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Negative affect does not impact semantic retrieval failure monitoring

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Abstract

This study investigated the effect of the emotional nature of to-be-retrieved material on semantic retrieval monitoring. Across two groups, participants were either asked whether they have experienced a tip-of-the-tongue (TOT) state or to make a feeling-of-knowing (FOK) judgment. We examined the overall reporting rate as well as subjective (not accompanied by partial information recall) TOT and FOK reporting, comparing whether these differed between emotional (negatively valenced and arousing) and neutral items. The results demonstrated that emotion does not impact semantic TOT and FOK reports, a conclusion supported by Bayesian analysis of the results. The outcomes extend other findings in the metamemory literature, and are discussed with a focus on future research avenues concerning interactions between emotion and metamemory.

Keywords: Metamemory, Emotion, Tip-of-the-tongue, Feeling-of-knowing

Introduction

The current study investigated how negative affect impacts metacognitive monitoring of semantic retrieval failures (i.e. instances when a piece of factual information stored in memory becomes temporarily inaccessible). Emotion has been widely shown to influence memory (see Kensinger & Schacter, 2008, for a review) and more recently the investigation has turned to how this translates to effects on metamemory. For example, it has been demonstrated that emotion impacts monitoring judgments made at learning, with participants consistently predicting better retrieval for emotional as compared to neutral items, even though the effect of emotion on memory changed with the type of retrieval test used (Zimmerman & Kelley, 2010). Drawing on metamemory accounts of retrieval failure (e.g. Koriat, 2000), we examined whether emotion can be misinterpreted as a cue signaling that currently inaccessible information will be retrieved in the near future.

When we fail to retrieve an item from memory, we are often able to evaluate (i.e. metacognitively monitor) that this has occurred and even whether we will be able to recognize or retrieve the answer at some later point (Nelson & Narens, 1990). Two metacognitive paradigms used to assess such instances of loss of retrieval access are feeling-of-knowing (FOK) judgments and tip-of-the-tongue (TOT) experiences. In a semantic version of these metamemory tasks, participants are usually presented with general knowledge questions and asked to provide the answer. When they fail to retrieve an answer on an FOK task, participants are asked to evaluate whether they feel they will be able to recognize the sought-after item among multiple options presented to them later (Hart, 1965). In a TOT paradigm, participants are asked to indicate whether they feel on the verge of recalling the momentarily inaccessible answer or, in other

words, whether they feel the answer is on 'the tip-of-their-tongue' (Brown & McNeill, 1966). Both TOT and FOK reports are usually followed by a recognition task for the unretrieved items to assess the report accuracy, defined as the ability to discriminate between information that will and will not be retrieved.

Research has suggested that negative affect is an intrinsic part of the TOT experience (Schwartz, 2001) and might even be directly related to the intensity and likelihood of resolving a TOT (Schwartz, Travis, Castro & Smith, 2000). While there is thus an established link between the two states, it remains unclear whether emotion can causally influence a TOT experience. Schwartz (2010) found that in instances when participants were unable to recall an answer to a question, they reported experiencing TOT more often when the topic of the question and answer was emotional than when the sought-after item was neutral. There was also an increase in TOT reports for neutral questions directly following an emotional question, suggesting a carry-over effect. D'Angelo and Humphreys (2012) used the same questions as those used by Schwartz intermixed with 20 additional neutral trials to balance for variables known to influence TOTs (e.g. word frequency). No effects of emotion emerged even when the researchers directly contrasted TOT reports only for the items subset of items used in Schwartz's study, possibly suggesting the original finding to be a false positive. There is therefore a clear need for further research given the inconsistency in outcomes to date.

Notably, both Schwartz (2010) and D'Angelo and Humphreys (2012) used general knowledge questions differing in the affective charge of the knowledge domain they tapped into (e.g. names of mortal diseases as compared to names of writers) as rated on a 5-point emotionality scale ('not at all' to 'very' emotional). However, current understanding of emotion is two-dimensional, thought best captured by considering both its valence (how negative or positive) and arousal (how calming or exciting; an idea

first proposed by Russell, 1980) with each dimension impacting memory through different channels (Kensinger, 2004). Correspondingly, studies that have observed an effect of emotion on metamemory assessments (e.g. Zimmerman & Kelley, 2010) have manipulated both dimensions suggesting both might play a role and need to be considered. In line with this previous research, we compared retrieval failure monitoring for negatively valenced, arousing items to neutral, non-arousing items.

While the effect of emotion has been investigated in relation to TOTs, it has not been investigated for FOKs. There are many parallels which can be drawn between TOTs and FOKs (Bahrick, 2008) but they also react differently to the same manipulations (Schwartz, 2008, Widner, Smith & Graziano, 1996) and show differential brain activations (Maril, Simons, Weaver & Schacter, 2005). Brown (2012) describes TOTs as unique subjective states and FOKs as a general assessment of knowing. In line with current understanding of metamemory as a dual-level process (Koriat, 2000), Moulin and Souchay (2013) have suggested that while TOTs might be best characterized as an epistemic feeling, FOKs might represent a mix of feeling- and judgment-based metacognition, capturing a range of implicit and more controlled processes. In relation to this, Zimmerman and Kelley (2010) suggested that in metamemory tasks emotion is relied on as an epistemically meaningful heuristic, and Schwartz (2010) further speculated that the emotional experience brought on by the sought after information might be misattributed for a TOT experience. Such an interpretation would be congruent with findings that subjective variables, such as fluency, can be misattributed as indicative of memory (Jacoby & Whitehouse, 1989) and metamemory (Rhodes & Castel, 2008). It is possible that emotion might be similarly misinterpreted, particularly in instances of monitoring that rely heavily on heuristic processes. This would indicate that

if emotion does impact metacognitive judgments, TOTs might be more sensitive to this manipulation (relative to FOKs) if indeed they are more heuristic-dependent.

