

The effect of incubation on the resolution of Tip-of-the-tongue states and the relation between resolution, incidence and cognitive ability

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Abstract

This study replicated Choi and Smith (2005) by examining the effect of incubation on the resolution of tip-of-the-tongue (TOT) states. Is it better to be persistent in one's retrieval efforts of an unrecalled word, or does an incubation period - that is, time away from retrieval attempts - enable resolution more effectively? In addition, the relation between cognitive ability on the one hand and TOT incidence and TOT resolution on the other was examined. Researchers gave participants each of 48 general knowledge questions twice. The retest of each question was either immediately after the initial presentation of the question or after an incubation period. During this incubation period participants were presented with other unrelated questions. Participants could indicate that they either knew the answer, did not know the answer or rate their TOT state, ranging from weak to very strong. In order to test for cognitive ability three separate tests were administered: a vocabulary test, a working memory test and a word fluency test. The results replicate the findings of Choi and Smith that when one's initially unsuccessful retrieval attempts leads to a TOT state, resolution is more likely when the second retrieval attempt follows after an incubation period rather than immediately. The results were in line with the blocking theory of TOTs. In addition, this study showed that TOTs are more likely to be resolved than non-TOTs and that the stronger the experience of a TOT is the more likely it is to be resolved. No relation was found between cognitive ability and TOT incidence or TOT resolution. Implications for further research are discussed.

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Introduction

The retrieval of information from memory is normally smooth and taken for granted, however the tip-of-the-tongue (TOT) phenomenon describes what happens when memory falters. All of a sudden, recollection no longer seems so obvious. Being in a TOT state is “when you are unable to think of a word but you feel sure you know it and that it is on the verge of coming back to you” (Brown & McNeill, 1966, p. 327). Two important aspects of any definition of a TOT state are that the word is known but presently not retrievable and, at the same time, recall seems to be imminent (Brown, 1991).

This study replicates a study of Choi and Smith (2005). They set out to answer the question what to do when one finds oneself in a TOT state. “When one’s initial unsuccessful retrieval attempts lead to TOT states, is resolution more likely from persistence or from procrastination of additional retrieval attempts?” (p. 365). In other words, is resolving a TOT state more likely when one tries to retrieve the unrecalled word (target word) immediately or after an incubation period? In the context of TOT an incubation period means time away from an attempt to retrieve the target word. A TOT is considered resolved if the next retrieval attempt leads to recollection of the target word.

Choi and Smith provided participants with general knowledge questions twice in a row. In order to manipulate incubation the retest of any given question was either immediately after the initial presentation of the question or after a delay, during which a number of other unrelated questions were presented. In case participants could not answer a question they were asked to indicate whether they experienced a TOT. In addition, they measured TOT strength, which is the subjective appraisal of how strong a person is experiencing a TOT. They took TOT strength into account in order to study the relation between the strength of an experienced TOT and the likelihood of resolving the TOT.

With respect to the effect of incubation Smith and Blankenship (1991) showed that initial blocks in problem solving were likely to be resolved after an incubation period than when one keeps working on the problem. The explanation is that during incubation interfering solutions or memories (e.g. a blocking word) become less accessible through a natural forgetting process. In turn, this should make correct targets more accessible during the delayed attempt (Smith & Blankenship, 1991). Choi and Smith reasoned that this finding might also apply to the resolution of TOT states.

According to Choi and Smith, speculations on the cause of TOT states have lately centered around three theories: 1) the blocking theory (e.g. Warriner & Humphreys, 2008), 2) the partial activation theory (e.g. Meyer & Bock 1992), and 3) the metacognitive control theory (Schwartz, 1999). According to the blocking theory, TOTs occur when the process of retrieving information from the memory is hindered by the sudden recollection of other plausible, but incorrect information. The information to be recalled - or target word - gets blocked by another improper word popping up in the mind. An observation in line with this theory is that people often come up with blocking words similar to the target word itself when they experience a TOT (Woodworth, 1929, 1938 in: Choi & Smith, 2005). Both Jones and Langford (1987) and Jones (1989) showed that by presenting participants with words phonologically similar to the target word, TOT incidence increased.

According to the partial activation theory a TOT arises when information gathered from various sources in the memory does not exceed a threshold that is required for proper recollection. Furthermore, the theory states that the strength of the activation of the unrecalled word causes TOT feelings. So, the closer to the threshold the unrecalled word is, the stronger the experienced TOT strength is. Evidence for this incomplete memory tracing comes from research showing that people experiencing a TOT often accurately describe the first letter, or number of syllables of the target word (Cohen & Falkner, 1986). Also consistent with the partial activation theory, some studies have demonstrated that TOTs are reliable predictors of resolution (Burke, MacKay, Worthley, & Wade, 1991; Read & Bruce, 1982; Schwartz 1998). In addition, TOT strength predicts resolution as well. Schwartz, Travis, Castro and Smith (2000) showed that questions which elicit strong TOTs are more likely to be resolved than questions which elicit weak TOTs.

The third theory, discussed by Choi and Smith is the metacognitive control theory, which also predicts higher resolution rates for strong or imminent TOTs. This theory differs from the other two theories by stating that a TOT has the function of regulating the amount of effort a person puts into his retrieval attempt. The stronger the experiences of a TOT, the more effort people invest in retrieving the target word. Schwartz (2001) kept track of participant's persistence in retrieving a target word. Participants who experienced TOTs were more likely to engage in longer retrieval attempts than participants who did not experience a TOT. So, according to Schwartz, being persistent in one's retrieval efforts will eventually lead to higher resolution of TOT states.

By combining the three theories and the effect of incubation on memory retrieval in general, Choi and Smith derived possible predictions about the benefits of immediate versus

delayed retrieval attempts when being in a TOT state. First, from the blocking theory they inferred that incubation should be beneficial for retrieving unrecalled words. This is because interfering information or blocking words become less accessible after an incubation period. If TOTs are caused by memory blocking, unresolved TOT items at the first test should be more likely to be resolved during a delayed retest than during an immediate retest through a natural forgetting of the interfering information, or blocking word (incubation effect). TOT strength should, in this case decrease from the initial test to the delayed retest, indicating that the blocking word has lost its blocking power, making it more likely for the target word to pop up in the mind.

