Canadian Journal of Experimental Psychology / Revue canadienne de psychologie expérimentale
2012, Vol. 66, No. 3, 212–216

1196-1961/12/$12.00 DOI: 10.1037/a0028309

Aging and the Production Effect: A Test of the Distinctiveness Account

Olivia Y. H. Lin and Colin M. MacLeod
University of Waterloo

The production effect refers to the benefit in memory for items read aloud relative to items read silently during study. Previous research has explained this benefit as due to distinctiveness, attributable to the additional dimension of encoding for the aloud items that is later used during retrieval. We investigated the production effect in older adults, a population known to have difficulty using distinctiveness to assist remembering. Results showed a production benefit for both younger and older adults on both recall and recognition tests; however, this benefit was reliably smaller for older adults on both measures of memory. This pattern addresses both a theoretical issue and an applied issue: (1) that the role of distinctiveness is pivotal in the production effect, and (2) that production does assist older people in remembering.

Keywords: memory, aging, production effect, distinctiveness

Saying thoughts aloud is often done with the goal of improving memory for those thoughts in the future. The prototypical illustration is that of students studying aloud for an upcoming test, believing that this will improve their memory for the material. But does reading aloud really improve remembering? Studies have, in fact, repeatedly found that saying words aloud is beneficial for remembering them later (Kurtz & Hovland, 1953; Conway & Gathercole, 1987; Gathercole & Conway, 1988; Hopkins & Edwards, 1972). Moreover, this advantage is quite substantial and robust (Forrin, Ozubko, & MacLeod, in press; Hourihan & MacLeod, 2008; MacDonald & MacLeod, 1998; MacLeod, 2011; MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010; Ozubko & MacLeod, 2010; Ozubko, Gopie, & MacLeod, 2012).[1] This benefit for later remembering of having said words aloud at encoding has been labelled *the production effect* (MacLeod et al., 2010). We also know that the benefit is an enduring one and that it is not restricted to arbitrary word lists but occurs for meaningful material as well (Ozubko, Hourihan, & MacLeod, 2012).

Recent research on the production effect has provided evidence for the critical role of distinctiveness both at encoding and at retrieval. To explain the production benefit, MacLeod and his colleagues (e.g., Forrin et al., in press; MacLeod, 2011; MacLeod et al., 2010; Ozubko & MacLeod, 2010; Ozubko, Gopie, & MacLeod, 2012) have argued that the distinctiveness of aloud words relative to silent words at the time of encoding underlies the better memory for the aloud words at the time of test (see Conway & Gathercole, 1987, for the origin of this idea). Hunt (2006) describes distinctiveness as the processing of similarities and the processing of differences. Having said some words aloud makes those words distinctive by virtue of their having an additional dimension of encoding—that they were produced. At the time of test, participants can use retrieval of the fact that they produced a word during study to certify that it was indeed experienced before.

Evidence for the role of distinctiveness comes from three main sources. First, Hopkins and Edwards (1972) and MacLeod et al. (2010) have shown that the production effect is restricted to mixed list, within-subject designs, where the produced words are observably distinct from the unproduced words. The effect does not appear for pure list, between-subjects designs, suggesting that it relies on the relative comparison between aloud and silent words, where aloud words are made distinctive. Second, Ozubko and MacLeod (2010) have directly tested the distinctiveness account. Their participants studied a critical mixed list containing some words read aloud and others read silently. An additional pure list was studied either all aloud or all silently. The test was list discrimination—to decide to which list each test word belonged. When the additional pure list was read silently during study, the production effect was as strong as usual; when the additional pure list was read aloud, the production effect vanished. Undermining the distinctiveness of having said a word aloud eliminated the production advantage. Third, MacLeod (2011) has shown that the production benefit is larger when it involves self-production than production by another person; it makes sense that one's own productions would be the most distinctive.

This article was published Online First June 11, 2012.

Olivia Y. H. Lin and Colin M. MacLeod, Department of Psychology, University of Waterloo, Waterloo, Ontario, Canada.

This research was supported by Natural Sciences and Engineering Research Council of Canada discovery grant A7459. We are grateful to Merrick Levene for assistance with collecting the data.

