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Do Age-Related Increases in Tip-of-the-Tongue Experiences Signify Episodic Memory Impairments?

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Abstract

Tip-of-the-tongue experiences (TOTs), in which a name is known but cannot be immediately retrieved from memory, can be a cause of concern if these experiences are viewed as a sign of memory decline. The current study was conducted to investigate the relation between age and TOT frequency, and the influence of episodic memory, which is the type of memory most often assessed to detect memory problems, on that relation. In a sample of adults, increased age was found to be associated with more TOTs across different types of materials, and additional analyses suggested that these relations between age and TOT frequency were not attributable to the use of different response criteria or to different amounts of knowledge. Because statistical control of a measure of episodic memory had little effect on the relation between age and TOT frequency, age-related increases in TOTs and age-related decreases in episodic memory appear to be at least partially independent phenomena.

Keywords

tip of the tongue, knowledge, memory, aging, cognitive ability

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Increased age has been reported to be associated with more frequent tip-of-the-tongue experiences (TOTs), in which there is a strong feeling that a target item is known but cannot be retrieved from memory at the current time (e.g., Burke, MacKay, Worthley, & Wade, 1991; Cohen & Faulkner, 1986; Evrard, 2002; Heine, Ober, & Shenaut, 1999; James, 2006; Rastle & Burke, 1996; Shafto, Burke, Stamatakis, Tam, & Tyler, 2007; for a recent review, see Brown, 2012). TOTs can be embarrassing to people of all ages, but among older adults they may also be interpreted as a sign of impending memory decline. In fact, Sunderland, Watts, Baddeley, and Harris (1986) found that TOTs were the most frequently reported memory problem among healthy adults between 64 and 75 years of age, and other researchers have also noted that difficulty in remembering names is often mentioned as an age-related memory problem (e.g., Cohen & Faulkner, 1986; Lovelace & Twohig, 1990).

Because the primary tests used to assess memory problems are tests of episodic memory, a key question in the current study was whether age-related increases in TOTs are a manifestation of episodic memory decline. This question was investigated by examining the relation between TOT frequency and a composite measure of episodic memory at different ages, and by comparing the relation between age and TOT frequency before and after controlling for individual differences in the composite measure of episodic memory. If age-related memory declines contribute to age-related increases in TOT frequency, then (a) the relation between memory and TOT frequency might be stronger at older ages if TOTs become more dependent on memory level with increased age, and (b) substantial attenuation of the age-TOT relation would be expected when people of different ages are statistically equated with respect to their memory level.

Although these predictions seem straightforward, several issues regarding TOTs need to be considered before

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examining the influence of memory on the relation between age and TOT frequency. First, although TOTs have been reported with different types of stimuli, it is not yet clear whether the same people who experience TOTs with certain material, such as pictures of faces of politicians, also experience TOTs with other material, such as written descriptions of famous places. That is, susceptibility to TOTs may not be a general characteristic of individuals, but instead could reflect problems certain people have with particular types of stimuli. Therefore, in this study, we investigated the degree to which the TOT phenomenon reflects a unitary dimension of individual differences by examining interrelations of TOT frequency across different types of stimulus materials (involving verbal definitions, verbal descriptions of people and places, and faces of politicians and celebrities) within the same individuals.

Second, because TOTs are measured by self-reports, the TOT category may not have the same meaning at all ages if people of different ages differ in the ability to discriminate among internal states or differ in the criteria used to identify a TOT (cf. Cohen & Faulkner, 1986). We investigated discriminability by including multiple-choice recognition items within TOT tasks. For each question on the TOT tasks, participants reported whether they knew the answer, did not know it, or were experiencing a TOT state; they were then given a recognition test for that item. We compared participants' recognition accuracy for items that elicited a TOT with their accuracy for items reported as known and items reported as not known. "Know," "TOT," and "don't know" responses can be postulated to be based on different distributions along an accuracy continuum, such that the relative placement of criteria along this continuum can be inferred by differences in the average accuracy for items that elicited these three types of responses. For example, individuals with a smaller difference in accuracy between "TOT" and "don't know" items may have a greater tendency to report items that are not known as eliciting a TOT, whereas a smaller difference in accuracy between "know" and "TOT" items might correspond to a greater tendency to report known items as eliciting a TOT. Following this logic, possible age differences in response criteria can be investigated by examining the relation between age and accuracy differences across the three response categories.

