across condition for accuracy in any state, so accuracy scores were not analyzed separately by condition. Scores could range from 0 to 1, with 0 representing a perfect score. Not surprisingly, accuracy was highest for those questions which participants had been able correctly answer during the first trivia portion of the experiment: the RTOT and K states (means shown in Figure 3). Tukey's HSD revealed that the difference between RTOT and K

accuracy scores was not significant ($p > 0.4$), but the differences between all other accuracy scores were significant ($p < .001$ for all comparisons). The difference in accuracy between the URTOT and DK states is the most noteworthy. This difference indicates that the participants were significantly more accurate in answering recognition trivia questions which they had previously been unable to answer if they had experienced a TOT state on those questions rather than a DK state.

Discussion

The purpose of this study was to investigate the effect of demand characteristics on participants' experiences of curiosity within a variety of feeling-of-knowing states (Resolved and Unresolved tip-of-the-tongue states, Know states, and Don't Know states). Based on previous research, I predicted that the demand manipulation would cause participants in the high demand group to experience more negative forms of curiosity (uncertainty and tension) and the low-demand group to experience more positive forms of curiosity (interest in learning). I also predicted that the demand manipulation would affect the overall level of curiosity experienced by the participants. Reported curiosity levels and performance on a surprise recognition task were also expected to differ as a function of the type of state reported by participants.

The results indicate that demand characteristics did have some effect on curiosity level. Participants in the low demand condition reported higher levels of curiosity than those in the high demand condition for all feeling-of-knowing states except Don't Know. This difference is inconsistent with the approach-gradient theory, which would predict that participants in the high demand condition should experience higher levels of curiosity due to the heightened feeling of imminence. However, this result is consistent with the literature on curiosity which indicates that social anxiety and curiosity are inversely related (Kashdan, 2007).

Additionally, curiosity levels, collapsed across demand condition, varied as a result of participants' feeling-of-knowing states, with participants reporting the highest levels of curiosity while experiencing Unresolved TOT states, followed by Resolved TOT, Don't Know, and lastly Know states. That Resolved TOT states yielded significantly higher curiosity ratings than Know states is somewhat surprising considering that in both situations the participant had correctly retrieved the correct answer to the trivia question (and so should be experiencing very little curiosity according to the approach-gradient theory). It is possible that the participants were simply confused by the question (why would they be curious about something which they already knew) and so interpreted the question as being past-tense (how curious *were* you instead of how curious *are* you). The participants likely experienced heightened levels of curiosity during the period of time prior to the resolution of their TOT state (technically every Resolved TOT state must be preceded by an Unresolved TOT state) which may have influenced their final curiosity self-rating if they were indeed interpreting the question in the past-tense. Another possibility is that participants were less of sure of their answers following a Resolved TOT state and so were interested in verifying their answer.

The curiosity correlation results are decidedly more difficult to interpret. While many of the differences between the correlation coefficients were numerically different in the predicted directions, only a handful of those differences were significant. State curiosity for Unresolved-TOT states in the low-demand condition was significantly correlated with trait Epistemic Curiosity. This correlation indicates that participants in the low-demand condition were experiencing this more positive form of curiosity while experiencing a TOT state. As predicted, the difference between this correlation and the comparable correlation in the high-demand condition was approaching significance, indicating that participants were experiencing a more

positive form of curiosity while in a TOT state in the low demand condition as compared to the high demand condition. This result is consistent with the approach-gradient theory of curiosity in that demand characteristics were expected to affect the perception of knowledge gaps, and larger knowledge gaps were associated with more positive forms of curiosity.

In contrast to this result, Curiosity as a Feeling-of-Deprivation was not significantly correlated with state curiosity for any feeling-of-knowing state for either demand condition, nor were there significant differences between the correlation coefficients across demand condition. This is contradictory to the approach-gradient theory of curiosity in that smaller perceived knowledge gaps, which were expected to be created by the demand manipulation, are associated with this more negative form of curiosity. However, as mentioned earlier, a meta-analysis by Kashdan (2007) found that social anxiety is negatively correlated with curiosity. The demand manipulation used in this experiment, in addition to affecting the perception of knowledge gaps, likely placed participants under some amount of stress and social pressure. This social pressure may then have affected the type and level of curiosity felt by participants, especially in the high demand condition. The marginal difference across demand condition in the correlation between the two types of curiosity may also be explained by this social pressure if it differentially affected the types of curiosity.