Correspondence concerning this article should be addressed to Olivia Y. H. Lin, Department of Psychology, University of Waterloo, 200 University Avenue West, Waterloo, ON N2L 3G1, Canada. E-mail: y39lin@uwaterloo.ca or cmacleod@uwaterloo.ca

[1] It is not clear why Hashtroudi, Johnson, and Chrosniak (1989) found no production effect in their source monitoring experiments. In their conditions that were most similar to production effect experiments, participants were asked to say aloud half of the words and to think that they had said aloud the other half of the words. Hashtroudi et al. obtained the usual result that older adults remembered less well overall than younger adults; however, there was no difference between the said aloud items and the think items in either age group.

Under a distinctiveness account, the ability to retrieve the distinctive information at retrieval is clearly important. At the time of test, retrieval of the distinctive encoding of produced items requires that memory be monitored for whether items were spoken aloud during study. Using the remember/know (e.g., Gardiner, 1988; Rajaram, 1993) and receiver operating characteristic (e.g., Yonelinas, 1994) paradigms, Ozubko, Gopie, & MacLeod (2012) have demonstrated that the production effect is evident both in recollection-based and in familiarity-based recognition. Moreover, in the same study, source memory—in this case, memory for whether a word had been studied aloud or silently—was also better for the produced words. These findings also are consistent with the production benefit hinging on the retrieval of distinctive information in memory indicating that an item had in fact been produced during study.

Because retrieval of distinctive information appears to be crucial for the production advantage, it follows that individuals who have difficulty with retrieving distinctive information should be at a disadvantage, and should show a reduced production effect. This in turn would support the central role of distinctiveness in the production effect. In fact, studies have shown a decline in memory monitoring with age (see, e.g., remember/know in McIntyre & Craik, 1987; source memory in Perfect & Dasgupta, 1997; reality monitoring in Johnson & Raye, 1981; judgments of learning in Daniels, Toth, & Hertzog, 2009). Although these findings must be considered in the light of others that have reported no reliable age difference in memory monitoring (Connor, Dunlosky, & Hertzog, 1997; Halamish, McGillivray, & Castel, 2011; Hertzog, Kidder, Powell-Moman, & Dunlosky, 2002), we take the fact that corresponding costs have been shown for older adults in remembering distinctive events (e.g., Butler, McDaniel, McCabe, & Dornburg, 2010; Ferguson, Hashtroudi, & Johnson, 1992; Geraci, McDaniel, Manzano, & Roediger, 2009; Rankin & Firnhaber, 1986; Smith, 2011; Smith, Lozito, & Bayen, 2005) as corroborating the studies showing costs in memory monitoring as a function of aging.

Exploring the effects of age on production will potentially support the account that retrieval of distinctive information plays an important role in the production effect. In addition, if the production effect still leads to some benefit even in older individuals, it would constitute a simple technique for improving their memory. While existing means of improving memory in older adults often rely on some sort of elaboration of the stimuli, the production effect relies solely on making a simple unique response to the stimulus, one that is quite automatic given a lifetime of reading. The act of saying things aloud to provide a boost in memory is therefore not dependent on whether stimuli must be elaborated to be encoded deeply. Consequently, the production effect could be a simple task to perform at the time of encoding for a population that has more difficulty in elaboration or in using strategies to boost memory.

In this study, we compared the production effect in younger and older adults. Following the standard procedure (MacLeod et al., 2010), both groups were shown a list of words at the time of study and were cued by print color to say half of them aloud and half of them silently. At the time of test, they were given both a free recall test and a yes/no recognition test. We predicted that the production effect would be evident for older adults but that, relative to younger adults, it would be reduced because of the older adults' less successful use of the distinctive information that a word had been said aloud.

Method

Participants

Twenty-eight older adults were recruited from the Waterloo Research in Aging Participant (WRAP) pool at the University of Waterloo. Their ages ranged from 67–88, with a mean of 75.7 years and a standard deviation of 6.04. For participating, older adults were given $10. The data of one older adult were discarded for failure to recall any words at all, leaving 27 in the final data set. Twenty-four younger adults were recruited from the undergraduate participant pool at the University of Waterloo. Age range was from 17 to 25 (with the exception of one student who was 40 years old). The younger adults received course credit for participation. All participants in both groups were healthy, had normal or corrected-to-normal vision, and spoke English fluently. Informed consent was obtained from all participants.

