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The Surprisingly Powerful Influence of Drawing on Memory

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Abstract

The colloquialism "a picture is worth a thousand words" has reverberated through the decades, yet there is very little basic cognitive research assessing the merit of drawing as a mnemonic strategy. In our recent research, we explored whether drawing to-be-learned information enhanced memory and found it to be a reliable, replicable means of boosting performance. Specifically, we have shown this technique can be applied to enhance learning of individual words and pictures as well as textbook definitions. In delineating the mechanism of action, we have shown that gains are greater from drawing than other known mnemonic techniques, such as semantic elaboration, visualization, writing, and even tracing to-be-remembered information. We propose that drawing improves memory by promoting the integration of elaborative, pictorial, and motor codes, facilitating creation of a context-rich representation. Importantly, the simplicity of this strategy means it can be used by people with cognitive impairments to enhance memory, with preliminary findings suggesting measurable gains in performance in both normally aging individuals and patients with dementia.

Keywords

drawing, encoding strategy, memory enhancement

One traditional method of learning information, especially encouraged in an educational setting, is for students to take written notes. But how effective is this approach? Memory researchers have documented the effectiveness of several strategies to boost memory that can be carried out during encoding. Rote rehearsal (Rundus, 1971) is somewhat helpful, though semantic elaboration is more effective (Craik & Lockhart, 1972), as is generating to-be-remembered information from one's own mind rather than simply reading (Slamecka & Graf, 1978). Related to this is production, wherein words read aloud are favored during memory retrieval, relative to words read silently during study (MacLeod, Gopie, Hourihan, Neary, & Ozubko, 2010). Finally, enactment (Engelkamp & Zimmer, 1997) is also helpful, at least for memory of verb phrases, which are better remembered if one performs an associated action during learning, compared with just reading the verbal information.

These strategies, though useful, may not be practical in a typical learning environment such as a classroom, because they may be disruptive (talking aloud in class is usually discouraged) and require additional time to complete, as in the case of generation. While enactment is effective in enhancing memory, not all study materials have an associated action, limiting this strategy's generalizability. For these reasons, there is a need to find practical unobtrusive techniques that people can apply in their everyday lives to remember important information or that students can apply in classrooms.

There are theoretical reasons to believe that drawing is particularly able to boost memory. The finding that images are better remembered than words, termed the *picture-superiority effect*, has been well supported and replicated in the literature, consistently across various paradigms and demographic groups (Paivio, 1971). The source of this effect is a hypothesized *dual coding*: Pictures can be represented in terms of visual features and also verbal labels (Paivio, Rogers, & Smythe, 1968). It stands to reason that drawing to-be-learned information

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would also elicit dual coding and may in fact be even more beneficial because it requires motoric as well as elaborative processing or coding to create one's unique, personal depiction of target information.

Early evidence supporting this claim comes from Paivio and Csapo's (1973) work, in which free recall was enhanced for words that were drawn versus written at encoding. Later work (Peynircioğlu, 1989) revived the study of drawing as a memory facilitator, showing that creating drawings of scenes improved memory relative to rating or verbally describing them. However, because Peynircioğlu's retrieval task involved reproducing a drawing of the original image, the observed benefit might not have been attributable to drawing per se but rather to transfer-appropriate processing (Morris, Bransford, & Franks, 1977). There are also analogous findings about the usefulness of drawing in the educational literature (see Van Meter & Garner, 2005, for a review). Thus, while there is preliminary evidence that drawing may improve memory, there is sparse evidence for how or why.

