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Brief article

Bimodal bilinguals reveal the source of tip-of-the-tongue states

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ABSTRACT

Bilinguals report more tip-of-the-tongue (TOT) failures than monolinguals. Three accounts of this disadvantage are that bilinguals experience between-language interference at (a) semantic and/or (b) phonological levels, or (c) that bilinguals use each language less frequently than monolinguals. Bilinguals who speak one language and sign another help decide between these alternatives because their languages lack phonological overlap. Twenty-two American Sign Language (ASL)–English bilinguals, 22 English monolinguals, and 11 Spanish–English bilinguals named 52 pictures in English. Despite no phonological overlap between languages, ASL–English bilinguals had more TOTs than monolinguals, and equivalent TOTs as Spanish–English bilinguals. These data eliminate phonological blocking as the exclusive source of bilingual disadvantages. A small advantage of ASL–English over Spanish–English bilinguals in correct retrievals is consistent with semantic interference and a minor role for phonological blocking. However, this account faces substantial challenges. We argue reduced frequency of use is the more comprehensive explanation of TOT rates in all bilinguals.

1. Introduction

All language users report occasional difficulty retrieving words they are sure they know (Brown, 1991; Brown & McNeill, 1966; Schwartz, 1999). Such experiences have been called tip-of-the-tongue (TOT) states for speakers and tip-of-the-fingers (TOF) states for signers (Thompson, Emmorey, & Gollan, 2005). TOTs offer an opportunity to view the mechanisms of language production under a magnifying glass by illuminating points of weakness in the system. Signers and speakers experiencing a TOF/TOT often retrieve meaning-related alternative words (e.g., *hyena* for *scavenger*), and also form-related alternatives (e.g., *scaffolding* for *scavenger*) suggesting separate access stages for meaning and for form in language production (e.g., Bock & Levelt, 1994). Bilinguals with two spoken languages, *unimodal bilinguals*, experience significantly more TOTs than monolinguals, suggesting that the mechanism underlying TOTs is sensitive to the existence of two lexicons, two phonological systems, or both (Gollan & Acenas, 2004; Gollan & Silverberg, 2001). Evidence from bilinguals who are fluent in a spoken and a signed language, *bimodal bilinguals*, can help differentiate between accounts of the increased TOT rate in bilinguals and of the TOT phenomenon itself.

The activation of form-related words during TOTs led to perhaps the most intuitive account of the TOT phenomenon, the "phonological blocking" hypothesis. On this view, TOTs arise at the point of phonological encoding, and may be related to *malapropisms*, a different type of speech error in which speakers mistakenly retrieve a phonologically related word instead of the intended target (e.g., saying *anecdote* instead of *antidote*). Early studies on TOTs seemed to confirm phonological blocking (Jones 1989; Jones & Langford, 1987; Roediger, 1974; for review see Brown, 1991), but this account was challenged by evidence that experimenter-provided phonologically related words facilitate correct retrievals (James & Burke, 2000; Meyer & Bock, 1992, Vitevitch, 2002). Nevertheless, blocking accounts of

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the TOT phenomenon could be viable if internally generated competitors affect retrieval differently than externally provided cues. In bilinguals, there may be increased opportunities for phonological blocking to occur if form-related words between languages can compete. For example, the Spanish word for *kite*, *papalote*, could interfere with retrieval of a phonologically related English word such as *popsicle*. Phonological competition is argued to occur during language production for monolinguals (for review see Wheeldon, 2003), and phonological-level competition could extend across languages, but only in bilinguals with two spoken languages. Importantly, phonological representations in both languages are always active for bilinguals (Colomé, 2001), and bilinguals report that words in their other language come to mind during naturally occurring TOTs (Ecke, 2004).