Stimuli

The item pool consisted of the same 120 words that appear in the Appendix of MacDonald and MacLeod (1998). From these, a random 36 words were selected as study items for each participant, with 18 studied in blue and 18 studied in white, in random order. The recognition test consisted of 72 words, half of them the "old" words that had been studied (the 18 blue words and the 18 white words) and half of them "new" words that had not been studied, with new words also drawn at random from the remaining 84 words in the pool. All words were presented in yellow during the test, so that there was no color match or mismatch with study.

Apparatus

A PC-compatible computer with a 15-in color monitor was used for testing. The controlling program was written in E-prime (Psychology Software Tools, Pittsburgh, PA, U.S.A.).

Procedure

Participants took part individually in the three phases of the experiment: study, recall, and recognition. During the study phase, participants were randomly assigned to one of two counterbalancing groups: In the blue aloud condition, participants were told to read the blue words aloud and the white words silently; in the white aloud condition, they were told to read the white words aloud and the blue words silently. Study trials initiated with a blank of 250 ms, then the word appeared in lower case at the centre of the screen for 3,000 ms, and this was followed by a blank of 250 ms. The experimenter was present to ensure that participants correctly read only their assigned words aloud; participants had no difficulty doing so.

For the recall test, participants were asked to write down on a piece of paper, in any order, all words that they could remember having seen during the study phase, whether originally read aloud or silently. Participants were allowed as much time as they wished to do so and were encouraged to write words down even if they were not sure.

For the recognition test, test words appeared one at a time at the center of the screen, with a new randomization intermixing the studied and unstudied words. Participants were asked to make a judgment whether each word was a previously studied word (old item) or a previously unstudied word (new item). It was made clear that all words presented in the study phase, whether read aloud or read silently, were to be considered "old." Participants pressed "m" if they thought a word was "old" and "z" if they thought it was "new." Each test word remained on the screen until the participant responded; a 250-ms blank preceded presentation of the next test word.

Some studies have shown that a prior recall test can affect the likelihood of items subsequently being correctly recognized (Belbin, 1950; Postman, Jenkins, & Postman, 1948; Rabinowitz, Mandler, & Patterson, 1977), but the effect is not large. In a study aimed directly at the possibility of such "contamination," Darley and Murdock (1971) found no influence of a prior recall test on subsequent recognition performance. For this reason, we adopted the very common tactic of administering both tests, with recall preceding recognition.

Results

Recall

The proportions of words correctly recalled are shown as a function of condition on the left side of Table 1. These data were submitted to a 2 × 2 mixed analysis of variance (ANOVA) with Age (younger vs. older) as the between-subjects variable and Study condition (aloud vs. silent) as the within-subject variable. There was a reliable main effect of Age, with younger adults (.24) recalling more words than older adults (.14), $F(1, 49) = 23.58$, $MSE = 0.011$, $p < .001$, partial $\eta^2 = 0.33$. There was also a reliable main effect of study condition, with more words recalled that had been studied aloud (.27) than that had been studied silently (.10), $F(1, 49) = 55.90$, $MSE = 0.012$, $p < .001$, partial $\eta^2 = 0.53$. Of central interest, the interaction between Study condition and Age was also significant, $F(1, 49) = 17.28$, $MSE = 0.012$, $p < .001$, partial $\eta^2 = 0.26$. This interaction indicates that although there was a reliable production effect both for younger adults, $t(23) = 7.95$, $p < .001$, and for older adults, $t(26) = 2.43$, $p < .05$, the benefit of production was considerably larger for the younger adults because they recalled the words that they had produced aloud better than did the older adults, $t(49) = 6.20$, $p < .001$.

Table 1
Proportion Correct in Recall and Proportion of Hits in Recognition as a Function of Age and Encoding Condition

	Recall		Recognition	
Age	Aloud	Silent	Aloud	Silent
Younger	.36 (.02)	.11 (.02)	.85 (.03)	.58 (.04)
Older	.17 (.02)	.10 (.02)	.76 (.03)	.62 (.04)

Note. Standard errors are shown in parentheses below the corresponding means. The false alarm rates in recognition, in common for the Aloud and Silent conditions for each participant, were low (for younger adults: $M = .13$, $SE = .02$; for older adults: $M = .18$, $SE = .03$).

