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TIP-OF-THE-TONGUE STATES

Past and Future

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In the 2001 British film *Tip of the Tongue* a man has a second chance at a lost love, if only he could recall the woman's name. Despite passionate feelings towards his love interest, he is stuck in a tip-of-the-tongue state for the woman's name, with comical consequences. In real life, people often describe the frustrating experience of not being able to recall something that they are sure they know. Ask anybody you know, and they will tell you about a time they could not remember the name of a neighbor, or the name of the restaurant they dined at the previous week, but were sure they knew it and would eventually recall it. Moreover, tip-of-the-tongue states are likely to increase as we age until we are experiencing them once a day by the time that we are approaching 70 (Brown, 2012).

Psychology has been interested in tip-of-the-tongue states (henceforth, TOTs) since the beginnings of experimental psychology. Indeed, one of the most famous and often-quoted sections of William James's 1890 *Principles of Psychology* is the following:

> There is a gap therein; but no mere gap. It is a gap that is intensively active. A sort of wraith of the name is in it, beckoning us in a given direction, making us at moments tingle with the sense of our closeness, and then letting us sink back without the longed-for term.
>
> (James, 1890, pp. 163–164)

The vivid description of the phenomenology involved in a TOT appears to be universal, as TOTs have been observed across languages and cultures, and the vast majority of languages use the same metaphor of a word being "on the tongue" to describe the experience of temporary inaccessibility (Schwartz, 1999).

Like the other phenomena described in this book, TOTs are often dismissed as an odd quirk, and the implication is often that serious memory researchers study more serious phenomena. Early in the first author's career (here, I), I told a well-known senior colleague, well-regarded for his theories of recognition, that I studied TOTs and feeling-of-knowing judgments, and he told me it was a waste of time. To some extent this paper and this book are a rebuttal of such thinking. It is our assertion that understanding odd phenomena like the TOT can tell us a great deal about how memory works and how it interacts with metamemory. Just as perception researchers understand the basic processes of perception by seeking out how people process illusions, memory research can advance by understanding why we have odd quirks, like TOTs, déjà vu experiences, unconscious plagiarism, and

blank-in-the-mind states. Thus, our goal as TOT researchers is to examine what TOTs tell us about the nature of retrieval, the nature of metacognitive monitoring, and what the TOTs can tells us about conscious experience (see Metcalfe & Schwartz, 2016; Schwartz & Cleary, 2016).

TOTs are defined as the conscious feeling that accompanies, or is a reflection upon, the cognitive process of retrieval when an item that a person is trying to retrieve is temporarily inaccessible. Thus, the TOT is composed of two components—at a cognitive level, there is a failure to retrieve, and at a metacognitive level, there is an experience of knowing (Bacon, Schwartz, Paire-Ficout, & Izaute, 2007). This metacognitive experience reflects upon the lack of retrieval and tells us that it is an error and we do know the missing item. Much of the early work in the first author's career centered on demonstrating that these two aspects of a TOT were dissociable; that is, that it was possible to increase TOT levels without a corresponding increase in retrievability (see Schwartz, 2008; Schwartz & Metcalfe, 2011; Schwartz & Cleary, 2016). As such, a TOT is actually a double memory-quirk. First, there is seemingly a failure to retrieve what is well-learned information. Second, there is the phenomenological experience that lights up one's consciousness when one feels sure that a missing item can be retrieved. That these two quirks are dissociable has now been repeatedly demonstrated (see Schwartz & Cleary, 2016).

The goal of the current paper is to outline what the foci of TOT research has been in the past and then to point to important directions in the future. We have come a long way in understanding TOTs since Roger Brown and David McNeill first prospected for TOTs (Brown & McNeill, 1966). We now have made some headway in understanding the underlying processes that produce TOTs (Schwartz & Metcalfe, 2011), the consequences of being in a TOT on our cognition (e.g., Cleary, 2019; Cleary & Claxton, 2015), why TOTs occur repeatedly for the same items (D'Angelo & Humphreys, 2015), how TOTs relate to subsequent curiosity in an answer (Metcalfe, Schwartz, & Bloom, 2017), how gesturing interacts with TOTs (Theocharopoulou, Cocks, Pring, & Dipper, 2015), and the beginnings of the neuroscience of TOTs (Maril, Simons, Weaver, & Schacter, 2005; Huijbers, et al., 2016). Each of these studies tells us a little about the underlying nature of TOTs, how TOTs predict retrieval, and why retrieval for known items sometimes fails (Jersakova, Souchay, & Allen, 2015). The structure of this paper is to outline what we understand about the processes that underlie TOTs, and—just as important—what we do not understand and need to keep working toward understanding. Similarly, we will outline what we know about the consequences of being in a TOT and what remains to be found about how TOTs influence our ongoing cognition. We also consider the issue of how best to measure TOT rates, why different research has used different measures of TOTs, and how best to standardize measuring TOT rates.

