CANADIAN PSYCHOLOGICAL ASSOCIATION SOCIÉTÉ CANADIENNE DE PSYCHOLOGIE

Canadian Journal of Experimental Psychology /
Revue canadienne de psychologie expérimentale

ISSN: 1196-1961

2022, Vol. 76, No. 3, 226–233
https://doi.org/10.1037/cep0000284

Production as a Distinctive Contextual Cue for Retrieving Intentionally Forgotten Information

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The production effect—the memory benefit for information studied aloud as opposed to silently—has been credited to the distinctive processing of the aloud information. Could the production effect be characterized more broadly as a context-based memory effect? At encoding, the distinctive "aloud" information could create a global contextual cue that becomes associated with only the produced information. This cue could then be elicited at retrieval to facilitate memory for the produced information. To test this idea, a mixed-list production effect manipulation was combined with a list-method directed forgetting procedure. According to the contextual change account of list-method directed forgetting, when the first of two lists is to be forgotten, that list is poorly remembered later due to the mental context change between the lists, which causes the context of the second list to better match the test context. Reinstating the relevant contextual cues, therefore, improves memory for the to-be-forgotten list. Our results showed that reading aloud did indeed function as contextual information: Reactivating this production information at retrieval enhanced memory only for aloud items—and not for silent items—from the to-be-forgotten list.

Public Significance Statement

Reading information aloud ("production") has been shown to be a simple way to improve memory for that information. Here, reading aloud was shown to act similarly to the way in which an environmental cue does to aid memory for information studied in that environment. Production provides learners with an active cueing method that they can use when encoding and retrieving information, particularly when that information was previously forgotten.

Keywords: memory, context, production effect, directed forgetting, distinctiveness

Supplemental materials: https://doi.org/10.1037/cep0000284.supp

The production effect—in particular, studying information aloud—is a simple memory technique wherein information produced during encoding is better remembered than unproduced information (see the special issue of this journal: Bodner & MacLeod, 2016). The beginning of the modern production effect literature is usually attributed to Hopkins and Edwards (1972), who demonstrated a production effect in a within-subject, mixed-list design, where some words were studied aloud and other words were studied silently; in a between-subjects, pure-list design, however, when separate groups of participants studied the words either all aloud or all silently, they observed no production effect. Other early research on the effect (e.g., Conway & Gathercole, 1987; Dodson & Schacter, 2001) remained sparse prior to it being named and given prominence by MacLeod et al. (2010). Demonstrations of production effects now have also been extended to realistic learning situations (see MacLeod & Bodner, 2017, for a brief review).

The primary explanation for the production effect in recognition has been that production results in distinctive processing applied to the produced information (e.g., MacLeod et al., 2010; Quinlan & Taylor, 2013). Under this distinctiveness account, produced items stand out from unproduced items during study, resulting in one or more additional dimensions of encoding for produced relative to unproduced information. This distinctive processing during study is then influential at the time of test: In addition to trying to remember the actual studied information, people can use the strategy of trying to remember whether an item was produced at study. Thus, on a recognition test, memory of having produced the information during study serves as an additional pathway for the retrieval of that information, providing assistance that is especially critical when remembering the studied information itself is difficult. Jamieson et al. (2016) and Kelly et al. (2022) have presented formal models to illustrate this distinctiveness mechanism, demonstrating that the production effect can be predicted by the encoding of additional sensory features for produced items, which are then used as memory cues during later retrieval of these items.

This article was published Online First May 12, 2022.
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This experiment forms part of the Yichu Zhou's PhD dissertation, which contains a more detailed account. This work was supported by Natural Sciences and Engineering Research Council (NSERC) of Canada Discovery Grant A7459. The data set and programme code for this study are available from the authors upon request.
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Support for the distinctiveness-based explanation of the production effect also comes from the stark contrast in the magnitudes of the effect observed between the mixed-list and pure-list designs: Although we now know that pure-list production effects can be elicited (see Fawcett, 2013, for a review), they are typically considerably smaller than those observed under mixed-list designs. Using a remember-know approach, Fawcett and Ozubko (2016) showed that participants "recollected"—defined as mentally reexperiencing or remembering the episodic details of past events (see Yonelinas, 2002, for a review)—significantly more aloud items than silent items under the within-subject design, whereas recollection did not differ between aloud and silent items under the between-subjects design. This replicated and extended an earlier study by Ozubko et al. (2012), showing that participants' source memory for whether a word was produced at study is better for words studied aloud than for words studied silently. Larger production effects under mixed-list designs due to better memory for source details of produced information clearly support the distinctiveness account because establishing the contrast between aloud and silent items during study is obvious under such designs.