According to Choi and Smith, the partial activation and the metacognitive control theory do not make clear predictions about the effect of incubation on the resolution of TOT states. However, they tried to extrapolate reasonable predictions from them. From the partial activation theory they inferred that incubation should not have a beneficial effect on TOT resolution, because it seems implausible that the activation of an initially unretrieved target word becomes stronger between the initial test and the retest. In fact, Choi and Smith suggest that it would be fairer to say that the strength of activation should decrease after a delay. They stated that “if memory fades over time, then both the average strength of TOT ratings and resolution rate should decrease during the incubation period” (p. 368).

Third, the metacognitive control theory also suggest that resolution rates are higher for strong TOTs, assuming that stronger TOTs make people put more effort in retrieving initially unrecalled words. Schwartz (1998) demonstrated that TOT frequency was higher during initials attempts to answer questions compared to second attempts made on the same questions several minutes later. Choi and Smith (2005) predicted on the basis of this finding that TOT strength will decrease, rather than increase after an incubation period between the initial test and the retest. Therefore, according to the metacognitive control theory, people will put less effort in retrieving an unrecalled word in a delayed retest compared to the immediate retest. This should be indicated by lower TOT strengths and consequentially lead to lower resolution rates.

Thus, whereas the blocking theory predicts an incubation effect, both the partial activation theory and the metacognitive control theory predict a reverse incubation effect. That is, the resolution of TOT states should be higher for immediate retesting, compared to delayed retesting because during the initial test TOTs are still likely to be strong, whereas TOTs strength during the delayed retest are likely to be weaker.

In short, Choi and Smith (2005) observed an incubation effect: greater resolution of TOTs was found for items retested after a delay than in an immediate retest. In addition, TOT strength was positively related to resolution. That is, the stronger the experience of a TOT, the more likely it was for a TOT to be resolved after the delay. Also, the incubation effect was greater for stronger TOTs. That is, TOT strength decreased from the first presentation to the second presentation and the drop-off was greater for delayed retesting than it was for immediate retesting. This suggests that an incubation period facilitates a release from blocking. So, the results found by Choi and Smith seem consistent with the blocking theory. However, the results of research on the effect of incubation on TOT resolution are still inconsistent. For instance, Kornell and Metcalfe (2006) suggested that blocking words do not cause retrieval difficulties during TOTs, as the blocking theory states. In a first experiment, they provided participants with general knowledge questions and then retested on the ones that elicited TOTs. This was done either immediately or after a delay. In a second experiment, they included a distinction between blocked TOTs and unblocked TOTs. When participant indicated that a wrong answer was coming to mind and blocked the target word, it was labeled as a blocked TOT. An unblocked TOT was identified if the participant indicated that the answer was on the tip of their tongue, without a wrong answer in particular coming to mind. As Choi and Smith, they found an incubation effect. Resolution was greater for TOTs retested after a delay rather than immediately tested. However, contrary to the blocking hypothesis, they found that delay did not enhance resolution of blocked TOTs more than unblocked TOTs. Therefore, Kornell and Metcalfe (2006) stated that “blockers may be a side effect, not a cause, of retrieval difficulty during TOTs” (p. 248).

As said, the goal of this study is to replicate the study of Choi and Smith. As an extension, this study also addresses the question if there is a relationship between vocabulary, working memory and word fluency (long-term memory) performance on the one side, and TOT incidence and TOT resolution on the other. The TOT phenomenon falls within the area of cognitive psychology. In order to facilitate a better understanding of TOTs, it might be interesting to relate cognitive ability to the incidence and resolution of TOT states. Relations between cognitive ability measures TOT incidence and TOT resolution may help to deepen our insights of the origin of TOT states.

For example, Dahlgren (1998) presented participants with general knowledge questions about words, objects and people and showed that the level of general knowledge contributed to the number of TOTs experienced; those people with higher levels of knowledge experienced more TOTs. This might also apply to vocabulary, what can be seen as a form of

(word) knowledge. The prediction that can be derived from the results of Dahlgren (1998) is that the level of word knowledge is positively related to TOT incidence; that is, more word knowledge goes together with a higher TOT incidence. This prediction can also be derived from the blocking theory. Higher word knowledge means a heightened risk of potential blocking words popping up in the mind during the retrieval attempt of an unrecalled word.

Several researchers have found that difficulty in retrieving proper names is very common in the early stages of Alzheimer disease (AD) (Ahmed, Arnold, Thompson, Graham, & Hodges, 2008; De Jaeger & Budge, 2005; Semenza, Borgo, Mondini, Pasini & Sgaramella, 2003). In addition, research has shown that people with aphasic syndrome experience many TOTs (Funnell, Metcalfe, & Tsapkini, 1996). Because these syndromes involve memory impairments associated with higher TOT incidence, it is predicted that memory performance has a negative relationship with TOT incidence and a positive relation with TOT resolution. In other words, the better someone's memory performance is, the less likely it is to experience TOTs and the more likely it is to resolve TOTs.

There has been little specific research on the relation between word fluency and TOTs. However, research shows that weakened connections between lexical and phonological nodes cause TOTs (Burke, 1996). In earlier work, Burke et al. (1991) explains that retrieval errors occur in the linkage between phonological word systems and semantical word systems. During a correct retrieval of a word the *meaning representation* allows direct access to the *phonological representation*. This direct access enables word production and word fluency can be seen as a measure of word production. So, it is predicted that high performance rather than low performance on a word fluency task goes together with a lower TOT incidence and a higher TOT resolution.

In the same way as in the study of Choi and Smith (2005), participants in this study were presented with 48 general knowledge questions which were each repeated once, either immediately or after a delay. During this delay other questions were asked, so that the presentation of questions was continuous. New but similar knowledge items were used to test the robustness of the effect. Participants were asked to do one of three things. They could either indicate that they knew the answer, did not know the answer or they could indicate if they were in a TOT state and rate their TOTs on a scale from 1-4 (with 1 being a *weak TOT* and 4 being a *very strong TOT*). TOT states were defined as the state of mind in which a person is unable to recollect a word from his memory, but is certain he knows it. The word seems to be on the tip of one's tongue (Koriat & Lieblich, 1974). Afterwards, in order to test

for cognitive ability participants were presented with three separate cognitive tests: a vocabulary test, a working memory test, and a word fluency task.

