INFLUENCES OF MEDIATED PRIMING ON TIP-OF-THE-TONGUE INCIDENCE AND RESOLUTION

By

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To my parents

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Previous research indicates that tip-of-the-tongue (TOT) states, characterized by the temporary inability to retrieve a known word, can be reduced as well as resolved via phonological priming, i.e., presentation of prime words phonologically related to the TOT target word. The current study investigated the influences of mediated phonological priming, in which the prime and target were indirectly related, on the incidence and resolution of TOT states. Participants answered general knowledge questions designed to induce a TOT state and named pictures in which one was either a prime or unrelated picture. The prime was a near-synonymous picture that corresponded to a dominant (e.g., *motorcycle*) and secondary (e.g., *bike*) name, where the dominant name referred to the name typically produced upon seeing the picture. The secondary name was phonologically related to the TOT word by sharing its first syllable (e.g., *biopsy*). In Experiment 1, participants named a near-synonymous picture *before* answering a general knowledge question, and the results showed that producing the dominant name of prime pictures increased target retrieval and decreased TOT states for subsequently presented targets, relative to naming unrelated pictures. In Experiment 2, participants named a near-synonymous picture *after* answering the general knowledge questions, and for targets that were in TOT states,

naming the prime pictures' dominant name increased resolution of those TOT states compared to unrelated pictures. Because production of the dominant name led to decreased TOT incidence and increased TOT resolution than did an unrelated name, these results demonstrate that the phonologically-related secondary name (without being produced) primed the target for retrieval. In addition to providing another method of priming TOT states for future research, exposure to the TOT word's first-syllable phonology via mediated priming may be a process involved in the spontaneous resolution of TOT states in everyday life.

CHAPTER 1
INTRODUCTION

Tip-of-the-tongue (TOT) states, characterized by the temporary inability to retrieve a known word (e.g., Brown & McNeill, 1966), are common disruptions to fluent speech that are not always immediately resolved (e.g., Burke, MacKay, Worthley, & Wade, 1991). The cause of TOT states is thought to result from weakened phonological connections, which makes the TOT word unable to receive sufficient activation for production (e.g., MacKay, 1987; MacKay & Burke, 1990). Support for this view comes from previous research, in which presenting primes that are phonologically related to the target word can facilitate TOT resolution (e.g., seeing *abdomen* primes the TOT word *abacus*; Abrams & Rodriguez, 2005; Abrams, Trunk, & Merrill, in press; Abrams, White, & Eitel, 2003; James & Burke, 2000; White & Abrams, 2002). This method is thought to mimic the spontaneous resolution of TOTs in everyday life, as exposure (i.e., via seeing or hearing) to a TOT word's phonological connections induces the word to be more accessible but without a person's conscious knowledge (James & Burke, 2000). The current experiments examined TOT incidence and resolution via phonologically-*mediated* priming, which may be another means of spontaneous TOT resolution. That is, instead of direct exposure to the first-syllable phonology of the TOT word, TOT incidence and resolution may also occur because of mediated exposure to the first-syllable phonology of the TOT word, without actually encountering that phonology directly.

Mediated Priming

Mediated priming involves primes and targets that are indirectly related by a connecting link (e.g., *pasture* and *milk* are indirectly related by their connecting link *cow*) and is beneficial for investigating factors of spreading activation. Spreading activation models contend that activation of a lemma (i.e., the semantically and syntactically specified representation, which is

the word concept and corresponding properties) spreads to distant, indirectly-related and close, directly-related associates, where relationship can be defined at multiple levels, such as meaning (semantic) or sound (phonology; Balota & Lorch, 1986). For example, as seen in Figure 1-1, because *milk* receives activation through *pasture*'s directly-related semantic associate *cow*, *milk* is an indirectly-related semantic associate of *pasture*. In addition to semantic associates, mediated priming also occurs with phonological associates. For example, *calculator* is a phonological, indirectly-related associate of *pasture* through the mediated prime *cow*. These latter types of mediated primes were used in the present experiments to influence TOT incidence and resolution.

Even though indirectly-related semantic and phonological associates are activated via spreading activation, Dell and O'Seaghdha (1991, 1992) proposed that these lemmas receive only a proportion of the original activation. In Figure 1, the connector lines between the lemmas demonstrate this notion. For example, the fully activated prime *pasture* cannot send its full amount of activation to its associate *cow*, as it sends some of its activation to other associates (e.g., *passage*, *grass*, etc.). Of its received activation, the associate *cow* sends a share of its activation to its associate *milk*. Even though indirectly-related associates receive only a proportion of the original activation, they can nevertheless influence activity in the lexical system (e.g., prime other words for activation). Thus, when considering mediated priming's role in word retrieval, even though the prime is indirectly related to the target word, the target word may still receive enough activation to decrease TOT incidence and increase TOT resolution.

Previous research has used mediated priming to investigate the processes underlying word recognition, word retrieval, phonological processing, and lexical activation (e.g., Cutting & Ferreira, 1999; Jeschniak & Schriefers, 1998; Peterson & Savoy, 1998; White & Abrams, 2004).

For example, Peterson and Savoy (1998) demonstrated the effects of mediated priming on word recognition[1] using near-synonyms, which are two or more words that correspond to the same target. The most frequently used word is referred to as the dominant name, and the other, less frequently used word(s) are the secondary names. For example, a long upholstered article of furniture to seat more than one person can be appropriately referred to as either *couch* (dominant) or *sofa* (secondary). Peterson and Savoy (1998) first determined the pictures' dominant and secondary names by having participants name a series of pictures for which there was more than one appropriate name. A picture was considered near-synonymous if participants provided two basic-level names in at least 75% of the names given, and the frequency of the names was distinctly disproportionate. The most frequently used name, averaged across all responses, was the dominant name, which was produced a mean of 84% (range of 67% - 98%), and the less frequently used name was considered the secondary name.

To examine the effects of mediated priming on word recognition, participants viewed a near-synonymous picture and an experimental word that was either phonologically related (e.g., *soda*) or unrelated (e.g., *horse*) to the secondary name (e.g., *sofa*), and they produced the experimental word aloud. Participants named the phonologically-related word faster than the phonologically-unrelated word, demonstrating that word recognition was facilitated via mediated priming. Viewing a near-synonymous picture spread activation to both the corresponding dominant and secondary names, which similarly activated their semantically- and phonologically-related lemmas. Being phonologically related to the secondary name, the

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[1]Peterson and Savoy (1998) described their task as representing both word recognition and production. However, participants read aloud words presented on the screen; they did not *retrieve* the word from memory, as the word was provided for them. Therefore, I refer to the task in terms of word recognition only to differentiate it from tasks that require self-initiated production.

experimental word received enough priming to be activated and produced more quickly, relative to the phonologically-unrelated word. Another alternative explanation may be that instead of the dominant name spreading activation to the secondary name, priming may have occurred only for participants who silently named the picture with the secondary name, thereby directly activating the phonology of the experimental word. However, these results of mediated priming have been replicated in similar word recognition studies using Dutch words (Jeschniak & Schriefers, 1998) and homonyms (Cutting & Ferreira, 1999), suggesting that mediated priming did occur in this study.

Furthermore, White and Abrams (2004) demonstrated mediated priming in word *retrieval* by using an associate word-stem completion task. Participants completed word-stems in one of three conditions: 1) a semantic condition, in which a word was paired with the first letter of a specific semantic associate (e.g., *beach-s___* with *sand* as the target); 2) a phonological condition, in which a word was paired with the first letter of its homophone's semantic associate (e.g., *beech-s___*), and 3) an unrelated condition, in which an orthographically similar word to the homophones was paired with the first letter used in the other conditions (e.*g., batch-s___*). White and Abrams (2004) found that relative to the unrelated condition, participants produced the semantic associate more often in the phonological condition (i.e., *sand* was produced more often following *beech* than *batch*). In this example, *beech* activates its phonological associate, *beach*, which in turn activates its own semantic associates, such as *sand*. Thus, *beech* and *sand* have a preexisting relationship through their mediated prime *beach*, meaning that *beech* can activate *sand* (and vice versa) via the activation of *beach*. Similar processes could be invoked in TOT resolution, in which the TOT word (e.g., *abacus*) and the mediated prime (e.g., *stomach*) have a preexisting relationship through their connecting link (e.g., *abdomen*). That is, having a

TOT for *abacus*, an individual's TOT resolution may be increased by exposure to *stomach*, which is the mediated prime: *stomach* semantically activates *abdomen,* which phonologically activates *abacus*.

Evidence from mediated priming in both word recognition and word retrieval tasks offers support for an interactive activation model of language production. Both discrete and interactive activation models contend that language production involves two distinct stages of semantically selecting and phonologically encoding a particular lemma to satisfy a communicative goal (e.g., Dell, 1986; Levelt, 1989). However, they disagree about the time course of these stages. Discrete theories emphasize the successive time course of these stages, in which a particular lemma is first selected for semantic goals and then phonologically encoded for production. Thus, activation operates in a feed forward, top-down system. Even though multiple lemmas can be activated for one semantic goal (e.g., near-synonyms), only the selected lemma for production receives phonological encoding. Thus, because discrete theories do not allow for bottom-up processing between phonemes and lemmas, these theories would predict that phonological mediated priming cannot influence TOTs, similar to as they would predict that mediated priming in Peterson and Savoy's (1998) task could not affect speed of naming. For example, when *stomach* activates its semantic associate *abdomen*, bottom-up processing needs to occur for *abdomen* to prime its phonological associate *abacus*. Conversely, interactive activation theories postulate that these stages can co-occur via cascaded processing (Dell, 1986; MacKay, 1987; Stemberger, 1985). That is, before a single lemma is selected to satisfy a communicative goal, all lexical candidates are semantically and phonologically encoded. Following the "most primed wins" principle, the lemma with the most semantic and phonological priming is selected (Burke, et al., 1991; MacKay, 1987; MacKay & Burke, 1990). Thus, both top-down (feed forward) and

bottom-up (feedback) processing can influence lexical selection in interactive activation theories. Within mediated priming, this interactive activation system is important as both top-down and bottom-up processing are needed. For example, *stomach* relies on top-down processing to activate its semantic associate *abdomen*, which relies on bottom-up processing to prime its phonological associate *abacus*. Dell, Schwartz, Martin, Saffran, and Gagnon (1997) proposed that this feed-forward and feed-back interaction between lexical candidates is functional for fluent discourse, which can be disrupted by TOT states. However, the interaction provides more activation to the temporarily inaccessible nodes, thereby increasing its accessibility for production and reducing/resolving TOT states.