The retrieval of form-related words during a TOT seems to provide compelling evidence for phonological blocking. However, many TOTs occur with meaning-related alternate words (Cohen & Faulkner, 1986; Kohn et al., 1987; Reason & Lucas, 1984, for review see Brown, 1991). The frequent retrieval of semantically related alternative words could be taken as evidence that TOTs arise at an early locus of retrieval, where semantically related lexical representations might compete for selection (Gollan & Acenas, 2004; Miozzo & Caramazza, 1997). In bilinguals, such blocking might be especially likely if translation equivalents – which overlap almost entirely in meaning and are ubiquitous throughout the bilingual lexicon – could function as blockers. On this view, when a Spanish–English bilingual tries to retrieve an English word (e.g., *kite*), the translation equivalent (e.g., *papalote*), interferes with retrieval. If translations can function as blockers during lemma retrieval, then both unimodal and bimodal bilinguals have virtually double the number of particularly strong potential blockers when compared to monolinguals.

A third account assumes no direct competition for selection between languages, and no blocking effect underlying TOTs in all speakers, and instead attributes TOTs to weakness in the strength of connections between meaning and form. TOT targets are usually low-frequency words implying that TOTs arise at a frequency-sensitive processing stage (e.g., Burke, MacKay, Worthley, & Wade, 1991). In bilinguals there could be a frequency-based disadvantage relative to monolinguals because bilinguals divide their language production between two languages, and therefore use each language less frequently than monolinguals who speak just one language (Gollan, Montoya, Cera, & Sandoval, 2008). The reduced-frequency account assigns a common mechanism to TOTs in bilinguals and monolinguals, and resembles accounts of the age-related increase in TOTs in that no blocking is assumed (Burke et al., 1991). However, age-related production deficits are hypothesized to affect all connections within the lexicon, whereas bilingual deficits are hypothesized to arise exclusively at frequency-sensitive processing stages, thereby affecting word retrieval at the form level (Jescheniak & Levelt, 1994), and possibly also at the lemma level (Kittredge, Dell, Verkuilen, & Schwartz, 2008). Consistent with this proposal, both bilinguals and older adults name pictures more slowly than monolinguals and younger adults, respectively, but the size of these effects is modulated by frequency only for bilinguals (Gollan et al., 2008; Ivanova & Costa, 2008).

In the current study we tested these three possible accounts by examining TOT rates in bimodal bilinguals: hearing adults, born to signing deaf parents, who become fluent in a signed and in a spoken language at an early age. The two languages of bimodal bilinguals are articulated in different modalities – vocal and manual – and consequently do not overlap in phonology. The phonological features of spoken languages are based on oral articulators (e.g., voiced, bilabial), whereas those of sign languages are based on manual articulators (e.g., selected fingers, flexed joints; for reviews see Brentari, 1998; Sandler & Lillo-Martin, 2006). Bimodal bilinguals provide an opportunity to distinguish between phonological blocking, semantic blocking, and reduced frequency of use as accounts of the TOT phenomenon. Unlike unimodal bilinguals with two spoken languages, bimodal bilinguals experience no phonological competition between their two languages. Like unimodal bilinguals, bimodal bilinguals could experience semantic competition, and they divide their language use between two languages, using spoken language less frequently than monolinguals.

If TOT states arise because of blocking that interferes with word-form selection, then bimodal bilinguals fluent in American Sign Language (ASL) and English should not experience more TOTs than monolingual English speakers, and phonological blocking would be supported. Alternatively, if TOTs arise because of competition at the lemma level or because of reduced frequency of use, then ASL–English bilinguals should experience more TOTs than monolinguals. Furthermore, if both frequency of use (in all bilinguals) and phonological blocking (only in Spanish–English bilinguals) affect TOT rates, or if both lemma blocking (in all bilinguals) and phonological blocking (in Spanish–English bilinguals) affect TOT rates, then ASL–English bilinguals should have more TOTs than monolinguals but fewer TOTs than Spanish–English bilinguals.

2. Methods

2.1. Participants

Twenty-two English-speaking monolinguals (14 females), 22 hearing ASL–English bilinguals (16 females), and 11 Spanish–English bilinguals (10 females), participated in this study. Monolinguals reported not being fluent in any language other than English. Monolinguals and Spanish–English bilinguals were recruited from the San Diego area and participated either for course credit or for a small payment. ASL–English bilinguals were recruited from across the United States and were paid for their participation. Thirteen ASL–English bilinguals were employed as interpreters; the pattern of results is the same when the interpreters and their matches are excluded from the analysis. Therefore we included the interpreters in the analyses below.