Distinctiveness and Context

The central question motivating the present research pertains to whether the effect of distinctiveness in the production effect can be characterized as a context-based memory effect. When information is produced during study, does this additional dimension of encoding essentially result in a contextual cue being stored with the produced item, which can then be recovered at retrieval to facilitate remembering specifically of the produced information?

Broadly, we know that context is profoundly influential in remembering, as has long been emphasized in theorizing (e.g., McGeoch, 1932). As evidence, environmental contextual similarity between encoding and retrieval has been presented as a key factor in determining whether studied information will be remembered (see Smith & Vela, 2001, for a review). The phenomenon of context-based remembering can be characterized as an effect of encoding specificity (Tulving & Thomson, 1973): Overlap of contextual cues between encoding and retrieval facilitates memory of studied information. Alternatively, it can be characterized as a facilitation effect from the use of mental schemas. Learning and retrieving information are facilitated when existing mental schemas are used to organize new information (e.g., Tse et al., 2007); by analogy, a contextual cue can also serve as a mental schema to which newly acquired information becomes attached, thereby facilitating memory when the same contextual cue is reinstated at retrieval (Shin et al., 2021).

That the production effect involves a recollective process tells us that source memory for produced information—as an associative detail—at least partly determines the memory enhancement for these produced items. This, of course, is the core proposal of the distinctiveness account. The aim of the present study is thus to combine the core theoretical ideas of the production effect and context-based memory effects by proposing that the act of producing an item—though item-specific—becomes associated with these produced items as an overarching *global* (i.e., list-wide) contextual framework. For mixed-list encoding designs containing both produced and unproduced information (as in the present study), this means that production becomes selectively associated *only* with the produced target information as a contextual detail: Encoding nonproduced information obviously does not involve the act of production and also is not distinct relative to produced information.[1] Intentionally, reinstating the use of this production framework at retrieval should facilitate memory for those items that were produced during study but are now proving difficult to remember based on item information alone.

The design of the present experiment was informed by the contextual change hypothesis introduced by Sahakyan and Kelley (2002) as an account of list-method directed forgetting. Their procedure used context reinstatement after intentional forgetting, precisely the approach that is required to address the research question in the present study.

Contextual Change in Directed Forgetting

The contextual change hypothesis uses a framework of global (i.e., list-wide) set differentiation (Bjork, 1970) to explain the effects of directed forgetting in the list-method procedure. In this procedure, participants are typically given two lists of items to study. After studying list 1 but prior to studying list 2, some participants are falsely led to believe that the items from list 1 will not be tested; in fact, all participants are tested on both lists. Relative to a control ("remember") group not instructed to forget list 1, participants in this "forget" group show worse memory for the list 1 items coupled with enhanced memory for the list 2 items (see MacLeod, 1998; Sahakyan et al., 2013, for reviews). The contextual change hypothesis proposes that when participants are told that they can forget list 1, a mental context change occurs such that the new information from list 2 becomes associated with a set of contextual features different from those associated with list 1, the result of sampling of new contextual cues during the study of list 2.

When participants are given a memory test with little or no temporal delay after study, retrieval occurs within the same mental context as for the study phase of list 2, facilitating memory for list 2 because the same contextual cues remain in place. In contrast, the relevant contextual cues from list 1 are less available, leading to a contextual mismatch between list 1 and retrieval, and consequently making list 1 information relatively inaccessible. If, however, participants are prompted at retrieval to try to remember and use the relevant contextual information from the study of list 1, then the effect of directed forgetting should be attenuated to at least some extent.