TOT Incidence

TOT incidence refers to the frequency of occurrence of these particular word retrieval failures. One theoretical framework of language production, the Transmission Deficit Hypothesis of TOTs proposes that TOT states occur because of insufficient priming to the phonological nodes of the intended target (Burke et al., 1991; MacKay & Burke, 1990). Within this framework, the phonological system is depicted as a hierarchical network of phonological nodes that represent syllables, vowels, and other phonological information. These nodes are connected by links through which node priming passes. For a word to be retrieved for production, all nodes must be activated above threshold. However, the amount and rate of activation a node receives depends on the strength of the links, which are weakened by frequency of use, recency of use, and aging, as TOT states increase for low-frequency words, non-recently used words, and older adults (Burke, MacKay, & James, 2000; Burke et al., 1991; MacKay & Burke, 1990).

To determine if strengthening the phonological connections lowers TOT incidence, James and Burke (2000) presented participants with five primes that collectively contained all

the syllables of the upcoming target word, intermixed with five unrelated words. For example, if the upcoming target word was *abacus*, participants viewed abrogate, abject, element, caucus, and hibiscus, with each word containing one syllable of *abacus* (i.e., *ab*rogate, *ab*ject, el*e*ment, cau*cus*, and hibis*cus*). James and Burke (2000) found that relative to the control condition in which the words were not phonologically related to the target word, presenting phonological primes before the question decreased the incidence of TOT states. Thus, they concluded that recent exposure to the phonological connections of a target word decreased the probability of TOT onset, as the phonological connections have been strengthened. Experiment 1 of the current study investigated this phenomenon via mediated priming. That is, is the activation of the phonology of an upcoming target word via a mediated prime (a connecting link between the target and the phonological prime) strong enough to strengthen the phonological connections, resulting in the occurrence of fewer TOT states?

TOT Resolution

Similar to TOT incidence, strengthening of phonological connections is relevant to TOT resolution (i.e., retrieving the intended word after having a TOT). Because TOT states are thought to result from weakened connections between phonological nodes (Dell, 1986; MacKay, 1987), James and Burke (2000) hypothesized that phonological priming should also facilitate TOT resolution. That is, once having a TOT state, exposure to similar phonology should strengthen the connections of the target word, thereby increasing activation above threshold for production. Similar to their investigation of TOT incidence, they investigated this hypothesis by phonologically priming all syllables of a target word after presenting the question and inducing a TOT state. For example, if in a TOT state for the target word *abacus*, participants viewed five primes that collectively contained all the syllables of the target: *ab*rogate, *ab*ject, el*e*ment,

cau*cus*, hibis*cus*. James and Burke (2000) found that relative to the control condition in which the words were not phonologically related to the target word, presenting primes during a TOT state increased resolution. Abrams and her colleagues (Abrams et al., 2003; White & Abrams, 2002) furthered this phenomenon, finding that priming only the first syllable of the TOT word provided sufficient activation for TOT resolution.

The strengthening of a TOT word's phonological connections is not limited to overt production. Abrams et al. (2003) demonstrated the effects of silent production of phonological primes on TOT resolution. In one experiment, when in a TOT state, participants silently read a list of words that included two phonological first-syllable primes intermixed with unrelated words. Relative to the control condition, silent production of the primes strengthened the TOT connections and increased TOT resolution. Together, these studies (e.g., Abrams et al., 2003; James & Burke, 2000; White & Abrams, 2002) showed that the primes strengthened the nodes of a target word, thereby decreasing the incidence of TOT states and increasing TOT resolution.

Experiment 2 of the current study investigated whether mediated priming has a similar effect on TOT resolution to that of direct priming. However, even if mediated priming strengthens the phonological connection enough for resolution, a factor that may influence resolution is the part-of-speech of the primes and targets. Abrams and Rodriguez (2005) found that primes of a different part-of-speech from the TOT word facilitated resolution, whereas primes of the same part-of-speech had no effect on resolution. However, the part-of-speech effects were correlated with frequency. For different part-of-speech primes, high-frequency primes increased TOT resolution, whereas for same part-of-speech primes, high-frequency primes decreased resolution. The current study used low-frequency primes (below 20) in hopes of minimizing any impact from the prime's part of speech.

The Current Study

The current experiments examined the effects of mediated priming on TOT incidence and resolution. In Experiment 1, participants named a near-synonymous picture that had a secondary name to share phonology with the target word. Even if the dominant name was produced, the secondary name was presumably activated because of spreading activation (Balota & Lorch, 1986). Participants then answered a definition-like question that corresponded to a low-frequency word, and TOT incidence and target retrieval were measured. In Experiment 2, participants named a near-synonymous picture that had a secondary name sharing phonology with the target word *after* having a "TOT" or "Unknown" response to a definition-like question that corresponded to a low-frequency word. If the connections are strong enough to indirectly transmit activation to the target word, then mediated priming may be a phenomenon that occurs in spontaneous TOT incidence and resolution. That is, being exposed to words whose activated associates overlap in first-syllable phonology with the TOT word may decrease TOT incidence and increase TOT resolution without individuals' awareness.

Mediated priming is hypothesized to decrease TOT incidence and increase TOT resolution, respectively, similar to providing a phonological prime before and during a TOT state. Because activation increasingly diminishes the further away from the activated lemma, the activation to the target word will be reduced. Nevertheless, this amount of activation is expected to be sufficient to strengthen the connections above threshold for TOT resolution. As seen in Abrams et al. (2003, Exp. 3), silent production of primes (i.e., reading primes silently) increased TOT resolution. Thus, even though participants did not overtly produce the primes, the TOT word received enough priming activation for resolution. In the current experiments, the primes will be similarly activated without purposeful silent production. That is, production of the

dominant picture name will activate its near-synonymous secondary name (i.e., the prime) via spreading activation. Even though the prime is not being directly produced, its activation from the dominant name is expected to be sufficiently activated to affect TOT incidence and resolution.

However, when participants produce the picture's secondary name, then the name will serve as a directly activated prime, comparable to the primes in other phonological priming studies (e.g., Abrams et al., in press; Abrams et al., 2003; James & Burke, 2000; White & Abrams, 2002). Similar to the mediated priming via production of the dominant name, we predict production of the secondary name to decrease TOT incidence and increase TOT resolution. In both instances, the TOT phonological connections are strengthened by the activation of a prime. However, directly activated primes are expected to prime TOT incidence and resolution even more than production of the dominant name, as production of the dominant name requires mediated (indirect) priming.

Generally, individuals produce the dominant name of a picture, as it is most frequently used. However, can they be more likely to produce the secondary, less frequently used name as a function of having a TOT? A secondary investigation in Experiment 2 is the ability of a TOT word to feed back activation to influence lemma selection. That is, does the mere activation of a lemma in a TOT state feed back to influence the selection of the secondary (as it shares phonology with the TOT word) rather than the dominant name in the semantic selection stage? If the connections are strong enough to activate the secondary name as the most-primed-wins name, then influential feedback on lemma should occur, as the participants named the picture *after* TOT onset.

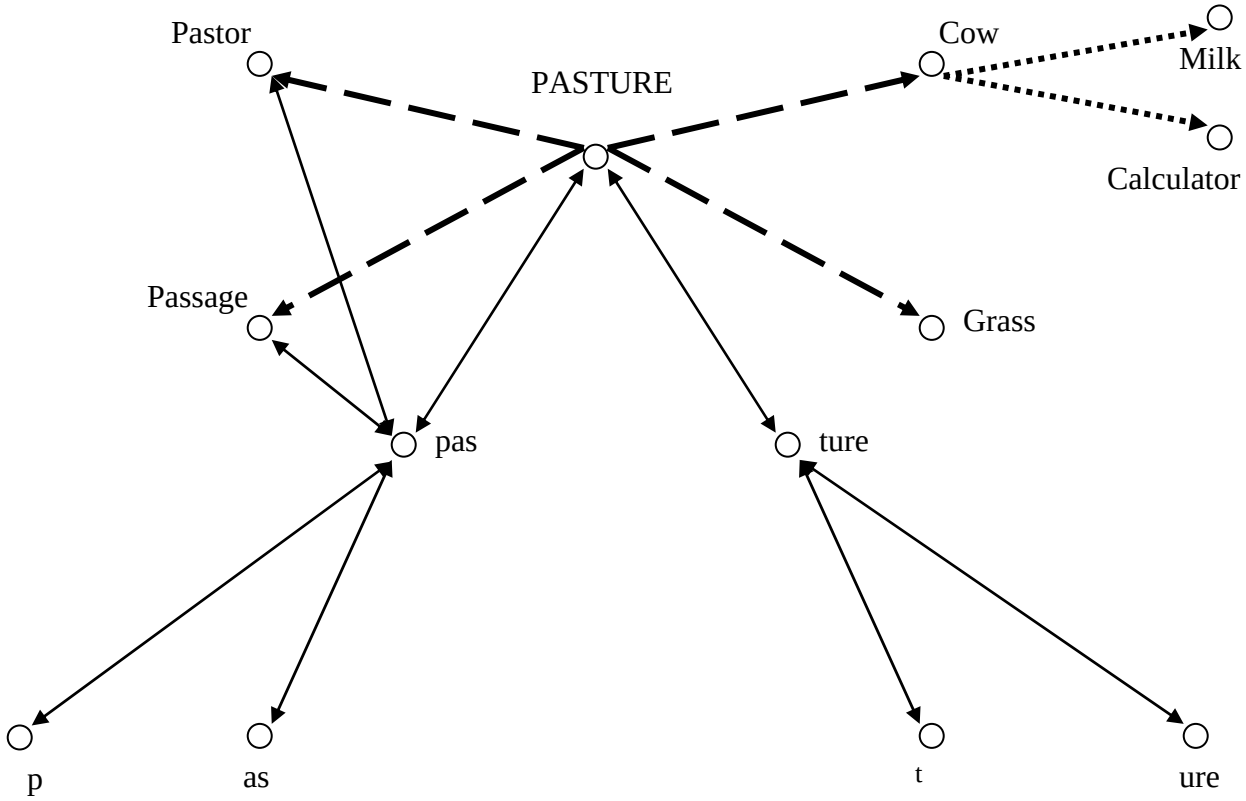

Figure 1-1. Phonologically mediated priming via spreading activation. This figure demonstrates how the activation of *pasture* spreads activation to related semantic and phonological associates. *Cow* is a mediated prime between *pasture* and *milk*. The dashed lines represent activation sent between words, whereas the solid lines represent activation between phonemes or words and phonemes. The thickness of dashed lines between the nodes indicates the strength of activation the node receives, with the thickest lines to the associates indicating the most activation.

