

EDITORIAL / ÉDITORIAL

The Benefits of Studying by Production . . . and of Studying Production: Introduction to the Special Issue on the Production Effect in Memory

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The *production effect* refers to enhanced memory for materials that were produced at study (e.g., those read aloud) relative to materials that were not produced (e.g., those read silently). The effect has generated a wave of interest since being named in 2010 (MacLeod, Gopie, Hourihan, Neary, and Ozubko, 2010)—likely because of the simplicity of production tasks and of the substantial memory improvements that they can yield. This special issue of the *Canadian Journal of Experimental Psychology* brings together 10 new studies on the production effect in memory. Our introduction provides an expanded definition of the effect along with some examples to help orient readers. The present studies contribute to our understanding of the production effect and to memory more broadly. Just as important, they also raise new questions and provide a honed set of methodological tools that will help to guide further research and theorizing about memory.

Keywords: memory, production effect, distinctiveness, recognition, recall

The encoding techniques that we routinely recommend to learners are quite laborious. They require learners to be imaginative (e.g., imagery; Paivio, 1971), engaged (e.g., elaborative processing; Craik & Lockhart, 1972), or physically active (e.g., enactment; Engelkamp, 1998), or to acquire specially prepared materials prior to study (e.g., self-generation from cues; Slamecka & Graf, 1978). When lecturing about the stock set of study strategies, one can almost hear the students saying “there has to be an easier way.” It turns out that they may be right. A wave of research on the production effect—so named by MacLeod, Gopie, Hourihan, Neary, and Ozubko (2010)—suggests that the simple act of saying study materials out loud can yield substantial memory benefits. This special issue of the *Canadian Journal of Experimental Psychology* adds 10 studies that advance our understanding of the effect, and of memory more broadly.

On the topic of broadening, now is a good time to expand the definition of the production effect given that, relative to silent reading, a wide range of production routes have been shown to enhance memory. These include mouthing (e.g., MacLeod et al.,

2010), singing (e.g., Quinlan & Taylor, 2013), writing or typing or spelling (e.g., Forrin, MacLeod, & Ozubko, 2012), and even drawing (Wammes, Meade, & Fernandes, 2016). By contrast, there appears to be little or no benefit to memory from performing the same production task on a subset of studied items, such as saying “yes” or pressing a spacebar for multiple items (MacLeod et al., 2010). Therefore, we will define the *production effect* as enhanced memory for materials that were given unique productions during study relative to materials that were not produced.

Research on the production effect caught fire with MacLeod et al.’s (2010) delineation of the phenomenon, but it was preceded by a long, slow burn. A hundred years ago, in the published version of his dissertation exploring the value of study versus test cycles (which he called “reading” vs. “reciting”), Gates (1917, p. 67) noted that his participants “reported that practice in accurate pronunciation of the material was an aid in learning.” Many learners share his intuition, as MacLeod et al. (2010) heard when debriefing their participants. Castel, Rhodes, and Friedman (2013) confirmed that the production advantage is intuitive to participants (although they also showed that participants overgeneralized this intuition). In fact, though, Hopkins and Edwards (1972) were the first to empirically test and confirm this intuition for long-term retention, aligning with earlier work in the realm of short-term retention (e.g., Crowder, 1970; Murray, 1965).

As reviewed in MacLeod et al. (2010), only a handful of other studies of the effect appeared in the intervening years, with relevant—but isolated—observations cropping up every decade or so (e.g., Conway & Gathercole, 1987; MacDonald & MacLeod, 1998). By contrast, considerably more articles on the effect have appeared since 2010. Many of these recent articles have concentrated on specifying the mechanisms of the production advantage,

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whether it reflects the enhanced distinctiveness of produced material (e.g., Ozubko, Major, & MacLeod, 2014) and/or their greater memory strength (e.g., Bodner & Taikh, 2012). As of yet, only a few have examined the potential applications of production, including for students studying text materials (e.g., Ozubko, Hourihan, & MacLeod, 2012) and for musicians learning to play new piano melodies (Mathias, Palmer, Perrin, & Tillmann, 2015).