Further, a distinction has been made by some researchers between subjective and objective TOTs (Jones & Langford, 1987). Subjective TOTs are thought to be purely feeling-based whereas objective TOTs are instances where the participant is able to retrieve partial information about the sought after word. Within the theoretical framework employed here of misattributing emotion to an experience of TOT (Schwartz, 2010), it is possible that emotion might impact subjective TOTs more strongly or even exclusively, something which has not yet been investigated. This would imply that one might not observe effects of emotion on overall TOT rates if objective TOTs were predominant, but one might see an effect of emotion on the type of TOTs reported. In order to distinguish between subjective and objective TOTs, we asked participants to report whether they can remember the first letter and the number of syllables of the sought after items – two of the most commonly reported types of partial information retrieved in instances of retrieval failure (Brown, 2012).

An alternative view is that TOTs represent instances of access to semantic features without full access to phonological features of the target word, impeding articulation of the target item (Burke, MacKay, Worthley & Wade, 1991). Based on the 2-stage model of lexical access, it follows that TOTs always represent instances of (some) partial access although that partial access differs in whether its content is only semantic and syntactic (stage 1) or whether it also incorporates phonological features (stage 2; Vigliocco, Antonini & Garrett, 1997). In contrast to the metamemory view, a TOT in this view is not inferred but rather known, eliminating the importance of the subjective feeling component. It is not clear whether such lexical-access accounts would predict any effect of emotion on TOTs. However, given emotional items facilitate lexical processing in

contrast to neutral items (e.g. Vinson, Ponari & Vigliocco, 2014), such a finding could be reconciled with a linguistic account of TOT.

In summary, we investigated the effect of emotion (negative valence and high arousal) associated with the to-be-retrieved material on the reporting of TOTs and FOKs. We assessed the general TOT and FOK rates and investigated whether they were subjective or objective (accompanied by partial information recall). We were interested in observing whether emotion would increase the rate of TOTs and FOKs reported. We were also interested in seeing whether this would be reflected in a decrease in accuracy if indeed participants are *misinterpreting* emotion as indicative of future retrieval. The prediction was that emotion would have the most discernible impact on monitoring that strongly relies on feeling-based processes; that is subjective TOTs in particular, and this should lead to a corresponding decrease in metamemory monitoring accuracy.

Method

Participants

The participants were 40 students at the University of Leeds (28 females and 12 males, average age = 19.7, *SD* = 1.14) randomly assigned to one of two conditions (TOT or FOK). They were all native English speakers and completed the experiment for course credit. Ethical approval was granted by the School of Psychology Ethics Committee, University of Leeds, U.K.

Materials

A set of 200 general knowledge questions were initially created and piloted in an online experiment. Neutral general knowledge questions were taken from existing studies and norms (Beattie & Coughlan, 1999; Brown & Nix, 1996; Frick-Horbury &

Guttentag, 1998; Nelson & Narens, 1980; Schwartz, 2010; Yaniv & Meyer, 1987). For emotional questions, those created by Schwartz (2010) were used and further questions, based around the same themes as the original study (profanity, death, sex, bodily functions and diseases) were developed. In the pilot, each participant was randomly assigned 40 questions (emotional to neutral ratio of 2:3). They were presented with one question at a time and asked to type in the answer if they knew it and to rate the question on both emotional valence and arousal using the self-assessment manikin scales (Bradley & Lang, 1994). These are non-verbal, pictorial, 9-point scales, one for each concept with the valence scale ranging from very pleasant to very unpleasant and the arousal scale ranging from not at all aroused to very aroused. A total of 71 participants completed this online experiment (ages 18-40) with each question having been rated by at least 10 participants.

A set of 100 questions (35 emotional and 65 neutral, see appendix) was selected based on the outcomes of this pilot (see Table 1). The ratio of emotional to neutral items was chosen so as to satisfy two key considerations. Firstly, research suggests that a lower number of emotional than neutral items should be used due to the possibility of dampening effects of emotional reaction with repeated exposure to emotional stimuli (Gyurak, Gross & Etkin, 2011). Secondly, the number of trials should be large enough to produce sufficient data points on both neutral and emotional items, minimizing the risk of type I errors. We ensured that the ratio was not higher than that used in our pilot so that effect dampening could not be an issue (in case no effects were observed). As a result, we increased the ratio of 1:4 (emotional:neutral) used in Schwartz's (2010) study (on which we based much of our methods) to around 1:2.