Finally, increased age is often associated with higher levels of knowledge (Ackerman, 2008). Because an individual with greater knowledge has more opportunities to fail to retrieve stored information, age-related increases in TOTs could be due to these age-related increases in knowledge. The relationship between knowledge and TOTs has been examined in past studies, but possibly because different types of knowledge have been assessed with different methods of analysis in relatively small samples, the results have been mixed (e.g., Cross & Burke, 2004; Dahlgren, 1998; Gollan & Brown, 2006; Juncos-Rabadan, Facal, Rodriguez, & Pereiro, 2010). Two different methods were used to investigate the relations between knowledge and TOTs in the current study. Because accuracy in the multiple-choice recognition test can be considered a measure of relevant knowledge, one method consisted of dividing the number of TOT responses for each individual by his or her number of correct responses on the recognition test and examining the relation between age and these ratios. A second method involved examining the relation between age and TOTs after statistically controlling for scores on the multiple-choice recognition test and after statistically controlling for a measure of more general knowledge (i.e., the average score across several vocabulary tests). If the age-TOT relation is attributable to age-related increases in knowledge, this relation should be substantially reduced, or possibly even eliminated, when it is assessed using these methods.

These analyses required moderately large samples of adults across a wide age range, with sensitive measures of memory and vocabulary from each participant. These requirements were satisfied by adding TOT tasks to the 2012 data collection in the Virginia Cognitive Aging Project (VCAP), which is an ongoing study involving the administration of an extensive battery of cognitive tests to moderately large samples of adults between 18 and 99 years of age (Salthouse, 2009).

Method

Participants

Participants in VCAP performed a battery of 16 cognitive tests assessing five cognitive abilities in each of three sessions. A TOT task was administered at the end of each session; thus, if a participant did not complete the other tests in less than 2 hr, he or she was not presented with the TOT task. Three different TOT tasks were administered: In Session 1, the stimuli were definitions; in Session 2, the stimuli were written descriptions; and in Session 3, the stimuli were faces. TOT data were available from 451 participants for the definitions task, 423 participants for the descriptions task, and 673 participants for the faces task. A total of 290 participants performed all three TOT tasks, 297 performed only the definitions and descriptions tasks, 406 performed only the descriptions and faces tasks, and 416 performed only the definitions and faces tasks. The numbers of participants who performed only one task were 28 for definitions, 10 for descriptions, and 141 for faces.

The sample with data from at least one of the three TOT tasks consisted of 718 adults ranging from 18 to 99

years of age (mean age = 55.9, *SD* = 15.8); 67% were females and 33% males. Each age decade was represented by between 32 and 208 participants, and the concentration of participants was greatest for the 50s and 60s. The average number of years of education was 16.1, and greater age was associated with more years of education ($r = .20$, $p < .01$). The mean scaled scores on four standardized tests from the Wechsler Adult Intelligence Scale—Third Edition (Wechsler, 1997a) and Wechsler Memory Scale—Third Edition (Wechsler, 1997b) were 12.9 for Vocabulary and 12.5 each for Digit Symbol, Logical Memory, and Word Recall. Because scaled scores on these tests have means of 10 and standard deviations of 3 in the nationally representative normative sample, the participants in the current sample performed between 0.8 and 1 standard deviation above the normative sample. Correlations between the scaled scores and age ranged from .04 to .12 (with only the .12 correlation for Vocabulary significant at $p < .01$), indicating that the older participants in the sample were functioning at slightly higher levels relative to their age peers than the younger participants were.