Sahakyan and Kelley (2002) investigated their context hypothesis using a deliberate reinstatement procedure: Prior to recall, participants who were assigned to the context reinstatement manipulation were asked to try to remember specific thoughts or feelings that they had at the beginning of the study session and through the study phase of list 1. Two differences—both as predicted—were observed between the reinstatement and nonreinstatement groups. First, memory for list 1 was improved for participants told to recollect the initial context relative to participants for whom contextual cues

[1] Hence, in mixed-list designs, the conceptualization of production as a *global* contextual detail stands in contrast to memory tasks, where to-be-encoded items are differentially associated with a series of "localized" contextual cues—such as individual, unique background pictures (e.g., Hockley, 2008; Hockley et al., 2012)—because memory of the nondistinctive unproduced information is not supported by any equivalently distinctive contextual associations.

from list 1 were not reinstated. Second, memory for list 2 after context reinstatement was worse than when reinstatement was not elicited, becoming similar to that of the control remember groups.

Based on this logic, our hypothesis was that if production serves as a contextual framework that becomes associated with produced information, then prompting its use should facilitate memory of this information when it had been intentionally forgotten. In this formulation, production perhaps acts like a category cue, which has been shown to eliminate directed forgetting effects when studying categorically related items—but only when participants are explicitly reminded of the category cue at retrieval (Lehman & Malmberg, 2011). To test this production-as-context hypothesis, a production effect manipulation was inserted into a list-method directed forgetting procedure. Participants were given two lists of words to study, both containing a mixture of items studied aloud and items studied silently. After studying list 1, one group was instructed that it would not be tested and thus did not need to be remembered (the forget group); the other group was simply instructed to go on to study list 2 (the remember group). If participants in the forget group are then explicitly told to try to remember whether each item was studied aloud (i.e., the distinctiveness heuristic), memory for the aloud items in this forget group (studied in both list 1 and list 2) should resemble that of the remember group—without the typical effects of directed forgetting.

Recall Versus Recognition

One additional key issue had to be resolved in designing the experimental procedure. In the production effect literature, the distinctiveness account serves as an explanation for the effect specifically when the method of retrieval is recognition. However, in list-method directed forgetting, when recognition tests have been used, a directed forgetting effect often has not been observed or has been only partially observed (e.g., Benjamin, 2006; Sahakyan & Delaney, 2005). In their original proposal, Sahakyan and Kelley (2002) presented the contextual change hypothesis as an account of directed forgetting specific to when the test is recalled. In so doing, they were taking into account the apparent similarity that recognition tests often fail to reveal any effect not only in list-method directed forgetting but also in (environmental) context-dependent procedures (see Smith & Vela, 2001, for a review).

In subsequent work, Lehman and Malmberg (2009) argued that to enable recognition tests in list-method directed forgetting to reveal the effects of contextual change on memory, the recognition test procedure must be modified. At issue was whether the recognition test was one of "inclusion" versus "exclusion" (Jacoby, 1991). On an inclusion recognition test—the typically used procedure—participants only have to differentiate studied items from unstudied items (e.g., by providing a "yes" or "no" response for each test item); they do not have to differentiate whether items identified as studied came from list 1 or from list 2. On an exclusion recognition test, however, participants would be required to remember the source list of each studied item, responding only to items from one specified list. To do so, participants would have to differentiate the contextual cues associated with each list. Using a modified list-method procedure paired with an exclusion recognition test, Lehman and Malmberg (2009) showed the same pattern of results as was usually seen in recall—forgetting of list 1 and facilitation of list 2 due to the mental context shift caused by the "forget" instruction.

The use of exclusion recognition tests was incorporated into the design of the present study by assigning participants to two different procedures at the time of the recognition test. Within both the forget and remember groups, one subgroup was instructed to indicate for each item that they believed was studied whether that item had been studied aloud or silently (the "aloud vs. silent differentiation" condition). The other subgroup was instructed to indicate for each item that they believed was studied whether that item had been studied in list 1 or list 2 (the "list 1 vs. list 2 differentiation" condition). By prompting participants in the aloud versus silent differentiation condition to use the distinctiveness heuristic at retrieval, the prediction was that those in the subgroup instructed to forget list 1 would show a reduced effect of directed forgetting specifically for the items that had been studied aloud because they would use the relevant contextual cue that facilitates memory for the produced items. In contrast, participants in the list 1 versus list 2 differentiation condition were expected to show the typical effects of directed forgetting for the aloud items. It is important to note that, as explained earlier, these subgroup manipulations were not predicted to differentially affect memory for the silent items because the use of the distinctiveness heuristic represents a cue for contextual reinstatement specifically associated with the produced information.

