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A modality congruency effect in verbal false memory

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This experiment tests the modality congruency hypothesis, which suggests that in short-term recall of auditory or visual verbal information false memories can be suppressed more effectively if presentation modality and recall mode are in congruent relation (i.e., in oral recall of auditorily presented and written recall of visually presented materials). The experiment is based on the DRM paradigm (as used by Kellogg, 2001). The results demonstrate more intrusions if presentation and recall are in an incongruent relation than if they are in a congruent relation. This finding supports the assumption of a privileged pathway from the auditory input system to oral output on the one hand, and from the visual input system to written output on the other hand, which aids source monitoring.

Keywords: DRM paradigm; False memory; Modality congruency; Modality effect.

The present paper aims at testing whether the magnitude of the contribution of surface representations to short-term recall is modified by the relation between presentation modality and recall mode. We expect a *modality congruency effect*: Linguistic surface information provided by auditory presentation (i.e., phonemic information) should be accessed more efficiently in oral recall as compared to the incongruent case in which auditorily presented materials have to be (re-)written. Similarly, we predict that linguistic surface information available from visual presentation (i.e., graphemic information) can be accessed more efficiently in written as compared to spoken recall. This assumption is motivated by the transfer-appropriate

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processing approach (e.g., Roediger, 1990) as well as by the encoding specificity hypothesis (Tulving & Thomson, 1973). According to the transfer-appropriate processing approach, "performance on memory tests benefits to the extent that the cognitive operations at test recapitulate (or overlap) those engaged during initial learning" (Roediger, 1990, p. 1049).

MODALITY EFFECTS IN SHORT-TERM RECALL OF VERBAL INFORMATION

Most research devoted to the role of modality in short-term memory for verbal information has varied the *presentation modality*, whereas the *recall modality* has been kept constant. Interestingly, the term modality effect is not used unambiguously. We know two phenomena the term "modality effect" is applied to: In short-term memory research the term "modality effect" refers to the well-known phenomenon that auditorily presented verbal materials are better recalled than visually presented verbal materials (for an overview see Neath, 1998; Penney, 1989). With respect to false memory research, however, the term "modality effect" is used to describe the inverse effect that (written) recall for visually presented verbal materials is better than for auditorily presented materials (Kellogg, 2001). Subsequently, we will discuss possible explanations for these effects in more detail.

Since the 1960s (e.g., Conrad, 1964), we know that the last one or two items of auditorily presented lists of digits, nonwords, or words are better retained than those of visually presented lists. That is, a stronger recency effect is obtained with auditory than visual lists. Penney (1989) suggested that the advantage for auditory presentation can be attributed to the fact that auditory and visual verbal materials are represented in separate streams. With respect to recall performance, the separate stream hypothesis predicts that the recall of auditorily presented items should be better than recall of items processed in the visual stream, because the acoustic code is assumed to endure for a longer period of time and, thus, is more useful for recall than the visual code. The modality effect (i.e., the advantage for auditory presentation) can be found both with oral and written recall (though the effect is stronger with written recall; e.g., Penney, 1989; see later) and, since an acoustic-sensory code is extremely sensitive to acoustic interference, it can only be found with respect to the most recent item positions.

Interestingly, in the field of false memory research, the term "modality effect" refers to a recall advantage of visual over auditory presentation. As far as we know, this *inverse* modality effect was observed exclusively in experiments using false memory procedures and only when the recall mode was *written* or recognition was visual (e.g., Gallo, McDermott, Percer, & Roediger, 2001; Israel & Schacter, 1997; Kellogg, 2001; Smith & Hunt, 1998).

Usually, the smaller proportion of errors for visual than for auditory presentation is explained as a result of better distinctiveness of visual stimuli. According to Einstein and Hunt (1980), who distinguish a memory system for item-specific information and one for relational information, visual presentation decreases relational processing while at the same time facilitating item-specific processing. As a result, the recollection of visual stimuli is more accurate than the recollection of auditory stimuli.