To conclude, the following predictions were tested: 1) the blocking theory predicts an incubation effect whereas the partial activation theory and the metacognitive control theory predict a reverse incubation effect, 2) TOTs are more likely to be resolved than non-TOTs, 3) the magnitude of rated TOT strength determines TOT resolution, and 4) vocabulary score is positively related to TOT incidence whereas memory performance and word fluency are negatively related to TOT incidence. In addition, memory performance and word fluency are positively related to TOT resolution.

Method

Participants

The participants were 25 undergraduate students from the University of Twente, who volunteered by means of an online sign-up system. Volunteers had the possibility to enroll for a variety of experiments, including the present experiment. Participants who enrolled for a similar study on TOT states were excluded. The sample consisted of 11 male and 13 female participants. Their age varied between 18 and 25 years with a mean age of 20 years old ($SD = 2.16$). Nine test sessions were held in approximately 1-6 participants at a time.

Materials

Each session included testing on both TOT states and cognitive ability. The testing on TOT states preceded the testing on cognitive ability in order to control for priming effects, since the cognitive ability tests also called upon memory. There was not counterbalanced in order to leave the TOT data unaffected.

TOT Stimuli

The stimuli consisted of 48 general knowledge questions presented in six categories of eight questions each. In this experiment a new set of questions was used in order to test the robustness of the effect. The categories were the same as used by Choi and Smith and included questions whose answers were capital cities, names of diseases, names of male

celebrities, names of female celebrities, names of politicians, and geographical locations (see appendix B for the Dutch items). All answers were cued by verbal descriptions and definitions. The questions were presented as a quiz by use of a PowerPoint presentation displayed on a beamer screen. The participants could write their answers down on a paper response form. In order to manipulate incubation as a within subjects variable the questions per category were randomly assigned to be either immediate questions or delayed questions. By doing so half of the items were presented twice in a row and so repeated immediately. The other half of the questions was presented once and was not yet repeated before all other questions were presented. This created a delay between the initial test and delayed retest for these questions varying from 13 minutes to 29 minutes with an average of 21 minutes. The time of delay varied because the number of questions presented between the first and the second presentation differed among the questions. For example, it took 28 minutes for the first question to be repeated and 13 minutes for the last question to be repeated. In addition, the questions were counterbalanced in order to control for any sequence effects: immediate items in one counterbalancing group were delayed questions in the other counterbalancing group, and vice versa.

Cognitive Measures

Testing on cognitive ability included the administration of three separate tests: a vocabulary test, working memory tests and a categorical fluency task.

Vocabulary test. In order to test on vocabulary participants were presented with 60 multiple choice questions about the meaning of a word (Elshout, & Veenman, 1992). Each question was accompanied by four possible answers. Participants had to choose the answer corresponding in meaning to the target word.

Working memory test. Working memory was assessed by presenting participants with 15 pairs of words from which one word was a name and the other word was a type of profession (e.g. Beltman – writer). In two minutes, participants were asked to memorize these pairs. After this time period, they answered 15 multiple choice questions. Answers were words semantically related to the presented profession matching the proper name (e.g. Beltman - 1. Hammer, 2. Canteen, 3. Sky, 4. Text) (Elshout, 1979).

Word fluency test. In order to assess word fluency, a test was used similar to the one used by Brucki and Rocha (2004). However, the test was administered in a similar way as the Thurstone word fluency task (Bolter, Long, & Wagner, 1983). That is, participants were asked to write down, instead of name, as much animals as they could think of. In this way

group testing was possible. The fluency test used by Brucki and Rocha was preferred over the Thurstone fluency task, because it was more easily translated to Dutch.

Procedure

Prior to the experiment, participants were asked to read the instructions (see appendix A for the Dutch protocol). In order to clarify the procedure some important aspects of the instruction were verbally highlighted, such as the meaning of a TOT state. From Koriat and Lieblich (1974) the following definition was used: a TOT stands for tip-of-the-tongue and is “the state of mind in which a person is unable to think of a word that he is certain he knows, the state of mind in which a word seems to be on the tip of one’s tongue” (p. 648). This definition was adopted in this study because of the analogy with a Dutch saying: “when a word lies on the tip of your tongue”. Participants were also told that when a question was presented they had to do one of three things: 1) fill in the answer if they knew it, 2) indicate on the answer form ‘do not know the answer’ or, 3) in case of experiencing a TOT state, indicate how strongly they experienced the TOT state on a scale of 1 to 4 (1= *weak TOT*, 4= *very strong TOT*). Then the participants were informed that each question would be repeated and they were asked to treat the repeated question as if it were the first time that they saw the question (Choi & Smith, 2005). So, each participant was presented with a total of 96 questions. It was also emphasized that after a question had been repeated, participants were provided with the right answer in order to eliminate “false” TOTs. A TOT is considered false when the word one searches for does not correspond to the target word. In case of a TOT, participants needed to indicate on the answer form if the word they searched for corresponded with the target word. Before starting with the quiz participants were given the opportunity to ask questions about the procedure to make sure that they fully understood it. After completing the quiz participants were provided with the cognitive tests and were asked to read the instructions. Again, prior to the start of the tests they were given the opportunity to ask questions about the procedure.

The experimenter verbally gave the sign to start of. In case of the testing on TOT states the quiz ran automatically. Participants had 20 seconds for reading, and either answering, marking ‘do not know the answer’, or rating their TOT states. In order to be able to turn the page of the response form, participant had seven seconds. The participants had eight seconds to verify if the word they searched for corresponded with the target word. In case of testing on cognitive ability the experimenter used a stopwatch to keep track of the time. The vocabulary

test, working memory test and word fluency test took 18, 7 and 2 minutes respectively. The total procedure lasted about 90 minutes.