Establishing the Drawing Effect

Across several studies, we systematically examined whether drawing pictures depicting to-be-remembered information boosted memory more than other encoding strategies did. In our work, participants were typically presented with at least 30 words in succession (e.g., "truck," "pear"), each preceded by a prompt indicating the encoding strategy to apply to the word and with the time allotted per trial matched. The memory test was typically incidental, except where otherwise indicated. In our first demonstration of the effect (Wammes, Meade, & Fernandes, 2016), we compared the influence of drawing and writing prompts, presented intermixed during encoding, allowing 40 s per trial. A prompt of "draw" meant the participant was to draw a picture on a pad of paper to illustrate the word on the screen and to continue adding detail until the next prompt was presented. A prompt of "write" meant they were to write out the word multiple times. Alternate instructions were explored in a subsequent experiment, in which writing was to be embellished and drawing to be repeated. In both experiments, words drawn relative to written at encoding were better recalled. The effect also proved generalizable, even when conducted in a lecture hall with groups of 10 to 30 participants, establishing drawing as an effective and reliable encoding strategy, far superior to writing.

Ruling Out Alternate Mechanisms

Having documented a replicable drawing effect, we aimed to contrast the magnitude of the memory boost with that from other kinds of encoding strategies to determine whether the benefit could be explained by invoking these other modes of processing rather than by drawing per se (Wammes et al., 2016). We first considered whether drawing improved memory simply as a result of adding visual imagery, as dual-code theory suggests is the case for pictures (Paivio, 1971). To test this, we introduced alternate encoding trial types, wherein participants were asked to either visualize a study word or simply view pictures of the presented words. We speculated that creating a mental image or viewing a picture would boost memory relative to writing, though not as dramatically as our drawing manipulation. When drawing, participants indeed must create a mental image of the word but also perform the mechanistic process of moving their pencil to create an image, which provides motor information, perhaps akin to a muted enactment effect. As shown in Figure 1, drawing led to recall performance that was superior not only to writing but also to visual imagery and viewing pictures.

Next, we sought to determine whether the drawing effect occurred because it invoked enhanced semantic analysis, which is known to improve subsequent memory more than superficial encoding (Craik & Lockhart, 1972). To do so, we compared drawing with an encoding task in which participants had to list semantic characteristics of the target word when prompted. As shown in Figure 1, recall of words from draw trials surpassed recall of words from list trials, suggesting that the effect of drawing cannot be dismissed as simply being due to a deep (semantic) level of processing. In the following two experiments (Wammes, Meade, & Fernandes, 2018), we switched to intentional encoding to facilitate comparison with other established effects thought to be driven by distinctiveness. In these experiments, we demonstrated that drawing exerts its beneficial effects on memory even when participants were allowed only a fraction of the time (4 s) to draw and when the manipulation was applied between subjects, a change that often undermines several well-replicated effects (McDaniel & Bugg, 2008).

Academic Materials

Graphic representation, especially in science texts, can benefit later learning (Scaife & Rogers, 1996). Accordingly, we aimed to determine whether the drawing effect previously observed for individual words (Wammes et al., 2016) would generalize to the learning of lengthier definitions of academic terms consisting of nouns, verbs, and adjectives, together describing a concept. As described by Wammes, Meade, and Fernandes (2017), participants were given 20 terms and prompted to either draw a picture representing a given definition