A different explanation stems from Kellogg (2001), who emphasises the finding that an advantage for visual presentation was only found with written recall (and visual recognition tests) so far. He explained this visual advantage in terms of a *triple-code hypothesis*. This is based on the assumption that auditory words are encoded linguistically in two different ways, specifically as phonemic and semantic codes, whereas visual words are (at least potentially) encoded in three different ways, namely in a graphemic code, in a phonemic code, and in a semantic code. According to Kellogg, oral recall should benefit from phonemic and semantic representations, whereas written recall tests should benefit from semantic, phonemic, and graphemic information. Kellogg thus concluded that there should be an advantage for written recall of visually presented materials over written recall of auditorily presented materials as well as over oral recall of both auditorily and visually presented materials. Only in the visual presentation–written recall condition are all three codes provided at study and available to be used at test.

In order to test this triple-code hypothesis, Kellogg (2001) used the Deese-Roediger-McDermott (DRM) paradigm (cf. Deese, 1959; Roediger & McDermott, 1995). He used either visual or auditory presentation of 15-word lists. These words were semantically related to each other (e.g., table, desk, legs, bench) and to a *lure word* (e.g., chair). The lure word was explicitly not included in the presented word list. The critical dependent variable of DRM experiments is the proportion of false memory for this nonpresented lure word.

In Experiment 1, immediately after the visual or auditory presentation of the list, participants had to recall it either in an oral or in a written mode. Two dependent variables were recorded: first, recall accuracy for the studied items, and second, the intrusion rate for the lure word in immediate recall. As predicted by his model, Kellogg (2001) observed a recall advantage for visually presented materials which were recalled in a written mode. Recall performance in all other conditions was significantly lower. The intrusion data show a slightly different pattern: In the written recall conditions, fewer lure intrusions were observed with visual than with auditory presentation. This was in line with Kellogg's hypothesis. According to Ron Kellogg (personal communication) the two-factor ANOVA or planned comparisons between the visual-oral and the visual-written as well as between the

auditory-oral and the auditory-written conditions reached significance. However, Figure 1a (adapted from Figure 1 of Kellogg, 2001, p. 915) indicates that—in addition to the expected advantage of visual presentation with written recall—there is also a numerical advantage for auditory presentation with oral recall, though the respective planned comparison only approached significance (Kellogg, personal communication). To the extent that there is an advantage for spoken over written recall with auditory presentation, it cannot be explained in terms of Kellogg's triple-code hypothesis.

Given this nonperfect fit of the data to the triple-code hypothesis, we want to offer another possible explanation for Kellogg's intrusion data. We propose that there is a modality congruency effect for recall of verbal information. The modality congruency effect is hypothesised to result from the contribution of modality-specific linguistic (i.e., phonemic and graphemic) representations. We assume that the modality congruency effect is based on privileged use of phonemic information in oral recall and of graphemic information in written recall. Figure 2 illustrates this assumption.

So far, the modality congruency effect has been observed in recall of sentences. Rummer, Schweppe, and Martin (2008) used Potter and Lombardi's (1990) intrusion paradigm to demonstrate a modality congruency effect. They presented their subjects with auditory or visual sentences which had to be recalled in oral or written mode. One of the sentence's nouns was semantically similar to a lure word presented (lure condition) or not presented (control condition) on an accompanying word list. The size of the lure intrusion effect (i.e., intrusions of the lure word in sentence recall in the lure condition minus intrusions in the control condition) served as dependent variable. The authors observed a smaller intrusion effect in the modality congruent conditions than in the incongruent ones. Both Kellogg's