CHAPTER 2
EXPERIMENT 1

Experiment 1 was designed to examine whether mediated priming influences TOT incidence. If mediated priming effectively activates the phonology of the upcoming target word via bottom-up processing, then participants should experience fewer TOT states than when not presented with the mediated prime. A secondary aim of Experiment 1 was to assess whether production of the dominant name influences word retrieval differently from production of the secondary name. Production of the secondary name is a direct prime because its phonology matches that of its target. Therefore, production of the dominant name is a mediated prime because the phonology of the target word is indirectly activated via semantic activation of the secondary name. Thus, because the phonology of the target word will be more strongly activated via the direct rather than mediated prime (Dell & O'Seaghdha, 1991; 1992), we expect participants to experience fewer TOTs after production of the secondary name, relative to production of the dominant name.

Method

Participants

Participants included 60 young adults (50 females, 10 males), aged 18-25 (M = 19.13, SD = 1.01), recruited from introductory psychology courses and given partial course credit for participation. All reported English to be their native language.

Materials

The program was developed using Visual Basic 5.0 and conducted on a Pentium 4, 1.8 GHz PC-compatible computer. Experimental stimuli to elicit TOT states consisted of 79 definition-like questions that corresponded to a target word, with 18 borrowed from previous TOT studies (Abrams & Rodriguez, 2005; Abrams et al., in press) and 61 novel questions

developed by the experimenter. Seventy-nine questions were selected because that was the maximum number of appropriate target words that met the criteria to correspond to the prime pictures. Target words were common nouns (67.09%), adjectives (8.86%), and verbs (24.05%) that were low in Francis and Kucera (1982; 0 to 26 per million, except one at 114 and one at 147, M = 6.56, SD = 20.90) and between one and five syllables (M = 2.37, SD = .89).

Pilot study

Each target word was paired with an experimental, i.e., prime, picture and a control picture. Prime pictures were nouns that had two near-synonymous names, with some obtained from Peterson and Savoy (1998) and Snodgrass and Vanderwart (1980), and some generated by the experimenter. Control pictures were nouns that had one name and were obtained from the same sources as the prime pictures. All pictures were pilot tested by having 180 participants view 70 pictures (out of 350 possible) one at a time. Each participant named only 70 pictures to reduce the chance of fatigue. Participants were asked to name the object in the picture and then provide up to three alternative names that one might also call the picture. The first name produced was considered their dominant name, whereas the second name they produced was considered their secondary name for the object. As previously mentioned, Peterson and Savoy (1998) tabulated the names across different responses and considered the highest frequency response the dominant name and the less frequent response the secondary name. However, because the primes would be designed based on the name individuals most frequently produce first to ensure they receive mediated rather than direct priming, we tabulated names according to response position (i.e., first, second). Participants were given the option of providing a third response so that they did not feel constrained when providing responses; rather, they could freely respond as the names came to mind. From the 350 pictures pilot tested, 79 prime (near-synonymous) pictures were

selected that met the following criteria: across participants had 1) at least two appropriate, distinctly disproportionately frequent names, 2) a name produced in the first response above 50%, and 3) a name produced in the second response above 35%. Dominant names were produced 79.7% of the time on average, whereas subordinate names were produced on average 43.9% of the time. Furthermore, the secondary names were produced an average of 17.8% on the first response, and the dominant names were produced an average of 14.6% on the second response.

Stimuli for materials

For prime pictures, the first-syllable phonology of the secondary name matched that of its target word, but not that of its corresponding dominant name. For example, the *biopsy* matched in first-syllable phonology with its corresponding near-synonymous picture's secondary name *bike* but not dominant name *motorcycle*. Of the 79 chosen prime pictures, the mean Francis and Kucera (1982) frequency of the dominant names was 45.80 (*SD* = 112.30, range = 0 to 91, with 5 greater than 100) and of the secondary names was 38.80 (*SD* = 3086.50, range = 0 to 89, with 5 greater than 100). Additionally, the mean syllable length of the dominant names was 1.6 (*SD* = .77, range = 0 to 4) and of the secondary names was 1.7 (*SD* = .79, range = 0 to 4). Prime pictures and targets shared part of speech 67% of the time (both were nouns).

The control picture corresponded to only one name that had at least 95% agreement (e.g., pencil) and was neither phonologically nor semantically related to the target. The Francis and Kucera (1982) frequency of the controls' names (*M* = 22, *SD* = 44, range = 0 to 88, with 4 greater than 100) was similar to that of the prime pictures' dominant and secondary name, and the number of syllables of the control picture matched its corresponding prime picture's dominant name. While control pictures were intended as a baseline against which to measure the

effects of the prime pictures, filler pictures were included to disguise the relationship between the prime pictures and the target word. Instead of naming just the prime or control picture, participants named two filler pictures with either the prime or control picture, resulting in 158 filler pictures (two pictures per target). For each target word, one filler picture corresponded to one primary name with at least 90% agreement, e.g., *anchor*, and the other was a near-synonymous object corresponding to a dominant and secondary name, e.g., *sheep* (dominant)/*lamb* (secondary). The means for the dominant (79.7%) and secondary (43.9%) name productions of the near-synonymous filler pictures were the same as those of the prime pictures. The near-synonymous pictures were included as filler pictures to disguise the purpose of the prime pictures. Additionally, each filler picture had a different first-syllable phonology and first letter than its corresponding target, prime picture, control picture, and other filler picture. Targets, dominant and secondary names of prime picture, and names of control pictures are presented in Appendix A.

Design and Procedure

The experimental design was a single-factor design with Prime Condition (Prime Picture, Control Picture) as a within-participants factor. Upon arrival to the lab, participants received written and oral instructions that the purpose of the study was to examine TOT states. To disguise the relation between answering the questions and naming the pictures, participants were told that to give them a break between answering questions, they would complete a picture-naming task for a separate study investigating names associated with certain objects. Before beginning the experiment, the experimenter ensured that participants understood the definition of a TOT, a temporary state of inaccessibility to a known word, accompanied by a feeling of

knowing, by having them explain the meaning (see Appendix B for a detailed explanation of instructions given to participants).

To begin the study, participants viewed and named three pictures one at a time, two filler pictures and either a prime or control picture. The prime or control picture always appeared second, so the first and last picture that participants named were filler pictures. The computer generated the order so that participants received half prime and half control pictures in a randomized order. Participants then viewed a question and responded "Known", "Unknown", "TOT", or "None of the Above" by clicking on the button next to the appropriate response (see Figure 2-1 for an example of the order of tasks). A "Known" response was one in which participants knew and could provide the answer, whereas an "Unknown" response was one in which participants did not know the answer and would be unfamiliar with the word if told the answer. A "TOT" response was defined as knowing the answer but temporarily not having access to it, whereas a "None of the Above" response was described as knowing the answer but not being able to retrieve it on their own.

After a "Known" response, participants indicated the answer and proceeded to the next question. After a "TOT" response, participants were asked to indicate how many minutes would be needed to resolve their TOT, and they then proceeded to the next question. After an "Unknown" or "None of the Above" response, participants were asked if they could provide any partial information (e.g., number of syllables, first letter, and so forth) about the target, and then proceeded to the next question. This process continued until all 79 experimental questions had been answered.

After answering the last question, participants completed the stem-completion test for the questions for which they did not provide an answer. This test was intended to determine if

participants could retrieve the word when provided with letter cues. Each question was shown with the first letter of its target word. If participants knew the answer from the cue of the first letter, they provided the answer and proceeded to the next question. If they did not know the answer, they were shown both the first and second letter to the word and given a chance to type in the word. This process repeated until they typed in the word or were shown the maximum number of letters of the word allowed (ranging from one to four), which was determined by the number of letters overlapping between the prime and target's first syllable. For example, the first two letters of the target *biopsy* were the maximum number of letters participants could see because *biopsy* and its prime *bike* overlap in the first two phonemes and letters.

For the questions they did not answer on the stem-completion test, participants took a recognition test. Each question was shown with four possible answers: the target word, a word semantically related to the target word, a word phonologically related to the target word, and a word semantically and phonologically unrelated to the target word. Participants were asked to select the best answer.

Lastly, participants completed a post-experiment questionnaire that was intended to determine whether they recognized a phonological relation between the pictures and the target words, and if so, whether they intentionally used this association to determine the target word. Participants were then debriefed.

Results

The responses to the post-experiment questionnaire revealed that no participants recognized the intended relationship between the questions and prime pictures and thus did not consciously use the relationship to influence their responses to the questions and pictures, a finding consistent with previous TOT research (e.g., Abrams et al., in press). All analyses were

conducted by participants only (to get a mean for each participant rather than each item) because the stimulus items were not selected randomly, a condition that has been suggested to be inappropriate for item analyses (e.g., Cohen, 1976; Raaijmakers, Schrijnemakers, & Gremmen, 1999; Vitevitch & Sommers, 2003).

Response Types for Questions, Reported Minutes for TOT Resolution, and Picture Names

Of the initial responses to the questions, 35.7% were correct "Known" responses, 15.6% were incorrect "Known" responses, 10.3% were correct "TOT" responses, 1.9% were incorrect "TOT" responses, 25.3% were "Unknown" responses, and 11.1% were "None of the Above" responses. A correct "Known" response was when the answer given to the general knowledge question matched the target. A correct "TOT" response was one in which the participant correctly retrieved the target on the stem-completion test or chose the correct answer on the recognition test. After a "TOT" response, participants estimated that they could resolve the TOT within 10 minutes on 94.4% of the responses (M = 4.95 minutes, SD = 4.57, range = 1-40). Of the responses to the prime pictures, 76.7% produced the intended dominant name, 14.3% produced the intended secondary name, and 9.1% produced names other than the intended dominant and secondary names.

Stem-Completion Test

Because the stem-completion test determined if participants could retrieve the word when provided with letter cues, it examined the activation level of the target word for participants who were and were not having a TOT. To investigate the efficacy of the stem-completion test, for initial correct "TOT" responses, "Unknown" responses, and "None of the Above" responses, a repeated-measures ANOVA was conducted on mean percentage of targets correctly retrieved on the stem-completion test. The main effect of response type was significant, $F(2, 88) = 16.90$,

MSE = .04, $p < .001$, with more correct target retrievals following "TOT" responses (*M* = 66.13%) than either "Unknown" responses (*M* = 44.68%) or "None of the Above" responses (*M* = 44.44%), which did not differ ($p > .95$). Because of the nonsignificant difference between "Unknown" and "None of the Above" responses, we combined these responses into one category for subsequent analyses.

