Research Article

Cherry Pit Primes Brad Pitt

Homophone Priming Effects on Young and Older Adults' Production of Proper Names

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ABSTRACT—*This study investigated why proper names are difficult to retrieve, especially for older adults. On intermixed trials, young and older adults produced a word for a definition or a proper name for a picture of a famous person. Prior production of a homophone (e.g.,* pit*) as the response on a definition trial increased correct naming and reduced tip-of-the-tongue experiences for a proper name (e.g.,* Pitt*) on a picture-naming trial. Among participants with no awareness of the homophone manipulation, older but not young adults showed these homophone priming effects. With a procedure that reduced awareness effects (Experiment 2), prior production of a homophone improved correct naming only for older adults, but speeded naming latency for both age groups. We suggest that representations of proper names are susceptible to weak connections that cause deficits in the transmission of excitation, impairing retrieval especially in older adults. We conclude that homophone production strengthens phonological connections, increasing the transmission of excitation.*

"I'll never forget what's-her-name" expresses the familiar experience of vividly remembering a person, but not his or her name. People's names are not only more difficult to learn than biographical information (G. Cohen & Faulkner, 1986; McWeeny, Young, Hay, & Ellis, 1987), but also more difficult to retrieve once learned (e.g., Young, Hay, & Ellis, 1985). Older adults in particular suffer retrieval failures for familiar proper names (Maylor, 1990), reporting this as their most irritating and embarrassing memory problem (Lovelace & Twohig, 1990). The tip-of-the-tongue experience (TOT) is a retrieval failure coupled with a strong feeling of being on the verge of recall (see A.S. Brown, 1991). The majority of naturally occurring TOTs involve failures to retrieve proper names, and the increase in TOTs with aging is greater for proper names than for other types of words (Burke, MacKay, Worthley, & Wade, 1991; Evrard, 2002; Rastle & Burke, 1996). TOTs appear to be caused by a failure to retrieve phonology (James & Burke, 2000; Meyer & Bock, 1992; White & Abrams, 2002), and thus they can provide information about the locus of the deficit in retrieval of proper names.

Why are proper names so difficult to retrieve? Researchers and philosophers agree that proper names carry reference because they indicate individuals, but little sense or meaning because they indicate few attributes or qualities (G. Cohen, 1990; Kripke, 1980; Mill, 1856; Semenza, 1997; Valentine, Brennen, & Bredart, 1996). Thus, for example, you may have considerable semantic knowledge about a specific person, but the fact that this person shares a name with someone else does not imply these semantic features (except possibly features of sex or ethnicity) apply to that other person. The paucity of semantic content for proper names makes them difficult to learn, and to retrieve once learned (Burke et al., 1991; G. Cohen, 1990). A few exceptional proper names do have meaning either because they are unusually descriptive (e.g., Snow White) or because they have acquired meaning from the characteristics of a person they refer to (e.g., Scrooge). Bredart and Valentine (1998) found that cartoon characters with such proper names were correctly named more often and with fewer TOTs than equally familiar characters with less meaningful names (e.g., Peter Pan). Similar benefits to retrieval should hold for proper names like Kleenex or Xerox, which have acquired the meaning of the products themselves.[1]

The different semantic content of proper versus common names is represented in Figure 1, which depicts semantic and phonological representations of the common noun-proper name homophones *pit-Pitt* within an interactive activation model, node structure theory (NST; MacKay, 1987). Models of production agree that homophones share phonological representations, but have different lexical and semantic representations (Cutting & Ferreira, 1999; Dell, 1990; Jescheniak & Levelt, 1994; Valentine, Moore, & Bredart, 1995; but see Caramazza, Costa, Miozzo, & Bi, 2001). The lexical node for *pit* (common noun) is connected to a number of nodes in the semantic system representing information about the stony seed of fruits, whereas the lexical node for *Pitt* (family name) has no semantic connections independent of those for the person

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[1]We are grateful to Sam Glucksberg for this point.