In summary, by inserting a production effect manipulation within a list-method directed forgetting procedure, the present study investigated whether distinctiveness within the production effect can be characterized as a context-based memory effect. The central prediction was that despite the occurrence of a mental context change between the study of two sets of information—caused by an instruction to forget—the use of the distinctiveness heuristic at retrieval would reinstate a key contextual cue that should specifically facilitate memory of produced information that was intentionally forgotten.

Method

Participants

Participants were 212 students (51 men, 153 women; age range: 17–46 years, M_{age}: 20.1 years, $SD = 3.7$ years; 8 participants declined to provide demographic information) from the University of Waterloo, recruited via the Department of Psychology's research participation system. Ethics approval was obtained from the University of Waterloo Research Ethics Board (ORE #31870), and informed consent was obtained from all participants. Participants received course credit or were paid $10 in exchange for their participation.

Apparatus

The experiment was initially conducted in the laboratory and was subsequently moved online due to the COVID-19 pandemic (51 participants completed the study in the laboratory, of which all were assigned to the forget group; 161 participants completed the study online, of which 48 were assigned to the forget group and 113 were assigned to the remember group). In the laboratory, the study was conducted on a Windows 10-operated computer running a programme written in E-Prime 3.0 (Psychology Software Tools, Pittsburgh, Pennsylvania). Study and test trials were presented on an LCD monitor, with responses collected via a standard QWERTY keyboard. The online version of the study was conducted at https://Pavlovia.org/ running a programme built in PsychoPy Version 2020.1.3 (Open Science Tools, Nottingham, England). Participants completed the experiment on their own computers. An experimenter present for the duration of the study via online video using Cisco Webex (Cisco Systems, San Jose, California) monitored participants to ensure compliance with all of the instructions.

Materials

The study materials consisted of a set of 240 words (listed in the online Supplemental Materials). For the laboratory group, the words were presented in lowercase in the Consolas font, size 36; for the online group, the size of the words was 5% of the height of each participant's computer screen. In both cases, the words were presented against a black background. Words assigned to each condition (i.e., aloud, silent, or new) and to each list were selected randomly for each participant. Each of the two lists in the encoding phase contained 80 words, 40 aloud words and 40 silent words; the remaining 80 words were used as distractors on the recognition test, where the resulting 240 test words were randomized anew.

Procedure

For the study phase, participants were instructed that they would be studying two lists of words. For both lists, they were to read words presented in blue aloud and words presented in white silently; silent reading was to be done without moving their lips. Each blue or white study word was presented individually for 3 s at the centre of the screen with a 500-ms blank screen between successive stimuli. After studying list 1, participants in the forget group were told that only list 2 would be tested. Participants in the remember group were simply instructed to continue on to study list 2 after completing list 1.

A recognition test immediately followed the study phase, with all participants tested on both lists of studied words. The 160 studied words, intermingled with the 80 distractor words, were presented one at a time in a random order in yellow, so that colour would not serve as a retrieval cue. In the aloud versus silent differentiation condition, participants used a keypress to indicate whether each word was studied aloud, was studied silently, or was new ("A" for aloud, "L" for silent, and "N" for new). In the list 1 versus list 2 differentiation condition, participants used a keypress to indicate whether each word was studied in list 1, was studied in list 2, or was new ("1" for list 1, "2" for list 2, and "N" for new). Participants could take as long as they needed for each response. Upon response, the word disappeared and, after a 500-ms blank screen, the next word appeared. The entire procedure took under 30 min.