Mechanisms or Processes underlying TOTs

TOTs start with retrieval failure, or at least the experience of one. Our concern in this paper is not with the processes that lead people to fail at retrieval (see Brown, 2012; D'Angelo & Humphreys, 2015) but the processes that occur that lead people to experience the subjective TOT. Thus, the processes discussed in this section concern what may prompt people to have TOT experiences, not the processes that lead them to have temporarily forgotten the target item. Our research has focused on the idea that TOTs are inferences based on heuristic cues that accumulate to inform us that a given item may be retrievable (Schwartz, 1999; Schwartz & Cleary, 2016).

Fluency

TOTs seem to be sensitive to the fluency or familiarity of the cue (for reviews, see Schwartz & Cleary, 2016; Metcalfe & Schwartz, 2016; Schwartz & Metcalfe, 2011). A cue here means the question eliciting the TOT. Thus, if the question is, "What is the name of the traditional Barbadian drink made from tree bark, mixed with cinnamon, orange peel, nutmeg and cloves, and sweetened to taste," the entire question can be considered the cue, whereas the answer (mauby) can be considered the target. Going back to some of the first author's earliest work, we find evidence that increasing the familiarity of the cue can increase the number of reported TOTs without affecting retrieval (e.g., Metcalfe et al., 1993; Schwartz & Smith, 1997). Later work from Cleary's lab has also documented how cue fluency affects TOTs (Cleary, 2006; Cleary, Konkel, Nomi, and McCabe, 2010; Cleary, Staley, & Klein, 2014).

Retrieval of Partial and Related Information

TOTs increase when participants have more partial and related information (Schwartz & Smith, 1997; Schwartz, Bacon, & Pillot, 2014). That TOTs covary with the amount of information has been well documented in the field (Brown & McNeill, 1966; Koriat & Lieblich, 1974; but see Cleary, 2019) but most studies have not approached the role of related information with an experimental manipulation. Schwartz and Smith (1997) varied the amount of related information provided to participants. In their study, participants studied fictional animals. If the participants encoded biographical information about the animal, they were more likely to have a TOT for the animal's name, even though the names were not more memorable in those conditions. Thus, this study shows that the retrieval of information related to the target word increased the likelihood of a TOT in an experimental manner.

Earlier TOT Status

Previously being in a TOT informs one's current state of being in a TOT. Warriner and Humphreys (2008) showed that having recently been in a TOT predicted a higher likelihood of being in a TOT again (also see D'Angelo & Humphreys, 2015). Warriner and Humphreys interpret this to show that people get stuck in a particular retrieval rut, leading them in the wrong path towards retrieval. However, in terms of the underlying processes that produce the TOT experience, it is also possible that people use the remembered TOT as a cue for being in a TOT at the later time period (Schwartz & Cleary, 2016).

Other Sources of Information that Inform the TOT State

A potential problem for TOT research is that, in any given study documenting the influence of these factors on TOTs, the effect size is relatively small, and the variable itself only accounts for a small percentage of the variance. Thus, at present the effort to understand the processes that underlie TOTs is incomplete. In this chapter, we speculate on what some of the other sources of information are that can potentially inform the TOT state. We consider four in particular. The first is blocking, a hypothesis that has been around for some time (e.g., Reason & Lucas, 1984). The second is inferring we must be in a TOT state from the gestures we are making to help us communicate the missing information, also a concept that has been around for a while (Rauscher, Krauss, & Chen, 1996). For the third, we revisit the issue as to whether emotional states are considered a source of information for TOTs in light

of new data (e.g., Cleary, 2019). Finally we also briefly consider if social factors might play a role in TOT formation. That is, is there a social contagion effect? If one person is experiencing a TOT for a particular item, does that make it more likely that another person, aware of that TOT, will have one themselves. There are almost no data on the potential role that emotion and social factors play on producing TOT experiences, and therefore, the current review focuses heavily on blocking and gestures.

Blocking

The blocking hypothesis refers to the view that retrieved incorrect items are recognized as such and create the retrieval failure of the correct target and produce the phenomenal experience of a TOT (Kornell & Metcalfe, 2006). Brown (1991) wrote, "the blocking perspective suggests that the TOT represents a memory search that has become sidetracked" (p. 215). As with many issues with respect to TOTs, there are two components of the blocking hypothesis. First, as originally described by Reason and Lucas (1984) and Jones and Langford (1987), "blockers" refers to the items that interfere with retrieval of the sought-after target and are recognized as such. In this view, the blockers create the temporary inaccessibility of the sought-after target. Second, retrieving a blocker might serve as a cue that the actual target is known and therefore increase the likelihood of experiencing a TOT. Blocking can either occur naturally, as when we retrieve "Jude Law" when trying to retrieve "Michael Fassbender." Researchers can also attempt to provide blockers by providing words or names at the time of retrieval that are related to the target word. In diary studies, research suggests that around 50 percent of TOTs occur alongside natural blockers (Heine, Ober, & Shenaut, 1999; Reason & Lucas, 1984).

Blocking can be induced when a researcher provides an answer that is acknowledged as wrong, but may interfere with the retrieval of the correct answer. In such a case, if the question is "Who played Mary Poppins in *Mary Poppins Returns*,' a presentation of the name "Julie Andrews" may serve as a blocker in retrieving the actual answer ("Emily Blunt"). The inclusion of a blocking item is designed to create the experience of the natural blocker and allow researchers to look at how retrieval and the formation of TOTs occurs during a blocked retrieval (Kornell & Metcalfe, 2006).