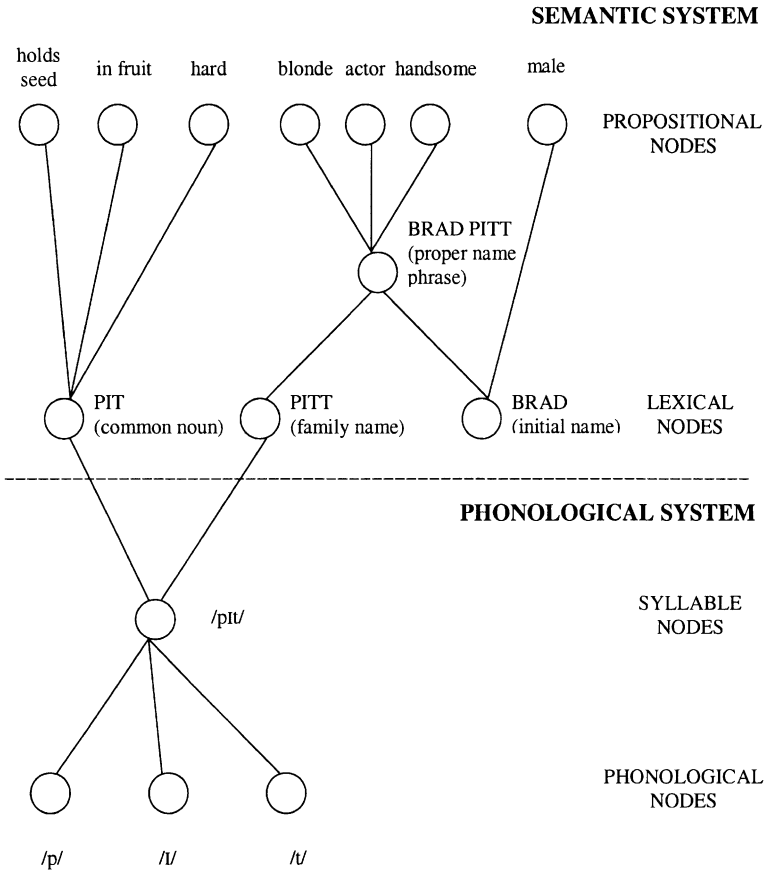

Fig. 1. Semantic, lexical, and phonological nodes representing the homophones *pit* and *Pitt* in node structure theory. Many nodes necessary for producing these words have been omitted for simplification.

Brad Pitt. *Brad* is connected only to the semantic information: a male name.

Within NST, the distinct architecture of proper names, in particular, the absence of multiple semantic connections, makes them vulnerable to deficits in the transmission of priming, a form of excitation necessary to prepare a node for activation.[2] For example, the lexical node for *pit* would receive more top-down excitation than the lexical node for *Pitt* during respective attempts to produce each word: Top-down excitation to the lexical node for *pit* converges from many semantic attributes, whereas top-down excitation to *Pitt* occurs via a single connection from a representation for a specific person, Brad Pitt. Deficits in transmission of excitation from semantic to phonological nodes can prevent a node from reaching a threshold of excitation necessary for activation, resulting in retrieval failure (MacKay, 1987).

Within NST, three factors weaken connections between nodes, decreasing the transmission of excitation: nonrecent use, infrequent use, and aging of the speaker (Burke et al., 1991; MacKay & Burke, 1990). When only a single connection links nodes in a production hierarchy, a weakened connection is particularly likely to cause retrieval failure because no other top-down connection can compensate for the transmission deficit. For example, when the person node *Brad Pitt* is activated, a weak connection to *Pitt* (family name) would reduce the transmission of excitation to this node and to phonological representations for the name, making a TOT possible. Although there are words other than proper names that have few semantic connections within this framework (e.g., the common noun *thing* or the article *the*), they are unlikely candidates for TOTs because of their very high frequency (Harley & Bown, 1998). Even in the case of proper names, TOTs occur mostly for names that have not been used recently (Burke et al., 1991).

