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Two Modality Effects in Verbal Short-Term Memory: Evidence from Sentence Recall

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Abstract

This paper investigates the mechanisms underlying the standard modality effect (i.e., better recall performance for auditorily presented than for visually presented materials), and the modality congruency effect (i.e., better memory performance if the mode of recall and presentation are congruent rather than incongruent, Rummer, Schweppe, & Martin, 2009). We tested the assumption that the standard modality effect is restricted to the most recent word(s) of the sentences but occurs in both verbatim and gist recall (Experiments 1 and 2), whereas the modality congruency effect should be evident for the rest of the sentence when using verbatim recall (Experiment 3) but not when using gist recall (Experiment 4). All experiments used the Potter-Lombardi intrusion paradigm (Potter & Lombardi, 1990). When the target word was the most recent word of the sentence, a standard modality effect was found with both verbatim recall and gist recall. When the target word was included in the middle of the sentences, a modality congruency effect was found with verbatim recall but not with gist recall.

Keywords

Modality effect; sentence recall; gist recall; modality congruency

The present paper contrasts two modality effects in verbal short-term recall. The first one is the standard *modality effect* according to which recall is better for auditorily than for visually presented lists (and sentences). This effect is independent of the modality of recall. The second effect concerns the relation between modality of presentation and modality of recall. This *modality congruency effect*, which manifests itself in more accurate recall when the modality of presentation and the modality of recall are congruent rather than incongruent, was recently introduced by Rummer, Schweppe, and Martin (2009). Specifically, the modality congruency effect consists of an advantage for oral over written recall for auditory lists, and an advantage for written over oral recall for visual lists. In contrast to the standard modality effect we know little about the modality congruency effect. Until now, the only systematic study of this effect is the above mentioned paper which applied a (long term) false memory paradigm. In order to learn more about the mechanisms underlying the modality congruency effect, it would be helpful to use a more standard, short-term memory task. However, so far it is unclear whether the modality congruency effect also occurs in such a task (in which also the standard modality effect can be found). If both the assumptions underlying the modality effect and the modality congruency effect applied to short-term memory, they would predict contradictory outcomes for written recall of auditory and visual materials. Here, the standard modality effect would manifest itself in

an advantage for auditory over visual presentation and the modality congruency effect in an advantage for visual over auditory presentation for written recall. However, we assume that the two effects rely on different representations with different characteristics, with the result that different variables affect the standard modality effect and the modality congruency effect. The purpose of the present paper is to test our assumptions regarding the mechanisms underlying these two effects. To do so, we will investigate the influence of two variables, namely, *serial position* and *task constraints*. The two investigated effects are assumed to differ with respect to the serial positions which they affect. Furthermore, the modality effect should be found irrespective of whether or not the task requires the maintenance of surface information, while the modality congruency effect should be restricted to cases in which surface information needs to be retained. In the following, we will briefly describe the effects, their (hypothesized) theoretical bases, and how they are affected by the two manipulations (serial position and task constraints), starting with the standard modality effect.

The standard modality effect

In textbooks on cognitive psychology the term “modality effect” (almost always) refers to an advantage of auditory over visual presentation modality in short-term retention of verbal information. Since the 1960s, it has been well known that immediate recall (as well as recognition) of verbal materials is better for lists presented in the auditory than visual modality. This advantage for the auditory modality is restricted to the last one or two items of a list of digits, characters, pseudo-words, or words (e.g., Conrad & Hull, 1968; Crowder, 1967; Crowder & Morton, 1969). That is why the modality effect is sometimes termed auditory recency effect (Neath, 1998). More recently, Rummer and Engelkamp (2001, 2003) demonstrated that a memory advantage for auditory over visual presentation can even be observed with respect to the most recent words of sentences.

Cognitive psychology textbooks usually favour the classical interpretation of the modality effect. Here, the auditory advantage is attributed to an acoustic-sensory code. Crowder and Morton (1969) assumed a pre-categorical acoustic store (PAS), a kind of echoic memory system which stores the sound of the most recent item in an acoustic sensory format (prior to categorisation). A largely similar account is Catherine Penney's (1989) *separate stream hypothesis*. Penney assumes that auditory and visual verbal materials are represented and processed in separate streams. The differences in memory performance between the two modalities are traced back to the properties and capabilities of these streams. Crucially, the acoustic code is assumed to endure for a longer period of time and to be more useful for recall than the visual code. This explains why recall of auditorily presented items is better than recall of items processed in the visual stream. In addition, in serial recall, better memory for the final item should also improve performance on the penultimate item because it cannot be confused with the last item.

The assumption that the modality effect is due to acoustic-sensory information (Crowder & Morton, 1969; Penney, 1989) is supported by the suffix effect, which implies that the modality effect disappears if a not-to-be-recalled item is attached to the memory list. The suffix “overwrites” acoustic representations (e.g., Crowder & Morton, 1969). The effects of suffix presentation are particularly strong when list and suffix items are perceptually similar.