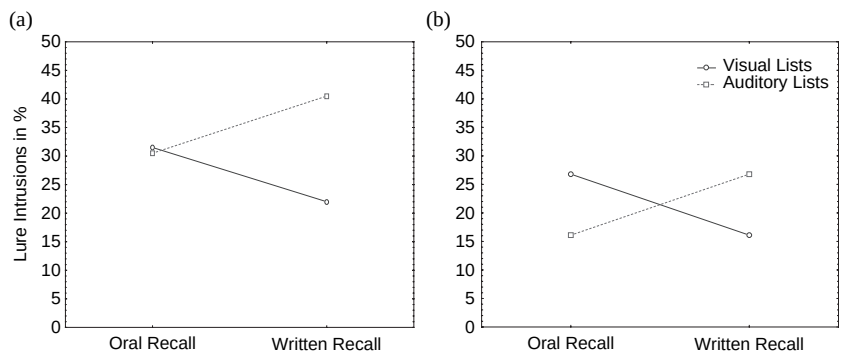

Figure 1. Intrusion data as a function of modality of presentation and mode of recall: (a) Kellogg's (2001) Experiment 1 and (b) the present study.

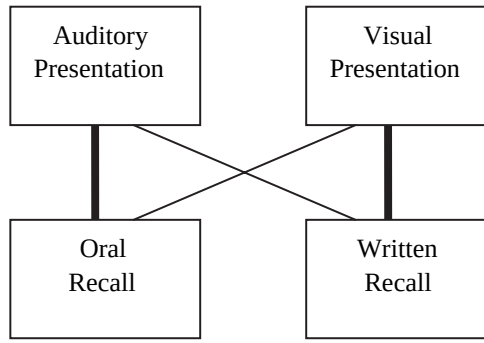

Figure 2. Illustration of the modality congruency hypothesis.

(2001) and Rummer et al.'s data provide first evidences for the modality congruency hypothesis.

The purpose of the present paper is to further test the modality congruency hypothesis and to assess whether it is also (or even more) appropriate for explaining Kellogg's intrusion data. To this end, we replicated the first experiment of Kellogg's (2001) DRM study. This allows us to conduct those analyses necessary to test the modality congruency hypothesis.

EXPERIMENT

DRM lists were presented either visually or auditorily. Subsequently, participants had to recall these lists as accurately as possible using either oral or written recall. The two factors (i.e., presentation modality and recall mode) were manipulated within participants. The critical dependent variables were the proportion of false recall for the lure words and recall accuracy for the studied items. As a control variable, we report noncritical intrusions. The modality congruency hypothesis predicts a disordinal interaction between presentation modality and mode of recall; that is, we predict fewer intrusions and better recall for the visual-written than for visual-oral conditions and fewer intrusions and better recall for the auditory-oral than for the auditory-written conditions.

Method

Participants and materials. Twenty-eight participants from Saarland University were presented with German translations of the 16 lists of 15 words each used by Kellogg (2001). In addition, four practice lists (one for each block) were constructed. A block of four lists was assigned to each of

the four conditions defined by the combination of presentation modality and mode of recall. Block A, identified by the critical lure words, consisted of the *anger*, *rough*, *bread*, and *chair* lists; Block B included the *cold*, *doctor*, *sleep*, and *fruit* lists; Block C was made up by the *girl*, *high*, *king*, and *sweet* lists; and Block D consisted of the *mountain*, *music*, *needle*, and *river* lists. The order of conditions was counterbalanced across the 28 participants, and each block was presented equally often in each condition.

Procedure. Participants were tested individually. Before the experiment started, they were instructed to recall the lists presented to them as accurately as possible. They were told to start recall with the lists' most recent items. For each block a set of instructions appropriate to the respective condition was presented.

Each block started with a practice trial. These trials consisted of four words only. Then the four experimental lists were presented. The lists in the visual blocks were presented on the computer screen one word at a time; the lists of the auditory blocks were presented via external loudspeakers. At the beginning of each list the word "start" was presented on the screen. Then, the 15 to-be-remembered words appeared. Both visual and auditory lists were presented at a presentation rate of 500 ms per word. The interstimulus interval (ISI) was 1 s. To indicate that participants should start recall, finally, the word "ABRUF" [recall] was presented on the screen. Within 150 s, participants had to recall as many list items as possible. The beginning of the next list was indicated by a tone of 1000 Hz, followed by the word "START". After the last of the four lists of a block had been recalled, the next set of instructions introducing one of the remaining three experimental conditions was presented on the screen, and the same scheme was applied to each block. The entire experimental procedure was programmed with DMDX (Forster & Forster, 2003).