TOT materials

For the TOT tasks, definitions of nouns and verbs, written descriptions of people and places, and pictures of faces of politicians and celebrities were displayed on a computer monitor, and participants were asked to provide the names of the target items. The tasks were self-paced, and therefore each eliciting stimulus display could be viewed as long as desired. Participants were instructed that after attempting to provide a target name, they should respond "know" if they knew the target name and "don't know" if they did not know the target name. If they were not able to produce the name but felt that they knew it, they were to report being in the "TOT" state. Each response was followed by a four-alternative multiple-choice recognition test. A TOT was scored for an item if the participant both reported a TOT and selected the correct alternative in the multiple-choice test.

Written definitions. In the first TOT task, the stimuli were written definitions of 40 nouns and 10 verbs (obtained from a list of items in Abrams, Trunk, & Margolin, 2007). The item with the highest "TOT" rate (i.e., 40%) was "What is the name of the building where one can view projected images of celestial bodies on the inner surface of a dome?"

Because accuracy for the definition items had a wide range in the multiple-choice recognition test, and because Gollan and Brown (2006) found different patterns of results for easy and difficult items, the definition items were divided into easy and hard sets on the basis of a median split. Three items were omitted from subsequent analyses because accuracy for those items on the multiple-choice recognition test was below chance, likely because of the presence of plausible alternatives among the response options.

Written descriptions. The second TOT task used written descriptions of 25 people and 25 places (many obtained from a list in Burke et al., 1991). In contrast to the targets in the definitions task, which primarily were common nouns, the targets in this task were all proper nouns. The items with the highest "TOT" rates were "What is the name of the author of the Dr. Seuss children's books?" (48%) and "What is the name of the large waterfall in Zambia that is one of the Seven Wonders of the World?" (27%).

Pictures of faces. The final TOT task involved pictures of faces of 25 politicians and 25 celebrities obtained from the Internet. The two types of stimuli may have been differentially familiar to people of different ages as the average birth year for the politicians was 1938, whereas that for the celebrities was 1957. The items with the highest "TOT" rates were pictures of Joe Lieberman (43%) and of Ben Stiller (54%). One picture of a politician was excluded from subsequent analyses because the correct alternative was inadvertently omitted from the recognition test.

Other tests

Episodic memory was assessed by tests of word recall, paired associates, and logical memory, and vocabulary was assessed by a provide-the-definition test, a picture vocabulary test, and multiple-choice tests of synonym vocabulary and antonym vocabulary. Details about the tests, including their sources, reliabilities, and validities, are available in other reports (i.e., Salthouse, 2009; Salthouse, Pink, & Tucker-Drob, 2008). Scores on these tests were converted into *z*-score units; the *z* scores for the three memory tests were averaged to form a composite memory variable, and the *z* scores for the four vocabulary tests were averaged to form a composite vocabulary variable. The correlation between age and the composite memory variable was –.28, and the correlation between age and the composite vocabulary variable was .31.

Results

Table 1 presents the mean number of "know," "don't know," and "TOT" responses (regardless of subsequent multiple-choice recognition accuracy) for each TOT task, along with the correlations between "TOT" response frequency and age. Between 17% and 30% of the items within each stimulus type elicited a "TOT" response. Age

Table 1. Results From the Tip-of-the-Tongue (TOT) Tasks: Mean Number of Responses in Each Response Category and Correlations With Age

	"Know" responses		"TOT" responses		"Don't know" responses	
TOT task and stimulus type	*M* (*SD*)	*r*	*M* (*SD*)	*r*	*M* (*SD*)	*r*
Definitions						
Easy	14.5 (5.4)	–.03	5.8 (3.9)	.04	3.5 (4.2)	–.00
Hard	9.4 (4.6)	–.02	6.3 (4.2)	.06	7.0 (4.8)	–.03
Descriptions						
Places	9.5 (6.2)	.26*	4.3 (4.0)	.33*	10.9 (7.0)	–.34*
People	9.6 (6.1)	.33*	6.8 (4.4)	.24*	8.4 (6.3)	–.51*
Faces						
Politicians	10.0 (5.9)	.27*	6.5 (4.6)	.38*	8.3 (6.5)	–.52*
Celebrities	13.8 (6.7)	–.33*	7.2 (4.8)	.26*	3.9 (5.1)	.16*

*$p < .01$.

was not significantly related to the frequency of any response type for the definition stimuli. However, age was positively related to the number of "know" and "TOT" responses and negatively related to the number of "don't know" responses for descriptions of places and people and for faces of politicians. Perhaps because many of the celebrities were relatively young, age had a negative correlation with the frequency of "know" responses and a positive correlation with the frequency of "don't know" responses for these stimuli.