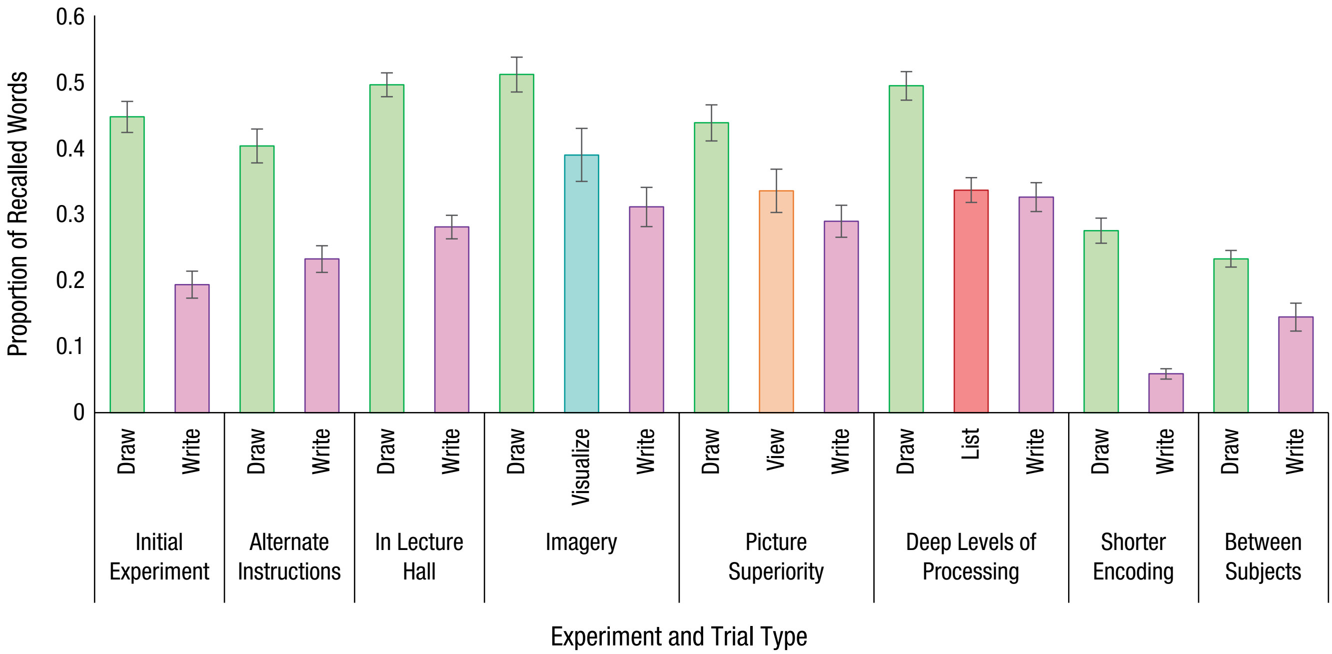

Fig. 1. Proportion of words recalled following encoding instructions to draw, write, visualize, view, or list related characteristics of to-be-remembered target words in multiple experiments in younger adults, as reported by Wammes, Meade, and Fernandes (2016). In all cases, words were best remembered when they were drawn at encoding. Error bars show standard errors of the mean.

or write it verbatim, with trial types intermixed. For example, participants had 60 s to either write the definition of “spore” or “isotope” or to draw an image representing that concept.

As with individual words, drawing conferred a reliable memory advantage relative to verbatim writing, even when we controlled (in separate follow-up experiments) for participants’ preexisting familiarity with the terms and even when we invented novel fictitious terms, thus removing the influence of familiarity. As with single words, we reasoned that drawing facilitates retention, at least in part, because it requires elaboration on the meaning of the term and translating the definition to a new form (a picture). In line with this interpretation, our study showed that paraphrasing our given definitions (rewriting in one’s own words), which like drawing and in contrast to verbatim writing, requires self-generated elaboration, led to memory performance that was comparable with that following drawing. Together, these experiments suggest that using transcription as a note-taking method to retain newly learned information is not the most effective practice and that creating drawings of information is a viable, and much more efficacious, mnemonic strategy.

Mechanism of Action

We propose that drawing improves memory by encouraging a seamless integration of elaborative, motoric, and pictorial components of a memory trace. That is, to transfer a word into a drawn visual representation, one must elaborate on its meaning and semantic features, engage in the actual hand movements needed for drawing (motor action), and visually inspect one’s created picture (pictorial processing). We argue that the mechanism driving the drawing effect is one that promotes the seamless integration of these codes, or modes of representation, into one cohesive memory trace, and it is this that facilitates later retrieval of the studied words.

For this integrated-trace hypothesis to be plausible, however, participants must be able to retrieve specific contextual information from the initial encoding experience to a greater extent when they had drawn, relative to written, target items. That is, they must have a detailed recollection, as opposed to a more general feeling of familiarity (Yonelinas, 2002). To test whether drawing indeed improves contextual memory (i.e., recollection), we recently conducted a study (Wammes et al., 2018) in which we employed multiple variants of recognition memory tasks: source memory decisions, identifying whether a word was drawn or written during encoding; the remember-know-new paradigm, indicating whether memory is accompanied by contextual features from encoding (“remember”) or not (“know”); and a response-deadline procedure, wherein responses are forced into a time frame that is thought to precede recollection (Sauvage, Beer, & Eichenbaum, 2010).