Scoring and Data analysis

The dependent variables were resolution and TOT strength. Resolution was calculated by dividing the number of items resolved in the second presentation by the number of unsolved items in the first presentation (Choi & Smith, 2005). TOT strength was rated by the participants on a four-point scale with 1 (weak TOT) to 4 (very strong TOT). A two factor repeated measures ANOVA was used in order to test for the effect of incubation on TOT resolution. In order to test if TOTs would be more likely to be resolved than non-TOTs, a paired sample *t* test was carried out. TOT strength in relation to resolution was studied by calculating the mean resolution rates for each type of TOT strength from 1 to 4. For the cognitive tests, the dependent variables were number of questions solved correctly in the vocabulary test and number of questions solved correctly in the working memory test. Concerning the word fluency task the dependent variables were the number of quoted animals and the reported number of animal categories (naming animals representing a defined semantic subcategory of animals). In order to study the relation between cognitive ability and both TOT resolution and TOT incidence, a correlation analysis was used (see results).

Results

An alpha of .05 was used on all statistical tests. Similar to Choi and Smith, a two factor repeated measures analysis of variance (ANOVA) was executed with incubation (immediate retest vs. delayed retest) and TOT state (TOTs rated as 1-4 vs. non-TOTs) as the independent variables. Resolution was used as the dependent measure and represented the proportion of initially unsolved items that were successfully resolved at the retest. Participants who did not experience any TOT at both presentations could not be included in the analysis, because of the within subject design. This concerned only one participant. There was a significant effect of incubation ($F(1, 24) = 6.79, p = 0.02$) and there was a significant effect of TOT state, $F(1, 24) = 11.10, p < 0.01$). In line with Choi and Smith, initially unrecalled items were more likely to be resolved during delayed retesting rather than immediate retesting, and when people were experiencing TOT states compared to experiencing non-TOT states.

Table 1. Mean Resolution Scores as a Function of Incubation and Initial TOT State

TOT state	Incubation					
	Immediate			Delayed		
	Mean	SD	No. of TOTs / non-TOTs	Mean	SD	No. of TOTs / non-TOTs
Non-TOTs	0.07	0.02	5.50	0.03	0.08	5.63
TOTs	0.08	0.02	7.25	0.19	0.05	5.25

Note. Mean resolution scores are the proportion of initially unsolved items that were successfully resolved at the retest, TOT = tip-of-the-tongue, N= 24.

However, and inconsistent with Choi and Smith, the incubation \times TOT state interaction was also significant, ($F(1, 24) = 7.45, p = 0.01$); the effect of incubation depended on whether or not participants experienced a TOT. That is, delayed retesting did not improve the resolution of non-TOT items whereas it did improve the resolution of TOT items (see Table 1). Paired sample t test showed that the resolution of TOT states was significantly higher than the resolution of non-TOT states $t(24) = 3.21, p < 0.01$). Figure 1 shows the relationship between TOT strength and resolution. The mean resolution rates for TOT strengths from 1 to 4 were 1.4%, 2.5%, 7.6% and 7.8%, respectively. Paired sample t test showed that the resolution of TOT states was significantly higher than the resolution of non-TOT states $t(24) = 3.21, p < 0.01$). Figure 1 shows the relationship between TOT strength and resolution. The mean resolution rates for TOT strengths from 1 to 4 were 1.4%, 2.5%, 7.6% and 7.8%, respectively.

Correlation analysis showed no significant relation between TOT incidence (total number of TOTs experienced at both presentations) and the scores on the cognitive test (vocabulary scores ($r(24) = 0.02, p = 0.59$), working memory scores ($r(24) = 0.03, p = 0.91$), word fluency scores ($r(24) = -0.11, p = 0.61$), or number of categories named during the fluency test ($r(24) = -0.01, p = 0.99$)). In addition, no significant correlation was found between TOT resolution and vocabulary scores ($r(24) = -0.17, p = 0.42$), working memory scores ($r(24) = 0.01, p = 0.66$), word fluency scores ($r(24) = 0.16, p = 0.44$), or number of categories named during the fluency test ($r(24) = 0.14, p = 0.53$).