Results

Three dependent variables were recorded: (1) intrusions of the lure word, (2) proportion of correctly reproduced words, and, as control variable, (3) noncritical intrusions.

Lure intrusions. Table 1 (see also Figure 1b) shows the proportion of lure intrusions as a function of presentation modality (visual vs. auditory) and recall mode (oral vs. written recall). An ANOVA reveals the expected two-way interaction, $F(1, 27) = 8.24$, $MSE = 390.21$, $p = .008$. This result is clearly in line with the modality congruency hypothesis. With auditory presentation we observed fewer intrusions with oral than with written recall

TABLE 1
Means and 95% confidence intervals (in parentheses) of lure intrusions and recall accuracy as a function of modality of presentation and mode of recall

	Oral recall	*Written recall*
Lure intrusions		
Auditory presentation	16.1 (8.0)	26.8 (10.2)
Visual presentation	26.8 (10.2)	16.1 (6.5)
Recall accuracy		
Auditory presentation	70.6 (3.9)	71.8 (4.2)
Visual presentation	72.8 (3.0)	74.2 (4.5)

(16.1% vs. 26.8%, respectively), and with visual presentation, there were fewer intrusions in the written than in the oral mode (16.1% vs. 26.8%, respectively). One-tailed t-tests reveal that the difference between the congruent and the incongruent recall mode was significant with both auditory presentation, $t(27) = 2.26$, $p = .015$, $d = 0.45$, and visual presentation, $t(27) = -1.8$, $p = .042$, $d = 0.48$.

Recall performance. The results for this second dependent variable are given in Table 1. A two-way ANOVA with the factors presentation modality and mode of recall revealed a small but reliable main effect for presentation modality, $F(1, 27) = 4.86$, $MSE = 29.62$, $p = .036$, $d = 0.25$. Visually presented items were recalled better than auditorily presented items (73.4% vs. 71.2%, respectively). The main effect for mode of recall and the two-way interaction did not reach significance (all Fs < 1).

Noncritical intrusions. The ANOVA for noncritical intrusions (i.e., intrusions of words that had not been presented except the lure word) did not reveal any significant influence of the factors varied in this experiment (all Fs < 1). The means for the visual-written, visual-oral, auditory-written, and auditory-oral conditions were 1.4, 1.7, 1.7, and 1.5, respectively.

Discussion

The data show different patterns for the two critical dependent variables. The intrusion data clearly support the modality congruency hypothesis with the significant interaction between presentation modality and output modality: For auditorily presented lists we found a significant advantage of oral over written recall and for visually presented lists we found a significant advantage of written over oral recall.

Neither Kellogg's (2001) nor our results are in line with the triple-code hypothesis—that is, the assumption that written recall benefits from graphemic *and* phonemic information whereas oral recall solely benefits from phonemic information. Rather, the intrusion data support the modality congruency hypothesis. Although Kellogg's hypothesis would lead to a prediction of a two-way interaction between presentation modality and recall mode, this interaction should have shown superiority of the congruent visual presentation condition (i.e., visual-written) over the three other conditions of the experiment. This prediction is neither confirmed by the present results nor by the pattern of Kellogg's intrusion data. In particular, the significant difference found here between the congruent auditory-oral and the incongruent auditory-written condition cannot be explained in terms of Kellogg's approach.