It was ensured that the two sets of stimuli differed on emotional valence, $t(98) = 15.8$, $p < .001$, $d = 3.38$, and arousal, $t(98) = 4.72$, $p < .001$, $d = 1$. The emotional and

neutral sets did not differ on the likelihood of pilot participants knowing the answer, $t(98) = 1.31$, $p = .19$, $d = .22$. The answers (all single words) did not differ on frequency of use, $t(98) = 1.49$, $p = .14$, $d = 0.31$, as determined through the English Lexicon Project (Balota et al., 2007) using the recommended Hyperspace Analogue to Language (HAL) frequency norms.[1] The number of phonological neighbours was also assessed using the Washington University in St. Louis Speech and Hearing Lab Neighbourhood Database (Sommers, 2002). While only the neutral items generated any neighbours, an independent samples t-test showed that this was still not significantly different from the emotional set, $t(98) = 1.55$, $p = 0.12$, $d = .33$.

[Insert table 1 here]

Finally, a 5-alternative forced-choice recognition test was constructed in order to assess memory for the unrecalled items. For each question, this involved the correct answer, three semantically related distractors, and a "don't know" option.

Procedure

The experiment was programmed in PsychoPy (Peirce, 2007) and participants, randomly assigned to either a TOT or an FOK condition, completed it on a computer, on their own. They read instructions explaining the task after which they completed 4 practice questions before beginning the experiment. As part of the instructions (following phrasing used in previous research) participants were given an explanation of either TOT (e.g. Brown, 2012, Brown & McNeill, 1966, Schwartz, 2008,) or FOK (e.g. Hart, 1965, Nelson & Narens, 1980, Schwartz, 2008) as described below.

TOT: *For those instances when you indicate you do not know the answer, you will be asked whether you have had a tip-of the tongue experience. This is the state of mind in*

which a person is unable to think of a word that they are certain they know and that they feel they will recall soon. 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 tip-of-the-tongue state and you should indicate so. You should AVOID answering 'yes' if it is only the case that you feel you SHOULD know the answer. A tip-of-the-tongue experience is when you feel that the RECALL of the answer is IMMINENT.

FOK: *For those instances when you indicate you do not know the answer, you will be asked whether you feel that you know it and that you will be able to recognize it later. The criterion question to ask yourself is, 'Even though I don't remember the answer now, do I know the answer to the extent that I could pick the correct answer from among several wrong alternatives?*

Participants were shown all 100 questions in pseudo-random order, ensuring that each fifth of the entire list contained a fifth of the emotional items. The questions were all presented one at a time at the top-center of the computer screen in Gill Sans MT font. For each presented question, participants were asked to recall and type in the answer or indicate that they did not know it by typing 'DK'. Participants were encouraged to indicate not knowing rather than to guess the answer. They were given 30 seconds to answer the question after which it was assumed they could not retrieve it.

If participants provided an answer, they proceeded to the next question. If they indicated not knowing, or exceeded the 30-second limit, participants completed a series of consecutive judgments. Firstly, they indicated whether they had experienced a TOT (or they made FOK judgment, depending on the condition). As we were interested in contrasting TOTs and FOKs across the two groups, the same answer option (yes/no)

was implemented for both. When Hart (1965) introduced the FOK task, he used both a yes/no procedure and a rating scale of confidence to assess belief in future retrieval. On the other hand, TOTs are usually evaluated with a yes/no question (e.g. Brown and McNeill, 1966), the query being whether a unique state is being experienced. Yes/no thus seemed the more appropriate assessment for both tasks. After this response, in keeping with Schwartz's (2010) design, participants rated how emotional the question made them feel followed by how frustrating the question made them feel on a 5-point scale (5 indicating very emotional or frustrated and 1 indicating being not at all emotional or frustrated).

If participants said yes to the TOT/FOK question, they proceeded to the last stage in which they were asked to type in the first letter and the number of syllables of the word they were trying to recall, if possible.

This was followed by a recognition phase. Participants were shown all questions again and asked to choose the correct answer among 4 options (randomly ordered) or to indicate they did not know it.

Results

Recall

Firstly, we analyzed the rate of correct responses given for each type of question. Participants correctly recalled a higher percentage of neutral (M = 24.73, SD = 11.97) as compared to emotional items (M = 19.93, SD = 12.96), $t(19) = 3.35$, $p < .01$, $d = .39$. This is in contrast to the pilot data where there were no differences in performance between the two sets of items. This is possibly due to the age differences between the two samples; participants in the study were younger than participants in the pilot, which might explain differences in their general knowledge. Nevertheless, Schwartz (2010)

and D'Angelo and Humphreys (2012) likewise found a difference in correct recall rates across item types. The following analyses focus on items for which participants did not recall an answer for.

Rate of TOT and yes-FOK reports

Participants reported experiencing, on average, 10.7 TOTs (*SD* = 4.84) and 15.3 FOKs (*SD* = 10.08) during the experiment. We analysed the *rate* of reported TOTs and positive FOKs (those that garnered a 'yes' responses) for those items for which participants reported not knowing (see Table 2). This overall rate of TOTs/FOKs was further separated into the rate of objective and subjective TOTs/FOKs. This indicates whether the TOT/FOK was accompanied by any partial information recall (objective TOT/FOK) or not (subjective TOT/FOK). Partial information recall was indicated by participants reporting either the first letter or the number of syllables (or both) of the target word.