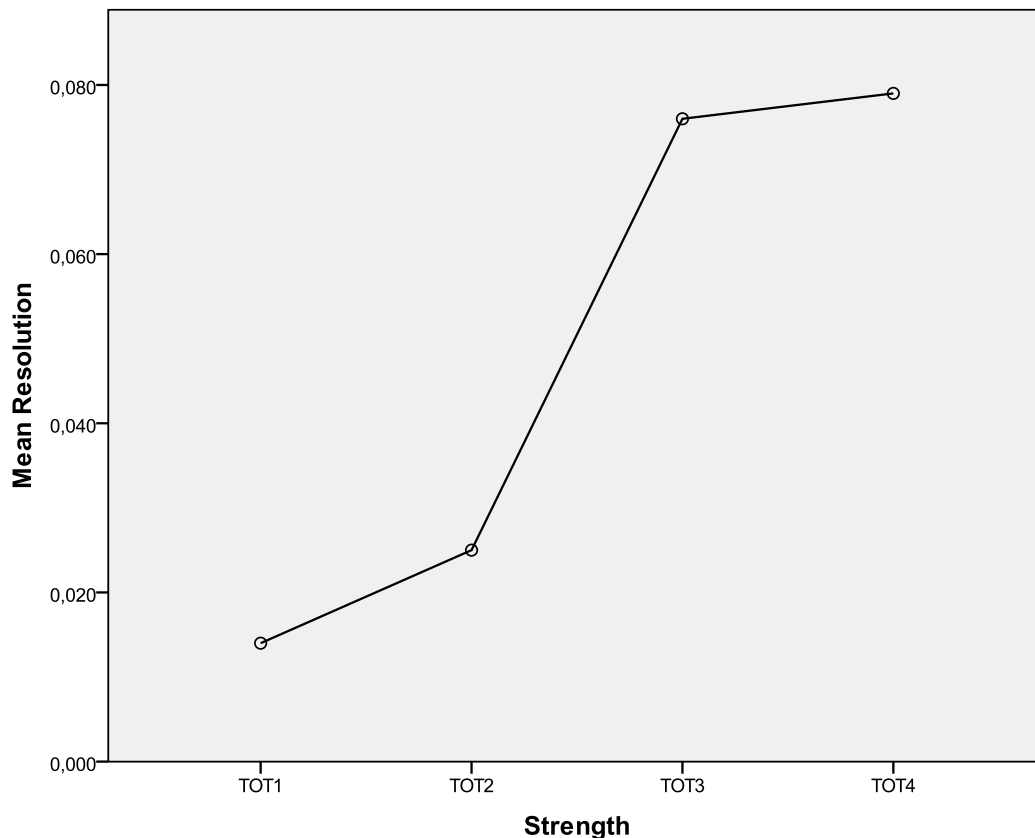


Figure 1. Relationship between initial TOT strength and resolution. TOT= tip-of-the-tongue, 1=weak TOT, 2=moderate TOT, 3=strong TOT, 4=very strong TOT.

Conclusions and Discussion

The goal of this study was to replicate the study of Choi and Smith (2005) by determining if resolution of TOT states is more likely from persistence or from procrastination of additional retrieval attempts. TOT strength was taken into account in order to study the relation between the strength of an experienced TOT state and the likelihood of resolving it. In addition, cognitive measures (vocabulary, working memory and word fluency) were included in order to study the relationship between TOT incidence, TOT resolution and cognitive ability.

The proportion of TOTs experienced at the initial presentation that was successfully resolved at the second presentation was twice as high for the delayed retesting (19%), compared to immediate retesting (8%). So, a clear incubation effect was found. This replicates the findings of Choi and Smith that when one's initially unsuccessful retrieval

attempts leads to a TOT state, resolution is more likely when the second retrieval attempt is made after an incubation period rather than immediately. In addition, this study shows that TOTs are more likely to be resolved than non-TOTs and that the stronger the experience of a TOT was, the more likely it was to be resolved. These findings are consistent with previous studies (Choi & Smith, 2005; Schwartz, 1998; Schwartz et al., 2000). On the account of cognitive ability no relation was found with either TOT incidence or TOT resolution. No evidence was found that vocabulary score is positively related to TOT incidence or that memory performance and word fluency are negatively related to TOT incidence. In addition, results did not show any relation between vocabulary, memory performance and word fluency on the one hand and TOT resolution on the other. It is to conclude that none of the hypotheses regarding cognitive ability and TOTs can be confirmed. This could mean that individual differences in cognitive ability do not affect TOT incidence and TOT resolution. However, several studies have shown a relation between TOT incidence and vocabulary (Dahlgren, 1998) and cognitive impairment (Funnell, Metcalfe, & Tsapkini, 1996; Ahmed, Arnold, Thompson, Graham, & Hodges, 2008; De Jaeger & Budge, 2005; Semenza, Borgo, Mondini, Pasini & Sgaramella, 2003). We will elaborate on this while discussing the limitations.

The TOT incubation effect, also shown by Kornell and Metcalfe (2006), was predicted by the blocking theory. This theory states that TOTs occur when the word to be retrieved gets blocked by another improper word, and predicts that participants should forget the blocking words after some time through a natural forgetting process. This would make it more likely for the target word to be retrieved at the delayed retest rather than at the immediate retest. The present study showed results in line with this assumption.

The other TOT theories, the partial activation theory and the metacognitive control theory predicted that both TOTs and TOT strength are reliable predictors of TOT resolution, which is shown by the present study. However, Choi and Smith also analyzed TOT strength changes over time. From the first presentation of a test question to the second presentation there was a significant decrease in TOT strength. In addition, this drop-off in TOT strength was greater for items that were retested after a delay rather than retested immediately. This is predicted by the partial activation theory. However, the partial activation theory does not make a clear prediction about TOT strength over time in combination with the effect of incubation. Remember that the partial activation theory states that the activation of a memory trace should exceed a threshold in order to be strong enough to retrieve the unrecalled word. From this theory, Choi and Smith predicted that TOT strength should decrease over time, because of a lessened activation. This would make it less likely for a target word to be recalled at the

delayed retest compared to immediate retest. In other words, according to the partial activation theory, resolution at the delayed retest should be lower than at the immediate retest; that is, a reversed incubation effect should be found. So, the decrease in TOT strength from the first presentation to the second presentation found by Choi and Smith cannot be taken as evidence for the partial activation theory, because they found an incubation effect, not a reverse incubation effect. In fact, they state that it provides substantial evidence for the blocking theory, because the decrease in TOT strength in combination with an observed incubation effect suggests a release from blocking. In order to further test the blocking theory, TOT strength changes in relation to incubation should be analyzed.

According to Choi and Smith, the observed incubation effect is not consistent with the metacognitive control theory. If TOT strength reflects the amount of effort invested by participants in their retrieval effort of the target word, then after an incubation period this effort should be lessened. This might be due to the fact that participants remember the question on which they initially failed and are no longer willing to invest effort in retrieving the right answer. On the contrary, during the immediate retest the amount of effort participants are willing to invest is still high, because the initial question is repeated right away. This would make it less likely for an initial TOT state to be resolved at a delayed retest than during a immediate retest. The results found by Choi and Smith which were also found in this study, cannot be interpreted in light of the metacognitive control theory, because an incubation effect was found.

Next, we will discuss limitations of this study. First, the present study took TOT strength into account. However, as said TOT strength changes in relation to incubation were not yet analyzed. If changes in TOT strength were included this could have led to a more thorough replication of Choi and Smith and perhaps provided a more theoretical background for the blocking theory. In addition, a second experiment could have been included in order to study if the found incubation effect was really caused by a release from blockers, as Choi and Smith suggest. In a second experiment of their study, Kornell and Metcalfe (2006) reminded participants of previous blockers during the retest. They showed that these reminders did not affect resolution of blocked TOTs. This is inconsistent with the blocking theory, which suggests that resolution should decrease when people are reminded of their previous blockers. By reminding participants of their previous blockers in the present study, more light could have been shed on which role the blocking plays in TOT resolution after an incubation period.