With respect to *recall accuracy*, we only observed a main effect for presentation modality. Visually presented lists were better recalled than auditorily presented lists. Surprisingly, this effect was independent of mode of recall. In contrast to our findings, Kellogg's (2001) recall results provided clear evidence for the triple-code hypothesis, with better recall for the visual-written condition than the other three conditions, which did not differ from each other. An obvious difference between our experiment and that of Kellogg is the language (German vs. English). However, we do not see how language differences might help to explain the different patterns of data found in Kellogg's and our study. The explanation of these differences is an important point that surely needs further investigation.

An important remaining question is why the recall and the intrusion data did not show a consistent pattern in the present study. Interestingly, in Kellogg's (2001) and Rummer et al.'s (2008) studies, the intrusion and recall data were inconsistent as well. To find an explanation for the different effects of modality congruency on recall of studied words and the intrusion of nonstudied words, it is worth looking at current explanations of the false memory effect in the DRM paradigm.

In the current literature, there are two influential accounts explaining the DRM effect: activation-monitoring (e.g., Seamon, Luo, & Gallo, 1998; Underwood, 1965) and fuzzy-trace theory (e.g., Reyna & Brainerd, 1995). Activation-monitoring accounts assume that during encoding, activation spreads from the presented items to nonpresented associates, particularly to the lure item, because of its association with all of the list items. In the case of a failure to monitor correctly the source of this item's activation, the lure word is later falsely recalled. According to fuzzy-trace theory, the lure word is falsely remembered because the thematic content of the list is encoded as a kind of gist representation. Being strongly associated with all words on the list, the lure word is a perfect fit for such a thematic representation. This can

compensate for its lack of a specific, verbatim representation from which the studied items benefit in addition to the gist representation.

In order to relate our results to the current state of theory in DRM research, it is useful to briefly describe factors that reduce the false memory effect. Several studies have demonstrated that the false memory effect in the DRM paradigm is very robust. It persists even when participants are informed about the existence of a lure word before study (Gallo, Roberts, & Seamon, 1997; McDermott & Roediger, 1998). However, there are certain conditions under which it can be reduced. One aspect particularly relevant to the current paper is the modality of presentation. As indicated earlier, DRM studies using written recall have observed reduced false remembering when the word list was presented visually instead of auditorily (Gallo et al., 2001; Smith & Hunt, 1998). It was concluded that visual presentation led to more distinctive item-specific processing (Smith & Hunt, 1998). This is in line with Kellogg's (2001) assumption that visually presented items provide an additional graphemic code, which allows for more accurate rejection of the lure word during recall. However, the present findings modify this (inverse) modality effect and its theoretical explanations. As soon as oral recall is used, the additional graphemic code does not provide any more distinct information than already available after auditory presentation. Instead, modality-specific item information provided at study seems to be useful only in a congruent recall modality. Thus, it is not the modality itself (be it modality of presentation or of recall) but the relation between input and output modality that makes the difference. We suggest that modality-specific item information can primarily be accessed when input and output modality are congruent. This information helps output monitoring and can thus reduce false recall rates. In terms of fuzzy-trace theory, modality-specific item information leads to more detailed verbatim representations and thus increases the difference between studied and nonstudied items.

Can these approaches explain the different findings regarding list recall and lure intrusions in our study? In our opinion only activation-monitoring accounts can. According to the fuzzy-trace theory a more detailed verbatim representation should improve recall of studied items and should reduce lure intrusions. Thus, it predicts that factors that influence intrusion errors also influence list recall. In contrast, the inclusion of a monitoring component in the activation-monitoring accounts allows for explaining differences between recall and intrusion rate. Activation-monitoring accounts can explain this difference if we assume that the activation component is not influenced by the relation between presentation modality and mode of recall, whereas the monitoring component is (see Smith & Hunt, 1998). With respect to modality congruency we assume that monitoring phonemic and graphemic information helps to distinguish true from false verbal memories whereas retrieval of list items is not enhanced.