Table 1 provides participant characteristics obtained from a language history questionnaire for monolinguals and ASL–English bilinguals. Because TOT rates are affected by age (Burke et al., 1991) vocabulary knowledge (Gollan & Brown, 2006), and language proficiency (Ecke, 2004; Gollan

Table 1
Means, standard deviations, and statistics comparing monolingual and ASL–English bilingual participant characteristics.

Participant or analysis type		Age in years		Years of education		English proficiency[a,b]		Non-English proficiency[a]		Age of English exposure[b]	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolingual		23.10	4.21	14.91	1.48	6.88	0.45	n/a	n/a	0	0
ASL–English bilingual		23.41	4.04	14.91	1.60	6.66	0.66	6.11	0.97	0.13	0.64
ASL–English versus monolingual	*df*	(1, 43)		(1, 43)		(1, 41)		–		(1, 41)	
	F	0.06		<1		1.48		–		<1	
	MSE	1.09		<.001		0.49		–		0.19	
	η_p^2	.002		<.001		.04		–		.02	
	p	.80		.99		.23		–		.35	

[a] Language production proficiency level based on self-ratings using a scale of 1–7 (1 = "little to no knowledge" and 7 = "like a native speaker").
[b] Data not available for two monolinguals.

Table 2
Means, standard deviations, and statistics comparing characteristics of age, education, and AoAE matched participants.

Participant or analysis type		Age in years		Years of education		English proficiency[a]		Non-English proficiency[a]		Age of English exposure	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolinguals		20.82	2.43	14.55	1.29	6.95	0.15			0.00	0.00
ASL–English bilingual		21.29	2.19	14.55	1.57	6.82	0.46	6.18	1.04	0.27	0.91
Spanish–English bilingual		20.64	2.4	14.36	1.21	6.91	0.30	6.09	1.04	0.27	0.91
ASL–English versus monolingual	*df*	(1, 21)		(1, 21)		(1, 21)		–		(1, 21)	
	F	<1		<1		<1		–		1.00	
	MSE	1.19		<.001		0.10		–		0.41	
	η_p^2	.01		<.001		.04		–		.05	
	p	.64		1.0		.36		–		.33	
ASL–English versus Spanish–English	*df*	(1, 21)		(1, 21)		(1, 21)		(1, 21)		(1, 21)	
	F	<1		<1		<1		<1		<1	
	MSE	2.35		0.18		0.05		0.05		<.001	
	η_p^2	.02		.005		.02		.002		<.001	
	p	.51		.76		.59		.85		1.00	

[a] Language production proficiency level based on self-ratings using a scale of 1–7 (1 = "little to no knowledge" and 7 = "like a native speaker").

& Silverberg, 2001), we individually matched participants from each group for age and education level, and verified that they did not differ in self-rated English fluency (see Table 1). We also individually matched a subset of 11 monolinguals (seven females) and 11 ASL–English bilinguals (nine females) to the 11 Spanish–English bilinguals on their age of English acquisition (AoAE; see Table 2). All bilinguals were exposed to English before the age of 3 years. A 2 (language: English, home language) × 2 (group: unimodal, bimodal) ANOVA showed that the bilingual groups rated themselves as more fluent in English than their home language (ASL or Spanish) ($F(1, 20) = 8.11$, $MSE = 5.82$, $\eta_p^2 = .29$, $p = .01$), with no interaction ($F(1, 20) < 1$, $MSE = 0.09$, $\eta_p^2 = .006$, $p = .73$). All but one Spanish–English bilingual and one ASL–English bilingual reported English as their dominant language; the pattern of results is the same when these two bilinguals are excluded from the analysis. Therefore we included all bilinguals in the analyses below.

2.2. Materials

Speakers attempted to produce the English names of 52 black-and-white pictures of objects with low-frequency names (see Appendix).[1] Object names averaged 2.92 ($SD = 4.26$) in frequency per million (Baayen, Piepenbrock, & Gulikers, 1995) and 2.17 ($SD = 0.81$) syllables in length.