[Insert table 2 here]

There was no effect of emotion on the overall rate of reported TOTs, $t(19) = .35$, $p = .73$, $d = .09$, nor FOKs, $t(19) = .01$, $p = .99$, $d = .001$. The emotional priming effect observed by Schwartz (2010) was also not observed as neutral items following emotional items did not show an increase in the rate of TOTs, $t(19) = .98$, $p = .34$, $d = .21$, or yes-FOKs reported, $t(19) = .88$, $p = .39$, $d = .12$.

We also predicted that subjective TOT/FOK reports might be more sensitive to the emotion manipulation. As such we further analysed the rate of subjective TOTs and FOKs reported for emotional as compared to neutral items. Neither subjective TOT reports, $t < 1$, nor subjective FOK reports, $t < 1$, differed between the two sets of items.[2]

Accuracy of TOT reports and FOK judgments

Firstly, absolute accuracy (calibration) was assessed by comparing recognition performance between items for which participants reported a TOT (or positive FOK) and those items they did not (see Table 3). To this end a Condition (TOT, FOK) x Question type (emotional, neutral) x Metacognitive response (yes-TOT/FOK, no-TOT/FOK) mixed ANOVA was carried out on the recognition task performance. There was a main effect of response, $F(1, 37) = 160.58$, $p < .001$, $\eta^2 = .57$, with participants recognizing more of those items for which they indicated experiencing a TOT or which they judged they will recognize (yes-FOK), but no other significant main effects or interactions (all *p*-values > .14).

Secondly, relative accuracy (resolution) of metacognitive judgments was measured using the Goodman-Kruskal Gamma correlation (generally referred to as gamma, Goodman & Kruskal, 1954). Gamma is a measure of association (ranging between values of -1 and 1) between the metacognitive judgments and the subsequent memory performance. Unlike absolute accuracy measures, gamma aims to track the relative relationship between judgments and performance, via an item-by-item analysis. A Question type (emotional, neutral) x condition (TOT, FOK) ANOVA revealed no main effects or interactions (all *ps* > .31). In other words, the gamma correlations for emotional ($M = .62$, $SD = .54$) and neutral items ($M = .53$, $SD = .45$) in the TOT condition and emotional ($M = .63$, $SD = .5$) and neutral items ($M = .72$, $SD = .22$) in the FOK condition were statistically equivalent. Overall then, participants' reports of TOT experiences and their FOK reports mapped fairly accurately onto their subsequent memory performance in both calibration and resolution. This accuracy was not affected by the emotional nature of the stimuli.

[Insert table 3 here]

Emotion and frustration ratings

Further analysis explored the extent to which the emotional nature of the to-be-retrieved material impacted the phenomenological experience associated with TOTs or positive FOKs (see Table 3). A Condition (TOT, FOK) x Question type (emotional, neutral) x Metacognitive response (yes-TOT/FOK, no-TOT/FOK) mixed ANOVA was carried out to analyze emotionality and frustration ratings for both the TOT and the FOK conditions. For emotion ratings, there was a main effect of question type, $F(1, 37) = 16.99$, $p < .001$, $\eta^2 = .078$, and response, $F(1, 37) = 30.4$, $p < .001$, $\eta^2 = .28$. The results for frustration ratings were parallel with a main effect of question type, $F(1, 37) = 4.58$, $p < .05$, $\eta^2 = .007$, and a main effect of response type, $F(1, 37) = 73.73$, $p < .001$, $\eta^2 = .59$. There was also a main effect of condition, $F(1, 37) = 5.0$, $p < .05$, $\eta^2 = .12$. To summarize, emotional questions were rated as more emotional and frustrating than neutral questions, and items for which participants reported a TOT or gave a yes-FOK response received higher emotionality and frustration ratings. Overall, participants in the TOT condition used higher frustration ratings than participants in the FOK condition.

Bayes Factor

Bayesian statistics allows for the evaluation of the null hypothesis as well as the alternative hypothesis, assessing whether the data provides evidence for either or neither (Dienes, 2014) and has been defended by many as superior to the classic null hypothesis testing (e.g. Kruschke, 2010). The Bayes Factor pits the probability of the null hypothesis against the probability of the experimental hypothesis being true for the given data. It is thus ultimately an odds ratio of the two probabilities allowing for a conclusion of which one is more likely. In other words, if Bayes Factor = 1 then the

probabilities of both the null and the experimental hypotheses being true are equal and nothing can be said about either as a fit for the data. Usually it is assumed that any value too close to 1 represents such a scenario. However, if Bayes Factor is less than 1/3 or more than 3, then researchers have argued one can make conclusions in favour of either hypothesis fitting the data (Jeffreys, 1961). We thus turn to the calculation of the Bayes Factor as a way of elaborating on the key null results obtained in this experiment.

We used the Bayesian t-test proposed by Rouder, Speckman, Sun, Morey and Iverson (2009) using the Jeffrey-Zellner-Siow Prior which is based on a Cauchy distribution on the effect size with the default scale parameter on effect size of 1. Rouder at al. (2009) propose this approach is appropriate where there are no strong prior assumptions such as is the case in this study.