To test the NST account of why proper names are so difficult to retrieve, we measured whether the probability of a TOT for a person's name (e.g., Brad *Pitt*) was affected by prior production of a homophone of that name (cherry *pit*). It has been proposed that production of a word strengthens connections throughout the production hierarchy for the word and facilitates its subsequent production, a form of implicit learning (Dell, Reed, Adams, & Meyer, 2000; Rastle & Burke, 1996; Wheeldon & Monsell, 1992). These repetition priming effects are well established when the prime and target word share lexical and semantic nodes, but not when they share only phonological nodes, as homophones do. For example, previous studies showed that

[2]Within NST, "priming" refers to the theoretical mechanism of subthreshold excitation that prepares a node for retrieval and is similar to spreading activation in some models (MacKay, 1987). "Priming effect" is a behavioral change of faster latency when the availability of target information is increased after related information is processed. To avoid confusion, we refer to theoretical "priming" as "excitation."

prior production of an identical name reduced latencies for naming a picture of an object or a celebrity, but prior production of a homophone for the name had little or no effect (Valentine et al., 1995; Wheeldon & Monsell, 1992; see also Griffin, 2002).[3]

Despite these negative results for homophone priming and production, further investigation is motivated by both empirical and theoretical reasons. On an empirical level, production of words that share partial phonology with a target word has been shown to increase resolution of a TOT for the target for both young and older adults (James & Burke, 2000; White & Abrams, 2002). This suggests that words that share the entire phonology of a target should also increase resolution of a TOT for the target. On a theoretical level, two mechanisms within NST (MacKay, 1987) and similar models (e.g., Dell, 1986, 1990; Vitevitch, 2002) would be expected to produce homophone priming effects. First, production strengthens connections among activated nodes, for example, increasing the availability of phonological nodes, even, in principle, when these phonological nodes are subsequently accessed via a homophone. Second, in interactive activation models such as NST, connections between levels of nodes are bidirectional, so that excitation reverberates between lexical and phonological levels, although it diminishes over successive connections. For example, during production of *Pitt*, excitation spreads top-down to the lexical node for *Pitt* and then to phonological nodes. If *pit* has been produced recently (as in a homophone priming paradigm), connections among nodes for its phonological form /pɪt/ will be strengthened, and these stronger connections will increase feedback to the lexical representation of *Pitt* (family name), increasing the probability of activation of the lexical node for *Pitt*.

EXPERIMENT 1

We created conditions conducive to transmission deficits in order to increase sensitivity to homophone priming effects: Proper names were the production targets, and older as well as young adults were the participants. We measured TOTs, which occur when semantic information is activated but transmission deficits prevent phonological retrieval (Burke et al., 1991). Within our theoretical account, proper names and aging will increase phonological retrieval deficits that produce TOTs, and these deficits will be reduced by prior homophone production. We also measured "don't know" responses. If homophone production improves subsequent name production by also reducing "don't know" responses, this would implicate a change at the lexical level because "don't know" responses occur when lexical selection fails. In this homophone priming paradigm, on intermixed trials participants produced a word for a definition or a proper name for a picture of a famous person (see Fig. 2). On critical trials, we measured whether responses to a target picture (e.g., *Brad Pitt*) varied as a function of whether a previous definition had elicited a homophone (e.g., *pit*) or an unrelated word (e.g., *cane*).

[3]A phonologically related (e.g., Cutting & Ferreira, 1999; Meyer & Schriefers, 1991) or homophone (Ferrand, Humphreys, & Segui, 1998) prime word presented within a few hundred milliseconds of a picture can facilitate naming of the picture, but these priming effects dissipate at longer prime-target intervals. This short-lived priming effect is attributed to residual excitation at phonological nodes shared by the prime and target, a mechanism different from the one underlying the long-term repetition effects we investigated in the present study.