2.3. Procedure

Individually tested participants were asked to name each picture in English and were instructed that a TOT state is "that frustrating feeling you have when you are sure you know a word but cannot recall it at the moment." The experimenter presented the pictures in a fixed random order one at a time. When participants could not retrieve a name, they were asked if they were in a TOT state, and were given approximately 30 s[2] to retrieve the word before the experimenter told them the target word. They were then asked if they knew the word, and if that was the target of their TOT state.

[1] Three native signers of ASL evaluated the English items and reported that 40 of the 52 items have single sign translation equivalents in ASL.
[2] Several participants gave up before 30 s had elapsed.

2.4. Response coding

Responses were classified into the following categories: (a) a GOT for correct retrievals, (b) a +TOT was either a failed or self-resolved retrieval of the target word, (c) a −TOT was a failed or self-resolved retrieval of a *different* word, e.g., *asteroid* for *comet*, (d) a notGOT for failed retrieval of later recognized target words (e) a postDK (DK = "didn't know") when, after being told the word, participants said they did not know it.

We report the raw number of each response type, and following Gollan and Brown's (2006) application of TOT data to models of language production (e.g., Dell, 1990; Levelt, Roelofs, & Meyer, 1999; Meyer & Bock, 1992), we also examined how groups differed in "True-TOTs" which are TOT rates after adjusting for opportunities to have a TOT. Within this approach +TOTs entail partially successful retrievals, relatively more successful than completely failed retrievals, and the "next best" retrieval outcome relative to a GOT. An opportunity to have a TOT can occur only when activation minimally reaches a level that could result in either a TOT or a correct retrieval. Thus, TOT rates must be calculated excluding experimental trials on which there was no opportunity to have a TOT, as follows:

$$\frac{\text{positive TOTs}}{(\text{positive TOTs} + \text{GOTs})}$$

A simple example illustrates the intuitive appeal of this approach. For example, imagine that speakers must name three pictures: *cup*, *frog*, and *divot*. Two speakers successfully retrieve *cup*, report a TOT for *frog*, and the first speaker retrieves *divot* while the second reports not knowing *divot*. The True-TOT rate would be 33% or 1/(1 + 2) for the first speaker, and 50% or 1/(1 + 1) for the second speaker. Thus, although the raw number of TOTs was the same for the two speakers, the speaker who also retrieved the more difficult word *divot* is assumed to have had just one TOT in the presence of three opportunities, whereas the second speaker is assumed to have had one TOT given just two opportunities. By excluding all trials in which activation did not reach the level necessary to have either a TOT or a successful retrieval, the True TOT calculation controls for between-group differences in vocabulary knowledge and the number of opportunities to have a TOT.

3. Results

All participants, with the exception of one monolingual, experienced at least one TOT. To examine whether bimodal bilinguals have more TOTs than monolinguals we carried out six one-way ANOVAs with GOTs, True TOTs, raw numbers of +TOTs, −TOTS, notGOTs, and postDKs as the dependent variables and participant group (monolingual, bimodal bilingual) as the independent variable. Contrary to the outcome predicted by the phonological blocking account, ASL–English bilinguals had significantly more +TOTs, more True TOTs, and fewer GOTs (correct retrievals) than monolinguals, and they also had more postDKs (see Table 3).

To examine if bimodal bilinguals differ from unimodal bilinguals, we conducted pair-wise comparisons in separate ANOVAs of unimodal bilinguals versus bimodal bilinguals, unimodal bilinguals versus monolinguals, and of monolinguals versus bimodal bilinguals with the same dependent variables as above. As with the larger sample, ASL–English bilinguals had significantly more True TOTs

Table 3
Means, standard deviations, and statistics comparing groups for each response type.