The procedure for the online version was the same as for the laboratory version, except that participants began by meeting an experimenter on the Cisco Webex online video platform, and the experimenter then provided them with the study's web link. Because of the extra time required for setup, the online version of the study typically took slightly longer to complete than the time required in the laboratory but never more than 60 min in total.

Results

Twenty participants were tested but excluded from analyses due to one of several factors: clear lack of effort based on evidently random responding (8 participants), difficulty in understanding instructions (5 participants), having a false-alarm rate of 2.5 *SD*s greater than the mean (2 participants), or technical issues (5 participants). Of the remaining 192 participants, 95 had been assigned to the forget group and 97 had been assigned to the remember group. In the forget group, 47 participants were assigned to the aloud versus silent differentiation condition and 48 to the list 1 versus list 2 differentiation condition. In the remember group, 49 participants were assigned to the aloud versus silent differentiation condition and 48 to the list 1 versus list 2 differentiation condition.[2]

The analyses were conducted in JASP Version 0.14 (JASP Team, 2020). Here, we present the primary findings for the recognition test data (i.e., hit rates with correct source identifications), shown in Table 1. Additional analyses for source memory errors (i.e., items correctly remembered but associated with the wrong aloud/silent or list 1/list 2 information), false-alarm rates, and production effects are provided in the online Supplemental Material.

False-alarm rates were lower than hit rates without regard to source identification (i.e., as measured on a typical recognition test; see Tables S2 and S3 in the online Supplemental Material), which is evidence of relatively good memory for the studied words. A series of analyses of variances (ANOVAs) was then performed to examine memory for the studied items as a function of test condition: (a) aloud versus silent differentiation or (b) list 1 versus list 2 differentiation.

Aloud Versus Silent Differentiation

A 2 (list 1/list 2; within) × 2 (aloud/silent; within) × 2 (forget/remember; between) mixed ANOVA was performed first to test the prediction that the influence of this retrieval instruction differed depending on whether the aloud items or the silent items were examined. Confirming the prediction, the critical three-way interaction was significant, $F(1, 94) = 11.22$, $MSE = 0.007$, $p = .001$, $\eta_p^2 = 0.107$. Next, two 2 (list 1/list 2; within) × 2 (forget/remember; between) mixed ANOVAs were performed to examine the hit rates as a function of list and study instruction group, separately for the aloud and silent items. Consider first the aloud items. Memory did not differ between lists, $F(1, 94) = 0.84$, $MSE = 0.009$, $p = .361$, $\eta_p^2 = 0.009$. Although participants in the forget group showed numerically better overall recognition than those in the remember group, this instructional difference was only marginal statistically, $F(1, 94) = 3.64$, $MSE = 0.053$, $p = .060$, $\eta_p^2 = 0.037$. The

[2] A post hoc power analysis was performed using G*Power Version 3.1.9.4 (Faul et al., 2007) to confirm that for the aloud items studied in the aloud versus silent differentiation condition, if retrieval using production as a contextual cue did not sufficiently offset the typically expected effects from the directed forgetting manipulation (which are expected in the list 1 vs. list 2 differentiation condition), that a sufficient number of participants had been included to detect these effects. The effect size used in this calculation was based on that from the 2 (list 1/list 2; within) × 2 (forget/remember; between) mixed ANOVA for the aloud items in the list 1 versus list 2 differentiation condition ($\eta_p^2 = 0.120$). The reasoning was that if the main hypothesis was incorrect, a similar difference between the forget and remember groups should be seen in the two experimental conditions. With $\alpha = .05$ and power = 0.95, the appropriate sample size needed to satisfy these parameters was estimated to be $N = 34$ for the forget and remember groups combined. Therefore, the sample size of $N = 96$ is more than adequate for investigating the main hypothesis.