The results from the surprise recognition portion of the experiment provide support for the validity of the TOT state (as distinct from other feeling-of-knowing states) and also support the distinction between Resolved and Unresolved TOT states. In previous studies, researchers have found no difference in accuracy on such surprise recognition between TOT states and Don't Know states, casting some doubt on the validity of the TOT phenomenon (Litman, Hutchins & Russon, 2005; Widner, Smith & Graziano, 1996). It is possible that these studies failed to find a

significant difference because they had smaller sample sizes and so may have lacked sufficient power (only 60 of Litman et al.'s participants completed a recognition task and only 40 of Widner et al.'s participants). If my study had not found a significant difference between recognition accuracy for Unresolved TOT states and for Don't Know states, this result would have been supportive of a model of TOT formation (such as the inferential model) which is not consistent with the doctrine of concordance. The lack of a significant difference would have indicated that recognition accuracy (a behavioral check of memory) and the phenomenological experience of a TOT state can be dissociated, and therefore must arise from separate cognitive processes. As it is, this result is consistent with either model of TOT formation (since models inconsistent with the doctrine of concordance still predict that behavior and phenomenology will be correlated).

Overall, these results are partially consistent with the approach-gradient theory of curiosity, but also indicate that the social pressure aspect of demand characteristics may differentially affect the two types of curiosity examined. Participants in the low demand group reported higher levels of curiosity, which was consistent with the literature on stress and curiosity, but inconsistent with the approach-gradient theory of curiosity. But participants reported higher levels of curiosity for TOT states than Know or Don't Know states across demand condition, which was consistent with the approach-gradient theory of curiosity. Demand characteristics also affected the type of curiosity participants experienced while in a TOT state, as indicated by differences in correlation coefficients. Participants in the low demand group experienced a more positive form of curiosity while in a TOT state compared to participants in the high demand group, but no significant differences for the more negative form of curiosity were found. Demand characteristics clearly had some kind of effect on the type and level of

curiosity experience during a tip-of-the-tongue state, but more research is needed to flesh out the components of this effect. Future research should focus on the differential effects of stress and demand characteristics on both the specific sub-types of curiosity and their specific effects on the TOT state.

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Appendix A: Curiosity Measures

EC Stimuli (Litman & Spielberger, 2003):

I enjoy exploring new ideas.
I enjoy learning about subjects which are unfamiliar.
I think it's fascinating to learn new information.
When I learn something new, I like to find out more about it.
I enjoy discussing abstract concepts.
If I encounter a complicated piece of machinery, I ask how it works.
When given an arithmetic problem, I enjoy imagining solutions.
If I am presented with an incomplete puzzle, I try and imagine the final solution.
I am interested in discovering how things work.
When presented with a riddle, I'm interested in trying to solve it.

CFD Stimuli (Litman & Jimerson, 2004):

When I read something that puzzles me, I keep reading until I understand.
I try to learn about complex topics because I don't like not knowing.
It's important to me to feel knowledgeable.
It bothers me if I don't know a word, so I will look up the meaning.
I spend time formulating my ideas clearly in order to be understood.
I have a hard time accepting mysteries that can't be solved.
It troubles me when there doesn't seem to be a reasonable solution to a problem.
It aggravates me if I can't remember a fact, and I think about it until it comes to me.
I'm critical of ideas and theories.
It really gets on my nerves when I am close to solving a problem, but still can't figure it out.
Conceptual problems keep me awake thinking about solutions.
When faced with a problem, I can't rest without knowing the answer.
I get frustrated if I can't figure out a solution and work even harder to solve it.
I brood for a long time in order to solve a problem.
I work like a fiend at problems which must be solved.

Interest-EC Stimuli (Litman, 2008):

I enjoy exploring new ideas.
I enjoy learning about subjects which are unfamiliar.
I think it's fascinating to learn new information.
When I learn something new, I like to find out more about it.
I enjoy discussing abstract concepts.