In keeping with the metacognitive-heuristic perspective, a retrieved blocker may also be considered a source of information for the TOT experience and thus could be classified as related information. However, we think blocking is a separate source of information from retrieved related information because in order for a retrieved item to be a blocker, it must be recognized as incorrect. The retrieval (or the presentation) of a near-miss target provides information that the person may actually know the unretrieved item. That is, if I know it is not Julie Andrews, but her name is related to the actual one, that information itself is indicative that I might have the correct answer in memory. Thus, the retrieval of a blocker is a viable cue that we may use to inform the experience of the TOT. Moreover, if an item is recognized as incorrect, that implies knowledge of what the correct answer is. Therefore, if one retrieves "Julie Andrews" but knows they hired a younger actor to play her in the sequel, then one has information to the effect that they know the unretrieved answer. Thus, the experience of blocking goes beyond the retrieval of related information precisely because we recognize the information as incorrect.

The difficulty in evaluating this evidence is the lack of appropriate experimental paradigms. Although there has been research on the effect of blockers on TOTs, such research falls into one of two categories, neither of which allows us experimentally to assess if blockers contribute to the experience of the TOT. On the one hand, some research relies

on naturally-occurring blockers (e.g., Kornell & Metcalfe, 2006). Given there is no experimental control over the blockers, one cannot conclude that any changes across conditions in TOT rates are a function of blockers rather than something that correlates with the retrieval of blockers. On the other hand, there are studies which provide blockers, but it is not clear if these provided blockers will hinder or help retrieval (e.g., Jones, 1989; Meyer & Bock, 1992; Smith, 1994).

The experimental literature in which blocking-like items are provided is problematic (Jones, 1989). First, we do not know if providing semantic or related information will be recognized as both related, but not correct. In some cases, such supplied information may be regarded as correct, whereas in others the semantic relationship may not be known by the participant. Second, we do not know if the same processes are involved in recognizing a word as a blocker as in producing the blocker itself. In most cases, we could expect that the processes involved in generating a blocker would be different from those in recognizing a provided blocker as incorrect. Third, the data that support that provided blockers increase TOTs is rather weak. For example, Meyer and Bock (1992) found providing phonologically-similar words led to the higher number of correct responses relative to control conditions, but there were no differences in number of TOTs. Thus, the role that providing blockers has in producing TOTs is still mostly misunderstood. Indeed, in many cases the blockers may actually serve as cues (Meyer & Bock, 1992; Smith, 1994).

One study does potentially point to a role blocking in TOTs (Smith, 1994). In this study, participants learned the names of fictional animals. Later, at test, participants were presented with the picture of the animal, along with a blocker that was phonologically similar to the name, the name of another animal (and therefore semantically similar), or a word that was unrelated to the target name. In contrast to the blocking hypothesis, the "blockers" actually served as primes, and in both the semantic and phonological condition, the blockers served to increase recall. Thus, the study does not show that providing external blockers is necessarily effective at creating them. However, the semantic condition did lead to an increase in TOTs. Thus, at the very least, the names of related animals were potentially serving as blockers and therefore increasing the likelihood of a TOT.

We outline a potential methodology that could allow us to determine if blocking does play a role in the production of TOTs. Consider what would be required to test if blocking has a role in TOTs. First, one needs naturally-occurring blockers. With external blockers, we do not know if they serve as blockers or as their opposites, retrieval cues (e.g., Smith, 1994). Even if they did inhibit retrieval, we would not know if providing blockers externally is the same as producing them internally on one's own. Given that the natural phenomenon we are trying to mimic in the lab is the experience of retrieving the name "Julie Andrews" but knowing it is wrong, we must design an experiment that controls the production of such naturally-occurring blockers. If we can control the rate of naturally-occurring blockers across conditions, then we can look at differences in TOT rates as a function of those differences.

One such method would be to prime an incorrect answer to a general-information question. That is, if we can render the accessibility of a known incorrect item to such a point that it is retrieved, it may interfere with the retrieval of the correct answer and therefore serve as a blocker. Once we have the difference between a primed and unprimed condition, we can look at differences in TOTs as function of blocking. Consider the following. In a primed condition, one could increase the likelihood that "Springfield" is a blocker when asked the capital of Massachusetts by asking questions about states in which the largest city is not the capital (e.g., New York, Ohio, Maryland). In the unprimed condition, asking for the capital of Massachusetts occurs after questions about the capitals of states for which

the largest city is the capital (e.g., Colorado, Arizona, Georgia). Thus, in the primed condition, "Springfield" will be more activated relative to the unprimed condition. One can then look at TOT rates as function of this priming. Such an experiment would require careful piloting of the materials—as what would be necessary is sufficient questions that increased producing blockers such as "Springfield" without altering correct recognition of the actual target (e.g., "Boston"). However, such a large-scale study of TOTs has not yet been done. There are other possible routes to cueing incorrect answers. One could show incomplete fragments of a related but incorrect answer (see Chapter 6 in this volume). One could also present the incorrect blockers under masked conditions, so that they might be processed non-consciously. In any of these procedures, the goal would be to make a particular blocker more accessibly.