Table 1
Proportions of Hits for Studied Targets and of False Alarms for Unstudied Distractors

Study condition	List 1		List 2		Distractor
	Aloud	Silent	Aloud	Silent	
Aloud versus silent differentiation					
Remember	.393 (.027)	.459 (.022)	.417 (.025)	.442 (.023)	.276 (.020)
Forget	.468 (.025)	.457 (.022)	.469 (.024)	.530 (.023)	.338 (.026)
List 1 versus list 2 differentiation					
Remember	.393 (.018)	.294 (.016)	.500 (.020)	.361 (.021)	.357 (.028)
Forget	.352 (.016)	.324 (.019)	.589 (.019)	.422 (.020)	.301 (.025)

Note. Standard errors are shown in parentheses beside each mean.

interaction was not significant, $F(1, 94) = 0.64$, $MSE = 0.009$, $p = .425$, $\eta_p^2 = 0.007$.[3]

Next, consider the silent items. A corresponding ANOVA showed that recognition was overall better for list 2 than for list 1, $F(1, 94) = 4.82$, $MSE = 0.008$, $p = .031$, $\eta_p^2 = 0.049$, but that memory did not differ as a function of instruction group, $F(1, 94) = 2.20$, $MSE = 0.040$, $p = .141$, $\eta_p^2 = 0.023$. Because the interaction was significant, $F(1, 94) = 12.35$, $MSE = 0.008$, $p < .001$, $\eta_p^2 = 0.116$, the relevant simple effects were probed. Paired-samples *t* tests showed that for list 1, there was no difference in memory between the forget and remember groups, $t(94) = 0.06$, $p = .956$, $d = 0.011$, but that for list 2 memory was significantly better in the forget group than in the remember group, $t(94) = 2.73$, $p = .008$, $d = 0.557$. This was entirely due to better memory in list 2 relative to list 1 in the forget group, $t(46) = 3.48$, $p = .001$, $d = 0.507$; there was no significant difference in memory between lists 1 and 2 in the remember group, $t(48) = 1.13$, $p = .263$, $d = 0.162$.

List 1 Versus List 2 Differentiation

The same three-way mixed ANOVA was performed first to test the prediction that the influence of this retrieval instruction differed for the aloud items versus the silent items. Confirming the prediction, the critical three-way interaction was again significant, $F(1, 94) = 6.08$, $MSE = 0.010$, $p = .015$, $\eta_p^2 = 0.061$. Thus, as was done for the aloud versus silent differentiation condition, two 2 (list 1/list 2; within) × 2 (forget/remember; between) mixed ANOVAs were then conducted to examine the hit rates as a function of list and study instruction group, separately for the aloud and silent items. Consider first the aloud items. Recognition was significantly better for list 2 items than for list 1 items, $F(1, 94) = 88.51$, $MSE = 0.016$, $p < .001$, $\eta_p^2 = 0.485$, but recognition did not differ between the two instructional groups, $F(1, 94) = 1.73$, $MSE = 0.016$, $p = .191$, $\eta_p^2 = 0.018$. Because the interaction was significant, $F(1, 94) = 12.76$, $MSE = 0.016$, $p < .001$, $\eta_p^2 = 0.120$, the relevant simple effects were probed. Paired-samples *t* tests showed significantly worse memory in list 1 for the forget group than for the remember group, $t(94) = 1.74$, $p = .043$, $d = 0.354$; this pattern reversed in list 2, where memory was significantly better in the forget group than in the remember group, $t(94) = 3.27$, $p < .001$, $d = 0.668$. This is the typical cost–benefit pattern seen in list-method directed forgetting.

Now consider the silent items. A corresponding ANOVA showed that recognition was again significantly better for list 2 than for list 1, $F(1, 94) = 22.61$, $MSE = 0.014$, $p < .001$, $\eta_p^2 = 0.194$, and was also significantly better in the forget group than in the remember group, $F(1, 94) = 4.86$, $MSE = 0.021$, $p = .030$, $\eta_p^2 = 0.049$.[4] The interaction was, however, not significant, $F(1, 94) = 0.82$, $MSE = 0.014$, $p = .369$, $\eta_p^2 = 0.009$.

Discussion

It has certainly not escaped our attention that this study explores many of the same issues that have been examined so elegantly over the years by Professor William Hockley and his colleagues, among them recognition memory (e.g., Hockley & Bancroft, 2011; Hockley & Corballis, 1982) and context effects in recognition and recall (e.g., Hockley, 2008; Hockley et al., 2012). Indeed, with his collaborators, Professor Hockley has also modelled the production effect (Jamieson et al., 2016), as we mentioned earlier, and has done extensive work on directed forgetting (e.g., Hockley et al., 2016; Tan et al., 2020) as well.