Mediated Priming

To test the hypothesis that mediated priming would influence TOT incidence, paired-samples t-tests with prime condition (Prime Picture, Control Picture) were conducted separately on the proportion of correct "Known" responses (i.e., proportion of targets correctly retrieved), correct "TOT" responses (i.e., proportion of correct TOT states), and "Unknown"/"None of the Above" responses. Only non-secondary name productions (i.e., dominant names as well as other name productions that did not overlap phonologically with the target) of the prime picture were included in the analyses, as those reflected mediated priming; the secondary name overlapped in first-syllable phonology and therefore would be a direct phonological prime for the target if produced. Means and standard deviations in percents are presented in Table 2-1. T-tests revealed significant effects of prime condition. There were more "Known" responses, $t(59) = 4.21$, *SE* = .03, $p < .001$, fewer "TOT" responses, $t(59) = -2.16$, *SE* = .01, $p < .04$, and marginally fewer "Unknown"/"None of the Above" responses, $t(59) = -1.68$, *SE* = .02, $p < .10$, following prime pictures than control pictures. Paired-samples t-tests were then conducted on the proportion of each response type following only dominant name productions to clarify whether including other phonologically-unrelated responses in analysis were contributing to the above results. These t-tests revealed similar results to those given above, with more "Known" responses, $t(59) = 4.37$, *SE* = .02, $p < .001$, marginally fewer "TOT" responses, $t(59) = -1.79$, *SE* = .01, $p < .08$, and

fewer "Unknown"/"None of the Above" responses, $t(59) = -2.07$, $SE = .02$, $p < .05$, following prime pictures.

Direct Priming

Because of its overlapping phonology with the target, production of the prime picture's secondary name was a direct prime of the target. Therefore, direct priming on TOT incidence was examined via paired-samples t-tests with prime condition (Prime Picture, Control Picture) that were conducted separately on the proportion of correct "Known" responses (i.e., proportion of targets correctly retrieved), correct "TOT" responses (i.e., proportion of correct TOT states), and "Unknown"/"None of the Above" responses. In this analysis, only secondary name productions of the prime picture were included in the analyses, as their first-syllable matched that of the target. Means and standard deviations in percents are presented in Table 2-2. Unlike the previous results on mediated priming, t-tests showed equivalent proportions of correct "Known" responses, $t < 1$, correct "TOT" responses, $t < 1$, and "Unknown"/"None of the Above" responses, $t < 1$, following production of the prime picture's secondary name versus the control picture.

Part of Speech

An analysis was conducted to determine if the observed mediated priming effects were dependent on the prime and target's part of speech, i.e., whether more priming occurred when primes and targets differed in part of speech than when they shared part of speech. Repeated-measures ANOVAs were conducted separately on percentage of correct "Known" responses, correct "TOT" responses, and "Unknown"/"None of the Above" responses, using Prime Part of Speech as a factor (phonologically-mediated prime and target were the same part of speech, phonologically-mediated prime and target were different parts of speech, and unrelated control

picture that was the same part of speech as the prime). Means and standard deviations in percents from the ANOVAs are presented in Table 2-3.

For "Known" responses, there was a significant effect of Prime Part of Speech, $F(2, 118) = 8.34$, $MSE = .02$, $p < .001$, with more "Known" responses following same part-of-speech primes and different part-of-speech primes than control pictures, ps < .03. There were also marginally more "Known" responses following different part-of-speech primes than same part-of-speech primes, $p < .10$. For "TOT" responses, the Prime Part of Speech effect was not significant, $F(2, 118) = 1.85$, $MSE = .01$, $p > .16$. Similarly, for "Unknown"/"None of the Above" responses, there was no effect of Prime Part of Speech, $F(2, 118) = 1.12$, $MSE = .01$, $p > .33$.

Discussion

As predicted, mediated priming influenced TOT incidence, demonstrated by more Known responses and fewer TOT responses following prime pictures relative to control pictures. Production of the prime picture's dominant name activated the first-syllable phonology of the upcoming target via mediated priming, allowing participants to retrieve the target more often than when the first-syllable phonology was not activated. Even though the activation strength of the phonology via mediated priming is thought to be weaker than that of direct priming (Dell & O'Seaghdha, 1991, 1992), the findings suggest that the activation is strong enough to strengthen the target's phonological connections, inducing it to be more accessible for production.

Despite finding mediated priming, we found no evidence for direct priming on incidence of TOT states, as production of the secondary name that overlapped phonologically with the target did not reduce TOT states or increase Known responses. These results are contradictory to previous findings that direct priming decreases TOT incidence (James & Burke, 2000), but the

current findings may not be a true assessment of direct priming's influence on TOT incidence because of the low percentage of secondary name productions (14.3%), which created a large amount of variability in participants' means and may have reduced the statistical power to detect an effect of direct priming.

The mediated priming effects on TOT incidence occurred independent of the overlap between the prime and target's parts of speech. Previous research has found that a direct prime's part of speech (i.e., whether it shares the same or has a different part of speech than the target) affects TOT resolution differently (Abrams & Rodriguez, 2005; Abrams et al., in press); different part-of-speech primes increase TOT resolution, whereas same part-of-speech primes have no effect. The current study also found effects due to the mediated prime's part of speech on TOT incidence, but both same- and different part-of-speech primes facilitated target retrieval by increasing "Known" responses, relative to control pictures, and different part-of-speech primes helped marginally more than same part-of-speech primes. While the different part-of-speech findings were predicted by the TDH, the facilitatory effect of same part-of-speech primes was not. The present study involved TOT incidence, whereas the previous studies on part of speech have only investigated their effects on TOT resolution, so perhaps TOT resolution is more sensitive to grammatical class than TOT incidence.

In sum, these findings demonstrated another process by which TOT states can be prevented from occurring in the first place. In addition to direct exposure to a phonologically-similar prime (James & Burke, 2000), TOT incidence may also be lowered via mediated priming, as the activation sent to related associates is strong enough to activate the node above threshold for production. Experiment 2 investigated mediated priming effects on TOT resolution. While TOT incidence and TOT resolution both involve strengthening the phonological

connections to the selected word for production, decreasing incidence requires strengthening prior to lemma selection, whereas increasing resolution requires strengthening after lemma selection. Determining if mediated priming can affect TOT incidence and resolution similar, similar to findings with direct priming (James & Burke, 2000), will provide further understanding of the processes involved in strengthening the phonological connections to both prevent and resolve TOT states.

Table 2-1. Initial responses (in %) following production of the prime pictures' non-secondary name and control pictures' name in Experiment 1

		Prime Condition			
	N	Prime Picture		Control Picture	
Initial Response		Mean	SD	Mean	SD
Known	60	42.21	19.23	31.66	15.35
TOT	60	8.75	7.55	11.73	9.03
Unknown/None of the Above	60	34.65	17.25	37.63	16.23

Table 2-2. Initial responses (in %) following production of the prime pictures' secondary name and control pictures' name in Experiment 1

		Prime Condition			
	N	Prime Picture		Control Picture	
Initial Response		Mean	SD	Mean	SD
Known	60	33.07	25.66	31.33	15.41
TOT	60	11.07	13.83	11.80	8.96
Unknown/None of the Above	60	38.80	25.13	37.65	16.15

Table 2-3. Initial responses (in %) following prime pictures that shared the part of speech (POS) with the target, prime pictures that differed in part of speech from the target, and control pictures in Experiment 1

		Prime Condition					
	N	Same POS Prime		Different POS Prime		Control	
Picture Initial Response		Mean	SD	Mean	SD	Mean	SD
Known	60	37.99	21.49	41.75	20.20	31.33	15.41
TOT	60	10.00	9.98	8.96	8.59	11.80	8.96
Unknown/None of the Above	60	35.27	17.83	35.07	18.11	37.65	16.15

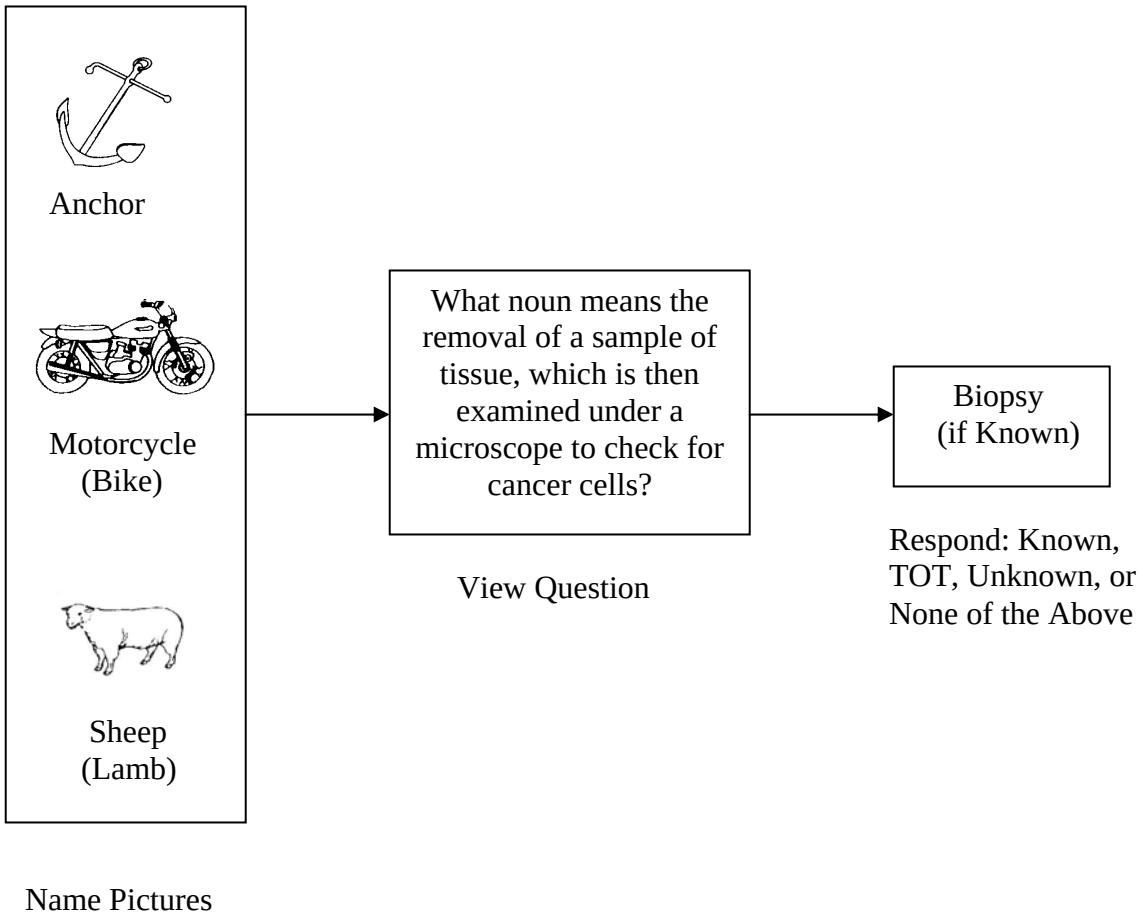

Figure 2-1. Order of tasks for Experiment 1. Participants named three pictures (two filler pictures and either a prime or control picture) and then answered a general knowledge question. The question was associated with a target word that was phonologically related to the secondary name of the prime picture. The target names of the pictures are below the corresponding picture. The secondary name of the prime picture is in parentheses.