In summary, blocking certainly still has a lot of intuitive appeal. Despite considerable research on the issue of blocking (Jones, 1989; Kornell & Metcalfe, 2006; Perfect & Hanley, 1992; Smith, 1994), it is not clear if and how blocking contributes to the process of producing a TOT. One healthy area of future TOT research would be to design the appropriate experimental techniques to either include blocking as a source of information for TOTs or finally remove it from the list of potential candidates.

Gestures

Gestures are movements of the limb and body that are made to help express meaning in speech (Theocharopoulou et al., 2015). Such gestures are often combined with or coordinated with speech. In some views on psycholinguistics, gestures are an integral part of language, and gestures may even be thought of as a semantic component of a word (Frick-Horbury & Guttentag, 1998). For example, a strong hand movement downward may be integral to the meaning of "hammer." In trying to resolve the TOT that just occurred to the first author for the French word for "hammer," the author made such a movement ("marteau"). Thus, gestures may not only help us retrieve words for particular actions, but the gestures themselves may be part of the representation (Theocharopoulou et al., 2015).

There are a small number of papers that document a relation between gestures and the TOT. Rauscher, Krauss, and Chen (1996), for example, showed that when people are in TOTs they make more gestures than when they are not in TOTs. Theocharopoulou et al. (2015) replicate that finding and also found that iconic gestures (e.g., the downward thrust of the hammer stroke) were more common than non-iconic gestures (e.g., moving one's hands up and down to indicate frustration) during TOTs. The question we ask is which comes first the TOT or the gestures? Do we have TOTs because we make gestures or do we make gestures because we are in a TOT? Is it possible to think of gestures as partial information when we cannot retrieve targets? Though research has not directly addressed this question, there are some relevant studies.

Two studies examined what happens when people are restrained from making gestures during word retrieval (Beattie & Coughlan, 1999; Frick-Horbury & Guttentag, 1998). In one of the studies, people either were free to move their hands during retrieval or were requested to sit on their hands so as not to move them in the other condition (Frick-Horbury & Guttentag, 1998). The results were mixed. Frick-Horbury and Guttentag found that when participants were free to gesture, they recalled more words than when they were not, but after that, there were no differences in TOTs. However, it could be argued that because gestures help with recall, the set of items that were not recalled in the gesture condition were more difficult than the ones in the no-gesture condition. In keeping with that interpretation,

Beattie and Coughlan found that no disadvantage in recall across the gesture and the no-gesture condition, but that when people were free to gesture, they resolved more of their TOTs. It is possible that Beattie and Coughlan used a more difficult set of items that were harder to recall. Then when relatively easier items entered the TOT pool, resolution was more likely to occur. In both studies, however, the restriction of movement came at the time of retrieval, not after retrieval when TOTs were being considered.

For our purposes here in trying to understand the processes that produce the TOT experience and not the processes that lead to failed retrieval, we would want to see a study in which people the freedom to gesture is controlled experimentally not as they choose during the initial recall attempt. Only after retrieval fails when people are considering if they are in a TOT or not should gestures be restricted or not. In this way, we can determine if gestures contribute to the TOT experience. If when people are allowed to gesture, they experience more TOTs than when they are not free to gesture, then it is possible to assert that the act of gesturing contributes to the experience of a TOT. In keeping with the work of Theocharopoulou et al. (2015), it may also be possible that only certain kinds of gestures, such as iconic gestures, are sources of information for TOTs.

Emotions

As we discussed at the beginning of the chapter, emotional frustration often occurs as part of the TOT experience, and the warm glow it creates is a paradoxical aspect of TOTs. Work in our lab some years ago indicated that there is a correlation between experience of TOT and experiencing a negative emotion, usually described as frustration (Schwartz, 2001; 2002; Schwartz, Travis, Castro, & Smith, 2000). In other work, we have also advanced that experiencing emotion during a difficult retrieval may be a cue to being in a TOT, consistent with the metacognitive-heuristic account (Schwartz & Metcalfe, 2011). That is, emotions can be a source of information, which providing participants with cues regarding the availability of the un-retrieved target in the memory system.

Although these early studies evaluated the correlation between TOT and emotions, Schwartz (2010) evaluated the impact of emotional information on the rate and the accuracy of TOTs. Schwartz provided participants with two sets of questions: neutral and emotional questions. In trials in which participants could not recall the answer correctly, participants were asked to indicate whether they were experiencing a TOT. Schwartz's results indicated that emotional items induce more TOTs than neutral items. Moreover, TOTs for emotional items more accurately predict future memory recognition performance than TOTs for neutral items. D'Angelo and Humphreys (2012), however challenged Schwartz's methodology. According to D'Angelo and Humphreys, Schwartz's study suffered from a methodological confound. Specifically, emotional items in Schwartz's study had lower usage frequency than neutral items and this might explain why they induce more TOTs than neutral items (for results regarding the association between item frequency and TOT, see Harley & Bown, 1998).