Deprivation-EC Stimuli (Litman, 2008):

Conceptual problems keep me awake thinking about solutions.
When faced with a problem, I can't rest without knowing the answer.
I get frustrated if I can't figure out a solution and work even harder to solve it.
I brood for a long time in order to solve a problem.
I work like a fiend at problems which must be solved.

Appendix B: Trivia Items

Trivia Questions	1	2	3	4	Answer
What is the name of the legendary one-eyed giant in Greek mythology?	Cyclops	Chimera	Satyr	Minotaur	1
Which sport uses the terms "stones" and "brooms"?	Curling	Luge	Shuffleboard	Bocce	1
What is the last name of the author of "Our Town"?	Wilder	Stein	Cather	Clift	1
What is the name of the island-city believed to have sunk into the ocean?	Olympus	Atlantis	Valhalla	El Dorado	2
What is the name of the furry animal that attacks cobra snakes?	Hyena	Mongoose	Civet	Weasel	2
What is the proper name for a badminton bird?	Stone	Shuttlecock	Wicket	Pallino	2
What is the last name of the man who assassinated president John F. Kennedy?	Ruby	Booth	Oswald	Hinckley	3
What is the last name of the artist who painted "Guernica"?	Gauguin	Braque	Picasso	Matisse	3
What is the name of the river that runs through Rome?	Tigris	Arno	Tiber	Po	3
What is the only word the raven says in Edgar Allen Poe's poem "The Raven"?	Dreary	Lenore	Weary	Nevermore	4
What is the last name of the man who began the Reformation in Germany?	Zwingli	Calvin	More	Luther	4
What is the last name of the author who wrote "Brothers Karamazov"?	Gogol	Nabokov	Tolstoy	Dostoyevski	4
What is the last name of the boxer who later became known as Mohammud Ali?	Clay	Frazier	Tyson	Dempsey	1
What is the name of the north star?	Sirius	Polaris	Cassiopeia	Orion	2
What is the name of the liquid portion of whole blood?	Lymph	Sebum	Plasma	Hemoglobin	3
What is the unit of electrical power that refers to a current of one ampere at one volt?	Pascal	Joule	Erg	Watt	4
What is the last name of the author of the book "1984"?	Orwell	Greene	Zamyatin	Huxley	1
What is the name of the Roman emperor who fiddled while Rome burned?	Caligula	Nero	Claudius	Augustus	2

What Italian city was destroyed when Mount Vesuvius erupted in 79 A.D.?	Naples	Salerno	Pompeii	Aquitania	3
What is the name of the constellation that looks like a flying horse?	Equuleus	Andromeda	Draco	Pegasus	4
What was the name of King Arthur's sword?	Excaliber	Gram	Hrunting	Glamdring	1
What is the last name of the artist who painted "American Gothic"?	Anderson	Wood	Benton	Lewis	2
What is the last name of the European author who wrote "The Trial"?	Joyce	Cocteau	Kafka	Brecht	3
What is the name of the island on which Napoleon was born?	Sicily	Majorca	Malta	Corsica	4
What is the last name of the woman who founded the American Red Cross?	Barton	Nightingale	Anthony	Pitcher	1
What is the capitol of Jamaica?	Portmore	Kingston	Mandeville	Montego Bay	2
What is the capitol of Canada?	Montreal	Toronto	Ottowa	Calgary	3
What was the last name of the female star of the movie "Casablanca"?	Bogart	Hepburn	Kelly	Bergman	4
What is the name of the project which developed the atomic bomb during World War II?	Hanford	Manhattan	Potsdam	Oppenheimer	2
Who is known as the father of geometry?	Descartes	Gauss	Euclid	Euler	3
What is the palace built in France by King Louis XIV?	Fontaineblea u	Luxembour g	Louvre	Versailles	4
What is the name of the captain of the Pequod in the book "Moby Dick"?	Ahab	Ishmael	Herman	Starbuck	1
What was Frank Lloyd Wright's profession?	Engineer	Architect	Professor	Lawyer	2
In which city is Heathrow airport located?	Manchester	Stratford	London	Birmingham	3
What is the name of the villainous people who lived underground in H.G. Wells' book "The Time Machine"?	Orcs	Eloi	Wargs	Morlocks	4
What was the name of the goldfish in the story of Pinnochio?	Cleo	Monstro	Figaro	Angel	1
What is the last name of the Cuban leader that Castro overthrew?	Ibarra	Batista	Bosque	Torrado	2