The goal of our study was to examine whether the within-subject mixed-list production effect observed in recognition could be characterized as a context-based memory effect. To accomplish this, a production manipulation was inserted within a list-method directed forgetting procedure. If production can act as a contextual framework to which produced information becomes associated, then remembering whether studied items were produced (i.e., using the distinctiveness heuristic) should improve memory for produced information that had been intentionally forgotten. Two experimental conditions were created: Both tested recognition of the studied items, but each required a unique differentiation. In the aloud versus silent differentiation condition, participants responded according to whether the studied items were aloud or silent: This is the condition in which the relevant contextual cue—production—should be reinstated and should thus attenuate the typical effects of directed forgetting on the items studied aloud in list 1. In the list 1 versus list 2 differentiation condition, participants responded according to whether the studied items were from list 1 or list 2: Because this procedure does not prompt the use of production as the relevant contextual cue from list 1, the typical pattern of directed forgetting effects was expected in this condition.

[3] A supporting Bayesian repeated-measures ANOVA, conducted using uniform priors, indicated moderate evidence for the null hypothesis (Lee & Wagenmakers, 2013) for the interaction, $BF_{01} = 3.704$. (Note that the error percentage from this analysis was 4.716%, indicating that the Bayes factor will change slightly when the analysis is repeated; however, this is within the acceptable error percentage limit: see van Doorn et al., 2021.)

[4] A post hoc analysis showed that although memory for the list 1 silent items was numerically better in the forget group than in the remember group, this was not significant, $t(94) = 1.22$, $p = .225$, $d = 0.249$.

The results supported the predictions for the aloud items. In the aloud versus silent differentiation condition, there was no difference in memory between the forget and the remember groups. Thus, the manipulation of explicitly prompting participants to use the distinctiveness heuristic at retrieval allowed them to overcome the otherwise expected forgetting of the list 1 items. With respect to the contextual change hypothesis, this result suggests that production indeed represents a contextual framework with which produced items become associated. This framework then facilitates memory of the intentionally forgotten produced items as an associative contextual cue when participants are prompted to use it at retrieval. These list 1 produced items would otherwise suffer from forgetting because of the mental context change caused by being instructed to forget list 1 prior to studying list 2.

In contrast, for the list 1 versus list 2 differentiation condition, the typical pattern of directed forgetting was found for the aloud items: Participants in the forget group showed worse memory for list 1 and better memory for list 2 compared to participants in the remember group. With respect to the contextual change hypothesis, this is the pattern of results predicted to occur when the relevant contextual cues are not reinstated at retrieval for the forget group. Whereas invoking the distinctiveness heuristic in the aloud versus silent differentiation condition served as an associative contextual cue that facilitated memory of the intentionally forgotten list 1 aloud items, in the list 1 versus list 2 differentiation condition, context remained similar to that of list 2 at retrieval because the list was not a distinct contextual cue, resulting in forgetting of the list 1 items together with enhancement for the list 2 items.

A different pattern emerged for the silent items. In both of the differentiation conditions, the silent items from list 2 were better remembered by the forget group than by the remember group, whereas memory for the list 1 silent items did not differ between the forget and the remember groups. With respect to the contextual change hypothesis, better memory for the list 2 items in the forget groups compared to the remember groups is expected: A change in mental context would have occurred between lists 1 and 2 in the forget groups, and because the experimental manipulations did not explicitly reinstate any relevant contextual cues from list 1 at retrieval, a context mismatch would have been present between list 1 and retrieval. There is, however, a remaining question: Why was memory for the list 1 silent items similar across the forget and remember groups within the two retrieval instruction conditions?