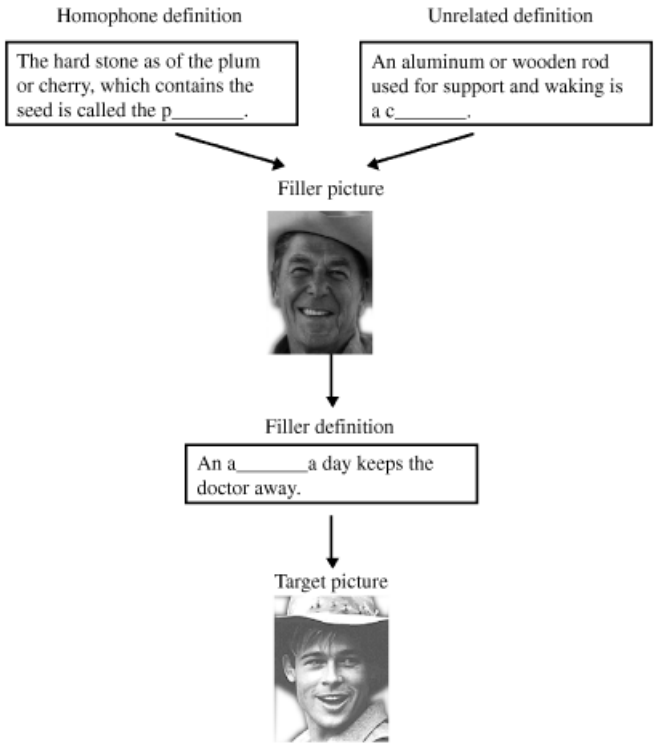

Fig. 2. Illustration of the sequence of trials presenting definitions and pictures in Experiment 1.

Method

Participants

Fifty-eight young adults ($M = 19.05$ years, $SD = 1.48$) participated for course credit, and 40 healthy older adults ($M = 72.23$ years, $SD = 4.20$) were paid to participate. Nelson-Denny vocabulary scores (J.I. Brown, 1960) were lower for young ($M = 17.97$, $SD = 2.49$) than for older ($M = 21.97$, $SD = 1.91$) participants, $t(96) = 9.11$. (All reported effects are significant at $p < .05$ or better unless noted otherwise.) Number of years of education was lower for young ($M = 13.09$, $SD = 1.30$) than for older ($M = 16.26$, $SD = 2.93$) participants, $t(96) = 9.70$. All participants were native English speakers.

Materials

Stimuli for the picture-naming task were 86 target and 86 filler pictures selected from 218 photographs of famous people collected from the media. The pictures were cropped to leave only the face, filling a rectangle 3 in. by 3.5 in. The last names for target pictures, but not filler pictures, had familiar homophones. Target pictures elicited TOTs from at least 1 young and 1 older participant in a pretest in which 10 young and 10 older adults named the 218 pictures.

Definitions were fill-in-the-blank statements, with the blank including the first one or two letters of the intended response. There were 86 definitions for homophones of the surnames of people in the target pictures, and 129 definitions for unrelated words were used for the 86 filler trials and 43 unrelated-target trials (see Fig. 2).

Procedure

A computer presented stimuli and recorded responses. Instructions directed participants to respond to each definition by saying aloud

TABLE 1

Mean Proportion of Correct Names Produced, TOT Responses, and "Don't Know" Responses in Experiment 1

	Correct name		TOT		"Don't know"	
Definition condition	Young adults	Older adults	Young adults	Older adults	Young adults	Older adults
			All participants			
Unprimed	.42	.33	.12	.21	.45	.46
Homophone primed	.47	.43	.10	.16	.44	.41
Priming effect	.05	.10	.02	.05	.01	.05
			Unaware participants only[a]			
Unprimed	.49	.32	.12	.23	.39	.44
Homophone primed	.49	.41	.11	.18	.40	.41
Priming effect	.00	.09	.01	.05	.01	.03