The articles in the special issue build on these foundations, but we will avoid stealing their thunder here. Instead, Table 1

provides an illustration of how each article in the issue contributes (a) to our understanding of the production effect, (b) to memory research more generally, and (c) to the future of research about memory. Our hope is that this summary captures and conveys the contents of the special issue and will remain useful as an organizational tool when viewed through the often unforgiving lens of time.

All of the contributions to the issue use traditional memory tasks (recognition, recall, or cued recall), and all but one use

Table 1
Sample Contributions of the Special Issue to the Production Effect, to Memory Research, and to Future Research Questions

Issue contributors	Sample contributions		
	The production effect	Memory research	Future research questions
Bodner, Jamieson, Cormack, McDonald, & Bernstein, 2016	Differences in memory strength for produced and unproduced items can mask a distinctiveness influence	Influences of distinctiveness and strength are not mutually exclusive	What conditions prompt reliance on distinctiveness vs. strength to guide memory judgments?
Fawcett & Ozubko, 2016	Production enhances recognition through recollection and familiarity in mixed-lists, but only through familiarity in pure lists	Implements a Bayesian data analysis approach with both remember/know and receiver-operating characteristic measures	Does a mixed list enhance distinctiveness, recollection, or both? Does a pure list enhance strength, familiarity, or both?
Forrin & MacLeod, 2016a	In recognition, presentation modality at study, but not at test, affects the magnitude of the production effect, consistent with the distinctiveness account	The effects of encoding tasks on recognition can be influenced differentially by study vs. test modality	Does the sensitivity of memory to presentation modality at encoding vs. retrieval depend on the type of memory test?
Forrin & MacLeod, 2016b ^a	The pattern of production effects on recall of a long list, across mixed-list and pure-list designs, suggests production influences the encoding of item-order information	The item-order account applies to the production effect, and to long-list recall	Does long-list recall rely on item-order information following other encoding tasks?
Hassall, Quinlan, Turk, Taylor, & Krigolson, 2016	The P300 ERP component covaries with production effects, consistent with a distinctiveness account	ERP provides a potentially useful tool for identifying the basis of recognition memory effects	Do distinctiveness and strength effects yield different ERP signatures?
Hourihan & Smith, 2016 ^a	Producing names does not improve recall of face-name associations	Production may only enhance associative memory when both members of pairs are produced	What strategies are supplanted by the requirement to produce the names that one is trying to learn?
Jamieson, Mewhort, & Hockley, 2016	MINERVA 2 captures several production results by assuming produced items are stored with more features, in line with the distinctiveness account	Simulations in a memory model help specify the mechanism driving production effects, and generate testable predictions	Can memory models articulate the difference between strength and distinctiveness? Does the larger mixed-list (vs. pure-list) production effect distinguish them?
Lambert, Bodner, & Taikh, 2016 ^a	The pattern of production effects on recall of a long list, across mixed-list and pure-list designs, suggests production influences the encoding of item-order information	Recall patterns in line with an item-order account are not always accompanied by corresponding patterns of item-order information	Could a task-switch cost for all items in a mixed list be offset by enhanced distinctiveness for produced items, resulting in a cost for nonproduced items?
Mama & Icht, 2016 ^a	The relative advantage of aloud vs. written production at study depends on both study modality and test modality, consistent with a retrieval-cost account	The influence of encoding tasks on recall can depend on the relation between study modality and test modality	On what bases (e.g., modality, motor vs. non-motor) are study list items in a mixed list grouped in memory?
Taikh & Bodner, 2016	The between-subject production effect in recognition is not ubiquitous and could reflect use of a distinctiveness strategy or evaluation of memory strength	Self reports provide another means of assessing whether/when participants use a distinctiveness strategy	Do self-reports provide a means of assessing whether/when participants evaluate memory strength?