Though each variant has its own strengths and weaknesses, they converged on the same conclusion: Drawing was associated with better recognition than writing, and this was largely driven by detailed, context-rich recollections. Specifically, drawing led to better identification of the source of the memory and a higher number of "remember" responses. When recognition responses were speeded (to limit the contribution of recollective processes), the benefit of drawing was substantially smaller or absent. Taken together, these experiments suggest that drawing improves memory by providing vivid contextual information that can later be called on to aid retrieval.

The Components of Drawing

Considering an integrated-components mechanism, we reasoned in subsequent work (Wammes et al., 2017; Wammes, Jonker, & Fernandes, 2018) that memory performance would scale linearly with the number of components invoked by a given encoding strategy (Fig. 2). We tested this idea across two experiments, using intentional encoding, by designing trial types that systematically varied the presence or absence of each of the three proposed components (elaborative, motor, pictorial). In addition to the draw, write, view, and imagine (visualize) trial types, two additional ones were devised. In trace trials, participants encoded to-be-remembered words by tracing over a faint line drawing depicting the object, and in blind-drawing trials, participants drew each word in an auditorily presented study list but did not see the outcome. The trace trial type thus required motor action and pictorial processing, but not semantic elaboration. The blind-drawing trial type required elaboration and motor action, but not pictorial processing.

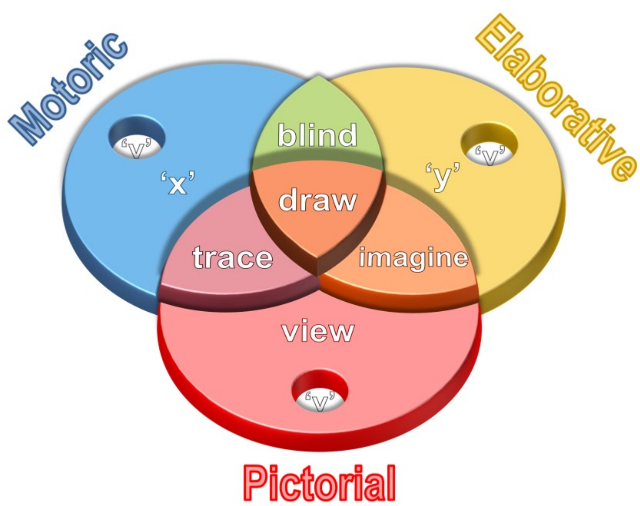

Fig. 2. The integrated-components model of the drawing effect. In this model, the beneficial effects of drawing, over and above basic verbal memory ("v"), are driven by the integrated contributions of elaborative, motoric, and pictorial information. The *draw* trial type lies at the intersection, as it engages all three components. The *trace* trial type lies at the intersection of the motoric and pictorial components, as it does not require elaborative thought. A purely motoric task ("x") as well as a task that involves only elaborative and pictorial information ("y") without undermining the elaborative process is difficult, if not impossible, to design. The model predicts additive effects on memory from inclusion of each type of processing at encoding, with drawing seamlessly integrating the components, resulting in a boost to performance over and above the additive effects.

We introduced a 2-day delay between study and recognition test and, remarkably, still found robust benefits of drawing relative to the other encoding strategies. Our baseline measure was memory following the write trial type. Adding an elaborative (imagine trials) or pictorial (view trials) component increased memory by a small margin, and adding a second component (trace and blind drawing) increased memory significantly more. Over and above these two trial types, drawing improved memory more still, ostensibly as a result of adding the remaining third component. In other words, memory scaled up as components were added to the encoding task. A secondary finding was that drawing sometimes led to better memory than the three components combined, suggesting that there may be some additional benefit of drawing resulting from the seamless integration of these components.