With regard to the testing on cognitive ability a few limitations must be considered as well. The number of participants was quite low. A higher number of participants would have been

more reliable. Also, it is possible that cognitive ability was not represented by the cognitive measures accurately enough. All cognitive test used, explored just a small area of cognitive ability.

Future research on the effect of incubation on TOT resolution needs to concentrate on determining what is really causing the incubation effect. As Choi and Smith provide evidence for the blocking theory, Kornell and Metcalfe found results inconsistent with the blocking theory. Tracking how TOT strength changes over time and providing participants with their previous blockers might lead to more solid argumentation on the cause of the incubation effect and theory of TOTs. In addition, future research should maintain a focus on the relation with cognitive ability. Although not provided in this study, research on mild cognitive impairment showed relations between cognitive ability and TOT incidence. Further investigating the relation between cognitive ability and TOT may help to deepen or insights of the origin of TOT states. In addition, since all theories on the cause of TOT states are of cognitive nature, research on the relation between cognitive ability and TOTs could perhaps help to clarify the seemingly difficult differentiation these theories make.

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Appendix A: Dutch protocol used during the experiment

Protocol voor ‘Benieuwd naar je algemene kennis? Doe de Quiz!’

Binnenkomst

“Hallo, welkom bij het onderzoek ‘benieuwd naar je algemene kennis? Doe de Quiz!’. Ik wil jullie allereerst vragen om de “geïnformeerde toestemming” door te lezen en in te vullen. Daarna zal ik de antwoordformulieren voor de quiz. Jullie mogen de instructies lezen.” Nadat de proefpersonen de instructies hebben gelezen: “Ik wil graag met jullie de instructie nog even mondeling doornemen om er zeker van te zijn dat jullie goed begrijpen wat de bedoeling is. Na afloop van de Quiz krijg jullie eventueel een korte pauze. Dan gaan we daarna verder met het laatste deel van het experiment: het maken van drie verschillende cognitieve taken. Zijn er vragen?”

TOT Quiz Instructie

Je krijgt zometeen een aantal quizvragen aangeboden. Dit gebeurt door middel van een PowerPoint presentatie. De vragen lees je van het scherm en de antwoorden kun je invullen op dit antwoordformulier. Voor het lezen én beantwoorden van elke vraag krijg je 20 seconden. Je kunt de bladzijde omslaan als de PowerPoint sheet dit aangeeft.

Het is de bedoeling dat je zoveel mogelijk vragen goed beantwoord. Probeer zo volledig mogelijk antwoord te geven. Als er bijvoorbeeld naar de naam van een beroemdheid gevraagd wordt, geef je zowel de voornaam als de achternaam. Mocht je alleen op de voornaam of achternaam komen, dan moet je dat invullen. Ga niet gokken.

“TOT” staat voor “Tip of the Tongue” en betekent dat je in een toestand bent waarin je tijdelijk niet in staat bent op het woord te komen, maar waar je zeker van bent dat je het woord weet. Het is de toestand waarin het woord op het puntje van je tong lijkt te liggen.

Na elke vraag kun je één van deze drie dingen doen:

- 1) Je vult het antwoord in op de lijn als je het weet.
- 2) Je zet een kruisje in de tabel bij ‘weet antwoord niet’ als je het antwoord niet weet.
- 3) Heb je een TOT dan geef je in de tabel aan in welke mate. Bijv:

Weet antwoord niet	Ik ervaar een TOT			
	1 (zwak)	2 (Matig)	3 (Sterk)	4 (zeer sterk)
0 (geen)		X		

Er zijn 48 verschillende vragen die ieder twee keer worden aangeboden. De gehele quiz bestaat dus uit 96 vragen. Sommige vragen worden direct herhaald, andere pas na een tijdje. Behandel de herhaalde vraag net zo alsof je de vraag voor de eerste keer ziet.

Nadat een vraag voor de tweede keer is aangeboden, krijg je het antwoord. In het geval dat je een TOT ervaart (je hebt een kruisje gezet bij 1,2, 3 of 4), geef je aan of het antwoord het woord was waar je naar zocht. Dit kan door 'JA' of 'NEE' te omcirkelen op het antwoordformulier. Je krijgt hier 8 seconden de tijd voor. Heb je geen TOT ervaren hoe je deze vraag niet te beantwoorden.

Je krijgt zo eerst 2 voorbeeldvragen om te oefenen. Ze worden beide herhaald, hetzij direct of na een tijdje. Er zijn dus 4 voorbeeldvragen in totaal.

Let op: De Quiz loop automatisch af!

Zijn er vragen? Stel ze dan nu.

Succes!

De instructie voor cognitieve testen

Dan volgen nu drie cognitieve testjes. Het duurt in totaal ongeveer 20 minuten. Ik wil jullie vragen om de instructies te lezen.

Woordenschattest: Deze test dient om een inzicht te krijgen in uw woordkennis. U zult telkens een woord vinden met daarachter vier andere woorden, die met een letter zijn aangegeven. Uit deze vier woorden (soms omschrijvingen) moet u dat woord kiezen dat praktisch hetzelfde betekent als het opgegeven woord. Als u uw keuze gedaan heeft, streep dan de bij dat woord behorende letter door.

Deze test bestaat uit twee delen met 60 items. Beide delen bevatten 30 items. U krijgt voor elk deel 9 minuten de tijd. Begin niet aan het tweede deel vóór de proefleider u hier het sein toe heeft gegeven! Werk de vragen in opeenvolgende volgorde af. Probeer zoveel mogelijk vragen goed te beantwoorden. Wanneer u een woord niet kent, sla het item dan niet over, maar probeer een zo verstandig mogelijke keuze te maken. Ga echter niet in het wilde weg raden, want dat heeft een nadelig effect op het eindresultaat. Blijf niet te lang hangen bij één opgave: als u geen keuze kunt doen, gaat u dan verder met het volgende woord. Zijn er vragen over deze taak? Stel ze dan nu.