Table 1: Epistemic Curiosity and Curiosity as a Feeling-of-Deprivation Means and Standard Deviations

Condition		Curiosity as a Feeling-of-Deprivation	Epistemic Curiosity
High Demand	Mean	2.702	2.785
	Std. Dev.	0.3742	0.3766
Low Demand	Mean	2.7682	2.708
	Std. Dev.	0.43835	0.5176

Table 2: Curiosity Tukey HSDa,b

	N	Subset for alpha = 0.05		
		1	2	3
Know	70	1.976		
Don't Know	80		2.5006	
Resolved TOT	72		2.7278	
Unresolved TOT	80			3.5181
Sig.		1	0.142	1

Means for groups in homogenous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 75.224

b. The group sizes are unequal. The harmonic mean of the group is used. Type I error levels are not guaranteed.

Table 3: Trait and State Curiosity Correlations

			CFD	EC	URTOT	DK
High Demand:	Pearson Correlation	CFD	1	0.335*	0.184	-0.017
	Sig			0.035	0.257	0.917
	N		40	40	40	40
	Pearson Correlation	EC		1	0.031	0.084
	Sig				0.85	0.605
	N			40	40	40
	Pearson Correlation	URTOT			1	0.286
	Sig					0.074
	N				40	40
	Pearson Correlation	DK				1
	Sig					
	N					40
			CFD	EC	URTOT	DK
Low Demand:	Pearson Correlation	CFD	1	0.598**	0.197	-0.112
	Sig			<0.001	0.223	0.492
	N		40	40	40	40
	Pearson Correlation	EC		1	.377*	0.236
	Sig				0.016	0.143
	N			40	40	40
	Pearson Correlation	URTOT			1	0.354*
	Sig					0.025
	N				40	40
	Pearson Correlation	DK				1
	Sig					
	N					40

Table 4: EC and CFD Correlation Comparisons

		EC/URTOT LD	CFD/URTOT HD
EC/URTOT HD	N	40	40
	Z’	1.57	0.67
	Sig	0.1164	0.502
CFD/URTOT LD	N	40	40
	Z’	0.85	0.058
	Sig	0.395	0.48

Table 5: Curiosity Scale Correlations

		D-EC	I-EC	CFD	EC
D-EC	Pearson Correlation	1	0.176	0.888	0.401
	Sig (2-tailed)		0.119	0.00	0.00
	N	80	80	80	80
I-EC	Pearson Correlation		1	0.335	0.785
	Sig (2-tailed)			0.002	0.00
	N		80	80	80
CFD	Pearson Correlation			1	0.485
	Sig (2-tailed)				0.00
	N			80	80
EC	Pearson Correlation				1
	Sig (2-tailed)				
	N				80

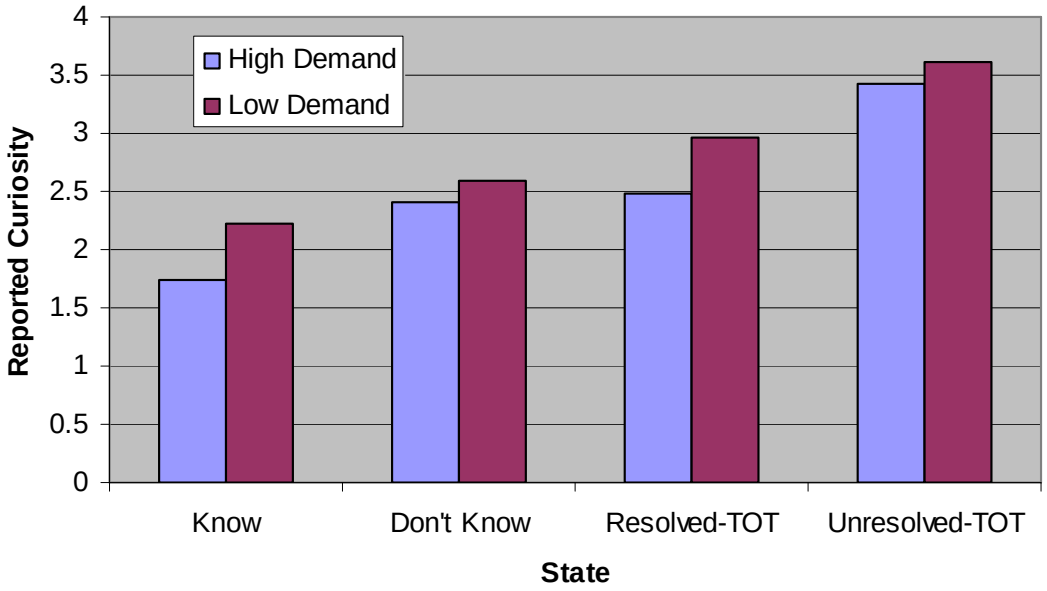
Table 6: Revised Trait and State Curiosity Correlations