Firstly, we analysed the overall rates of TOTs and FOKs between emotional and neutral items. This analysis revealed that for both TOTs (Bayes Factor = 5.53) and FOKs (Bayes Factor = 5.86), the evidence was in favour of the null hypothesis and there truly was no difference in the rate of both TOT and FOK reports between emotional and neutral items. Secondly, since our prediction was that emotion might especially impact subjective TOT and FOK reports rather than just overall rates, we also computed a Bayesian t-test for this comparison. Again, the rates of subjective TOT (Bayesian Factor = 5.68) and FOK (Bayesian Factor = 5.37) reports were the same for emotional and neutral items, supporting the null hypothesis.

Discussion

To summarize, both TOTs and positive FOKs were accompanied by an increase in recognition performance for those items, highlighting accuracy of metacognitive monitoring (Nelson, 1984). Additionally, a positive response to either a TOT or an FOK

assessment was accompanied by an increase in the ratings of emotionality and frustration experienced. The correlation between negative affect and TOTs has been demonstrated in the literature (Schwartz, 2001, Schwartz, 2010) and is consistent with both inferential and lexical-access models of TOTs. It is however a novel finding for FOK. This suggests that a retrieval failure experience is generally phenomenologically different to not knowing and underlines similarities between TOT and FOK reports although it also appeared that TOTs were rated more strongly than FOKs on frustration. Given that FOKS are likely to include a range of retrieval failure states, including TOTs as well as less singular epistemic feelings, this is consistent with the way these experiences are understood. There was however no impact of negative affect associated with the to-be-retrieved material on TOT or FOK reports. Thus, the increased rates of reported TOTs for emotional items observed by Schwartz (2010) were not replicated even when we explored subjective TOTs specifically and this was also extended to FOK reports. Additionally, neither absolute nor relative accuracy of metacognitive judgments were affected. Bayesian analysis, which allows for an evaluation of evidence for the null hypothesis, confirmed these results as reflecting the lack of an effect of emotion on semantic retrieval failure monitoring. These findings are consistent with those of D'Angelo and Humphreys (2012) who similarly did not report any effects of emotion on TOT reports. As such it seems that while semantic retrieval failures are experienced as emotional, negative affect associated with the questions and target items does not further impact on that experience. Notably, in both the TOT and FOK conditions, emotional questions were reported to be experienced as more emotional than neutral questions, confirming the pilot results and validating the experimental manipulation.

While no effects of emotion on semantic material were observed, exploring the same question with episodic material remains of interest. Episodic and semantic

retrieval (Moscovitch, Nadel, Winocur, Gilboa & Rosenbaum, 2006) as well as retrieval monitoring (Reggev, Zuckerman & Maril, 2011, Elman, Klostermann, Marian, Verstaen & Shimamura, 2012) are dissociable and as such it is possible that where emotion did not have any effect on a semantic task, one might observe these effects on an episodic task. In an episodic task one usually learns a pair of words where the first is later used as a cue to assess the memory for its associate. As such, one is being tested on a recently formed association and the only cue available is a single word. In a semantic task the cue, often a general knowledge question (as in the present experiment) or a word definition, contains a wealth of information such as whether the knowledge domain it taps into is known to the participant. This type of information is absent in an episodic task. As discussed in the introduction, the current understanding of any effects of emotion on metamemory evaluations builds on the heuristic nature of metamemory, suggesting an experience of emotion might be misattributed as epistemically significant in the context of metamemory monitoring. It is possible that semantic cues by their nature already contain a wealth of epistemic indicators and are thus less susceptible to extraneous and especially subjective manipulations such as emotion. This is consistent with the abundance of research that has established the importance of cues in metacognitive judgments (e.g. Metcalfe, Schwartz & Joaquim, 1993, Koriat & Lieblich, 1977, Schwartz & Smith, 1997).

Another possibility is that while the emotional nature of the to-be-retrieved material does not influence retrieval failure monitoring, being in an emotional, or in a particular stressful state, might. Possible support for this idea can be drawn from a study which demonstrated that participants reported more TOTs when they were told the questions were easy, thus putting higher demand on them, as compared to when they were told the questions were difficult (Widner et al., 1996). Schwartz (2002)

argues that in instances when participants were told the questions were easy and yet could not retrieve the answer, this could have led to a stress response that may have driven the effect. Brown (2012) also reports anecdotal data to support the notion that high arousal and particularly stress might increase TOT incidence. This would suggest that arousal arising from the social situation and its personal significance, one that is contextually meaningful, might impact TOT experiences in a way that simply being in a state of emotional arousal due to the nature of the to-be-retrieved information does not. Notably, such an effect, if found, would not provide evidence that emotion can be misinterpreted as an epistemically meaningful state. Rather, it could best be understood in terms of the effect of emotion on lexical access (which has been shown to decrease when one experiences negative affect and increase when one is in a positive mood; e.g. Pinheiro, del Re, Nestor, McCarley, Goncalves & Niznikiewicz, 2013).