Figure 1 portrays the mean number of TOTs scored for the six sets of stimuli as a function of participants' age

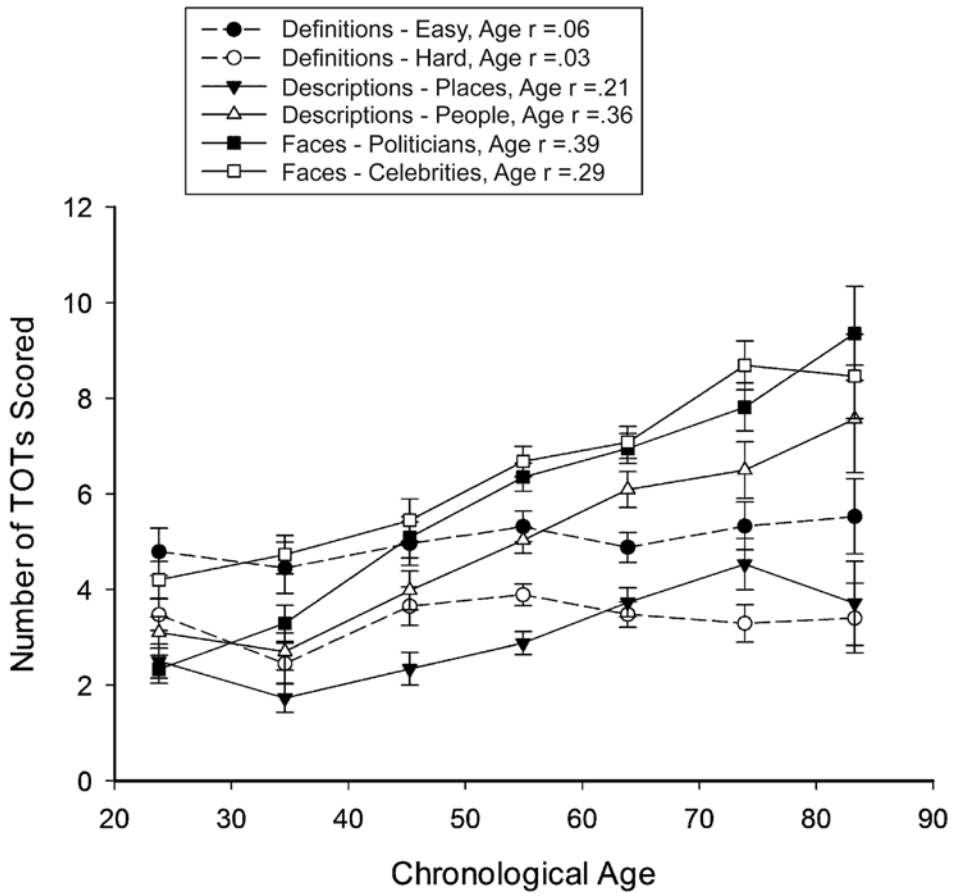

Fig. 1. Mean number of "tip-of-the tongue" (TOT) items scored for each type of stimulus as a function of participants' age decade. Error bars indicate ±1 *SE*. The key shows the correlation between TOT frequency and age for each stimulus type.

decade. The figure shows the absolute number of these items (i.e., the number of items that were reported as eliciting a TOT and for which the correct alternative was selected in the multiple-choice test), but the pattern was very similar when the number of TOTs was expressed as a proportion of correctly identified targets (i.e., the ratio of "TOT" responses to correct multiple-choice responses). Increased age was associated with more TOTs for all stimulus types except the easy and hard definitions. Furthermore, the relations between age and TOT frequency were predominantly linear; none of the quadratic age trends were significantly different from zero.