When controlling for word frequency, D'Angelo and Humphreys (2012) tried to conceptually replicate Schwartz's (2010) results. D'Angelo and Humphreys presented participants with the same emotional questions as Schwartz's study and asked participants to indicate their retrieval level ("know," "do not know" and "TOT" response). D'Angelo and Humphreys then compared participants' emotional TOT with their TOT for neutral items. They used new neutral questions as well as neutral questions from Schwartz's study. D'Angelo and Humphreys found no difference between rate of TOT for neutral and emotional items. This indicated that emotional information has no impact on inducing TOTs,

in contrast to the earlier study of Schwartz. However, the methodology of D'Angelo and Humphreys is also confounded, and therefore their data cannot be considered definitive either. There were at least three methodological confounds in the D'Angelo and Humphrey that may impacted their results, and these confounds might be the reasons as to why they could not replicate Schwartz's results.

First, some of the emotional questions used in both studies may have been less emotional for a student from a country other than United States (e.g. "What is the derogatory term for Americans in many Spanish-speaking countries? (gringo)." Note that participants in D'Angelo and Humphreys' (2012) study were not students from United States and they may have perceived these questions without the emotional weight than did a largely Hispanic-American student population at the university that Schwartz (2010) tested at. Second, in contrast to Schwartz, who asked participants to recall the respond items first and then indicate TOT (if recall failed), D'Angelo and Humphreys only asked participants to indicate their recollection statues using three alternatives: know, do not know and TOT. Third, D'Angelo and Humphreys' study lacks a crucial component from Schwartz's study, namely an overt recollection attempt. Overt compared to covert retrieval can have a large effect on metacognition in other domains (e.g., Tauber et al., 2018). Therefore, it would not be surprising if the overt vs covert dimension also impacted TOTs. We argue here that the attempt to recall the answer could serve as a heuristic that participants could use to indicate if they are in a TOT. Further studies are required to determine whether or not the experience of emotion influences the formation of a TOT.

Recently a study found more convincing evidence for the impact of emotional information on TOT. Through three experiments, Cleary (2019) showed that positively valanced items (responses to a question or the picture of a famous person) induce more TOTs than those with negative valance. Cleary also showed that participants in the TOT trials judge the unretrieved item as more positive than those in the trials without TOT. Based on these results, Cleary concluded that TOTs are accompanied by a positive feeling which is called warm glow (see also Monin, 2003). Two different conclusions can be drawn from Cleary's results. First, positively valanced questions induce more TOTs than negatively valanced questions (or it could be the valence of the unretrieved target that is driving the effect). However, it is not clear if questions with positive or negative valance induce more TOT than items with a neutral valance. Second, Cleary's study indicates that the TOT is associated with a positive feeling. This is in contrast with earlier assumptions regarding the association between TOT and negative emotions (frustration). Thus, this study establishes a new unanticipated finding, but also leads to a great many unanswered questions.

We argue that the future studies should investigate at least four aspects of the association between TOT and emotion: first, future studies should investigate the impact of different classes of emotions on the rate and accuracy of TOT. If positive emotions are associated with more TOTs (Cleary, 2019; Cleary & Claxton, 2015), what kind of positive emotions (such as surprise, excitement, or happiness) induce more TOTs? Second, future studies should investigate the mechanisms by which emotional stimuli impact TOT rates. Third, future studies should investigate the relationship between being in a TOT and accompanied emotional state. That is, we should investigate if TOT always produce a positive (warm glow) or if, under the right circumstances, TOT can produce negative emotions (i.e., a "cold glow"). TOTs might induce both types of emotions depending on the circumstances. Finally, future studies must investigate the mechanism by which TOTs induce these emotions, as understanding these mechanisms might help us to gain a better understanding regarding the nature and mechanisms of phenomenology.

Consequences—What Happens to People During TOTs?

TOTs are a unique state of consciousness. As we have argued elsewhere, TOTs are universally experienced—across age, culture, and language (Schwartz, 1999). Whereas other metacognitive judgments, such as JOLs may be unique to cultures that make learning and studying an explicit part of the culture, TOTs can be found anywhere (Schwartz, 1999; Brennen, Vikan, and Dybdahl, 2007). Elsewhere, we have also argued that TOTs are states, like déjà vu experiences, that alert us to cognitive conflict (Schwartz & Cleary, 2016). TOTs are conscious experiences that have referents—that is, they alert to a conflict between the certainty of knowledge and the truth of the failure to retrieve—a cognitive quirk if there ever was one. Both Cleary's lab (e.g., Cleary & Claxton, 2015) and our own (Schwartz & Metcalfe, 2011) have argued that TOTs have consequences—when we are in a TOT, our attitudes change, our behaviors change, and our cognition changes. In this section, we outline what some of those changes are, potentially why they occur and raise some questions about what future avenues there are for investigating the changes that occur when people experience TOTs.