Note. Priming effects reported are absolute values. TOT = tip-of-the-tongue experience.
[a]These participants did not report being aware that some of the defined words and picture names were homophones. See the text for explanation.

either the one word that best fit the blank or "don't know"; participants were asked to respond to the pictures by saying the name of the person, "don't know," or "TOT" if they were certain that they knew the name but could not produce it at the moment. Each "TOT" response was followed by the query, "Are you thinking of (correct name)?" The experimenter recorded the participants' responses on the computer keyboard. If a participant responded "TOT" but was thinking of an incorrect name, the response was recorded as "don't know."

After 12 practice trials, there were 86 continuous sets of 4 trials, each set consisting of alternating definitions and pictures, as shown in Figure 2: the definition of a homophone or unrelated word, a filler picture, a filler definition, and a target picture. The sets were presented in a different random order for each participant. For each participant, half the target pictures were assigned to the homophone-definition condition and half to the unrelated-definition condition, with pictures in these two counterbalancing groups matched for number of correct responses in pilot testing. Across participants, pictures appeared equally often in each definition condition.

After the experiment, participants were asked if they noticed any relationship between the pictures and the definitions, and if they tried to use this relationship when naming the pictures.

Results

Young and older participants responded incorrectly to 6.2% and 3.1%, respectively, of the definitions paired with target pictures, and these picture-naming trials were eliminated from analyses. Table 1 shows mean proportions of trials on which participants gave each kind of response: correct name, TOT, or "don't know"; these data were evaluated in separate multivariate analyses of variance. Young adults produced more correct names than older adults, $F_1(1, 96) = 4.06$, $MSE = 0.13$, and $F_2(1, 85) = 6.17$, $MSE = 0.12$, and correct names were produced more often for the homophone-primed than the unprimed condition, $F_1(1, 96) = 33.19$, $MSE = 0.01$, and $F_2(1, 85) = 66.90$, $MSE = 0.01$. Age group and definition condition interacted in the analysis by participants, but not in the analysis by items, $F_1(1, 96) = 5.47$, $MSE = 0.01$; $F_2(1, 85) = 1.07$, $MSE = 0.01$.[4] The homophone priming effect was larger for older than young adults, although significant for each age group, $t(39) = 6.73$ and $t(57) = 2.75$, respectively (see Table 1).

There were more TOTs for older than young adults, $F_1(1, 96) = 13.49$, $MSE = 0.04$; $F_2(1, 85) = 35.28$, $MSE = 0.01$; there were also more TOTs for the unprimed than the homophone-primed condition, $F_1(1, 96) = 31.97$, $MSE = 0.01$; $F_2(1, 85) = 21.73$, $MSE = 0.01$. The homophone priming effect was significant for both young and older adults, $t(57) = -3.22$ and $t(39) = -4.70$, respectively; although this effect was numerically larger for older than young adults (see Table 1), the interaction of age and definition condition was not significant.

There were fewer "don't know" responses for the homophone-primed than the unprimed condition, $F_1(1, 96) = 5.64$, $MSE = 0.01$, and $F_2(1, 85) = 16.62$, $MSE = 0.01$, although this homophone priming effect was significant only for older adults, $t(39) = -3.09$.

Some participants expressed awareness that definitions and pictures sometimes elicited homophones, and reported using this knowledge to anticipate picture names. Mean proportions for the 16 young and 28 older participants who reported no awareness of the definition-picture relationships are shown separately in Table 1. Correct naming was greater for young than older unaware participants, $F_1(1, 42) = 5.35$, $MSE = 0.14$; $F_2(1, 85) = 14.21$, $MSE = 0.14$; correct naming was also greater for the homophone-primed than the unprimed condition among these unaware participants, $F_1(1, 42) = 5.98$, $MSE = 0.01$; $F_2(1, 85) = 18.32$, $MSE = 0.02$. Age group and definition condition interacted, $F_1(1, 42) = 10.01$, $MSE = 0.01$; $F_2(1, 85) = 2.07$, $MSE = 0.02$, $p = .15$. The homophone priming effect was significant for older unaware adults, $t(27) = 5.29$, but not young unaware adults, $t(15) = -0.05$, in contrast with the significant priming effect found for both ages in the analysis including both aware and unaware participants.