Within each TOT task, the numbers of "TOT" responses for the two subtypes of stimuli were significantly correlated—easy and hard definitions: $r = .47$; descriptions of people and of places: $r = .64$; and faces of politicians and of celebrities: $r = .60$ (all ps $< .01$). Correlations between TOTs for the descriptions and faces ranged from .28 to .47 (ps $< .01$), but those between TOTs for the definitions and the other stimuli ranged only from −.03 to .06 (ps $> .25$). Two principal component analyses were conducted to examine interrelations among the TOT frequencies obtained with different stimulus materials: one based on the absolute number of "TOT" responses (regardless of recognition accuracy) and a second based on the ratio of "TOT" responses to correct responses in the multiple-choice recognition tests. As Table 2 shows, each analysis yielded two distinct components. TOT frequencies for the descriptions of people and places and for the faces of politicians and celebrities loaded on one component, and TOT frequencies for the easy and hard definitions loaded on the other component. Although regression coefficients are not reported in the table, only the first principal component was related to age (i.e., .48 for the number of "TOT" responses and .43 for the "TOT" ratios, both ps $< .01$.

Because the pattern of results for the definition stimuli differed from that for the other stimuli, and particularly because age was not related to "TOT" response frequency for the definition items, only the data from the descriptions of people and places and the faces of politicians and celebrities were included in subsequent analyses. The numbers of TOTs scored for these materials were converted into z-score units based on the means and standard deviations of the total sample and then averaged to form a composite TOT score. In a similar fashion, the multiple-choice recognition scores for these materials, summed across the "know," "TOT," and "don't know" response categories, were averaged to form a composite relevant-knowledge score.

Accuracy in the multiple-choice test was determined for each category of response on the TOT tasks, and the averages across the description and face stimuli are portrayed as a function of participants' age decade in Figure 2. As expected, accuracy was highest for items that received a "know" response. Accuracy for items that received a "TOT" response was lower than accuracy for items that received a "know" response, but higher than accuracy for items that received a "don't know" response. Note that this ordering was apparent at all ages, but differences in accuracy between items receiving "TOT" and "don't know" responses became larger at older ages, whereas differences in accuracy between items receiving "know" and "TOT" responses became smaller at older ages. Analyses revealed that age was significantly correlated with the difference in accuracy between items receiving "TOT" and "don't know" responses ($r = .23$) and with the difference in accuracy between items receiving "know" and "TOT" responses ($r = -.33$), ps $< .01$.

Because accuracy for items eliciting "TOT" responses relative to accuracy for items receiving the other types of

Table 2. Loadings in the Principal Component (PC) Analyses of "Tip-of-the-Tongue" Responses (TOTs)

	Number of TOTs		Ratio of TOTs to correct recognition responses	
TOT task and stimulus type	PC1	PC2	PC1	PC2
Definitions: easy	.20	**.79**	.13	**.86**
Definitions: hard	.17	**.81**	.10	**.86**
Descriptions: places	**.73**	−.12	**.73**	−.05
Descriptions: people	**.78**	−.20	**.79**	−.15
Faces: politicians	**.81**	−.06	**.77**	.01
Faces: celebrities	**.74**	.01	**.81**	−.06

Note: Boldface type indicates the strongest loadings on each component.
*$p < .01$.