Drawing Benefits to Memory in Aging Populations

It is well known that episodic memory abilities decline with increasing age (Light, 1991). The provision of rich pictorial stimuli at encoding, however, has been shown to enhance memory (Luo, Hendriks, & Craik, 2007), and picture-superiority effects are typically larger in older adults (Ally et al., 2008). In another study (Meade, Wammes, & Fernandes, in press), we reasoned that incorporating visuo-perceptual information into the memory trace, by drawing pictures at study, increases its reliance on visual sensory regions. These regions are relatively intact in normal aging (Raz et al., 2005). Therefore, older adults may stand to benefit differentially from this encoding strategy. In Experiment 1 of that research, we computed the proportion of each person's recall for words drawn rather than written at encoding. We indeed found a significant interaction between age and encoding trial type; specifically, older adults reported a larger proportion of words that were drawn at encoding than did younger adults. Within that study we also showed, using a remember-know-new

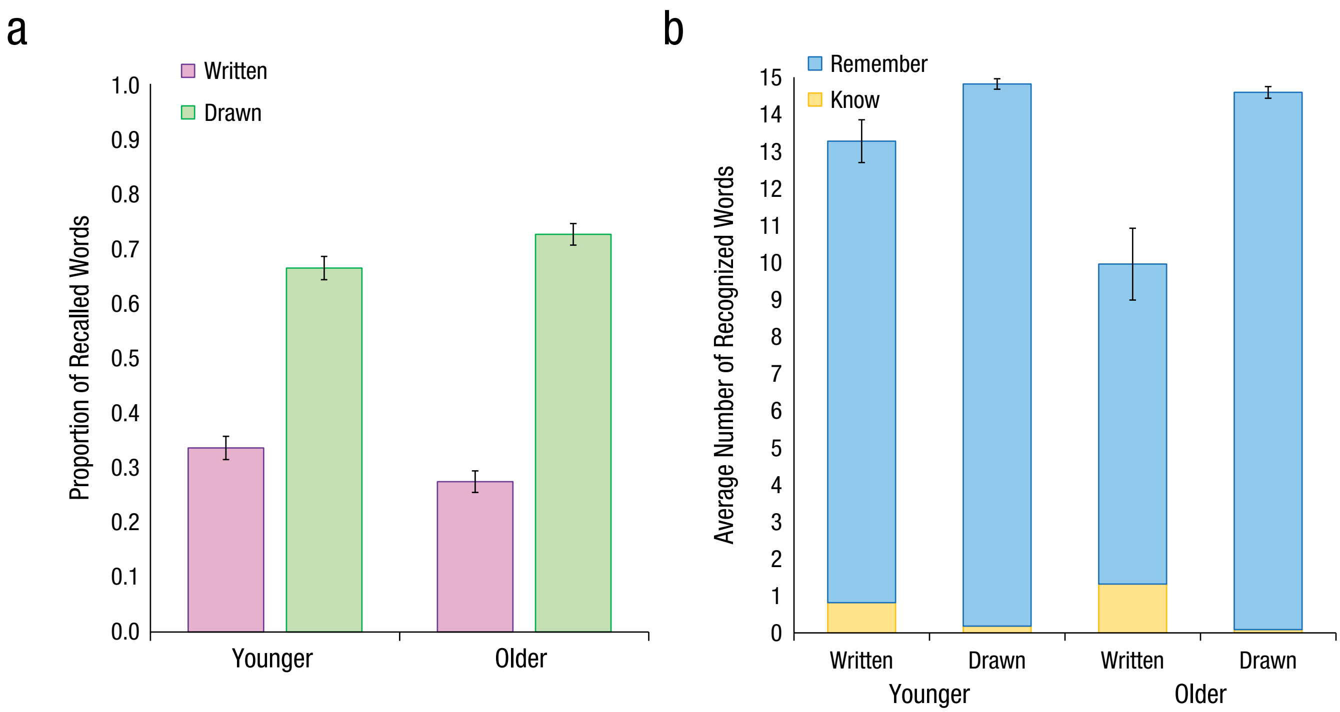

Fig. 3. Results from Meade, Wammes, and Fernandes (in press). The proportion of words recalled that were written and drawn at encoding (a) is shown for both younger and older adults. The average number of words recognized on a remember-know-new recognition test (b) is shown for words that were written or drawn at encoding, separately for younger and older adults. Hit rates are shown both for recollection-based recognition decisions and for familiarity-based recognition decisions. In both graphs, error bars show standard errors of the mean.