			D-EC	I-EC	URTOT	DK
High Demand:	Pearson Correlation	D-EC	1	-0.002	0.184	-0.065
	Sig			0.989	0.254	0.688
	N		40	40	40	40
	Pearson Correlation	I-EC		1	-0.016	0.181
	Sig				0.922	0.263
	N			40	40	40
	Pearson Correlation	URTOT			1	0.286
	Sig					0.074
	N				40	40
	Pearson Correlation	DK				1
	Sig					
	N					40
			D-EC	EC	URTOT	DK
Low Demand:	Pearson Correlation	D-EC	1	0.332*	0.089	-0.223
	Sig			0.036	0.586	0.167
	N		40	40	40	40
	Pearson Correlation	I-EC		1	.314*	.378*
	Sig				0.049	0.016
	N			40	40	40
	Pearson Correlation	URTOT			1	0.354*
	Sig					0.025
	N				40	40
	Pearson Correlation	DK				1
	Sig					
	N					40

Figure Caption

Figure 1. Average Curiosity Responses

Figure 2. Recognition Accuracy Means


4
3.5
3
2.5
2
1.5
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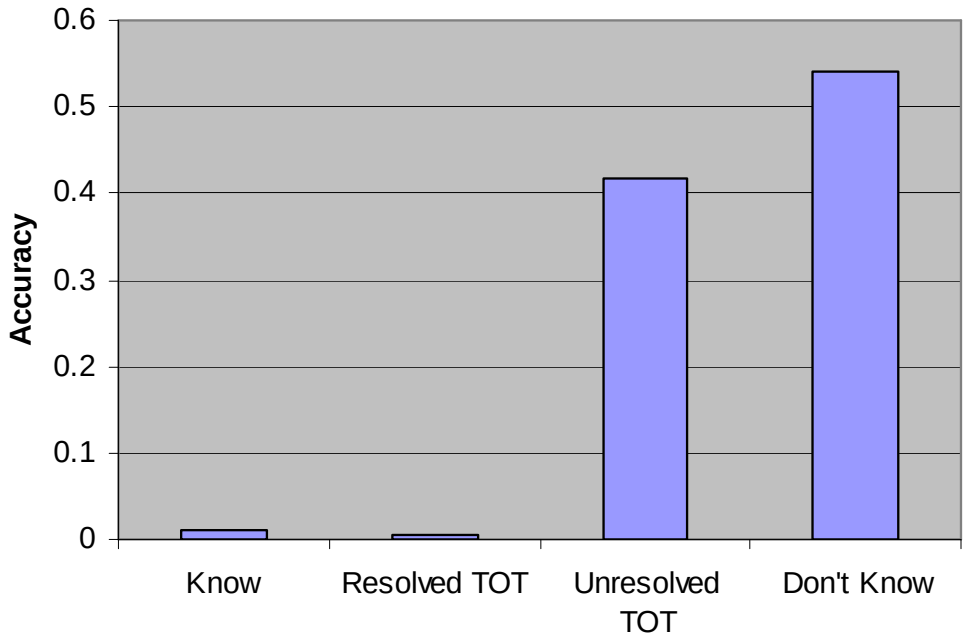
High Demand
Low Demand
Reported Curiosity
Know
Don't Know
Resolved-TOT
Unresolved-TOT
State


0.6
0.5
0.4
0.3
0.2
0.1
0
Accuracy
Know
Resolved TOT
Unresolved TOT
Don't Know