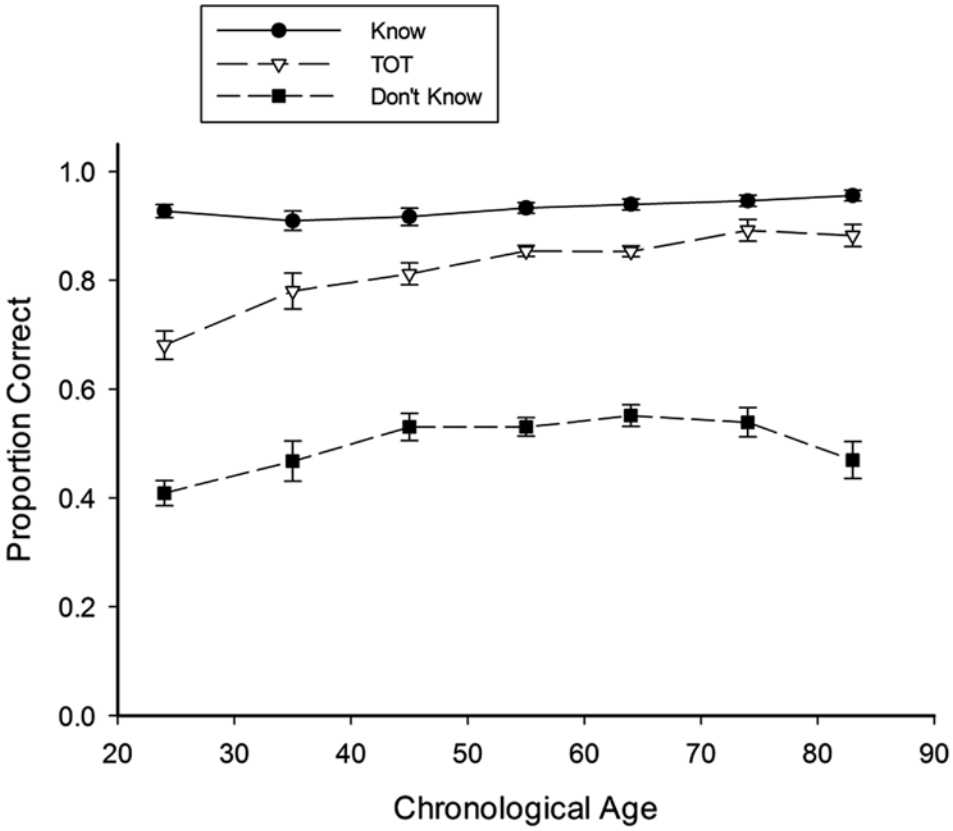

Fig. 2. Mean proportion correct on the recognition tests of description and face stimuli as a function of participants' age decade. Results are shown separately for items reported as known, not known, and on the tip of the tongue (TOT). Error bars represent ±1 *SE*.

responses can be postulated to reflect criterion placement, we investigated the influence of potential shifts in response criteria on the relation between age and TOTs by determining the correlation between age and TOT score after statistically controlling for the accuracy difference between items receiving "TOT" and "don't know" responses and the accuracy difference between items receiving "TOT" and "know" responses. The correlation of age with average TOT score was .41; it was only slightly reduced to .40 after control of the accuracy difference between items receiving "TOT" and "don't know" responses, to .35 after control of the accuracy difference between items receiving "TOT" and "know" responses, and to .37 after control of both accuracy differences (all ps < .01).

As expected, there was a positive correlation between age and general knowledge (r = .31, p < .01) as assessed by the composite vocabulary score, and between age and task-specific knowledge (r = .37, p < .01) as assessed by overall accuracy in the multiple-choice recognition test (i.e., collapsed across items that had elicited "know," "TOT," and "don't know" responses). Two analyses were carried out to determine whether the age-related increases in TOTs primarily reflected age-related increases in knowledge. First, we calculated the correlation between age and the ratio of an individual's number of "TOT" responses to his or her number of correct responses (across all categories) in the recognition test. Although this correlation (.33) was smaller than the simple correlation between age and TOT score (.41), it was still significantly significant from zero (p < .01). Second, we calculated the correlations between age and TOT score after statistically controlling for the general and task-specific measures of knowledge. Again, these correlations (.43 and .36, respectively) were significantly different from zero (both ps < .01). Thus, adjusting for knowledge did not eliminate the relation between age and TOT frequency.

The role of episodic memory in the relation between age and TOT frequency was also investigated with two types of analyses. The first was a multiple regression analysis in which age, the composite memory score, and the interaction of age and memory score were simultaneous predictors of the average TOT score. Of particular interest in this analysis was the interaction because it indicated whether the relation between memory and TOTs was stronger at older ages. The standardized coefficients in the analysis were 0.38 for age, –0.15 for memory, and –0.06 for their interaction. The age and memory effects were significantly different from zero ($p < .01$), but the interaction was not. Furthermore, a follow-up analysis revealed identical correlations of –.19 ($p < .01$) between the average TOT score and the composite episodic memory score in adults under and over 60 years of age.