recognition test, that the age groups did not differ in hit rate or endorsements of recollection-based responses to drawn words. In contrast, compared with young adults, seniors had a significant deficit in memory (hit rate and recollection) for words that were written at encoding. This suggests that drawing has the power to reduce age differences in recollection (Fig. 3).

We have since gone on to explore (Meade & Fernandes, 2018) whether drawing could be profitably used in a population of senior citizens with a diagnosis of dementia. We asked 13 patients in a long-term care facility to either draw or write 60 words (intermixed) that were read aloud by an experimenter. As can be seen from the samples of their drawings in Figure 4, the quality was relatively poor and, in some cases, consisted of little more than some scribbles on a page. Remarkably, however, memory performance showed a massive benefit for words that had been drawn rather than written at encoding. Although overall recall was predictably low, the words that they did manage to remember were almost exclusively those drawn at encoding. Recognition memory showed an advantage in the same direction as recall. Such patterns highlight the powerful influence of drawing on memory in the most compromised of patient populations.

In most of our experiments, we administered the Vividness of Visual Imagery Questionnaire (VVIQ; Marks, 1973), which quantifies drawing experience and assesses individual differences in the ability to create mental images of items and scenes. Interestingly, neither the VVIQ nor drawing experience was significantly correlated with memory performance. Indeed, there was a variety of skill level displayed in people's drawn images, yet the benefit was comparable in magnitude across individual differences in artistic tendencies and ability. This suggests that the benefit one can achieve from drawing during encoding applies regardless of one's artistic talent.

Overall, our results show that drawing should be considered among the ranks of generation (Slamecka & Graf, 1978), enactment (Engelkamp & Zimmer, 1997), and production (MacLeod et al., 2010) effects. The observed gains in memory performance apply consistently across tasks, settings, and populations and occur within as well as between subjects. Strikingly, drawing also requires no more than 4 s to provide a benefit. Taken together, the evidence provided here demonstrates that drawing is a robust encoding strategy that can, and does, improve memory performance dramatically.