There were more TOTs for older than young unaware participants, $F_1(1, 42) = 7.08$, $MSE = 0.05$; $F_2(1, 85) = 39.87$, $MSE = 0.02$; there

[4]When results of analyses by participants and items are inconsistent, we use the analysis by participants, because analysis by items may be overly conservative given that item selection was highly constrained and items were counterbalanced over treatments and matched in counterbalancing groups (J. Cohen, 1976; Raaijmakers, Schrijnemakers, & Gremmen, 1999).

were also more TOTs for the unprimed than the homophone-primed condition among the unaware participants, $F_1(1, 42) = 6.31$, $MSE = 0.01$; $F_2(1, 85) = 4.95$, $MSE = 0.02$. The interaction between age and definition condition was marginal, $F_1(1, 42) = 3.70$, $MSE = 0.01$, $p = .06$; $F_2(1, 85) = 2.01$, $MSE = 0.01$, $p = .16$. The homophone priming effect was significant only for older unaware adults, $t(27) = -3.88$, not young unaware adults, $t(15) = -0.41$, in contrast with the results found when both aware and unaware participants' TOT responses were analyzed.

"Don't know" responses showed only a marginal age-by-definition-condition interaction in the analysis by participants, $F_1(1, 42) = 3.08$, $MSE = 0.01$, $p = .087$. The homophone priming effect was significant for older unaware adults, $t(27) = -2.02$, but not young unaware adults.

In sum, prior production of a homophone increased correct reporting of proper names and decreased TOTs for both young and older adults when responses of aware and unaware participants were analyzed together. The beneficial effect for young adults, however, appears to depend on strategies based on awareness of the relation between the definition and picture name. In the analysis with only unaware participants, young adults showed no homophone priming effects, whereas older adults showed a priming effect on correct responses, TOTs, and "don't know" responses. Inasmuch as production of a homophone strengthens connections among nodes, these findings suggest that weak connections contribute more to older adults' difficulty in retrieving proper names than to younger adults' difficulty, a conclusion consistent with the greater number of TOTs for older adults overall. These conclusions, however, depend on older adults' accuracy in reporting that they were unaware, and on the sensitivity of young adults' relatively low rate of TOTs to priming effects. We designed Experiment 2 to limit the impact of strategies based on awareness and to increase the sensitivity of young adults' naming performance to priming effects by measuring speed of naming.

EXPERIMENT 2

We adjusted the procedure from Experiment 1 to make it more difficult for participants to use their definition responses to anticipate picture names: We decreased the number of primed pictures, increased the number of unrelated fillers, varied the lag between the prime definition and the target picture, reduced response options by eliminating the TOT response, and emphasized speed of responding.

Method

Participants

Thirty-six young ($M = 20.25$ years, $SD = 1.06$) and 36 older ($M = 71.33$ years, $SD = 3.47$) adults participated under the same conditions as in Experiment 1. Number of years of education was greater for older ($M = 16.33$, $SD = 2.96$) than young ($M = 14.58$, $SD = 1.24$) adults, $t(70) = 4.04$, as were vocabulary scores (Ms = 23.00 and 20.60, SDs = 2.54 and 1.67, respectively), $t(70) = 2.67$.

Materials

Stimuli for the picture-naming task included 20 target (homophone names) and 50 filler pictures named correctly by at least 70% of Experiment 1 participants in each age group. Twenty definitions elicited homophones of target proper names, and 60 definitions elicited unrelated words from Experiment 1.