CHAPTER 3
EXPERIMENT 2

Experiment 2 was designed to examine whether mediated priming influences TOT resolution, i.e., retrieval of targets following TOT states. Because mediated priming effectively influenced TOT incidence in Experiment 1, i.e., because the activation from the dominant name (e.g., *motorcycle*) to the secondary name (e.g., *bike*) was strong enough to activate the phonology for the target word to decrease TOT incidence, we expected the same strength of activation to facilitate TOT resolution. In addition to mediated priming, we also investigated differences in resolution following direct priming (production of the secondary name). Because direct priming has been shown to successfully facilitate TOT resolution (e.g., Abrams et al., 2003; Abrams et al., in press), we predicted greater resolution following direct priming relative to no priming, as the target receives more activation directly from a prime rather than indirectly (Dell & O'Seaghdha, 1991, 1992).

A secondary examination in this experiment was the ability of a TOT word to feed back activation to influence lemma selection; that is, can having a TOT induce participants to produce the secondary name of the picture, the phonologically-related name to the TOT word, more often than they would otherwise? We expected more secondary name productions when participants were in a TOT state (i.e., the target activates the secondary name's phonology via bottom-up processing) relative to when they did not know the answer (i.e., the target is not activated, so bottom-up processing cannot occur to activate secondary name's phonology).

Method

Participants

Participants included 60 young adults (41 females, 19 males), aged 18-25 (M = 18.92, SD = 1.13), recruited from introductory psychology courses and given partial course credit for

participation. All considered English to be their native language and did not participate in Experiment 1.

Materials

The same materials in Experiment 1 were used in Experiment 2.

Design and Procedure

The experimental design and procedure for Experiment 1 was used for Experiment 2, except for the order of the tasks. That is, participants named a picture *after* their response to the questions (see Figure 3-1 for example). Thus, participants viewed a question associated with a low-frequency word and responded "Known", "Unknown", "TOT", or "None of the Above". After a "Known" response, participants typed their response, named a control and two filler pictures, and proceeded to the next question. After a "TOT", "Unknown", or "None of the Above" response, participants named two filler pictures and either a prime or control picture, and then attempted to answer the same question before proceeding to the next question.

Results

Similar to Experiment 1, no participants indicated on the post-experiment questionnaire that they recognized the intended relationship between the questions and prime pictures or consciously used the relationship to influence their responses to the questions and pictures.

Response Types for Questions, Reported Minutes for TOT Resolution, and Picture Names

Of the initial responses to the questions, 36.8% were correct "Known" responses, 15.1% were incorrect "Known" responses, 11.1% were correct "TOT" responses, 1.9% were incorrect "TOT" responses, 24.9% were "Unknown" responses, and 10.3% were "None of the Above" responses. After a "TOT" response, participants estimated that they could resolve the TOT within 10 minutes on 91.8% of the responses (M = 5.43 minutes, SD = 6.57, range = 1-43). Of the

responses to the prime pictures, 70.7% were the intended dominant name, 20.9% were the intended secondary name, and 8.4% were names other than the intended dominant and secondary names.

Stem-Completion Test

Similar to Experiment 1, the stem-completion test examined the activation level of the target word for participants who were and were not having a TOT. For initial correct "TOT" responses, "Unknown" responses, and "None of the Above" responses, a repeated-measures ANOVA was conducted on mean percentage of correctly retrieved targets on the stem-completion test. Fourteen participants were excluded from this analysis because they did not have to take the stem-completion test at least once following each response type. The main effect of response type was significant, $F(2, 90) = 15.84$, $MSE = .02$, $p < .001$, with more correct target retrievals following "TOT" responses (66.21%) than "Unknown" (44.41%) and "None of the Above" (46.18%) responses, which did not differ from each other ($p > .66$). Because of the nonsignificant difference between "Unknown" and "None of the Above" responses, these responses were combined in subsequent analyses.

Mediated Priming

A 2 (Response Type: correct "TOT", "Unknown"/"None of the Above") x 2 (Prime Condition: Prime Picture, Control Picture) repeated-measures ANOVA was conducted on the proportion of targets correctly retrieved following the picture naming task. A correct "TOT" response was one in which the participant responded "TOT" when they first saw the question, and either 1) responded "Known" and provided the correct answer when viewing the question a second time; 2) provided the correct answer on the stem-completion test; 3) correctly identified the answer on the recognition test. This analysis included only non-secondary name productions

(dominant and other phonologically-unrelated responses), as those productions measure mediated priming, whereas secondary name productions assessed direct priming. Four participants were excluded from this analysis because they did not provide the non-secondary name of the prime picture at least in once in all of the conditions. The means and standard deviations from this analysis converted into percents are shown in Table 3-1.

The main effect of prime condition was significant, $F(1, 55) = 22.19$, $MSE = .12$, $p < .001$, showing more correct target retrievals following prime pictures than control pictures. The main effect of response type was also significant, $F(1, 55) = 50.03$, $MSE = .06$, $p < .001$, with greater resolution after correct "TOT" responses than after "Unknown"/"None of the Above" responses. These main effects were moderated by a significant Response Type x Prime Condition interaction, $F(1, 55) = 5.39$, $MSE = .04$, $p < .03$, shown in Figure 3-2. Follow-up tests on the Response Type x Prime Condition interaction revealed that significant priming occurred after initial correct "TOT" responses, $p < .001$, with more correct target retrievals following prime pictures than control pictures. There was also significant priming after initial "Unknown"/"None of the Above" responses, $p < .001$, but to a lesser extent. There was greater target retrieval following correct "TOT" responses than "Unknown"/"None of the Above" responses for both prime conditions, with a larger difference for the prime pictures, ps $< .001$.

To assess whether including other phonologically-unrelated responses in the above analyses contributed to the findings, a 2 (Response Type: correct "TOT", "Unknown"/"None of the Above") x 2 (Prime Condition: Prime Picture, Control Picture) repeated-measures ANOVA was conducted on target retrieval following dominant name productions only. Seven participants were excluded from the analysis because they did not have at least one intended dominant name

production in all of the conditions. The analysis revealed identical results to the previous analysis.

Direct Priming

A 2 (Response Type: correct "TOT", "Unknown"/"None of the Above") x 2 (Prime Condition: Secondary Name Production of Prime Picture, Control Picture) repeated-measures ANOVA was conducted on the proportion of targets correctly retrieved following the picture naming task. Thirty-three participants were excluded from this analysis because they did not provide the secondary name of the prime picture at least once following both response types. The means and standard deviations from this analysis converted into percents are shown in Table 3-2.

The main effect of prime condition was significant, $F(1, 26) = 24.58$, MSE = .23, $p < .001$, showing more correct target retrievals following secondary name productions of prime pictures than control pictures. The main effect of response type was also significant, $F(1, 26) = 16.09$, MSE = .07, $p < .001$, with greater resolution after correct "TOT" responses than after "Unknown"/"None of the Above" responses. These main effects were moderated by a marginally significant Response Type x Prime Condition interaction, $F(1, 26) = 2.98$, MSE = .04, $p < .10$. Follow-up tests on the Response Type x Prime Condition interaction revealed that significant priming occurred after initial correct "TOT" responses, $p < .001$, with more correct target retrievals following secondary name productions of prime pictures than control pictures. There was also significant priming after initial "Unknown"/"None of the Above" responses, $p < .001$, but to a lesser extent. There was greater target retrieval following correct "TOT" responses than "Unknown"/"None of the Above" responses for both prime conditions, with a larger difference for the prime pictures, $ps < .001$.

To compare whether there was greater priming of target retrieval following secondary versus non-secondary name production, a 2 (Response Type: correct "TOT", "Unknown"/"None of the Above") x 3 (Prime Condition: Secondary Name Production of Prime Picture, Non-Secondary Name Production of Prime Picture, Control Picture) was conducted on the proportion of targets correctly retrieved. Thirty-three participants were excluded from this analysis because they did not have at least one correct "TOT" response and one "Unknown"/"None of the Above" response in each of the prime conditions. The main effect of response type was significant, $F(1, 26) = 26.79$, $MSE = .07$, $p < .001$, with more correct target retrievals following correct "TOT" responses (44.6%) than "Unknown"/"None of the Above" (23.8%) responses. Additionally, the main effect of prime condition was significant, $F(2, 52) = 20.57$, $MSE = .14$, $p < .001$, where both secondary and non-secondary name production led to greater target retrieval than the control picture (8.2%), ps $< .001$, indicating significant priming for both types of names. However, more correct target retrievals occurred following secondary name production (52.4%) than non-secondary name production (42.1%), $p < .005$. The Response Type x Prime Condition interaction was not significant, $F(2, 52) = 1.62$, $MSE = .04$, $p > .20$.

Part of Speech

Potential part of speech effects on mediated priming were examined via a 2 (Response Type: Correct "TOT", "Unknown"/"None of the Above") x 3 (Prime Part of Speech: phonologically-mediated prime and target were the same part of speech, phonologically-mediated prime and target were different parts of speech, and unrelated control picture that was the same part of speech as the prime) repeated-measures ANOVA on target retrieval. Twenty participants were excluded from the analysis because they did not have at least one correct "TOT" response and "Unknown"/"None of the Above" response in each of the prime part-of-

speech categories. The means and standard deviations from this analysis converted into percents are shown in Table 3-3. The main effect of response type was significant, $F(1, 39) = 53.58$, $MSE = .07$, $p < .001$, showing more correct target retrievals following correct "TOT" than "Unknown"/"None of the Above" responses. The main effect of prime part of speech was also significant, $F(2, 78) = 16.01$, $MSE = .13$, $p < .001$, with greater resolution after same and different part-of-speech primes than control pictures, $p < .001$, but no difference in target retrieval between same and different part-of-speech primes, $p > .15$. The Response Type x Prime Part of Speech interaction, $F(2, 78) = 1.60$, $MSE = .05$, $p > .20$, was not significant.