Is production the "active ingredient" in the observed age difference? There are two measures that can help to rule out other possibilities: intrusion rate and output order. The number of intrusions (i.e., words recalled that were not studied) provides an index—albeit imperfect—of willingness to output responses. No reliable difference was observed in the mean number of intrusions between younger adults ($M = 1.81$) and older adults ($M = 1.08$), $t(49) = 1.50$, $p > .10$, indicating that younger adults were not simply willing to provide more responses. The other possibility is that younger adults were more likely than older adults to output their aloud words before their silent words, resulting in the younger adults suffering greater output interference for the silent words (see Roediger, 1974). Following the simple procedure of Macrae and MacLeod (1999), we calculated separate average recall positions for aloud items and for silent items for each participant. A smaller value would indicate that the average position of those items appears earlier in free recall. Two *t* tests comparing the average recall positions of aloud items and silent items indicated that these did not differ either in younger adults, $t(19) = 0.93$, $p > .20$, or in older adults, $t(19) = 0.52$, $p > .20$. Thus, the larger production effect in younger adults was neither due to differential output interference nor does it appear to have been due to differential willingness to provide responses.

Recognition

The recognition data are the mean proportions of "yes" responses in each condition; the correct "yes" responses (hits) are shown on the right side of Table 1.[2] The false alarm rates, in common for the Aloud and Silent conditions for each participant, are noted below Table 1. The false alarms were low and did not differ reliably between the age groups, $t(49) = 1.28$, $p > .20$. The same 2 × 2 mixed ANOVA was carried out on the hits as had been used to examine recall performance. This time, the main effect of Age was nonsignificant, $F < 1$, with older adults (.69) recognizing overall only slightly fewer studied words than younger adults (.72). There was a reliable main effect of Study condition with words studied aloud (.80) better recognized than words studied silently (.60), $F(1, 49) = 48.63$, $MSE = 0.022$, $p < .001$, partial $\eta^2 = 0.50$. Most important, there was a significant interaction of Study condition with Age, $F(1, 49) = 4.01$, $MSE = 0.022$, $p = .05$, partial $\eta^2 = 0.08$. This interaction indicates that although there was a reliable production effect both for younger adults, $t(23) = 6.35$, $p < .001$, and for older adults, $t(26) = 3.54$, $p < .01$, the benefit of production was larger for the younger adults because they recognized the words that they had produced aloud better than did the older adults, $t(49) = 2.08$, $p < .05$.[3]

[2] Because there was a single false alarm rate, analyses of corrected recognition (hits minus false alarms) would have been redundant. A parallel set of analyses using *d'* as the dependent measure supported the same conclusions.

[3] When older adults were divided into young-old adults (60–74 years old) and old-old adults (75–88 years old), Tukey's test revealed no difference between these two groups in recall of either aloud items or silent items ($ps > 0.05$).

Discussion

This study addresses both an applied issue and a theoretical issue—to determine whether production can benefit older adults and to ascertain whether this benefit is reduced in older adults relative to younger adults. If the production effect is reduced in older adults, then this would be consistent with the explanation (e.g., MacLeod et al., 2010) that the distinctiveness of items produced aloud underlies the production benefit, given that older adults have been shown in numerous studies to have difficulty using distinctive information in memory (e.g., Butler et al., 2010; Ferguson et al., 1992; Geraci et al., 2009; Smith, 2011; Rankin & Firnhaber, 1986; Smith et al., 2005). Our results indeed showed that older adults did benefit from production, whether measured by recall or recognition. Compared to younger adults, however, older adults showed a reduction in the production benefit in both recall and recognition.

The overall pattern—that older adults remembered less well on both the recall and recognition test, and that their disadvantage relative to younger adults was more evident in recall than in recognition (e.g., Craik & Jennings, 1992; Craik & McDowd, 1987; Naveh-Benjamin, 2000)—is consistent with the extensive aging and memory literature (see Yonelinas, 2002). The finding of an increased cost in recall is the conclusion frequently reached in the literature (see Yonelinas, 2002)—that the effect of aging is considerably greater on recollection than on familiarity. In addition, the findings are consistent with those of Ozubko, Gopie, & MacLeod (2012) that participants' source memory was better for produced items and that estimates of familiarity and recollection both showed reliable influences of production.