The second analysis conducted to investigate the role of memory compared the age-TOT relations before and after statistical control of the measure of episodic memory. These two relations were similar, as the standardized coefficients were 0.41 before the control and 0.35 after (both *p*s < .01). Residual TOT scores were created after partialing out the episodic memory variable; these scores, along with the original TOT scores, are plotted as a function of participants' age decade in Figure 3. Although the residual TOT scores were somewhat smaller than the original scores among adults in their 80s, the overall age-related trends were very similar whether or not the control for episodic memory was included (see Fig. 3).

Discussion

Several issues should be considered before discussing implications of the current results for the concern that age-related increases in TOTs may be an indication of episodic memory decline. First, the discovery of moderate correlations among TOT measures obtained with different types of stimuli (ranging from .28 to .64 for descriptions and face stimuli) provides evidence for convergent validity of a TOT construct. That is, these results indicate that the TOT phenomenon is not material- or modality-specific, and instead is manifested across different types of eliciting materials.

The stimuli consisting of definitions of common nouns and verbs are an exception because responses to these

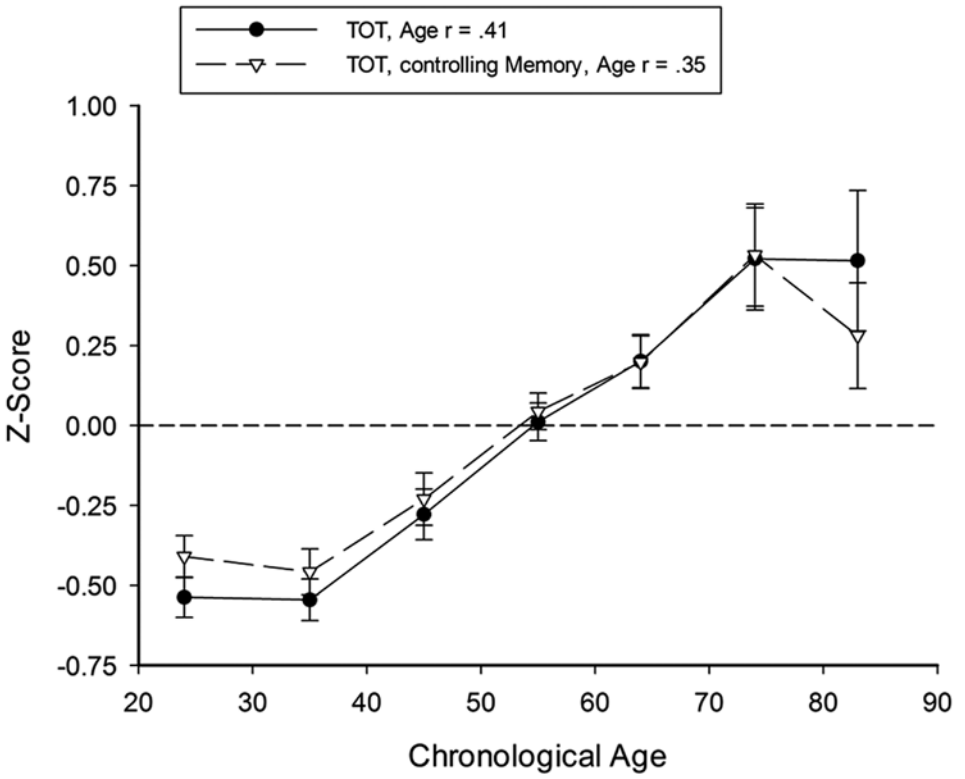

Fig. 3. Mean tip-of-the-tongue (TOT) score (in *z*-score units) for verbal descriptions and face stimuli as a function of participants' age decade. Separate functions are shown for TOT scores before and after controlling for variability in the composite episodic memory measure. Error bars represent ±1 *SE*. The key shows the correlations between age and the original and residual TOT scores.

materials formed a distinct component in the two principal component analyses. This pattern suggests that processing proper nouns (as required with the description and face materials) reflects a different dimension of individual differences than that associated with processing common nouns (as required with the definition materials). The finding that age is more strongly related to TOTs with proper nouns than to TOTs with common nouns is consistent with several earlier reports (e.g., Burke et al., 1991; Evrard, 2002; James, 2006; Rastle & Burke, 1996), and may reflect difficulty accessing names of unique entities, either because they have more vulnerable linkages in a conceptual network (e.g., Burke et al., 1991) or because the anatomical substrate for proper nouns (e.g., Grabowski et al., 2001; Tranel, 2006) is particularly susceptible to age-related neural declines.