Procedure

The procedure of Experiment 1 was followed except as noted. For each participant, half the target pictures were assigned to the homophone-definition condition and half to the unrelated-definition condition, and within each condition, half the pictures appeared at a lag of 2, as in Experiment 1, and half at a lag of 4, with 2 filler definitions and 2 filler pictures between the target definition and target picture. The temporal interval between target definition and picture was approximately 5 to 10 s for lag-2 trials and 10 to 20 s for lag-4 trials.

After participants responded to a definition, the correct word appeared, with instructions to press the green button if this was the word they had said. If they had produced an incorrect response, participants were instructed to say the correct word aloud. With this procedure, the intended prime word was always produced, preventing the need to eliminate trials because of production of an incorrect prime.

Participants produced only the last name of the person in each picture. Naming latency was measured from the onset of the picture to the participant's response using a microphone with input to a PsyScope button box with a millisecond timer. After a response, the correct name appeared on the screen, and participants pressed the green button if they had been correct and the red button if they had not produced the correct name. Pictures remained on the screen for a maximum of 5 s before participants were required to move on to the next trial. At the end of the experiment, participants were queried about their awareness of the relationship between definitions and pictures. These questions were the same as the ones used in Experiment 1.

Results

Correct Naming

As shown in Table 2, correct naming was greater in the homophone-primed than the unprimed condition, $F_1(1, 68) = 13.70$, $MSE = 0.05$; $F_2(1, 19) = 20.64$, $MSE = 0.02$; the age-by-definition-condition interaction was significant, $F_1(1, 68) = 8.80$, $MSE = 0.05$; $F_2(1, 19) = 18.90$, $MSE = 0.01$. The homophone priming effect was significant for older but not young participants, ts(35) = 4.82 and 0.71, respectively. Older adults produced fewer correct names than young adults in the unprimed condition, $t(70) = -3.18$, but not in the homophone-primed condition. There was no effect of lag. Twenty-seven young and 9 older adults indicated awareness of the relation between some definitions and pictures. Awareness was a variable in the analysis by participants and showed no significant effect or interaction. It was not included in the analysis by items because of empty cells in some counterbalancing groups. Although a number of participants reported awareness of the relation between some definitions and pictures, the varying lag, large number of fillers, and emphasis on speed appear to have reduced the usefulness of awareness for improving performance.

Response Times

Only latencies for correctly named pictures were included in the analyses. Median response times were used because of some excessively long latencies. There was no effect of awareness or lag in the analysis by participants, and the analysis by items collapsed across these variables to avoid empty cells for some items. Older adults were slower than young adults, $F_1(1, 68) = 5.59$, $MSE = 380{,}114$; $F_2(1, 18) = 3.83$, $MSE = 314{,}214$, $p = .066$; also, naming was faster in the

TABLE 2

Mean Proportion of Correct Responses and Naming Latency (in Milliseconds) in Experiment 2

	Young adults			Older adults		
Definition condition	Aware ($n = 27$)	Unaware ($n = 9$)	Combined	Aware ($n = 9$)	Unaware ($n = 27$)	Combined
	Proportion of correct responses					
Unprimed	.74	.71	.73	.61	.59	.59
Homophone primed	.77	.73	.76	.85	.76	.78
Priming effect	.03	.02	.03	.24	.17	.19
	Naming latency					
Unprimed	1,589	1,664	1,626	1,835	1,798	1,817
Homophone primed	1,539	1,420	1,480	1,537	1,700	1,618
Priming effect	50	244	146	298	98	199

Note. Priming effects reported are absolute values.

homophone-primed than the unprimed condition for both age groups, $F_1(1, 68) = 5.15$, $MSE = 282{,}043$; $F_2(1, 18) = 11.54$, $MSE = 89{,}834$ (see Table 2). Homophone priming decreased naming latency, although no conclusion is possible about age differences in the size of this effect. Older adults made more errors than young adults in the unprimed condition, and thus latency for older adults may be underestimated because difficult names with presumably slow latencies were selected out.