Cognitive Consequences of the TOT

Think about what happens to you when you are in a TOT for a moment before you continue. Nowadays, what most people do when they are in a TOT is reach for the nearest connection to the Internet so they can resolve the TOT as quickly as possible. In this way, TOTs are resolved in the amount of time it takes to look up an answer on a computer or phone. Research supports the notion that people in TOTs are motivated to get the answer and will behave in such a way as to ensure eventual retrieval or recognition of the TOT target. After being in a TOT, for example, we spend more time trying to resolve the TOT (that is, engaged in retrieval) than we do trying to retrieve items that were not in TOTs (Schwartz, 2001). When we are in a TOT, we are more curious to know the answer than when we are not in a TOT. Metcalfe et al. (2017), for example, showed that when participants could only see the answers to a minority of unanswered questions, they strongly preferred seeing the answers to those that were in a TOT. These findings make intuitive sense—if we feel like we know the answer to the question, it is sensible that we spend more time trying to retrieve it. Being in a TOT also affects whether other retrieval result in TOTs. Schwartz (2011) examined TOT data and found that the probability of being in a TOT diminished immediately after being in a TOT. That is, the TOT rate dropped for the item following an item that was in a TOT. This occurred without a change in the rate of successful recall. Thus, being in a TOT for one item has a consequence for the next item. Schwartz speculated that this may occur because attention is diverted to the TOT item, leading to less attention for thinking about the subsequent item.

Expanding Consequences

In a series of recent experiments, Cleary and her colleagues have demonstrated some stunning non-intuitive consequences of being in a TOT (Cleary, 2019; Cleary & Claxton, 2015). In these studies, they show that being in a TOT creates biases in the making of other decisions. Some of the consequences of being in a TOT concern the nature of the unretrieved target. Cleary and Claxton, for example, showed that participants judge an unretrieved target to be in a darker font, a larger font, and to be of higher frequency if that target was in a TOT relative to those targets that were not TOTs. These studies, therefore, turn conventional expectations about metacognitive judgments on their head. Typically, we vary frequency, font size or font clarity and determine how it affects a particular judgment (e.g. Rhodes &

Table 13.1 The Consequences of Being in a TOT

During TOTs, people
are less likely to be in TOT for next item (Schwartz, 2011)
feel that more curious about discovering the answer (Metcalfe et al., 2017)
feel that the unretrieved target answer to the question was presented earlier (Cleary, 2006; Cleary et al., 2010; 2014)
feel that the target was presented in a clearer font or a larger font (Cleary & Claxton, 2015)
feel that the target was a higher frequency word (Cleary & Claxton, 2015)
feel that the target was more positive (Cleary, 2019)
feel that the target was of higher value (Cleary, 2019)

Castel, 2008). In the Cleary and Claxton paper, the direction of judgment is reversed—when we experience a TOT, we think of the target as being more clear or fluent. For an overview of the consequences of TOTs, see Table 13.1.

Cleary (2019) advanced the view that one of the consequences of being in a TOT is that TOTs create a "warm glow." What she means by this is that being in a TOT creates a positive and optimistic bias towards the intended target of the TOT. In her experiments, when participants were in TOTs, they were more likely to judge the missing target word as being positively valenced than when they were not in a TOT. Thus, if participants were presented with the definition "an inability to sleep," people would judge the missing word (insomnia) as being less negative when the person was experiencing a TOT than when the person felt that they did not know the target word. This tendency to see TOT items as positive led to the "warm glow" moniker. In the second experiment, Cleary varied the value associated with target answers of general-information questions. When people were in TOTs, they thought the target was a higher-value target than when they were not in TOTs. And finally, in a third experiment, in which participants were presented with the faces of celebrities (e.g., Gwyneth Paltrow), people in TOTs judged faces as being of a more "ethical" person if they were in a TOT than if they were not. Thus, in three experiments, being in a TOT increased the rated positivity of the missing target word.

Cleary's work (2019; Cleary and Claxton, 2015) has made some interesting headway, but only a few factors have been examined. How far does the warm glow extend? If I am in a TOT, for example, for the name of the governor of North Dakota, do I have a more positive view of the governor of South Dakota, or either of the states in general? Also, can TOTs ever create a negative glow? If all the questions were to be about horrible things, (e.g., disease, war), might being in a TOT create a negative bias for those items. That is, after a series of questions about very negative things, if we induce a TOT state, will that item be judged more negatively under those circumstances? The nature and direction of the warm glow awaits further investigation.

One such direction would be to examine if TOTs increases in social contexts. If a TOT creates a warm glow, one person many communicate positive information about the missing target to others around them. If so, when one person has a TOT, it may increase the rate of TOTs for nearby people who are aware of the first person's TOT. This may be similar to

social contagion effects in memory (Roediger, Meade, & Burgman, 2001). In such a study, one could determine if one person (e.g., a confederate) has a TOT for an item, will that increase the likelihood of a TOT for the actual participants.

Another consequence of TOTs that we wonder about is whether being in a TOT has a consequence for learning. In particular, we think an important question is to determine if being in a TOT serves as a learning event. In particular, if I am in a TOT state for a specific item, once I learn the answer to that question, am I more or less likely to remember that items later on? We can think of several reasons why this might be the case. First, TOTs are relatively distinctive experiences. Thus, once we are in a TOT, the processing of that item may benefit from distinctiveness. Second, the act of making an effortful retrieval, even if it fails, is often associated with better memory (Carpenter, Haynes, Corral, & Yeung, 2018; Huelser & Metcalfe 2012). Because the retrieval involves more effort, TOTs could result in stronger encoding. Third, if the TOT motivates us to search for the correct answer, it may also motivate us to encode the correct answer. Thus, we suspect that people may explicitly engage in deeper processing when they are in a TOT than in a "don't know" state.