However, there are two lines of evidence that speak against a strict precategorical and acoustic explanation of the modality effect: For one, in some studies the “auditory” recency effect shows up with both reading aloud and silent mouthing (Spoehr & Corin, 1978; Nairne & Walters, 1983; but see Rummer & Schweppe, 2005). For another, it has been demonstrated that the physically identical stimulus can be more effective as a suffix when it

is perceived as speech rather than non-speech (Ayres, Jonides, Reitman, Egan, & Howard, 1979; Neath, Surprenant, & Crowder, 1993). Results like these support explanations of the modality effect which do not exclude categorical influences. An influential example is the feature model (Nairne, 1990), which preserves many characteristics of the PAS. However, it distinguishes modality-dependent features (which interfere only with modality-dependent features) and modality-independent features (which interfere only with modality-independent features). Stimuli that are categorized in the same way lead to interference both between the modality-dependent features of the list items and the suffix, whereas differently categorized stimuli only cause modality-dependent interference.

A part of the modality effect is also explained by the idea that acoustic representations are less susceptible to output interference than visual ones (Cowan, Saults, & Brown, 2004; Harvey & Beaman, 2007). However, it is assumed that this output based advantage does not hold for oral recall which is why the modality effect is (sometimes) less pronounced with oral as compared to written recall (e.g., Penney, 1979; Harvey & Beaman, 2007; but see Penney & Blackwood, 1989).

According to Penney (1989), acoustic sensory information is provided automatically and its maintenance does not need any (strategic) involvement of a central attentional control system (see also Cowan, 1995, 1999). This view is also in line with what would be expected on the basis of the PAS idea (e.g., Crowder & Morton, 1969). Thus, acoustic sensory information is assumed to be provided independently from the characteristics of the experimental task instructions and to contribute even when the retention of surface information is not directly required. In other words, acoustic-sensory representations should contribute to memory even when subjects are instructed to perform a content-related memory task. However, we do not know of any study that has ever tested this assumption. One reason for this might be that the standard short-term memory task – serial recall (or recognition) of unrelated lists of letters, numbers, pseudowords, or words – does not offer the opportunity to instruct *gist* retention and to abstract from surface information. Unlike list recall, sentence recall allows for instructing subjects to recall the gist instead of the surface (e.g., Anderson, 1974).

The Modality Congruency Effect

The expectation of a modality congruency effect is based on the idea that there are privileged pathways from auditory presentation to oral recall and from visual presentation to written recall of verbal information. Such an idea was previously proposed for the auditory-oral pathway by McLeod and Posner (1984) and for the visual-written pathway by Kellogg (2001). McLeod and Posner (1984, p. 64) assumed “a specific structure used solely for converting auditory words into an articulatory program”. Kellogg (2001) postulated that written recall of visually presented words is particularly good since only here the orthographic code is provided during presentation and can be efficiently used during recall. Combining these ideas, oral output should lead to more accurate recall with auditory input and written output should lead to more accurate recall with visual input (Rummer et al., 2009). This assumption is also compatible with two older accounts dealing particularly with episodic long-term memory, namely with the transfer-appropriate processing approach (e.g., Roediger, 1990) and with 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). The encoding specificity hypothesis predicts that context information enhances recall of the critical information, that is, the more context cues are shared between encoding and retrieval, the more information can be retrieved. This simple idea of a benefit of an encoding-retrieval match has been

criticized by Nairne (2002; cf. Goh & Lu, 2012). According to these authors, it is not the match itself that is helpful but “the presence of features that help discriminate the correct target from incorrect competitors – that is, the diagnostic of the retrieval cue” (Goh & Lu, 2012, p. 28f).

In a recent study conducted in our lab (Rummer et al., 2009), we proposed and tested the modality congruency hypothesis using the *Deese-Roediger-McDermott paradigm* (DRM; Deese, 1959; Roediger & McDermott, 1995). Participants had to retain semantically structured lists which included 15 words each and were constructed so that all words of a list were associated with one critical word which was not presented on the list (*lure word*). In this paradigm, lure words intrude relatively often into list recall, in fact, almost as often as actually presented words. We (Rummer et al., 2009, cf. also Kellogg, 2001) tested the assumption that modality-specific surface information, if available, reduces the intrusion rate. To this end, four experimental groups were compared: two modality congruent groups (i.e., visual presentation and written recall; auditory presentation and oral recall) and two modality incongruent groups (i.e., visual presentation and oral recall; auditory presentation and written recall). As dependent variables we measured, first, intrusions of the lure word (which was not included in the list) and, second, the proportion of correctly recalled words that were part of the list. As expected, we found a significant interaction between modality of presentation and mode of recall with lure intrusions, indicating that the proportion of intrusions was smaller when modality of presentation and mode of recall were in a congruent rather than in an incongruent relation. However, this modality congruency effect was restricted to the false memory data (i.e., the lure intrusions). There were no significant differences between the four experimental groups with true recall (i.e., recall of items presented on the DRM lists). Rummer et al. concluded that *phonemic* information provided by auditory presentation can be primarily accessed in oral recall and *graphemic* information provided during reading can be primarily accessed in written recall. We think that this type of information is inherently linguistic in nature. Graphemic information is represented in the visual input and output lexicons and the phonemic information is represented in the auditory input and output lexicons (Patterson, 1988). As suggested by the true recall data, the modality congruency effect seems to be restricted to cases in which phonemic and graphemic representations help to distinguish true from false verbal memories in the respective recall modality and/or to weakly activated items, such as the non-presented lure word in the DRM paradigm or items in the non-primacy and non-recency regions of lists and sentences. The finding of a benefit of a modality match only in terms of better rejection of false memories is in line with Nairne's (2002) idea that an overlap between encoding and retrieval is only helpful when this information can distinguish between targets and competitors.