An additional result in favour of a monitoring account of the modality congruency effect comes from Pierce, Gallo, Weiss, and Schacter (2005). In line with previous DRM studies, they observed fewer false alarms to lure items with visual recognition when lists were presented visually rather than auditorily (Exp. 1). This modality difference which might also be a modality congruency effect disappeared, however, when participants' task was to assess an item's semantic similarity to the list theme, that is, when there was no need for source monitoring or for differentiating between studied and nonstudied but semantically related items (Exp. 2).

In order to account for the difference between the effect of modality congruency on true versus false recall in our study, we might assume, first, that activation level in memory is higher for true items, due to their encoding, than for lures, which results solely from spreading activation. (Consistent with this claim, true items were recalled about 70% of the time, whereas lures were recalled only about 20% of the time.) Second, we might assume that the monitoring process, which checks for source information, is invoked mainly for more weakly activated items (i.e., strongly activated items are output without checking source). Monitoring for source is made easier or more accurate by a match in modality between encoding and output. Further research might pursue this line of reasoning by investigating modality congruency for true item recall under conditions in which the true items would arguably be weakly activated (e.g., with fast presentation rates or under divided attention).

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REFERENCES

Conrad, R. (1964). Acoustic confusions in immediate memory. *British Journal of Psychology*, *55*, 75–84.

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, *58*, 17–22.

Einstein, G. O., & Hunt, R. R. (1980). Levels of processing and organization: Additive effects of individual-item and relational processing. *Journal of Experimental Psychology: Human Learning and Memory*, *6*, 588–598.

Forster, J. C., & Forster, K. I. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, and Computers*, *35*, 116–124.

Gallo, D. A., McDermott, K. B., Percer, J. M., & Roediger, H. L., III. (2001). Modality effects in false recall and false recognition. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *27*, 339–353.

Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin and Review*, *4*, 271–276.

Israel, L., & Schacter, D. L. (1997). Pictorial encoding reduces false recognition of semantic associates. *Psychonomic Bulletin and Review*, *4*, 577–581.

Kellogg, R. T. (2001). Presentation modality and mode of recall in verbal false memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 913–919.

McDermott, K. B., & Roediger, H. L., III. (1998). Attempting to avoid illusory memories: Robust false recognition of associates persists under conditions of explicit warnings and immediate testing. *Journal of Memory and Language*, *39*, 508–520.

Neath, I. (1998). *Human memory: An introduction to research, data, and theory*. Pacific Grove, CA: Brooks/Cole.

Penney, C. G. (1989). Modality effects in the structure of short-term verbal memory. *Memory and Cognition*, *17*, 398–422.

Pierce, B. H., Gallo, D. A., Weiss, J. A., & Schacter, D. L. (2005). The modality effect in false recognition: Evidence for test-based monitoring. *Memory and Cognition*, *33*, 1407–1413.

Potter, M. C., & Lombardi, L. (1990). Regeneration in the short-term recall of sentences. *Journal of Memory and Language*, *29*, 633–654.

Reyna, V. F., & Brainerd, C. J. (1995). Fuzzy-trace theory: An interim synthesis. *Learning and Individual Differences*, *7*, 1–75.

Roediger, H. L., III. (1990). Implicit memory. *The American Psychologist*, *45*, 1043–1056.

Roediger, H. L., III, & McDermott, K. B (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803–814.

Rummer, R., Schweppe, J., & Martin, R. C. (2008). *Two modality effects in verbal short-term memory: Evidence from sentence recall*. Unpublished manuscript.

Seamon, J. G., Luo, C. R., & Gallo, D. A. (1998). Creating false memories of words with or without recognition of list items: Evidence for non-conscious processes. *Psychological Science*, *9*, 20–26.

Smith, R. E., & Hunt, R. R. (1998). Presentation modality affects false memory. *Psychonomic Bulletin and Review*, *5*, 710–715.

Tulving, E., & Thomson, D. M. (1973). Encoding specificity and retrieval processes in episodic memory. *Psychological Review*, *80*, 352–373.

Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology*, *70*, 122–129.