Feedback

To examine if the TOT word can feed back to influence picture name production, a paired-samples t-test was conducted on percentage of secondary name productions following correct "TOT" responses and "Unknown"/"None of the Above" responses. There was no difference between secondary name productions after correct "TOT" responses ($M = 19.8\%$) and "Unknown"/"None of the Above" responses ($M = 20.2\%$), $t < 1$.

The feedback effect was also examined by comparing percentage of secondary name productions in Experiment 2 with those in Experiment 1 (where the picture was named first before viewing the questions, so there was no opportunity for feedback from the unretrieved target). Independent-samples t-tests were conducted on percentage of secondary name productions between the two experiments, separately for correct "TOT" responses and "Unknown"/"None of the Above" responses. Following "TOT" responses, there were more secondary name productions in Experiment 2 (19.8%) than in Experiment 1 (14.5%), $t(117) = -1.74$, $SE = .03$, $p < .001$. A similar pattern emerged for secondary name productions following

"Unknown/None of the Above" responses in Experiment 2 (20.2%) than Experiment 1(14.5%), $t(118) = -2.49$, $SE = .02$, $p < .001$.

Discussion

Mediated priming increased TOT resolution by strengthening the needed phonological connections for target retrieval, evidenced by greater target retrieval following production of the prime pictures' dominant name relative to production of control pictures. Even though the first-syllable phonology of the TOT word was only indirectly activated (i.e., production of the dominant name activated its semantic associate, the secondary name, which spread phonological activation to the TOT word), the activation strength was strong enough to strengthen the phonological connections for TOT resolution. Similar to TOT incidence, this mediated priming effect was independent of part of speech, as both same and different part-of-speech primes facilitated TOT resolution. The hypothesis that direct priming would influence TOT resolution was also supported, as production of prime pictures' secondary name increased TOT resolution relative to control pictures. In addition to replicating previous findings on the facilitation of TOT resolution via direct phonological priming (e.g., Abrams et al., 2003; Abrams et al., in press; James & Burke, 2000), the current study extends these findings by showing that direct priming is more effective for resolving TOTs than mediated priming.

In addition to TOT states, direct and mediated priming also unexpectedly facilitated target retrieval after "Unknown"/"None of the Above" responses, a contradictory finding from previous TOT research that has shown virtually no target retrieval following "Unknown" responses (Abrams & Rodriguez, 2005; Abrams et al., 2006; James & Burke, 2000). One methodological difference between previous studies and the current study is that we included participants' estimates of their TOT resolution time. Participants in both Experiment 1 and 2

estimated that they could resolve the majority of their TOT states (over 90% of them) within 10 minutes. One possibility is that asking participants to report the time to resolve their TOT may have caused them to be more conservative about classifying a state a TOT state. Therefore, they classified only strong TOT states, ones in which they could resolve within 10 minutes, as TOT states; weaker TOT states with a less sense of imminent retrieval may have instead been reported as "Unknown"/"None of the Above" responses. Benefiting from priming, the TOT states included in the Unknown/None of the Above category would cause the category to show priming effects. The results from mediated priming's influence on TOT incidence supports this explanation, as fewer "Unknown"/"None of the Above" responses occurred following prime than control pictures. If participants were in a true "unknown" state, there should be no change in these responses following priming. Furthermore, the results from the stem-completion test support this misclassification explanation, as targets were retrieved at a fairly high rate following "Unknown" (44.14%) and "None of the Above" (46.18%) responses, although not as high following "TOT" responses (66.21%); if participants had responded "Unknown" only when the target was truly unknown, the retrieval rate on the stem-completion test would be expected to be closer to 0%. Additionally, despite its priming effect, the mediated and direct priming effects for "Unknown"/"None of the Above" responses were smaller than those for "TOT" responses, which supports the misclassification theory. Because the activation strength of both the TOT state and the prime determines if the TOT is activated above threshold for production, weak TOT states will need more activation strength from primes to get resolved than strong TOT states. Therefore, because the TOT states in "Unknown"/"None of the Above" and "TOT" responses received the same primes, i.e., received the same activation, then the priming effect difference

between "TOT" and "Unknown"/"None of the Above" responses must be attributable to the activation strength of the TOT states.

The prediction that secondary name productions would be more prevalent when participants were in a TOT state than when in an "unknown" state, as the activated TOT word would feed back to activate the phonology of the secondary name enough for production, was not supported. Following correct "TOT" responses, participants were no more likely to produce the secondary name than after "Unknown"/"None of the Above" responses, suggesting that the bottom-up processing from TOT states was not strong enough to influence lemma selection. An alternative explanation is that the lack of secondary name productions follow “TOT” and "Unknown"/ "None of the Above" responses could be due to the picture naming task; that is, the secondary name could always be activated for retrieval, an activation that may be greater than what is experienced in the TOT state. Therefore, regardless of whether in a TOT state, participants may produce the secondary name merely because it is always activated with the dominant name. However, the comparison of secondary name productions in Experiment 1 and Experiment 2 does demonstrate the occurrence of a feedback effect. Because participants in Experiment 1 named the pictures before viewing the question, the feedback effect was not possible; thus, Experiment 1 served as a control group to which secondary name productions in Experiment 2 were compared. The feedback effect was possible in Experiment 2 because participants named the picture after viewing the question.

For both TOT and "Unknown"/"None of the Above" responses, participants were more likely to produce the secondary name in Experiment 2 than Experiment 1. In the cases in which participants produced the secondary name in Experiment 2, the activation to the secondary name was strong enough to exceed that of the dominant name, the most frequently produced name, to

become the most-primed-wins node and get produced. Because this effect also occurred when participants said they were in an "unknown" state, we cannot decisively conclude that the activated TOT lemma is responsible for the effect.

However, if participants misclassified their weaker TOTs as "unknown" states as suggested earlier, then the partial activation of TOT states that would occur in both TOT and Unknown/None of Above categories may be strong enough to transmit enough phonological activation to related lemmas for production. If this partial activation of TOTs explanation is correct, then the feedback effect should have been smaller for "Unknown"/"None of the Above" responses than "TOT" responses, similar to the smaller effects of direct and mediated priming on "Unknown"/"None of the Above" relative to "TOT" responses. The finding that the feedback effect was similar for both response types suggests that the phonological activation strength of weak TOTs was sufficient to influence lemma selection similar to that of strong TOTs. Thus, misclassified TOTs, i.e., weak TOTs, may influence TOT resolution and feedback differently: More phonological activation may be required for a word to emerge from a TOT state (TOT resolution) than for a word to exceed the activation of the more frequently-produced dominant name (feedback). Thus, the activation strength of TOTs seems more important in TOT resolution than feedback. In TOT resolution, the word became a TOT state because of weak phonological connections (Burke et al., 1991; MacKay, 1987). For the word to be retrieved from its TOT state, the phonological activation had to exceed threshold. Because of their greater activation strength, strong TOTs needed less activation from the primes than weak TOTs; thus, TOT resolution occurred more for strong than weak TOTs. In the feedback instances, the common, familiar secondary name was different from the TOT word because their phonological connections were strong enough to not become a TOT state. Therefore, the secondary name was activated enough

when participants viewed the picture to only need a small amount of additional phonological activation from the TOT lemma to become the most-primed-wins node over the dominant name, meaning that the phonological activation from the weak TOT may be sufficient for the name to be produced (strong TOTs just provide extra activation that is not needed). In turn, TOTs may influence the lexical system sometimes better than they can be influenced.

In sum, similar to its influence on TOT incidence, mediated priming facilitated TOT resolution by indirectly activating the first-syllable phonology of the TOT word above threshold for production. These findings demonstrate that even though the activation strength sent to target words via mediated priming is weaker than that of direct priming (Dell & O'Seaghdha 1991, 1992), it is sufficient to influence TOT states. Thus, comparable to direct priming (e.g., Abrams et al., in press; James & Burke, 2000), mediated priming is an effective priming method by which spontaneous TOTs may be resolved. Collectively, these studies demonstrate that mediated priming can benefit TOT states by decreasing incidence and increasing resolution.

Table 3-1. Target retrieval (in %) following production of the prime pictures' non-secondary name and control pictures' name in Experiment 2

		Prime Condition			
	N	Prime Picture		Control Picture	
Initial Response		Mean	SD	Mean	SD
TOT	56	46.63	40.39	18.64	28.76
Unknown/None of the Above	56	18.36	27.87	2.37	5.10

Table 3-2. Target retrieval (in %) following production of the prime pictures' secondary name and control pictures' name in Experiment 2

		Prime Condition			
	N	Prime Picture		Control Picture	
Initial Response		Mean	SD	Mean	SD
TOT	27	65.93	45.60	14.82	24.02
Unknown/None of the Above	27	38.91	44.07	1.57	3.72

Table 3-3. Target retrieval (in %) following prime pictures that shared the part of speech (POS) with the target, prime pictures that differed in part of speech from the target, and control pictures in Experiment 2

		Prime Condition					
	N	Same POS Prime		Different POS Prime		Control	
Picture Initial Response		Mean	SD	Mean	SD	Mean	SD
TOT	40	55.38	40.71	50.05	45.43	19.85	29.24
Unknown/None of the Above	40	26.50	36.12	21.21	34.43	1.88	4.11