We argue that the reduction in the production effect for older adults is due to the difficulty that they have in retrieving distinctive information, in this case about whether words were said aloud. At the time of test, memory monitoring is required to retrieve distinctive encodings of produced items. Past research has shown that older adults often have greater difficulty than younger adults in monitoring memory (see, e.g., McIntyre & Craik,1987; Perfect & Dasgupta,1997; Daniels et al., 2009) and, most relevant, that they show more of a cost in memory for distinctive events (e.g., Butler et al., 2010; Ferguson et al., 1992; Geraci et al., 2009; Rankin & Firnhaber, 1986; Smith, 2011; Smith et al., 2005). This pattern is consistent with the distinctiveness account of the production effect.

Finally, it is noteworthy that the reduced production benefit for older adults is expressed largely in the aloud words: Older adults performed similarly to younger adults for silent words but showed reduced memory for aloud words. This interaction between age and production is consistent with the frequently reported finding that distinctiveness at encoding is not as beneficial at retrieval in older adults. If older adults are less able to retrieve the distinctive processing associated with the aloud items—that they were, in fact, studied aloud—then we would expect to see a reduction in memory primarily for aloud items.[4]

In sum, the present study supports the account of the production effect that has been advocated recently by MacLeod and colleagues (Forrin et al., in press; Hourihan & MacLeod, 2008; MacLeod, 2011; MacLeod et al., 2010; Ozubko & MacLeod, 2010; Ozubko, Gopie, & MacLeod, 2012) and earlier by Conway and Gathercole (1987) and Gathercole and Conway (1988). The argument has been that, at the time of study, people encode the distinctive information that an item was produced; then, at the time of test, they monitor memory for whether that distinctive information is present. The distinctiveness of production leads to produced items being more successfully remembered, and hence underlies their advantage. The role of distinctiveness in the production effect has been directly supported by Ozubko and MacLeod (2010), who have shown that the effect is eliminated when the distinctiveness of production is undermined. It is also clear that the production effect is robust for items associated with episodic information (i.e., items that are recollected) as well as for items whose familiarity is above criterion (Ozubko, Gopie, & MacLeod, 2012).

The production effect appears to be a useful encoding tactic even for older adults. This is true despite older adults not being as proficient as younger adults at recovering the distinctive processing engaged in during study of produced items. This deficiency should affect any measure of explicit memory, as it did both recall and recognition in the present study. Given the extensive evidence for a deficit in the use of distinctive encodings in older adults, we strongly suspect that this is the primary cause of the reduced production effect in older adults. Yet despite showing a reduced benefit, production still improved memory in older adults, and fairly substantially. Because production is very simple to execute mnemonically and because older adults tend to have more difficulty generating mnemonic strategies (Naveh-Benjamin, Brav, & Levi, 2007), we are optimistic that its application may well assist older adults in more successful remembering.

[4] It might be ventured that there could be a floor effect for silent items (close to zero in recall; close to chance = .5 in recognition). Although definitive rejection of such a speculation is not straightforward, single sample *t*-tests showed that, for both age groups, the silent condition was reliably different from either zero (recall) or chance (recognition), all four ts > 1.86, ps $< .05$.

Résumé

L'effet de production réfère aux bénéfices de mémorisation associés aux items qui sont lus à voix haute par rapport à ceux qui sont lus silencieusement durant l'étude. Les recherches antérieures ont expliqué cet effet en termes de caractère distinctif, attribuable à la dimension d'encodage additionnelle pour les items lus à voix haute qui est ensuite utilisée durant la récupération. Nous avons étudié l'effet de production chez des adultes âgés, une population connue pour avoir des difficultés à utiliser le caractère distinctif comme aide à la mémoire. Les résultats ont montré un bénéfice associé à la production chez les adultes jeunes et âgés, et ce, aux tests de rappel et de reconnaissance; cependant, ce bénéfice était sensiblement plus petit chez les adultes âgés pour les deux mesures de mémoire. Cette tendance observée revêt un intérêt théorique et un intérêt appliqué : (1) le rôle du caractère distinct est central dans l'effet de production et (2) la production aide les personnes âgées à se rappeler.