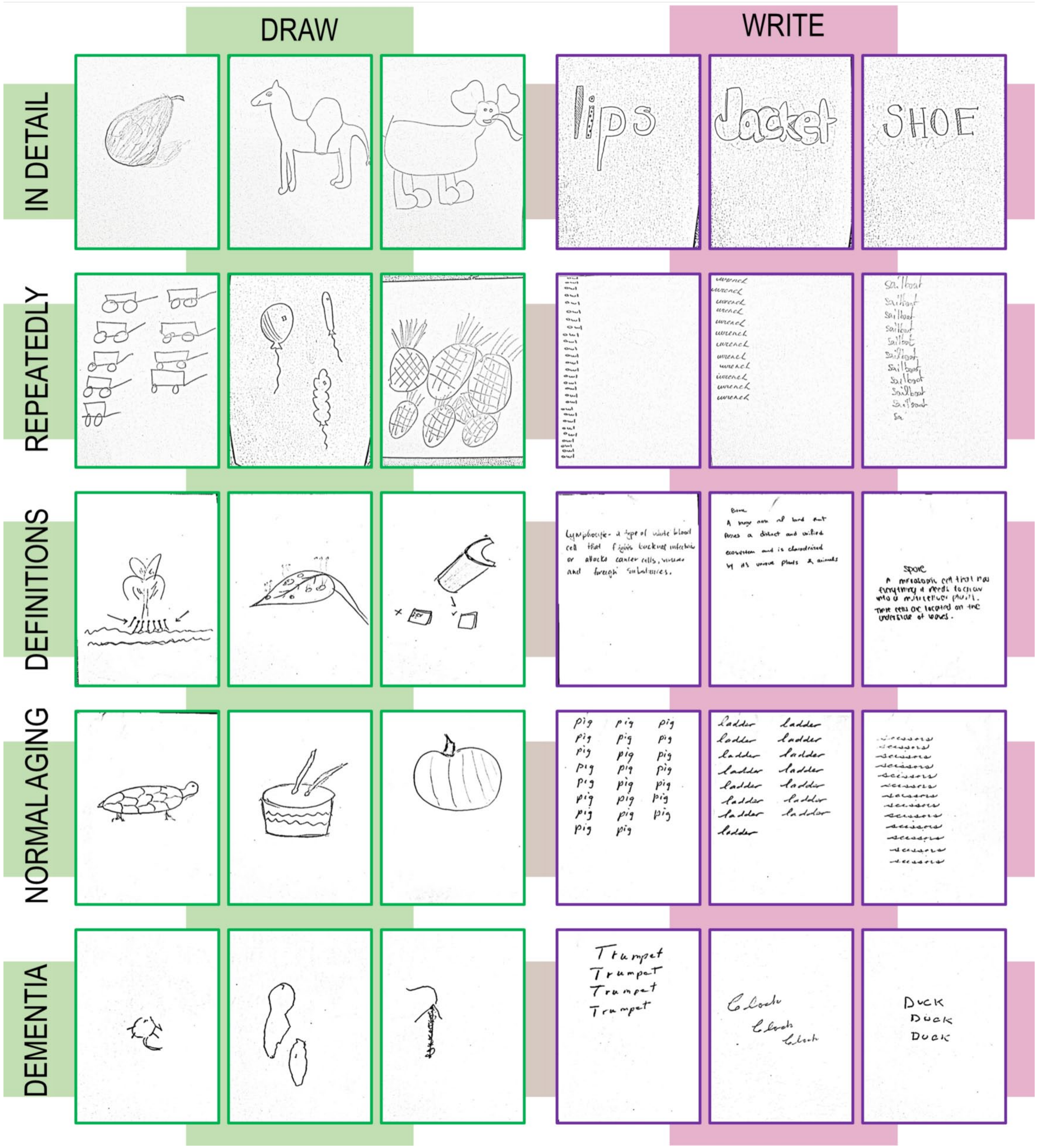

Fig. 4. Samples of to-be-remembered targets that were either drawn or written at encoding. Starting from the top, the first row shows samples of young adults' drawings of words, as well as their writings in response to an instruction to add detail to their productions (Wammes, Meade, & Fernandes, 2016). The second row shows samples from separate trials on which participants were asked to repeatedly draw or write, given 40 s of allotted encoding time per word (Wammes et al., 2016). Samples in the third row are from trials in which young adults either drew or wrote definitions for concepts (Wammes, Meade, & Fernandes, 2017). The fourth row shows words drawn or repeatedly written by normally aging adults (Meade, Wammes, & Fernandes, in press). The fifth row shows attempted drawings from patients with dementia, as well as productions in the repeated-writing encoding trials (Meade & Fernandes, 2018). In all cases, memory was significantly enhanced following an instruction to draw.

Recommended Reading

Luo, L., Hendriks, T., & Craik, F. I. (2007). (See References). Provides an overview of age-related declines in memory and illustrates that presenting pictures at encoding boosts memory performance.

MacLeod, C. M., Gopie, N., Hourihan, K. L., Neary, K. R., & Ozubko, J. D. (2010). (See References). A clearly written review of established encoding techniques and an introduction to the *production effect*, another effective means of enhancing memory.

Van Meter, P., & Garner, J. (2005). (See References). A comprehensive review of applied and empirical research suggesting that drawing can support learning goals in classroom settings.

Wammes, J. D., Meade, M. E., & Fernandes, M. A. (2016). (See References). A representative study that illustrates original research documenting the drawing effect.

Action Editor

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Declaration of Conflicting Interests

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