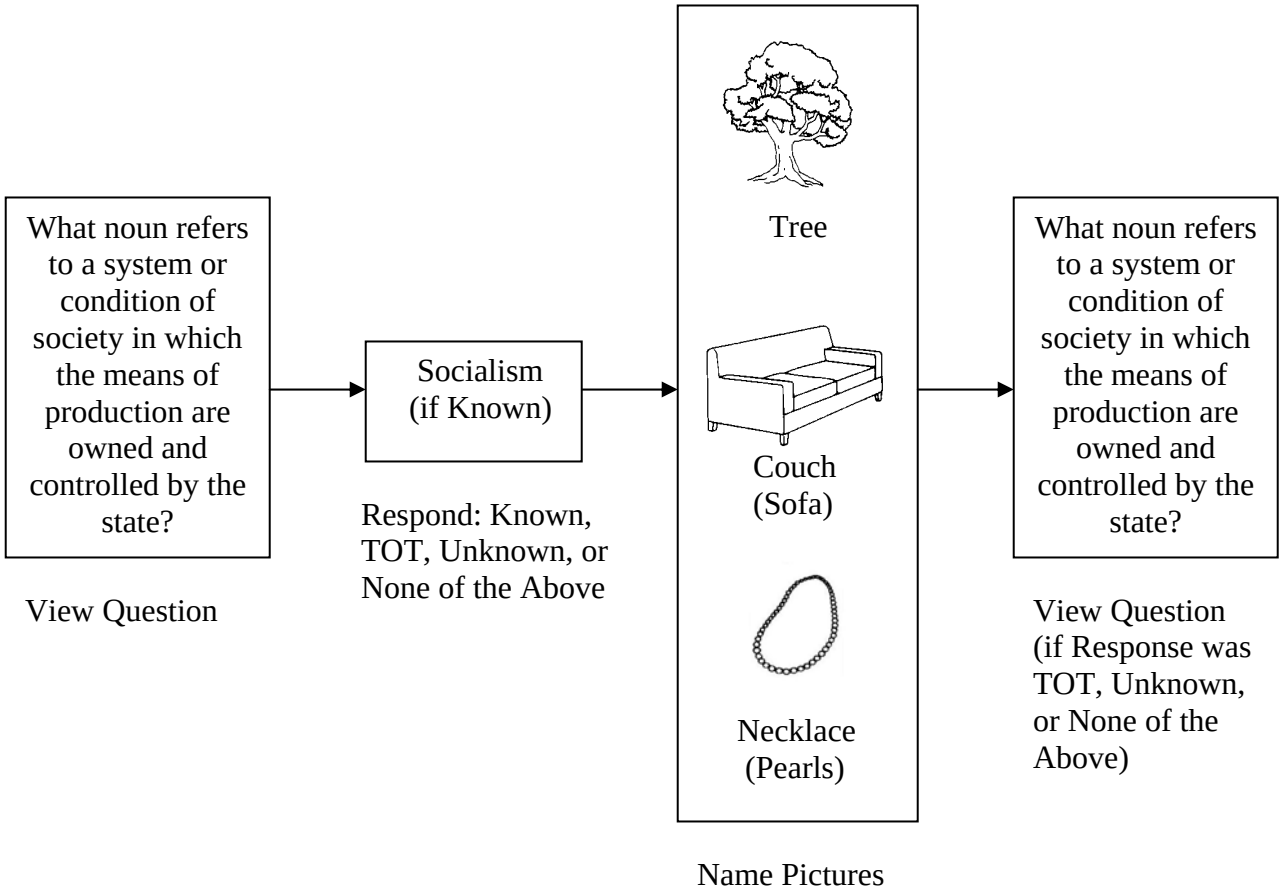

Figure 3-1. Order of tasks for Experiment 2. Participants viewed a question, provided their response, and then named three pictures (two filler pictures and either a prime or control picture). The question was associated with a target word that was phonologically related to the secondary name of the prime picture. The target names of the pictures are below the corresponding picture. The secondary name of the prime picture is in parentheses.

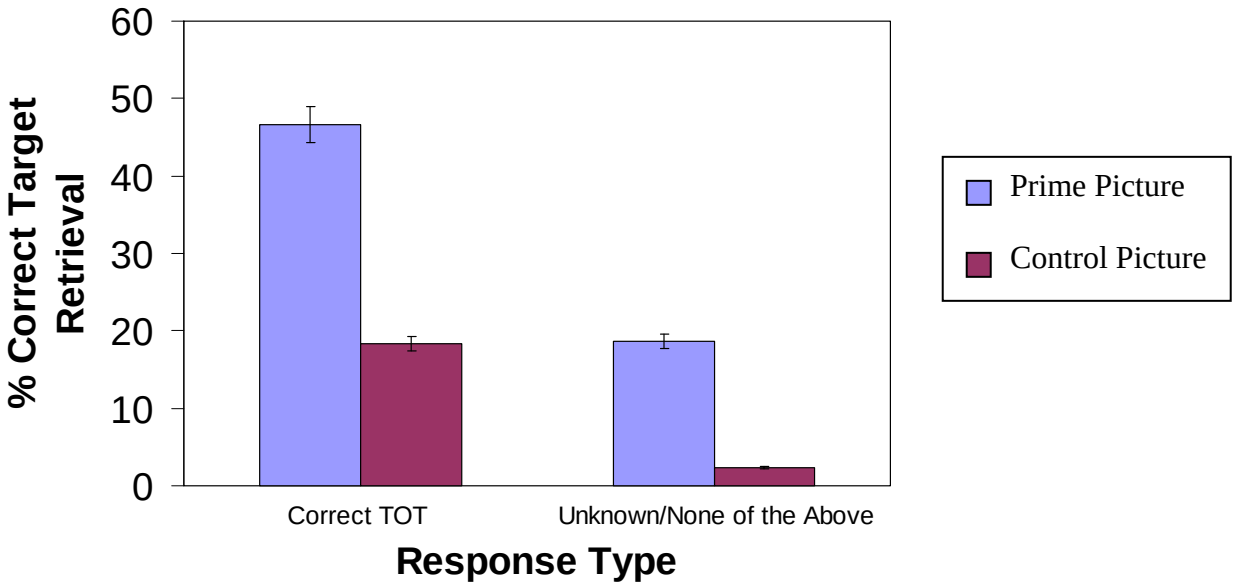

Figure 3-2. Percent correct target retrieval following prime and control pictures for "TOT" and "Unknown"/"None of the Above" responses in Experiment 2.

CHAPTER 4
GENERAL DISCUSSION

Analogous to Peterson and Savoy's (1998) demonstration of effective mediated priming in word *recognition*, the current study extended this phenomenon to word *retrieval* in relation to TOT states. These results coincide with previous TOT evidence that support interactive activation models of language production (Dell, 1986; MacKay, 1987; Stemberger, 1985), thereby supporting Dell et al.'s (1997) hypothesis that interactive activation is beneficial for fluent discourse. Because the phonological activation can occur before the selection of a lemma (i.e., the most activated lemma to be selected as the most-primed-wins node), discourse is more fluent as the nodes can be prepared for production via priming. In the case of TOT incidence, the lemma needed for production can receive phonological activation via mediated priming before lemma selection, thereby decreasing the incidence of TOT states. If the lemma does not receive sufficient activation prior to selection, it can nevertheless receive additional priming after selection, even if the individual is exposed to the phonology only indirectly. Therefore, mediated priming in TOT states furthers the notion that bottom-up processing is an important part of the lexical system, a process that is not predicted by discrete theories (Levelt, 1989).

In addition to interactive activation models, the findings that mediated priming influences TOT states supports the recency hypothesis of the TDH (Burke, et al., 2000; Burke et al., 1991; MacKay & Burke, 1990). Because the target's phonological connections were recently strengthened via the indirect activation of the phonologically-related secondary name, mediated priming decreased TOT incidence and increased TOT resolution, similar to the process thought to underlie direct priming from phonologically-related words (James & Burke, 2000). In conclusion, mediated priming has parallel effects on TOT incidence and resolution, as the same processes to strengthen phonological connections help to reduce as well as resolve TOT states.

Replicating previous TOT research (Abrams & Rodriguez, 2005; Abrams et al., in press; Abrams et al., 2003), the current study found that direct phonological priming of the TOT word's first syllable facilitated TOT resolution. A new contribution to the understanding of TOT states is that direct priming is more effective in resolution than mediated priming, as was predicted by Dell and O'Seaghdha (1991, 1992). Naming the picture's secondary name provided more activation to the phonological connections, thereby providing a greater chance of TOT resolution, because the phonology was a direct recipient of the activation. In mediated priming, the phonology is an indirect recipient that received a proportion of the original activation; thus, the probability of the TOT state receiving enough activation for production decreased.

Although not explicitly manipulated, the current study found part-of-speech to affect mediated priming of TOT incidence and resolution similarly, where both different and same part-of-speech primes decreased TOT incidence (measured by an increase in "Known" responses) and increased TOT resolution. However, while different part-of-speech primes decreased TOT incidence more than same part-of-speech primes, there was no difference in TOT resolution following same and different part-of-speech primes. These findings contrast with Abrams and Rodriguez (2005) and Abrams et al. (in press), who found that primes of a different part-of-speech from the TOT word facilitated resolution, whereas primes of the same part-of-speech resolution did not increase target retrieval. The similar, facilitatory effects of same and different part-of-speech primes on TOT states in the present study may be attributable to the frequency of the secondary names of the primes (i.e., frequency of picture name productions given as the second response on the pilot picture naming task; $M = 38.80$), which was lower than those in Abrams et al. (2006; $M = 63.01$). Frequency of same part-of-speech primes has been shown to negatively correlate with TOT resolution (Abrams & Rodriguez, 2005). Therefore, the primes

may have been too low in frequency to serve as potential competitors with the target for retrieval, which is necessary to delay retrieval as explained by the "most primed wins" principle of the Node Structure Theory (MacKay, 1987). The activation of a node in the same syntactic class as the target word should not help retrieval because the activated prime would be the most-primed-wins node for that class. However, not being activated as much as higher-frequency primes, low-frequency primes are activated enough to provide phonological activation to the target word but not compete to be the most-primed-wins node. Furthermore, as Dell and O'Seaghdha (1991, 1992) explained, mediated primes are activated less and, thus, send less activation to the target than direct primes because they receive only a proportion of the original activation from their activated associate. Because they do not have enough activation to be activated above threshold for production, mediated primes may not be as strong of a competitor in their grammatical class to be the most-primed-wins node as direct primes. Therefore, a target word in the same grammatical class can receive phonological activation from the mediated prime but not have to compete with the partially-activated prime.