In line with this possibility, it bears reconsidering Schwartz's (2010) original finding of the effect of emotion on TOTs. The findings of D'Angelo and Humphreys (2012) as well as those of the present study suggest the original effect was most likely a false positive. However, there was a slight methodological difference between the studies. Specifically, while Schwartz (2010) asked participants to verbalize their answers to the experimenter, the current study and that of D'Angelo and Humphreys (2012), asked participants to type the answers in themselves. It is possible the difference in results between the Schwartz (2010) and D'Angelo and Humphreys (2012) studies may be due to this slight difference in the method of testing, especially as the two studies were otherwise (almost) identical. It might be that having to say out loud answers to uncomfortable, emotionally charged topics could have of itself created emotional arousal or stress that resulted in an increased rate of TOT experiences reported. As stated above, if this were the case than this is unlikely to bear on the

question of whether emotion can be misinterpreted as a TOT but would nevertheless be an important point to address for anyone interested in mapping out the effect of emotion on metamemory experiences and judgments.

Overall, the level to which emotion has been demonstrated to impact memory processes (see Kensinger & Schacter, 2008, for review) demands that further investigation be applied to how this might translate into effects on metamemory. For example, emotional memories have been shown to be retrieved with a greater degree of confidence than neutral memories irrespective of a lack of change in memory accuracy (Neisser & Harsch, 1992; Talarico & Rubin, 2003). This suggests that in certain instances there can be a dissociation whereby emotion affects metacognitive monitoring, through altering the subjective retrieval experience, without affecting memory performance. This is consistent with findings that memory and metamemory are in some instances dissociable and it is possible for one to be impaired and the other intact (Janowsky, Shimamura & Squire, 1989, Souchay, Bacon & Danion, 2006). Understanding when and how emotion affects memory and metamemory would not only expand our understanding of how emotion and metacognition interact but also support the investigation into how cognitive and metacognitive processes impact each other. Since it has been demonstrated that metamemory tasks are minimally related to each other (Leonesio & Nelson, 1990), it is also necessary to explore this question with a number of different paradigms to fully appreciate the complexity of the processes involved.

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Table 1

Descriptive information on questions used by type (Emotional/Neutral). Standard deviations appear in parentheses.

	Emotional	Neutral
Valence	3.68 (.39)	4.94 (.37)
Arousal	3.82 (.68)	3.18 (.63)
Difficulty*	.41 (.15)	.44 (.13)
log-transformed HAL Frequency	3.50 (3.25)	4.48 (3.08)
Phonological neighbours	0	.22 (.82)

**Difficulty is determined as the percentage of pilot participants who knew the answer to the question*

Table 2

Mean rates (%) of TOTs and FOKs by type (Objective; or accompanied with retrieval of partial information/Subjective; or no partial information reported) and by question (Emotional/Neutral). Standard deviations appear in parentheses.

		Emotional	Neutral
TOT	Total	18.05 (11.62)	17.08 (9.87)
	Objective	4.96 (6.56)	4.65 (7.68)
	Subjective	13.09 (12.88)	12.43 (6.89)
FOK	Total	23.56 (17.63)	23.54 (14.55)
	Objective	10.61 (13.83)	9.65 (13.44)
	Subjective	12.95 (11.69)	13.88 (9.87)

Table 3

Mean recognition performance (rate of correctly recognized items), emotionality ratings and frustrating ratings as a function of question type (Emotional/Neutral) and response (Yes/No). Standard deviations appear in brackets.

		Emotional		Neutral	
		Yes	No	Yes	No
TOT	Recognition	.72 (.32)	.29 (.15)	.65 (.24)	.31 (.14)
	Emotion	2.58 (1.18)	1.70 (.61)	2.13 (1.06)	1.38 (.64)
	Frustration	3.32 (.98)	1.88 (.74)	3.04 (.99)	1.75 (.82)
FOK	Recognition	.66 (.29)	.22 (.15)	.74 (.18)	.29 (.11)
	Emotion	2.54 (1.30)	1.72 (.65)	2.11 (.77)	1.28 (.27)
	Frustration	2.81 (.90)	1.46 (.35)	2.77 (.83)	1.37 (.33)

Emotionality and Frustration ratings were on a scale of 1 to 5, with 1 being 'not at all' and 5 being 'very'.

Footnotes

1 Following D'Angelo and Humphreys (2012) we used a value of 0 for any words not in the database.

2 There is a debate in the literature regarding the optimal methods of estimating TOT rates. The common method in metamemory research (e.g. Schwartz, 2010) computes the rates as a proportion of "don't know" trials exclusively. Others (e.g. D'Angelo & Humphreys, 2012) argue that the rates should be computed as a proportion of all trials. They further argue that this is particularly appropriate where there is a difference in memory performance between the two set of items, as is the case in our study. The analyses of the rate of TOT/FOK reporting for emotional as compared to neutral items yield the same results when carried out on the rates calculated as a proportion of all trials.

Appendix: Questions used in the study with associated answers and distractors

Emotional Items

Question	Answer	Multiple Choice
What is the term the Nazi's used to describe living space they aimed to gain by killing and deporting what they perceived as inferior races?	Lebensraum	Altreich Frontgemeinschaft Welthauptstadt
What is the last name of the notorious Nazi doctor who performed medical experiments, now considered medical torture, on twins during World War II?	Mengele	Goering Eichmann Heydrich
What is the only European country that still practices the death penalty?	Belarus	Turkey Latvia Serbia
What Empire is responsible for the Armenian Genocide?	Ottoman	Roman British Russian
What disease resulting from the British settlement was the principal cause of death of Aboriginal Australians in the 19th Century?	smallpox	typhus measles influenza
What is the most common sexually transmitted disease?	chlamydia	HIV syphilis herpes
What is the name of the mythical Greek character that murdered his father and married his mother?	Oedipus	Sophocles Euripides Polybus
What was the name of the ship upon which African-born slaves revolted and eventually won their freedom when the Supreme Court ruled in their favour?	Amistad	Bounty Freedom Lancet
What is the name of the painful disease that is caused by the same virus as chicken pox and attacks people many years after their bout with chicken pox?	shingles	cholera polio ebola
What is the name of the procedure that introduces liquids into the rectum and colon via the anus?	enema	varicosis pangenesis analensis