Participant or analysis type		GOT		Proportion of "True TOTs"		+TOT		−TOT		Not GOT		PostDK	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolingual (*n* = 22)		40.18	4.14	.18	.07	8.73	3.78	2.32	1.64	0.41	0.59	0.36	0.79
ASL–English bilingual (*n* = 22)		35.41	4.09	.25	.08	12.18	4.32	2.18	2.08	0.77	0.97	1.41	1.92
ASL–English versus monolingual	$F(1, 43)$	14.81		9.63		7.97		<1		2.25		5.59	
	MSE	20.57		.006		131.27		0.21		1.46		12.02	
	η_p^2	.26		.19		.16		.001		.05		.12	
	p	<.001		.003		.007		.81		.14		.02	

Table 4
Means, standard deviations, and statistics comparing groups for each response type.

Participant or analysis type		GOT		Proportion of "True TOTs"		+TOT		−TOT		Not GOT		PostDK	
		M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolingual (*n* = 11)		40.82	3.49	.16	.08	7.55	3.73	2.82	1.60	0.55	0.69	0.27	0.65
ASL–English bilingual (*n* = 11)		35.18	3.6	.26	.08	12.55	4.23	2.27	1.74	0.82	1.17	1.18	0.98
Spanish–English bilingual (*n* = 11)		31.00	5.2	.27	.09	12.36	4.18	5.00	3.23	1.27	0.91	2.27	1.69
ASL–English versus monolingual	$F(1, 21)$	13.91		9.95		8.66		<1		<1		6.58	
	MSE	174.73		.006		137.50		1.67		.41		4.55	
	η_p^2	.41		.33		.30		.03		.02		.25	
	p	.001		.005		.008		.45		.51		.02	
ASL–English versus Spanish–English	$F(1, 21)$	4.08		<1		<1		6.10		1.04		3.46	
	MSE	96.18		.003		.18		40.91		1.14		6.55	
	η_p^2	.17		.02		.001		.23		.05		.15	
	p	.06		.51		.92		.02		.32		.08	

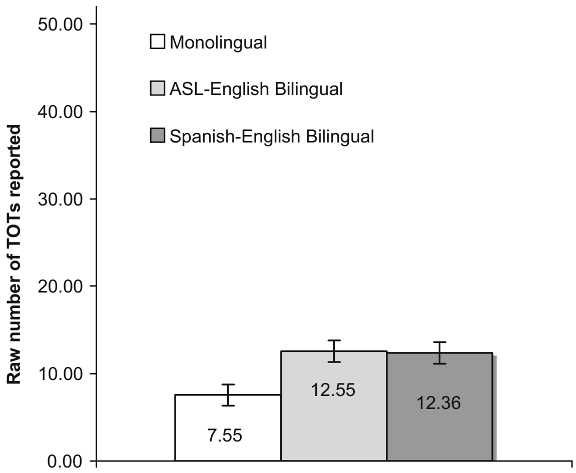

Fig. 1. Mean and standard error of +TOTs for each group.

than monolinguals (see Table 4). Further we replicate previous findings showing significant differences between monolinguals and Spanish–English bilinguals for all response types ($ps < .01$). Consistent with the hypothesis that the same mechanism underlies the increased TOT rate in bimodal and unimodal bilinguals, there was no difference between ASL–English and Spanish–English bilinguals in the number of +TOTs (see Fig. 1), the proportion of True TOTs, and the number of notGOTs. However, there was some indication that bimodal bilinguals fared better than unimodal bilinguals in retrieval success because they had significantly fewer −TOTs and a marginally higher number of correct retrievals (GOTs).[3]

4. Discussion

The current study replicates previous reports of an increased TOT rate in bilinguals, and extends the result to include bimodal bilinguals fluent in a signed and a spoken language: both types of bilinguals have more TOTs than do monolinguals. This result provides clear evidence that the increased TOT rate associated with bilingualism cannot be attributed exclusively to competition between phonological forms. Bilinguals with no possibility of competition between languages at the phonological level also experience more TOTs than monolinguals.

Bimodal and unimodal bilinguals did not differ in the number or rate of TOTs, yet other measures of lexical retrieval provide some evidence that bimodal bilinguals had slightly better retrieval success than unimodal bilinguals. Specifically, bimodal bilinguals exhibited significantly fewer −TOTs and a trend toward more correct retrievals (GOTs). Thus, bimodal bilinguals may have exhibited an “in between” pattern of slightly better lexical retrieval than that of unimodal bilinguals but significantly worse than that of monolinguals. A possible interpretation of the in-between pattern is to assume that retrieval failures can arise at either the lemma level or at the form level, with the majority arising at the earlier retrieval locus (e.g., via semantic blocking). On this view, bimodal bilinguals are sheltered from the small minority of retrieval errors that arise at the phonological level, and thus fare only somewhat better than unimodal bilinguals in terms of retrieval success.