Werkgeheugentest: Op de volgende bladzijde staan 15 namen van mensen met achter elke naam het beroep dat de persoon in kwestie uitoefent. Probeer uit het hoofd te leren het beroep wat bij elke persoon hoort, zodat als de naam gegeven wordt u het juiste beroep kan reproduceren. U hoeft niet de rij namen te kunnen opzeggen, bovendien zal er niet "andersom" worden gevraagd. U krijgt hiervoor 2 minuten de tijd. Zijn er vragen over deze taak? Stel ze dan nu.

Woord fluency test: U krijgt zometeen het teken van de onderzoeker om de bladzijde om te draaien. De bedoeling is om zoveel mogelijk verschillende dieren te bedenken en op het formulier in te vullen. U krijgt hier 2 minuten de tijd voor. Probeer duidelijk te schrijven. Wanneer u meer ruimte nodig heeft kunt u op de achterkant van deze bladzijde verder gaan. Wanneer u geen diersoorten meer kan bedenken, wacht dan totdat de 2 minuten voorbij zijn. Zijn er vragen over deze taak? Stel ze dan nu.

Einde

“Ik wil jullie bedanken voor jullie deelname aan het onderzoek.” In het geval dat een proefpersoon geïnteresseerd was in het doel van het onderzoek: “Dit onderzoek heeft als doel het vaststellen van het effect van incubatie op de resolutie van Tip-Of-the-Tongue (TOT) toestanden. Met andere woorden: wanneer iemand niet op een woord kan komen en het gevoel heeft dat het woord op het puntje van zijn tong ligt, is het dan beter om het te laten rusten of beter om langer te blijven nadenken? Een bijkomend doel is het verkennen van het verband tussen cognitieve vaardigheden en het oplopen en/of oplossen van een TOT-toestand. Houdt TOT-incidentie en TOT-resolutie verband met woordenschat, het werkgeheugen en/of woord-fluency?”

Appendix B: Dutch items used for the experiment

Namen van Hoofdsteden

Wat is...?

1. De hoofdstad van Haiti die in 2010 getroffen werd door een zware aarbeving?

Antwoord: Port-au-Prince

2. De IJslandse hoofdstad en geboorteplaats van de zangeres Björk?

Antwoord: Reykjavik

3. De hoofdstad van Bosnie en Hersegovina? Tussen 1992 en 1995, tijdens deBosnische Oorlog, werd deze stad zwaar gebombardeerd door Bosnisch-Servische troepen.

Antwoord: Sarajevo

4. De hoofdstad van Libië? Tijdens de opstand in 2011 was deze stad lange tijd het belangrijkste bolwerk van het Qadhafi-regime.

Antwoord: Tripoli

5. De hoofdstad en grootste stad van Oekraïne? Deze stad is onder andere thuisstad van een -uit de Europa Leage bekende- voetbalclub en de naam van deze voetbalclub bestaat gedeeltelijk uit de naam van de hoofdstad.

Antwoord: Kiev

6. Hoofdstad van Kazachstan? Naar deze hoofdstad is ook een wielerploeg vernoemd die onderandere Aleksandr Vinokoerov en Alberto Contador contracteerde.

Antwoord: Astana

7. De hoofdstad van de oud-nederlandse kolonië Suriname?

Antwoord: Paramaribo

8. De hoofdstad van Bolivia? Gelegen op 3600 meter is deze stad de “hoogste hoofdstad” ter wereld. De letterlijke nederlandse vertaling van de Spaanse naam van de stad is: ‘de vrede’.

Antwoord: La Paz

Namen van ziektes

Hoe heet...?

1. De ziekte die gekenmerkt wordt door geheugenstoornissen? Wordt vooral bij 65+ ers vastgesteld en is beter bekend onder de naam dementie.

Antwoord: Ziekte van Alzheimer

2. De infectieziekte die wordt gekenmerkt door koorts en meestal hevige spier- en gewrichtspijn? De infectie is ook bekend als knokkelkoorst en wordt, net als malaria, overgedragen wordt door de steek van bepaalde muggen levend in de (sub)tropen.

Antwoord: Dengue

3. Het virus dat griep veroorzaakt?

Antwoord: influenza-virus

4. Een ziekte die wordt gekenmerkt door vermoeidheid, keelontsteking en opgezette klieren? De besmetting gebeurt naar men aanneemt vaak via speeksel, de reden waarom deze ziekte wel eens de kusziekte wordt genoemd.

Antwoord: Ziekte van Pfeiffer

5. De verzameling van verschillende vormen van bloedkanker, of preciezer kanker van witte bloedcellen?

Antwoord: Leukemie

6. De ziekte waarvoor ongecontroleerde spierbewegingen en het maken van geluiden kenmerkend zijn? Mensen die hieraan lijden hebben een onbedwingbare drang bepaalde bewegingen te maken of bepaalde geluiden of, vaak, scheldwoorden te uiten.

Antwoord: Gilles de La Tourette

7. De aandoening aan de nek of rug waarbij tussenwervelschijven uitstulpen en zenuwen bekneld kunnen raken? Hetgeen wat ernstige pijn kan opleveren en vaak operatief verholpen moet worden.

Antwoord: Hernia

8. De ziekte die wordt gekenmerkt door stijfheid, zwellingen en pijn in gewrichten bij het bewegen?

Antwoord: Reuma

Namen van mannelijke bekendheden

Wie is/wie was...?

1. Een Amerikaanse rockzanger in zijn gelijknamige band? Hij werd in de jaren 80 bekend met nummers als 'Livin' on a Prayer' en 'You give love a bad name'. In 2000 had hij een comeback met het nummer 'It's My Life'.

Antwoord: John Bon Jovi

2. Een Amerikaanse acteur, speelt Michael in 'That 70's Show', presenteert 'Punk'D' en

is te zien in onder andere ‘Dude Where’s My Car’, ‘The Butterfly Effect’ en ‘What Happenes in Vegas...’? Hij is getrouwd met Demi Moore.

Antwoord: Ashton Kutcher

3. Een Amerikaanse acteur en regisseur? Hij Speelt onder andere in ‘The Good, the Bad and the Ugly’ en ‘Dirty Harry’. Regisseerde en speelde in ‘Million Dollar Baby’

Antwoord: Clint Eastwood

4. Een Britse popzanger? Hij maakte ooit deel uit van ‘Take That’ Daarna werd hij een succesvol solozanger met hits als ‘Angels’, ‘Freedom’ en ‘Feel’.