What is the term for Christians who use whipping to mortify their own flesh as a form of extreme religious penance?	Flagellant	Calvinist Congregationist Zealot
What is the last name of the leader of the Peoples Temple sect that instigated one of the largest mass suicides in history by asking his followers to take cyanide in 1978?	Jones	Green Smith Robins
What is the term for the medical procedure by which a section of the large intestine is brought out through the abdominal wall with a pouch put over the opening to collect waste?	colostomy	gastronomy penectomy sigmoidostomy
What is the name of the bacteria-borne disease that is used as a biological warfare agent and can also affect domestic animals?	anthrax	pertussis yaws listeria
What is the term for the spread of disease, such as cancer, from one organ or part to another non-adjacent organ or part?	metastasis	ablations regression biopsy
What is the term for forcefully removing organs from the abdominal area as a form of torture or execution?	disembowelment	dismemberment immurement impalement
What is the name of the Scottish town in which a school massacre took place in 1996?	Dunblane	Bethel Columbine Beslan
What is the name of the minority group targeted by the Hutu government during the Rwandan genocide?	Tutsi	Yoruba Zulu Maasai
What is the Mesoamerican civilization most notorious for human sacrifice?	Aztecs	Nepoyas Incas Olmecs
What is the name of the Scottish town into which an aeroplane crashed following a terrorist bomb attack aboard the flight in 1988?	Lockerbie	Dumfermline Inverness Kirkcaldy
What is the term for the study of hereditary improvement of the human race by controlled selective breeding?	eugenics	ethology sociobiology heritology

What Italian town was completely destroyed and buried under ash when Mount Vesuvius erupted in 79AD?	Pompeii	Heracleum Ephesus Palmyra
What is the term for killing one's brother?	fratricide	patricide deicide regicide
What was the name of the largest Nazi concentration camp in Poland?	Auschwitz	Treblinka Buchenwald Dachau
What potentially lethal disease does the archaic term "consumption" refer to?	tuberculosis	malaria pneumonia influenza
What is the term for marks or experiences of pain in locations corresponding to Jesus's crucifixion wounds?	stigmata	quorum nostra nuncio
What is the term used to denote racial segregation enforced the by the National Party in South Africa between the 40s and 90s?	apartheid	xenophobia segregation supremacism
What is the term for the inability to control one's excretory functions?	incontinence	**i**mpotence impuissance indocility
What is the name of the government building in Washington D.C. that was attacked on September 11, 2001?	Pentagon	Treasury Smithsonian Capitol
What is the word that means mercifully killing a person who is terminally ill and in great pain?	euthanasia	noxiousness exsanguination hypnoxia
What is the specific term used to describe the impairment in motor or sensory function of the lower half of the body?	paraplegia	monoplegia hemiplegia diplegia
What is the term for sexual attraction to corpses?	necrophilia	oenophilia hormephilia coitophilia
What is the name of the nuclear power plant in Ukraine that was the place of the worst nuclear disaster in history?	Chernobyl	Kyshtym Zaragoza Chelyabinsk
What type of a tumor is a cancerous tumor?	malignant	pestiferous

		noxious ablative
What is the term for the recurrent urge or behavior to expose one's genitals to an unsuspecting person?	exhibitionism	histrionics licentiousness debauchery

Neutral Items:

Question	Answer	Multiple Choice
What is the name of the submarine in Jules Verne's "20000 leagues beneath the sea"?	Nautilus	Proteus Hunley Lotus
Which country was the first to use gunpowder?	China	Britain Greece Egypt
What is the last name of the first person to complete a solo flight across the Atlantic Ocean?	Lindbergh	Earhart Hughes Yeager
What is the name of a small rhythmic instrument used especially by dancers, consisting of two small shells that are clicked together by the fingers?	castanets	shekere cabasa marimba
What is the term for the agreement made between God and Abraham, Moses and David?	covenant	bargain contract treaty
What is the surname of the scientist in the show "The Simpsons"?	Frink	Gunter Hibbert Muntz
What is the last name of the man who invented the telegraph?	Morse	Bell Volta Burt
What is the name of the lightest wood known?	balsa	bamboo cedar spruce
What is the last name of the author who wrote "Brave New World"?	Huxley	Conrad Golding Camus