We do know that when people experience TOTs, they are more likely to experience a TOT again for that item than for a control item (Warriner & Humphreys, 2008; D'Angelo & Humphreys, 2015). That is, TOTs do tend to re-occur across time for the same item. These studies also find that there is a "resolution effect" (D'Angelo & Humphreys, 2015). They showed that when their participants spontaneously resolved their TOTs, they were more likely to recall the target word for those TOTs than for when the TOT was not spontaneously resolved. Although the comparison here is between TOTs that spontaneously resolve and those that do not rather than between TOTS and n-TOTs, this finding does suggest that a TOT serves as distinct experience in which encoding occurs.

In our own lab, we were able to reanalyze data from an old experiment in which people made TOT judgments on general-information questions and then later had the opportunity to recall again the same questions. This was basically a very simple study—participants attempted recall. If they could not recall, they judged if there were in a TOT or not. Correct answers were then shown for all questions. Later, they were asked the same questions again. At the time of second recall, more initial TOTs were recall than were initial "don't-know" responses. We are not able to experimentally control for item difficulty and therefore we cannot rule out that advantages for recall of TOTs over "don't know" items are because the TOT items are inherently more memorable, but we did find that at the second recall, recall was greater for items that had been in TOTs than for items that had been marked 'don't know.' In addition, Oliver, Li, Harley, & Humphreys (2019) found greater recall of previous TOT items than previous "don't-know" items, even though feedback was not given. However, these data also did not control for difficulty of the TOT items and the don't-know items. Thus, we think there is good reason to suspect that future research will document that TOTs serve as learning events, and that to be in a TOT will mean better recall in the future.

Measurement Issues

One of the issues that has caused confusion in the TOT literature is the different manner in which TOT rates are measured across experiments. By TOT rates, we mean what proportion of items in a set of items are TOTs. The issue here is what constitutes the set of items. In some research, TOTs are considered to be part of a set of retrieval failures, whereas in other research, TOTs are considered to be a part of retrieval successes (Cleary & Reyes, 2009). Whether one chooses the first alternative or the second depends on the research questions being asked and the perspective of the research. However, in some cases, researchers may

not be aware of the different measure and how they may potentially change the conclusions of a study. There have been many papers which compare TOT rates across studies without considering that TOT rates were measured differently.

There are three ways in which different researchers have measured TOT rates. From a metacognitive perspective, a TOT is an experience that occurs during retrieval failure. It is the feeling that we know something for which there is retrieval failure. Therefore, the way we have done it in our research is to consider TOTs a subset of failed retrievals. Thus, TOTs are given by the following formula.

$$\text{TOT(1) rate} = \text{TOT}/(\text{TOT} + \text{Don't-know items})$$

In this case, the underlying assumption is that TOTs are only made on items that are not correctly recalled. Thus, once the items recalled are removed, we consider the effect of any experimental variable as a function as to how it affects the unrecalled items. Thus, if we are interested, for example, in the effects of cue priming on TOTs, we compare the effect of cue priming compared to no priming only on those items not recalled (e.g., Schwartz, 2008; Schwartz & Smith, 1997).

In contrast, other research is interested in why retrieval itself fails, and TOTs have been used as a marker of retrieval success rather than failure (Brown 2012; Gollan & Brown, 2006; Harley & Bown, 1998). The assumption here is that TOT only occur for items that are stored in memory, just not currently accessible. Although we think there is ample evidence to question such an assumption, there is still a large body of research that considers TOTs a direct reflection of a retrieval process gone awry (Gollan & Brown, 2006; Nordmann, Cleland, & Bull, 2013). And many researchers think of TOT as the "window" onto a slowed retrieval process (Brown, 1991). To the extent that one is interested in using TOTs to measure retrieval problems rather than the subjective experience of a TOT, then thinking about TOTs as reflecting an underlying knowledge structure may be useful. In these models of retrieval, TOTs are assumed to demonstrate completion of access to semantic structures (we retrieve or recognize meaning), but a failure to retrieve the phonological representation, that is, we cannot retrieve the specific name (Golland & Brown, 2006). Therefore, for this purpose, Gollan and Brown recommend the following formula:

$$\text{TOT(2) rate} = \text{TOT}/(\text{TOT} + \text{correct items})$$

The first thing to notice about the difference between formulae 1 and 2 is that they will not always produce the same TOT rate. If we have a difference between two experimental conditions in correct recall, then using formula 1 and formula 2 will lead to different estimates of TOT rate (see Table 13.2). Because of their interest in examining the nature of retrieval, Gollan and Brown (2006) argue for the value of Formula 2. Because we are interested in TOTs a metacognitive phenomenon, we think Formula 1 is more appropriate.