A second issue is that because categorization of TOTs is necessarily subjective, questions regarding the comparability of TOTs across different people can arise. These concerns may never be fully resolved, but one way of addressing them involves comparing accuracy in the subsequent recognition test for items eliciting "know," "don't know," and "TOT" responses. Specifically, good discrimination among the response categories would be expected to be manifested in very high accuracy for items receiving "know" responses, relatively low accuracy for items receiving "don't know" responses, and intermediate accuracy for items receiving "TOT" responses. The patterns in Figure 2 indicate that this was the observed ordering at all ages. However, increased age was associated with a shift in relative accuracy for items eliciting "TOT" responses, as accuracy for these items was closer to accuracy for items receiving "know" responses but farther from accuracy for items receiving "don't know" responses at older ages. This pattern suggests that although age-related increases in TOTs were apparently not attributable to older people reporting more items as unknown, they may have been partially attributable to older people having a greater tendency to report known items as eliciting TOTs. Nevertheless, statistical control of measures postulated to represent response criteria resulted in small decreases in the age-TOT relation, which implies that age differences in criteria for distinguishing among the response categories had only minor effects on the age-TOT relation.

A third issue is that increased age was associated with greater amounts of knowledge, and therefore it is important to consider the influence of knowledge on TOT frequency when interpreting the relation of age to TOTs. Two analytical methods were used in this study to investigate this influence: expressing "TOT" responses relative to the number of correct responses in the multiple-choice test and statistically controlling for measures of knowledge. Both procedures revealed large positive relations between age and TOTs, which suggests that the initial age-TOT relation was not an artifact of greater knowledge among older adults.

The three sets of results just described increase confidence in the reality of a positive relation between age and TOTs because they are inconsistent with artifactual interpretations of the phenomenon. That is, these results indicate that there is a relation at the level of a TOT construct defined by multiple measures (i.e., the association is not merely a reflection of problems certain people have with specific types of materials); that the relation is unlikely to be a consequence of poorer discriminability among the "know," "TOT," and "don't know" categories with increased age; and that the relation is not simply attributable to knowledge increasing with age.

The key question in this study concerned the relation between age-related increases in TOTs and age-related decreases in performance on episodic memory tests of the type used to assess memory problems. Our assumption was that if age-related increases in TOTs are a reflection of age-related declines in episodic memory, stronger memory-TOT relations would be expected at older ages, and the age-TOT relation would be substantially reduced after statistically controlling for a measure of episodic memory. Neither expectation was confirmed, as there was no evidence of stronger relations between memory and TOTs at older ages, and there was only modest reduction of the age-TOT relation when variation in the composite memory measure was controlled.

These results imply that the cross-sectional relation between age and TOTs is at least somewhat distinct from the cross-sectional relation between age and episodic memory. Even though increased age is associated with lower levels of episodic memory and with more frequent TOTs, which can be viewed as failures to access information from memory, the two phenomena seem to be largely independent of one another. It might be postulated that the age-related increase in TOTs and the age-related declines of episodic memory are only weakly related because the relevant information in TOTs involves semantic memory rather than episodic memory, but TOTs in this study were only weakly related to the composite vocabulary measure, which can be postulated to represent semantic memory. Another possibility is that because a defining characteristic of TOTs is a strong feeling that the information is known, age-related increases in TOTs may reflect age-related difficulties in metacognitive monitoring more than problems with either episodic or semantic memory.

Author Contributions

T. A. Salthouse developed the study concept and obtained funding. Both authors contributed to the study design, supervision of data collection, and data analysis. T. A. Salthouse drafted the manuscript, and A. R. Mandell provided critical revisions.

Both authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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