Pastötter et al. (2012; see also Pastötter et al., 2017) proposed a reset-of-encoding hypothesis as an alternative explanation for the memory enhancement of list 2 information in list-method directed forgetting. Essentially, providing a forget instruction after list 1 "resets" working memory load and thereby increases the efficacy of the encoding of (at least the initial items of) list 2 compared to the remember condition. Using serial position analyses, Pastötter et al. (2012) confirmed this prediction of memory enhancement for list 2 when participants were tested via recall. In addition, Pastötter et al. (2016) showed a similar list 2 memory enhancement effect as well as a lower false-alarm rate for list 2 in the forget group (by testing lists 1 and 2 separately) when examining participants' recognition. Notably, the typical effect of list 1 forgetting was absent, as has been the case in some previously directed forgetting studies that have examined recognition (e.g., Benjamin, 2006; Sahakyan & Delaney, 2005). The reset-of-encoding hypothesis proposes a dual-mechanism view of list-method directed forgetting, where the reset of working memory following the forget instruction results only in improved encoding for list 2, while a different mechanism explains forgetting effects (or lack thereof) in list 1 as well as possibly further contributing to the memory facilitation effects in list 2.

In the present study, it is possible that the silent items were perceived as "background" items relative to the distinct aloud items: This would be consistent with the distinctiveness account. Hunt (2013, p. 10) defined distinctive processing as "the processing of difference in the context of similarity." In the present study, the target items were similar in that they all were words being presented in the same font on a computer screen. The aloud items were, however, made more distinct by production serving as an additional encoding dimension. It is thus possible that, due to its distinctiveness, production served as the most obvious contextual framework in the present experimental procedure, which primarily affected the aloud items: Any contextual elements associated with the silent items would have been less apparent to participants. Consequently, contextual change would have had little effect on memory for the silent items, whereas memory facilitation for the list 2 silent items in the forget groups would still have been expected due to reset of encoding as a result of the instruction to forget list 1.

Overall, then, these results can be seen as fitting a dual-mechanism explanation of directed forgetting: Reset of encoding resulted in list 2 memory enhancement for both the aloud and the silent items, whereas, specific to the experimental manipulations, list 1 forgetting and list 2 memory enhancement due to contextual influences only affected the aloud items. More generally, then, the various mechanisms that contribute to directed forgetting can differentially affect memory of the target information when a mixture of methods is used to study that information.

In summary, this study provides evidence that the within-subject mixed-list production effect observed in recognition can be characterized as a context-based memory effect. When participants were prompted to use the distinctiveness heuristic at retrieval, production—as the relevant contextual framework to which the aloud items in list 1 were associated—was reinstated, facilitating memory for the intentionally forgotten information. In contrast, using list as a contextual cue did not change the typically expected directed forgetting effects. For the silent items, the one-sided memory enhancement of list 2 without forgetting effects in list 1 supported a dual-mechanism view of directed forgetting. Taken together, the findings support a context-based explanation of distinctiveness in the production effect.

Résumé

L'effet de production — le bénéfice de la mémoire pour les informations étudiées à voix haute par opposition à celles étudiées en silence — a été attribué au traitement distinct des informations à voix haute. L'effet de production pourrait-il être caractérisé plus largement comme un effet de mémoire basé sur le contexte? Lors de l'encodage, l'information distinctive « à voix haute » pourrait créer un indice contextuel global qui serait associé uniquement à l'information produite. Cet indice pourrait ensuite être sollicité lors de la récupération pour faciliter la mémorisation de l'information produite. Pour tester cette idée, une manipulation de l'effet de production de listes mixtes a été combinée à une procédure d'oubli dirigée par la méthode des listes. Selon le compte rendu du changement contextuel de l'oubli dirigé par la méthode des listes, lorsque la première de deux listes doit être oubliée, cette liste est mal mémorisée par la suite en raison du changement de contexte mental entre les listes, qui fait que le contexte de la deuxième liste correspond mieux au contexte du test. Le rétablissement des indices contextuels pertinents améliore donc la mémorisation de la liste à oublier. Nos résultats ont montré que la lecture à voix haute fonctionne effectivement comme une information contextuelle : la réactivation de cette information de production au moment de la récupération améliore la mémoire uniquement pour les items à voix haute — et non pour les items silencieux — de la liste à oublier.

Mots-clés : mémoire, contexte, effet de production, oubli dirigé, caractère distinctif

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Received November 9, 2021
Revision received March 29, 2022
Accepted April 3, 2022 ■