In Table 13.2, we can see two striking differences. First, using Formula 2, higher overall TOT rates are generated than using Formula 1. This will change if participants are recalling the correct answer at high percentages. If the recall rate were 85%, for example, it would be Formula 1 that would show higher TOT rates. Either way, the two formula can show different overall rates of TOTs. Second, the estimate of which condition produces higher TOTs also varies from Formula 1 to Formula 2. Thus, if one is making inferences at how a variable influences TOTs, the two formula can potentially lead researchers to make opposite conclusions. Thus, like Gollan and Brown (2006), we urge researchers to be careful as to how and what they report.

Table 13.2 Hypothetical Example of how Different Formula of TOT Rates Can Lead to Different Conclusions About Experimental Variables

	Condition 1	*Condition 2*
	50 total item	50 total items
	Recall = 5 items	Recall = 10 items
	TOT = 5 items	TOT = 5 items
	Don't know = 40	Don't know = 35
	Recall = 10%	Recall = 20%
Formula 1 = TOT rate = TOTs/TOTs + Don't-know items		
Formula 2 = TOT rate = TOTs/TOTs + correctly retrieved items		
Using Formula 1		
	TOTs = .111	.125
Using Formula 2		
	TOTs = .5	.333

Finally, there are other researchers who measure TOTs by the following formula:

TOT(3) rate = TOT/(TOT + correct items + don't know items).

In this formulation, the TOT is a function of all items, including both correct items and don't-know items. Although this formula is still widely and currently used (e.g., Oliver et al., 2019), it is highly problematic. As recall increases, the set for which TOTs (and don't know states) goes down. Thus, regardless of whether we should consider TOTs as instances of retrieval failure or retrieval success, the TOT rate will be lower or higher simply as a reflection of how many items were recalled (or not recalled). For example, if one condition results in higher recall rates than another condition, the TOT rate will be lower in the condition that produces higher recall, regardless of how it affects accessibility (formula 2) or metacognition (formula 1). Although both the use of formula 1 and formula 2 require researchers to consider issues of conditional samples, the use of formula 3 will always create confounds across conditions. Therefore, we recommend using formula 1 for issues of metacognition, and Formula 2 for issues of accessibility and for the nature of retrieval (Gollan & Brown, 2006). Moreover, we think researchers should discontinue the use of formula 3 and always report analyses with both formula 1 and formula 2.

Regardless of which formula is used, Gollan and Brown (2006) are correct in noting that when comparing across two or more conditions, changes in recall rate will change the estimated TOT rate across these two formulae. Thus, when examining the past literature, it is important to know which study used which definition of TOT rate. As Gollan and Brown point out these differences in formula have already created confusion in how to interpret differences in TOT rates between monolinguals and bilinguals. Indeed, what we recommend here is that studies should report TOT rates in both ways, both as function of total incorrect items (formula 1) and as a function of the combination of successfully recalled items and TOTs (formula 2), as has been done in some studies (Cleary, 2019; Cleary & Reyes, 2009). This will avoid the confusion that can occur when researchers are not paying attention to the measure used to determine TOT rates. Thus, a clear recommendation to other researchers is to use both methods and if one must only use one of the formulae to make it clear which formulae is being used and why.

Conclusion

TOTs are quirks of memory in which a person is highly confident that they know something that they cannot produce at that moment. Like other quirks, TOTs can tell us about the nature of memory retrieval and the nature of metacognition. In fact, some of the history of TOT research has been how to balance the equally important issues of memory retrieval and metacognition (see Bacon et al., 2007; Brown, 2012). It is our hope that TOT research can integrate the subjective nature of a TOT as a feeling with the ongoing research that uses TOTs a window on retrieval (Brown, 1991).

In this chapter, we briefly reviewed the existing literature on the causes of TOTs. Evidence exists for both a role to cue familiarity and to the retrieval of partial and related information. We then discussed if it is useful to return to the concept of blocking and examine if blocking has a role in the production of TOTs (e.g., Kornell and Metcalfe, 2006). We also made a suggestion as to how to prime people to produce blockers. If we were to be successful at pushing participants to retrieve blockers, we could experimentally examine blocking as a source of information for TOTs. We also considered if the making of gestures and the experience of emotion can also play a role in TOTs. We then considered the consequences of being in a TOT. Past research has shown that when people are in TOTs they spend more time searching for the answer and are more curious about the answer. Other work by Cleary and her colleagues (e.g., Cleary, 2019) has shown that people make inferences about the target word during a TOT that they do not when they are not experiencing a TOT. Indeed, being in a TOT creates a warm glow around the target item. Future research can consider if there is ever a "cold glow" if the conditions are right. Future research can also consider if TOTs serve as a learning event. Finally, we considered the issue of how best to measure TOT rates and how to measure their accuracy. Our fundamental conclusion is transparency. We encourage researchers to be clear about what measures they are using and for what purpose.

As cognitive scientists, we wish to explore the mechanisms underlying memory and metacognition. Studying quirks, illusions, or failures of cognition has been a traditional method of ferreting out the processes and mechanisms underlying our cognition (Bjork, Dunlosky, & Kornell, 2013). Memory quirks, such as the TOT are important to study because they tell us about how memory fails and succeeds, how metacognitive feelings work, how such feelings change the course of our behavior, how memory and metamemory interact, and perhaps the nature of consciousness. We look forward to what TOT can tell us about these issues in the near future.

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