Though the possibility of two different loci for retrieval failures is intriguing, other data challenge the feasibility of between-language competition at the lemma level. In unimodal bilinguals, experimental presentation of translation-equivalent cues significantly accelerates production in the picture–word interference paradigm (Costa & Caramazza, 1999). Moreover, TOT rates are lower for words that unimodal bilinguals know in both languages, and knowledge of translation equivalents seems to facilitate retrieval even when translations are never experimentally presented (Gollan & Acenas, 2004; Gollan, Montoya, Fennema-Notestine, & Morris, 2005). Finally, bimodal bilinguals do not exhibit the advantage in cognitive control that has been observed for unimodal bilinguals (Emmorey, Luk, Pyers, & Bialystok, 2008). If lemma competition between languages underlies the unimodal bilingual cognitive control advantage, and bimodal bilinguals do not experience such competition, then some other mechanism is needed to explain the increased TOT rate that both bilingual groups exhibit.

The reduced-frequency account does not face such challenges, and it can explain the increased TOT rate in bilinguals of all types and the small differences in retrieval success that we observed between the bilingual groups. ASL–English bilinguals may use English slightly more often than Spanish speakers because their two languages do not compete for articulators; several studies have documented that ASL–English bilinguals sometimes sign and speak *at the same time* (Casey & Emmorey, 2009; Emmorey, Borinstein, Thompson, & Gollan, 2008; Pyers & Emmorey, 2008). Thus, to the extent that they produce elements of both languages at the same time, bimodal bilinguals may produce their two languages more often than unimodal bilinguals resulting in a slightly improved overall retrieval profile.

Bimodal bilinguals provide a tool for determining whether bilingual processing costs should be attributed to modality-independent factors related to bilingualism, such as dual lexical representations at the lemma level, or to modality-sensitive factors, such as shared phonological representations, competition for linguistic articulators, or perceptual conflict between languages. There could be no more salient distinction between a bilingual’s two languages than to articulate each in a different modality. Yet even with such a physical distinction, bimodal bilinguals experience the same word retrieval difficulty as unimodal bilinguals whose languages do not differ in modality. The results from ASL–English bilinguals suggest that competition at the phonological level does not play a substantial role in retrieval success, and challenge the continued use

[3] When we consider only the 40 items for which ASL has a single sign translation, we replicate the main finding that word retrieval is more difficult for bimodal bilinguals than for monolinguals (GOTs: $p = .001$, +TOTs: $p = .009$, True TOTs: $p = .005$), and that the word retrieval profiles for bimodal and unimodal bilinguals are similar (GOTs: $p = .07$, +TOTs: $p = .72$, True TOTs: $p = .37$).

of the phonological blocking hypothesis to explain TOT states for all language users (e.g., Maril, Wagner, & Schacter, 2001). Instead, TOTs appear to reflect incomplete activation of target lexical representations resulting from reduced frequency of use. As such, all speakers who divide their language use between two languages, whether signed or spoken, experience increased TOT rates.

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Appendix.

Target English words in the picture-naming task

Hive	Eclipse	Unicycle	Gyroscope
Peacock	Bolt	Thermos	Mummy
Comet	Wheelbarrow	Carousel	Plunger
Microscope	Dynamite	Antlers	Hinge
Snorkel	Compass	Canteen	Harmonica
Megaphone	Chisels	Beaver	Cleft chin
Pitcher	Ostrich	Goggles	Metronome
Mantaray	Grater	Boomerang	Handcuffs
Axe	Braille	Easel	Noose
Gazebo	Well	Propeller	Harp
Hoe	Guillotine	Walnut	Slingshot
Baster	Weathervane	Catapult	Eiffel tower
Castle	Churn	Udder	Syringe

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