What is the last name of the actor who played Rhett Butler in "Gone with the Wind"?	Gable	Grant Cooper Curtis
What is the last name of the woman who began the profession of nursing?	Nightingale	Barton Blackwell Wollstonecraft
What word is used to describe a vessel for holding and pouring liquids such as wine and brandy?	decanter	tumbler tankard beaker
What word is used in Greek mythology to refer to the food of the gods?	ambrosia	aether asteria aenas
What is the surname of the first actor to play Doctor Who?	Hartnell	Troughton Pertwee Baker
What is the last name of the author who wrote under the pseudonym of Mark Twain?	Clemens	Miller Thompson Hamilton
What is the last name of the man who invented the phonograph?	Edison	Tesla Talbot Nobel
What brand of cigarettes was first to have the flip-top box?	Marlboro	Winston Camel Kent
In what mountain range is Mount Everest located?	Himalayas	Alps Rockies Andes
What is the word that means a nautical mile per hour?	knott	fathom cable log
What is the term for turning something into stone?	petrification	mineralization coagulation ossification
What is the last name of the man who wrote "Cantenbury Tales"?	Chaucer	Shakespeare Bacon Marlowe
What is the name for an ancient instrument for	abacus	rabdologia

performing calculations by sliding disks along a series of straight rods?		quipu arithmometre
What was the last name of the man who was the radio broadcaster for the "War of the Worlds"?	Welles	Bergman Mulligan Wood
What is the name for an eyeglass for one eye held in place by the lower eye socket and upper eye lid?	monocle	bifocal meniscus lunette
What is the last name of the male star of the movie "Casablanca"?	Bogart	Douglas Wayne Peck
What is the name for a large wall painting?	mural	etching lithograph panorama
What is the name of Socrates' most famous student?	Plato	Aristotle Cicero Epicurus
What is the unit of electrical power that refers to a current of one amper at one volt?	watt	ohm tesla decibel
What is the name of the poker hand in which all of the cards are of the same suit?	flush	blaze straight kilter
What is the term for an elf in Irish folklore?	leprechaun	urisk pixie banshee
What is the term for a triangle with two equal sides?	isosceles	equiangular isometric transversal
What is the name for an optical toy producing patterns by multiple reflections?	kaleidoscope	theumatrope fractal zoetrope
What is the term for the infraclass of mammals whose young are carried in a pouch?	marsupialia	placentalia boreoutheria macroscelidea
What is the name of the island-city believed since antiquity to have sunk into the ocean?	Atlantis	Agartha Avalon

		Nysa
What is the last name of the boxer who later became known as Muhammad Ali?	Clay	Taylor Anderson Moore
What is the name for the branch of zoology that is concerned with the study of birds?	ornithology	entomology herpetology ichthyology
What term is used to indicate pertaining to horseback riding?	equestrian	canine felinian ursine
What is the name of the constellation that looks like a flying horse?	Pegasus	Saggitarius Lepus Aries
What is the large, heavy knife used for cutting a path through the jungle called?	machete	scythe hatchet banderilla
What is the term for a mild word or phrase used as a substitute for an expression that is thought to be too harsh or blunt?	euphemism	ellipsis rhetoric hyperbole
What is the name of the flexible, threadlike, incandescent object inside a light bulb?	filament	fibril cilia gossamer
What is the term for the smallest blood vessels in the body?	capillary	venule arteriole iliac
What is the name of the liquid portion of whole body?	plasma	haemoglobin lactate globulin
What is the last name of the author of the book "1984"?	Orwell	Hemingway Steinbeck Fitzgerald
What is the name of the author who wrote "Oliver Twist"?	Dickens	Wilde Eliot Thackery
What is the term for someone who believes that nothing is known or cannot be known about the existence or nature of God?	agnostic	atheist anarchist sceptic

What is the capital of Afghanistan?	Kabul	Tehran Damascus Baghdad
Who was Pinocchio's father?	Geppetto	Pantalone Trivelino Brighella
What is the term in golf referring to a score of one under par on a particular hole?	birdie	bogey eagle albatross
What is the scientific study of earthquakes called?	seismology	stratigraphy volcanology geomorphology
What is the instrument used to keep time to music called?	metronome	chronometer horologe isochronon
What is material for starting a fire, such as dry wood or straw, called?	kindling	timber stave stake
What is the name of the instrument used for listening to the heart?	stethoscope	sphygmomanometer otoscope cardioverter
What is the last name of the scientist who discovered radium?	Curie	Geiger Rutherforde Thomson
What is the name for a large oven used to fire clay or ceramic pottery?	kiln	oast cinerator forge
What is the term for curving or bulging outwards, such as in a lens or mirror?	convex	concave chromatic astigmatic
What is the name of the kind of cat that spoke to Alice in the story "Alice's adventures in Wonderland"?	Cheshire	Munchkin Ragamuffin Scottish
What is the name of the thick layer of fat on a whale?	blubber	paunch muktuk fluke

What is a piece of music played outside the house of a woman called?	serenade	ballad chanson minstrelsy
What is the term for inordinate fascination with oneself or excessive self-love?	narcissism	audaciousness presumptuousness superciliousness
What is the term for the traditional money or goods that a wife brings to her husband at marriage?	dowry	heritage endowment patronage
What is the name for a carved grotesque human or animal figure projecting from the roof of a building, typical of older structures?	gargoyle	gable finial effigy
What is the term for the picture script of the ancient Egyptians usually carved on the stones in pyramids?	hieroglyphics	cuneiform calligraphy hieratics
What is the term for acting using silent gestures?	pantomime	gesticulation extemporization improvisation
What is the name of the three-leaf clover that is the emblem of Ireland?	shamrock	thistle oxalis henbit