GENERAL DISCUSSION

Successful retrieval of a proper name increased after production of a homophone, but among unaware participants in Experiment 1, this effect was obtained only for older, not young, adults. This age difference in priming effects was not due to older adults using awareness of homophones strategically but reporting their awareness less accurately than young adults. In Experiment 2, awareness did not affect naming, and homophone priming effects on correct naming followed the pattern of results for unaware participants in Experiment 1: priming effects for older but not young adults. Older adults produced more TOTs and fewer correct proper names than young adults in Experiment 1, but prior homophone production reduced this age deficit, and in Experiment 2, prior homophone production eliminated the age deficit in correct naming. For both age groups, retrieval of the correct proper name was faster after production of a homophone.

These findings are the first to show relatively long-lasting homophone priming effects. One important difference between the present experiments and previous studies reporting no homophone priming effects is that in this study, the maximum lag between definition and target was under 20 s, whereas the lag in previous studies was 5 to 20 min (e.g., Valentine et al., 1995). Although repetition priming effects for the same word occur over long intervals (e.g., Wheeldon & Monsell, 1992), homophone priming effects, in which overlapping representations are limited to the phonological system, may be more short-lived.

The pattern of findings helps to explain why older adults experience more frequent word retrieval failures than young adults and why proper names are hard to retrieve. According to NST, homophone production affects proper-name retrieval for old but not young adults because aging weakens connections, causing retrieval failures when connections among lexical and phonological representations in the production hierarchy are too weak to transmit adequate excitation. A similar mechanism of weak connections has been proposed to explain picture-naming failures in aphasics (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997). Within this framework, homophone production increases the strength of connections that are critical for proper-name production, increasing the probability of retrieval for older adults and speeding retrieval regardless of age. We have argued that proper names are difficult to produce because their functional architecture, in particular, the absence of multiple semantic connections, renders them vulnerable to transmission deficits at the lexical and phonological levels (see Fig. 1). Our results suggest that homophone production affects both levels because the reduction of TOTs reflects a phonological-level effect and the reduction of "don't know" responses reflects a lexical-level effect.

An effect at the phonological level is compatible with a number of language production models that agree that homophones share phonological nodes (e.g., Dell, 1986, 1990; Jescheniak & Levelt, 1994; Levelt, Roelofs, & Meyer, 1999; MacKay, 1987). Thus, the benefit of stronger phonological connections after production of a word accrues to homophones of the word. Stronger connections increase the transmission of excitation, and within the phonological system, this would reduce retrieval failures causing TOTs, as we observed in older participants, and would also increase speed of phonological retrieval, as we observed in all participants.

Evidence for an effect at the lexical level is that prior homophone production reduced "don't know" responses for older adults. Because such responses occur when lexical selection fails, this decrease suggests that the stronger phonological connections increased feedback of excitation to the target lexical node, allowing it to compete more successfully for selection. Language production models differ in whether they allow input from the phonological system to influence lexical selection. Our finding of an effect at the lexical level is inconsistent with sequential stage models of production, in which lexical selection is a modular process with no input from phonology (e.g., Levelt et al., 1999). Under interactive models of production, however, increased strength of phonological connections will facilitate lexical selection through interactive feedback of excitation between phonological and lexical nodes (Dell, 1986, 1990; Gordon & Dell, 2001; MacKay, 1987).

The present results bolster other evidence that excitation from phonological to lexical representations during production affects selection (e.g., Dell, 1990; Ferreira & Griffin, 2003; Harley & Bown, 1998; Vitevitch, 2002). Our findings, however, reveal a case in which the effect on selection is visible only for older adults. Within the present theoretical framework, this selective effect reflects the interaction between age-related weakening of connections and the functional architecture of proper names. Weakened connections reduce transmission between phonological and lexical levels (Gordon & Dell, 2001; MacKay, 1987; Taylor & Burke, 2002), and this impairs successful production of proper names because of the paucity of semantic top-down excitation for proper names, compared with other words.

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