Antwoord: Robbie Williams

5. Een Oostenrijks-Amerikaans bodybuilder, acteur en politicus? Van november 2003 tot januari 2011 was hij gouverneur van de Amerikaanse staat Californië. Bekend van onder andere ‘Terminator’.

Antwoord: Arnold Schwarzenegger

6. Was de Amerikaanse zanger en gitarist van Nirvana? Hij pleegde op 5 april 1994 zelfmoord.

Antwoord: Kurt Cobain

7. De zanger en oprichter van Guns N’ Roses?

Antwoord: Axl Rose

8. Een Amerikaanse filmacteur en speelt over het algemeen rollen met een komische inslag? Hij is onder ander bekend van ‘Beverly Hills Cop’ en ‘The Nutty Professor’. Sprak daarnaast de stem in van Donkey, de ezel van ‘Shrek’.

Antwoord: Eddie Murphy

Namen van vrouwlijke bekendheden

Wie is/wie was...?

1. Een Amerikaanse actrice met de hoofdrol in ‘Buffy the Vampire Slayer’?

Antwoord: Sarah Michelle Gellar

2. Een Amerikaanse actrice, onder andere bekend van ‘8 mile’, ‘Just Married’ en het inspreken van de stem van Gloria in ‘Happy Feet’? Ze overleed in december 2009.

Antwoord: Brittany Murphy

3. Een vrouwelijke Hollywood ster? Bekend van films als ‘Entrapment’, ‘The Mask of Zorro’ en ‘Ocean’s Twelve’. Ze is getrouwd met Michael Douglas.

Antwoord: Catherine Zeta Jones

4. De hoofdrolspeelster in ‘Sex and the City’? Ze is getrouwd met acteur Matthew Broderick.

Antwoord: Sarah Jessica Parker

5. Een Amerikaanse actrice, bekend door haar rol Rachel in ‘Friends’? Ze speelt onder andere in ‘The Bounty Hunter’, ‘Love Happens’ en ‘The Break-Up’. Ze was getrouwd met Brad Pitt.

Antwoord: Jennifer Aniston

6. Een Amerikaanse zangeres en actrice? Ze speelde in musicals als ‘Hello Dolly!’ en scoorde in Nederland een hit met ‘woman in love’ en ‘tell him’, een duet met Celine Dion. In 2010 wordt de hit van Duck Sauce naar haar vernoemd.

Antwoord: Barbra Streisand

7. Een Amerikaanse popzangeres? Brak door in 2008 met het nummer ‘I kissed a girl’. Ze is getrouwd met Russell Brand.

Antwoord: Katy Perry

8. Een Amerikaanse societyster, model, zangeres en actrice? Ze is de achterkleindochter van de oprichter van de gelijknamige Hotels Corporation. Speelde samen met Nicole Richie in ‘The Simple Life’.

Antwoord: Paris Hilton

Namen van politici en/of politieke figuren

Wie is.../ wie was?

1. Een Duitse christendemocratische politica? Ze is sinds 22 november 2005 bondskanselier van Duitsland en daarmee de eerste vrouwelijke regeringsleider van dat land.

Antwoord: Angela Merkel

2. Een Nederlandse politicus en econoom? Hij is namens het CDA minister van Financiën in het kabinet-Rutte.

Antwoord: Jan Kees de Jager

3. Een diplomaat afkomstig uit Ghana en was van 1997 tot en met 2006 de eerste zwarte secretaris-generaal van de Verenigde Naties? Hij geldt als een succesvol hervormer. Ontving in 2001 de Nobelprijs van de vrede.

Antwoord: Kofi Annan

4. De 44e en huidige president van Amerika? Hij is de eerste zwarte Amerikaan in deze functie.

Antwoord: Barack Obama

5. Een Nederlandse CDA-politicus geweest? Was van juli 2002 tot oktober 2010 minister-president van Nederland.

Antwoord: Jan Peter Balkenende

6. Een Nederlandse politicus en partijleider van de Partij voor de Vrijheid (PVV)?

Antwoord: Geert Wilders

7. Een Grieks politicus en vorige premier van Griekenland? Hij was veel in het nieuws te zien in verband met de economische crisis.

Antwoord: Giorgos Papandreou

8. Sinds 1578 de belangrijkste spiritueel leider in het Tibetaans boeddhisme?

Antwoord: Dalai Lama

Namen van geografische locaties

Hoe heet...

1. Het met heide begroeid Nederlands natuurgebied gelegen in Gelderland. Grote delen van dit gebied bestaan uit stuwwallen, die zo'n 150.000 jaar geleden ontstaan zijn in de voorlaatste ijstijd.

Antwoord de Veluwe

2. De randzee van de Middellandse Zee tussen Italië en Kroatië?

Antwoord: Adriatische zee

3. De hoogste berg van Afrika? Deze berg steekt ruim 5 kilometer uit boven zijn omgeving en is daarmee de hoogste vrijstaande berg ter wereld.

Antwoord: Kilimanjaro

4. Een groot meer op de grens tussen Zwitserland in het noorden en Frankrijk in het zuiden? De naam van dit meer komt ook voor in een viertal verdragen getekend na belangrijke oorlogen.

Antwoord: Meer van Genève

5. Een grote rivier in Zui-Amerika. Deze ontspringt in Peru en komt uit in de Atlantische Oceaan in Brazilië en stroomt door het gelijknamige regenwoud.

Antwoord: Amazone

6. Het gebergte in het zuiden van Azië? Dit gebergte is onder andere bekend door de hoogste berg ter wereld, de Mount Everest.

Antwoord: Himalaya

7. De vulkaan aan de oostkant van het Italiaanse eiland Sicilië?

Antwoord: Etna

8. De eilandengroep in de Middellandse Zee, ten oosten van het Spaanse vasteland. Tot deze eilandengroep behoren onder andere Mallorca en Ibiza.

Antwoord: Ballearen