Mots-clés : mémoire, vieillissement, effet de production, caractère distinct.

References

Belbin, E. (1950). The influence of interpolated recall upon recognition. *The Quarterly Journal of Experimental Psychology, 2,* 163–169. doi: 10.1080/17470215008416593

Butler, K. M., McDaniel, M. A., McCabe, D. P., & Dornburg, C. C. (2010). The influence of distinctive processing manipulations on older adults' false memory. *Neuropsychology, Development, and Cognition: Aging, Neuropsychology, and Cognition, 17,* 129–159. doi:10.1080/13825580903029715

Connor, L. T., Dunlosky, J., & Hertzog, C. (1997). Age-related differences in absolute but not relative metamemory accuracy. *Psychology and Aging, 12,* 50–71. doi:10.1037/0882-7974.12.1.50

Conway, M. A., & Gathercole, S. E. (1987). Modality and long-term memory. *Journal of Memory and Language, 26,* 341–361. doi:10.1016/0749-596X(87)90118-5

Craik, F. I. M., & Jennings, J. M. (1992). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 51–110). Hillsdale, NJ: Lawrence Erlbaum Associates.

Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 474–479. doi:10.1037/0278-7393.13.3.474

Daniels, K. A., Toth, J. P., & Hertzog, C. (2009). Aging and recollection in the accuracy of judgments of learning. *Psychology and Aging, 24,* 494–500. doi:10.1037/a0015269

Darley, C. F., & Murdock, B. B. (1971). Effects of prior free recall testing on final recall and recognition. *Journal of Experimental Psychology, 91,* 66–73. doi:10.1037/h0031836

Ferguson, S. A., Hashtroudi, S., & Johnson, M. K. (1992). Age differences in using source-relevant cues. *Psychology and Aging, 7,* 443–452. doi:10.1037/0882-7974.7.3.443

Forrin, N. D., Ozubko, J. D., & MacLeod, C. M. (in press). Extending the boundaries of the production effect. *Memory & Cognition.*

Gardiner, J. M. (1988). Generation and priming effects in word-fragment completion. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 495–501. doi:10.1037/0278-7393.14.3.495

Gathercole, S. E., & Conway, M. A. (1988). Exploring long-term modality effects: Vocalization leads to best retention. *Memory & Cognition, 16,* 110–119. doi:10.3758/BF03213478

Geraci, L., McDaniel, M. A., Manzano, I., & Roediger, H. L., III. (2009). The influence of age on memory for distinctive events. *Memory & Cognition, 37,* 175–180. doi:10.3758/MC.37.2.175

Halamish, V., McGillivray, S., & Castel, A. D. (2011). Monitoring one's own forgetting in younger and older adults. *Psychology and Aging, 26,* 631–635. doi:10.1037/a0022852

Hashtroudi, S., Johnson, M. K., & Chrosniak, L. D. (1989). Aging and source memory. *Psychology and Aging, 4,* 106–112. doi:10.1037/0882-7974.4.1.106

Hertzog, C., Kidder, D. P., Powell-Moman, A., & Dunlosky, J. (2002). Aging and monitoring associative learning: Is monitoring accuracy spared or impaired? *Psychology and Aging, 17,* 209–225. doi:10.1037/0882-7974.17.2.209

Hopkins, R. H., & Edwards, R. E. (1972). Pronunciation effects in recognition memory. *Journal of Verbal Learning & Verbal Behavior, 11,* 534–537. doi:10.1016/S0022-5371(72)80036-7

Hourihan, K. L., & MacLeod, C. M. (2008). Directed forgetting meets the production effect: Distinctive processing is resistant to intentional forgetting. *Canadian Journal of Experimental Psychology, 62,* 242–246. doi:10.1037/1196-1961.62.4.242

Hunt, R. R. (2006). The concept of distinctiveness in memory research. In R. R. Hunt & J. B. Worthen (Eds.), *Distinctiveness and memory* (pp. 3–25). New York, NY: Oxford University Press.