^a Memory test was recall or cued recall; for all others the memory test was recognition.

traditional word-list materials and yet—in abundance here—are clever and useful experimental designs, measures, and tools. For example, some of the contributors use Erlebacher's (1977) method for statistical comparison of effects in within-subject versus between-subjects designs, a task made easier by software developed by Merritt, Cook, and Wang (2014). Other contributors make valuable cross-modality comparisons (e.g., written vs. auditory recall or recognition), cross-proportion comparisons (e.g., memory performance as a function of the percentage of items that were produced), or cross-task comparisons (e.g., recall vs. recognition).

On the measures/tools front, contributors highlight the utility of developing new item-order measures for interpreting free recall results, of examining how to capture memory phenomena in a formal memory model, of exploring neural correlates of behavioral data concerning memory, and of the potential advantages of using Bayesian analytic approaches to memory data that have traditionally been analyzed using analysis of variance. As these examples illustrate, research on the production effect has inspired the development of more sophisticated experimental designs, methods, and analytical tools.

We are pleased to see that research on the production effect has enriched our research tools while generating a robust set of findings (a) to constrain theories of the effect and (b) to inform its potential application as a study strategy outside the laboratory. On the theory front, it is clear now that production effects might arise through various mechanisms (e.g., relative distinctiveness, a distinctiveness-based strategy, evaluation of memory strength, the influence of production on the encoding of item-order information). Here, one critical issue will be to explain why production appears to strongly enhance recognition but to have little effect on recall. There is emerging evidence that encoding distinctiveness influences recognition but not recall (e.g., Hunt, Smith, & Toth, 2016). This makes sense in that, for recognition, targets must be discriminated from distracters—hence being “distinctive” matters. In contrast, for recall, distinctiveness might not facilitate the generation of potential study items and/or the retrieval of study items from memory.

On the application front, it is clear that production is a profitable encoding strategy under some conditions, but not others. These conditions require further study. For example, producing some text is helpful relative to unproduced text in a mixed-list situation (Ozubko et al., 2012, Experiment 3) but is there a memory advantage to reading all text aloud? If not, what proportion of materials results in the best benefit-to-cost ratio for memory? Moving away from the memory realm, might production enhance comprehension or decision-making?

The current studies make real progress at fleshing out the “it depends” answers to the key questions of whether, when, and why unique production of study materials can enhance human memory. Not enough time has passed to allow a long view of the production effect, or to benefit from the wonders of hindsight: We will need some time to digest all of this good science! But, we are delighted to see so many informative findings rolling in—findings that constrain some possibilities while uncovering others, revealing a fascinating problem space for motivating productive memory research well into the future.

Résumé

L'effet de la production renvoie à l'amélioration de la mémoire d'éléments produits à l'étude (par ex., par leur lecture à haute voix), comparativement aux éléments non produits (ceux qui n'ont pas été lus à haute voix). L'effet a suscité une vague d'intérêt depuis qu'il a été dénommé en 2010 (MacLeod, Gopie, Hourihan, Neary & Ozubko, 2010), probablement en raison de la simplicité des tâches de production et des grandes améliorations qu'elles occasionnent. Ce numéro spécial de la Revue canadienne de psychologie expérimentale réunit 10 nouvelles études sur l'effet de la production sur la mémoire. L'introduction présente une définition élargie de l'effet ainsi que des exemples pour mieux orienter le lecteur. Quant aux études, elles permettent d'approfondir la compréhension de l'effet de la production et de la mémoire en général. De plus, elles soulèvent de nouvelles questions et fournissent un ensemble optimisé d'outils méthodologiques qui contribueront aux futures recherches et à l'élaboration de théories sur la mémoire.

Mots-clés : mémoire, effet de la production, distinctivité, reconnaissance, mémorisation.

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* denotes an article in the Special Issue

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