The feedback effect was demonstrated through TOT states, as the partially-activated words influenced lemma selection. Additionally, if participants misclassified their weak TOT states in the Unknown/None of the Above category, the results reveal that weak TOT states may have the same influence on the lexical systems as strong TOT states, which the further support the interactive activation theories, as bottom-up processing was required for the activated phonology to influence lemma selection. Additionally, these findings further our understanding of TOT states and their role in the lexical system. However, further investigations are necessary to clarify the relationship between the TOT state and the feedback effect. Instead of measuring the feedback effect by secondary name productions of near-synonymous pictures, future research

could investigate picture naming times following TOT and unknown states. If TOT states can uniquely feed back to prime lemmas, then participants should name the pictures faster following TOT states than unknown states. To specifically to determine if weak TOT states can influence lemma selection similarly to strong TOT states, future research could similarly investigate picture naming times but distinguish between weak and strong TOTs based on feeling-of-knowing judgments. If the TOT state does influence lemma selection, the finding will not only demonstrate the activation strength of TOT states but also their role in the lexical selection (i.e., similar to the way in which they receive phonological priming, they can provide phonological priming to related lemmas). Additionally, the feedback effect could be used understand the duration of TOT states: Can the feedback effect occur for TOT states that have been unresolved for 20 minutes similar to those that have been unresolved for 5 minutes? Theoretically, the sooner the TOT onset to lemma selection of another word, the most activation the TOT word and, thus, greater influence it will have on the lexical system.

Whereas this experiment investigated the TDH's recency hypothesis, future research might investigate the TDH's aging hypothesis by examining age-related influences of mediated priming on TOT states. Because aging weakens phonological connections (e.g., MacKay & Burke, 1990), node priming diminishes with age. In mediated priming, the TOT state being activated above threshold for production relies on a function of the activation of distant associates and the strength of the phonological connections. Thus, if one of these variables is weak, as the latter one is in aging, then mediated priming cannot activate the TOT word above threshold, which may be seen in older adults, particularly old-old adults. These results may have several informative outcomes. First, they would coincide with previous evidence demonstrating age-related changes in direct phonological priming of TOT resolution (Abrams et al., in press;

White & Abrams, 2002) and offer support for the TDH's aging hypothesis. Second, the results would help explain why older adults experience more TOT states than younger adults: Younger adults benefit from both direct and mediated priming to decrease TOT incidence, whereas older adults may only benefit from direct priming. Third, they would demonstrate that mediated priming may not be an effective method for investigating cognitive processes in older adults.

The previously discussed possibility of the misclassification of weak TOT states is an evident limitation to the current study. Although the results demonstrate that mediated priming is an effective priming strategy, we cannot decisively conclude that the feedback effect is due to TOT states. Additionally, while we attempted to include clear near-synonymous pictures, i.e., ones that have a clear dominant and secondary name that mean the same thing, we had to resort to using some that were more of semantic associates than near-synonyms (e.g., *world* and *globe*) to increase the stimuli size. However, near-synonyms and semantic associates may differ lexically, which could affect their role in mediated priming. For example, *mailman* and *postman* are clear near-synonyms, they can be appropriately used interchangeably and have the exact same definitions. Therefore, when either the definition or picture of *mailman*/*postman* is presented, theoretically the node representing the definition should send equal activation to both *mailman* and *postman*. Receiving equal activation as it near-synonym, the node that had the most activation prior to the definition or picture being presented, e.g., *mailman*, is the one that is selected for production. However, being the secondary name, the other node, e.g., *postman*, can still influence the lexical system, as it is partially activated. Conversely, the node representing the definition or picture of a *globe* should only send activation to *globe*, as it is the only term that accurately fits the definition or describes the picture. Because they are semantic associates, *globe* can then send activation to *world*; however, because *world* did not receive its activation from the

original source, i.e., the picture of the globe, *globe* will have more activation strength than *world.* Therefore, *postman,* the secondary name in the near-synonym example, should theoretically have more activation to influence lemmas than *world,* the secondary name in the semantic associate example. Understanding the potential difference of near-synonyms and semantic associates will further the theoretical understanding of lemma interaction in the lexical system.

The influence of mediated priming of TOTs is an intriguing phenomenon, as individuals are seemingly unaware of phonological similarity of the primes and the TOT words. These findings offer another means of understanding spontaneous TOT incidence and resolution. In addition to James and Burke's (2000) explanation that spontaneous TOT resolution may occur when the individual hears or sees a word phonologically related to the TOT word, spontaneous TOT resolution may occur via mediated priming. That is, the individual may hear or see a word that semantically activates a word phonologically related to the TOT word. When actively attempting to resolve the TOT state, individuals tend to think of same part of speech alternatives (Burke et al., 1991), which may actually hinder the resolution incidence (Abrams et al., in press, Abrams & Rodriguez, 2005). Thus, a beneficial method to induce resolution may merely be to not actively pursue TOT resolution, as it may be achieved via mediated priming. In everyday life, this phenomenon may simply mean that the individual disregards the TOT state, allowing for inadvertent exposure to the TOT word's first syllable phonology, whether via direct or mediated priming, may induce "spontaneous" TOT resolution. Given the high number of spontaneous resolutions in everyday life, it seems likely that mediated priming is responsible: Mediated priming provides individuals with more opportunities for resolution than would be expected if only direct priming influences TOT states.

APPENDIX A
TARGETS, DOMINANT NAMES OF PRIME PICTURES, SECONDARY NAMES OF PRIME PICTURES, AND UNRELATED CONTROL PICTURES

Target	Dominant Name of Prime Picture	Secondary Name of Prime Picture	Unrelated Control Picture
acquit	fish tank	aquarium	compass
aorta	gorilla	ape	tomato
badminton	scale	balance	dice
bailiff	bikini	bathing suit	lawn mower
ballad	purse	bag	heart
biopsy	motorcycle	bike	helicopter
bistro	mixer	beaters	elbow
boa	canoe	boat	pretzel
bogey	raft	boat	disk
bookworm	hedges	bushes	rainbow
bootee	stereo	boombox	cheerleader
botanist	chest	box	grapes
bunion	rabbit	bunny	eyebrow
cadaver	tape	cassette	door
calamine	money	cash	football
caviar	hat	cap	star
cherub	recliner	chair	typewriter
chives	baby	child	tiger
chronic	alligator	crocodile	rhinoceros
chute	boot	shoe	cat
compost	policeman	cop	swing
covet	cabinet	cupboard	trophy
dagger	ballerina	dancer	trampoline
discharge	plates	dishes	train
dungeon	weights	dumbbells	calendar
eligible	moose	elk	sun
fluoride	tile	floor	ball
garland	trashcan	garbage can	penguin
genealogy	pants	jeans	well
gingko	present	gift	handcuffs
gloat	world	globe	house
hemorrhage	chicken	hen	puzzle
hostel	pig	hog	rain
jester	airplane	jet	mushroom
justice	pitcher	jug	angel
kaleidoscope	mug	cup	lock
kosher	jacket	coat	pumpkin
liable	lamp	light	slide

liquidate	branch	limb	kite
lotus	bread	loaf	tank
lumberjack	suitcase	luggage	arrow
lynch	chain	links	hinge
mallet	rat	mouse	pipe
metronome	ruler	measuring stick	spider
misogynist	glove	mitt	fan
mount	lips	mouth	queen
mutiny	donkey	mule	cactus
nocturnal	book	novel	hamburger
nomad	binder	notebook	mermaid
papyrus	nightgown	pajamas	flower
pasteurize	pot	pan	snail
patriarchal	bucket	pail	camera
patronize	glue	paste	wrench
pawn	toilet	potty	skateboard
photosynthesis	pictures	photographs	balloon
pivot	needle	pin	hammer
potpourri	mailman	postman	horseshoe
ritual	bow	ribbon	squirrel
salvage	flip-flops	sandals	castle
satire	sub	sandwich	clock
saturate	bags	sacks	cake
sherbet	blouse	shirt	tree
socialism	couch	sofa	key
spay	rocket	spaceship	basket
spectrum	glasses	spectacles	feather
spritz	runner	sprinter	peacock
stock	traffic light	stop light	paperclip
stoic	rock	stone	cross
streamline	road	street	microscope
strobe	carriage	stroller	yo-yo
stutter	abdomen	stomach	violin
taxidermy	license plate	tag	skunk
tenor	teepee	tent	band-aid
toga	frog	toad	sewing machine
torpedo	turtle	tortoise	piñata
turban	record player	turntable	fire hydrant
typhoon	wheel	tire	harp
veto	car	vehicle	leaf
warden	cane	walking stick	roller coaster

APPENDIX B
EXPERIMENT INSTRUCTIONS

Upon arrival to the lab, participants read instructions indicating that the purpose of the experiment was to study tip-of-the-tongue (TOT) states. Participants read the following description to understand a TOT state:

> A TOT occurs when you are unable to retrieve a word that you are certain you know. When experiencing a TOT, you may know the word's definition, you know how you want to use it in a sentence, and sometimes you can say what letter it starts with or what it sounds like. A TOT state is different from just feeling like you "should" know the word; in a TOT state, you may have the feeling that the word is just beyond your reach, or you may feel a sense of frustration because of your inability to recall it. If you are uncertain what a TOT state is, please ask the experimenter to describe it more fully now.

After reading the instructions, all participants indicated that they understood a TOT state, but the experimenter reiterated the definition provided in the instructions.

The instructions stated that we would study TOT states by having participants complete two tasks. The first task would be answering definition-like, general knowledge questions that ask participants to produce the word that best fits the definition. After viewing the question, they are to respond in one of four ways: a) "Known" if they know and can provide the answer; b) "Unknown" if they do not know the answer and would not know it if someone told them; c) "TOT" if they know the word, but just cannot seem to access it at that moment, though possibly feeling as though it is "right there"; d) "None of the Above" if they know the word but are not in a TOT state for it; that is, they do not have that feeling that it is "right there", but if someone told them the word, they would know it. Participants read that they should give their response promptly after reading the question, and that the questions were intended to be difficult so to not worry if they do not know all of the answers.

The instructions described the second task as an unrelated task that involves naming pictures of objects to give them a break from answering the questions. Participants read that we

were collecting data for another study on names of common objects, so they would see various pictures. They were instructed to type the first name that comes to mind for the object when they see a picture. Additionally, they read that because we are interested in their first impression, there is no right or wrong answer, to feel free to give multiple words to name the picture if that is what comes to mind, and to not worry about the spelling. Lastly, they were informed that all pictures were nouns.

After participants read the instructions, the experimenter ensured that participants understood the procedure by reiterating the nature of the two tasks and the response options to the questions. When the experimenter felt assured that participants understood the procedure, participants were allowed to begin the experiment.

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BIOGRAPHICAL SKETCH

Lisa Merrill was born in Monroe, North Carolina. After graduating from Forest Hills High School, she attended Furman University where she earned her Bachelor of Arts in psychology. Later that same year, she began conducting research with Dr. Lise Abrams at University of Florida and will earn her Master of Science in psychology in 2007.