Johnson, M. K., & Raye, C. L. (1981). Reality monitoring. *Psychological Review, 88,* 67–85. doi:10.1037/0033-295X.88.1.67

Kurtz, K. H., & Hovland, C. I. (1953). The effect of verbalization during observation of stimulus objects upon accuracy of recognition and recall. *Journal of Experimental Psychology, 45,* 157–164. doi:10.1037/h0061022

MacDonald, P. A., & MacLeod, C. M. (1998). The influence of attention at encoding on direct and indirect remembering. *Acta Psychologica, 98,* 291–310. doi:10.1016/S0001-6918(97)00047-4

MacLeod, C. M. (2011). I said, you said: The production effect gets personal. *Psychonomic Bulletin & Review, 18,* 1197–1202. doi:10.3758/s13423-011-0168-8

MacLeod, C. M., Gopie, N., Hourihan, K. L., Neary, K. R., & Ozubko, J. D. (2010). The production effect: Delineation of a phenomenon. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36,* 671–685. doi:10.1037/a0018785

Macrae, C. N., & MacLeod, M. D. (1999). On recollections lost: When practice makes imperfect. *Journal of Personality and Social Psychology, 77,* 463–473. doi:10.1037/0022-3514.77.3.463

McIntyre, J. S., & Craik, F. I. M. (1987). Age differences in memory for item and source information. *Canadian Journal of Psychology, 41,* 175–192. doi:10.1037/h0084154

Naveh-Benjamin, M. (2000). Adult age differences in memory performance: Tests of an associative deficit hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 26,* 1170–1187. doi:10.1037/0278-7393.26.5.1170

Naveh-Benjamin, M., Keshet Brav, T., & Levi, D. (2007). The associative memory deficit of older adults: The role of efficient strategy utilization. *Psychology and Aging, 22,* 202–208. doi:10.1037/0882-7974.22.1.202

Ozubko, J. D., Gopie, N., & MacLeod, C. M. (2012). Production benefits both recollection and familiarity. *Memory & Cognition, 40,* 326–338.

Ozubko, J. D., Hourihan, K. L., & MacLeod, C. M. (2012). Production benefits learning: The production effect endures and improves memory for text. *Manuscript submitted for publication.*

Ozubko, J. D., & MacLeod, C. M. (2010). The production effect in memory: Evidence that distinctiveness underlies the benefit. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 36,* 1543–1547. doi:10.1037/a0020604

Perfect, T. J., & Dasgupta, Z. R. R. (1997). What underlies the deficit in reported recollective experience in old age? *Memory & Cognition, 25,* 849–858. doi:10.3758/BF03211329

Postman, L., Jenkins, W. O., & Postman, D. L. (1948). An experimental comparison of active recall and recognition. *American Journal of Psychology, 61,* 511–519. doi:10.2307/1418315

Rabinowitz, J., C., Mandler, G., & Patterson, K. E. (1977). Determinants of recognition and recall: Accessibility and generation. *Journal of Experimental Psychology: General, 106,* 302–329. doi:10.1037/0096-3445.106.3.302

Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory & Cognition, 21,* 89–102. doi:10.3758/BF03211168

Rankin, J. L., & Firnhaber, S. (1986). Adult age differences in memory: Effects of distinctive and common encodings. *Experimental Aging Research, 12,* 141–146. doi:10.1080/03610738608259451

Roediger, H. L. (1974). Inhibiting effects of recall. *Memory & Cognition, 2,* 261–269. doi:10.3758/BF03208993

Smith, R. E. (2011). Providing support for distinctive processing: The isolation effect in young and older adults. *Psychology and Aging, 26,* 744–751. doi:10.1037/a0022715

Smith, R. E., Lozito, J. P., & Bayen, U. J. (2005). Adult age differences in distinctive processing: The modality effect on false recall. *Psychology and Aging, 20,* 486–492. doi:10.1037/0882-7974.20.3.486

Yonelinas, A. P. (1994). Receiver-operating characteristics in recognition memory: Evidence for a dual-process model. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 1341–1354. doi:10.1037/0278-7393.20.6.1341

Yonelinas, A. P. (2002). The nature of recollection and familiarity: A review of 30 years of research. *Journal of Memory and Language, 46,* 441–517. doi:10.1006/jmla.2002.2864

Received September 8, 2011
Accepted March 26, 2012 ■