Unlike the DRM paradigm, Potter and Lombardi's intrusion paradigm (Potter & Lombardi, 1990) involves actual presentation of the lure word (in the lure condition). In addition, in the Potter and Lombardi paradigm, lure and target words are presented in the same modality. This implies that, in the lure condition, the target word and the lure word do not differ as to whether a surface related memory trace has been activated or not. However, by the time the sentence is recalled, phonemic and graphemic representations of the list should be substantially weaker than the phonemic and graphemic representations of the target word. The (graphemic or phonemic) activation differences between target and lure should favour the target word over the lure word. As suggested above, this should only be the case when the recall modality is congruent to the modality of presentation, that is, when the provided phonemic or graphemic code is involved in both presentation and recall. However, this effect is expected to be rather small. The modality congruency effect is thus less potent than the above-described standard modality effect.

Our interpretation of the modality congruency effect is based on the idea that working memory is the activated part of long-term memory (e.g., Cowan, 1995, 1999). Specifically, we assume that the modality congruency effect is based on the activation of modality-specific linguistic surface representations in long-term memory, more precisely, on the activation of graphemic or phonemic representations. We assume that these representations are automatically activated when visual or auditory linguistic stimuli are processed but are usually not kept in a state of activation for a longer period of time. Keeping these representations activated requires the involvement of executive control processes and is thus attentionally demanding. Hence, it is plausible to assume that these types of representation are kept in a state of activation solely when they benefit the experimental task. This should be the case when verbatim recall (of lists or sentences) is required but not when participants are instructed to perform a content-related memory task (e.g., gist recall of sentences).

The scopes of the modality congruency effect and the standard modality effect

Based on the above assumptions regarding the representations that cause the two types of modality effects and their process characteristics, one can predict the conditions under which a modality effect or a modality congruency effect should occur. These predictions depend on item position and the task - particularly with regard to the relevance of literal recall for the task. Given what we know about the standard modality effect reported above, it should be restricted to words located at the end of lists and sentences. The modality congruency effect, on the other hand, seems to be observable mainly for weakly activated items and should thus be restricted to words located in the middle of lists or sentences.

As stated above, the standard modality effect is attributed to the higher longevity of acoustic sensory than of visual sensory information. This type of information is assumed to be provided automatically and should contribute to memory independently from the characteristics of the memory task. In other words, acoustic representations should contribute to recall even though their contribution is not directly afforded by the task. For instance, a recall task that particularly requires semantic information should nonetheless be influenced by acoustic information. The present experiments aim at testing this long standing assumption.

With phonemic and graphemic information the situation is different: This type of information is assumed to decay rather quickly when it is not a subject of processing. Process models such as Cowan's (1995, 1999) assume, however, that representations may be kept activated by means of the attentional system. Clearly, those types of information that are important for the task at hand should be highlighted. For verbatim recall, conceptual, semantic, and surface information are important, whereas for gist recall surface information is negligible.

The purpose of this paper is to contrast the two modality effects within one paradigm which allows for the opportunity to manipulate item position and the relevance of recalling the exact wording. So far, the modality congruency effect has been demonstrated solely with false memories so that a false memory paradigm would seem to be the optimal candidate here. However, it is not possible to test the standard modality effect using the DRM paradigm (i.e., the experimental procedure with which the modality congruency effect has been demonstrated). The standard modality effect is based on representations which can only be available for actually presented items. Auditory presentation of DRM lists should provide an acoustic representation of their final word(s). However, better recall of the final word should not reduce the proportion of falsely recalled lure words, as in DRM experiments the occurrence of lure intrusions is independent of the true recall rate.

What is needed to test our assumption that the modality congruency effect is restricted to the middle of a list or a sentence is a false memory paradigm in which a physically present target word is (potentially) replaced by a lure word and in which it is possible to present that target word either at final or mid positions. In order to test the assumption that the modality congruency effect is restricted to verbatim recall and that the modality effect occurs with both verbatim and gist recall, we need a task in which the relevance of surface information can be manipulated. How can this be done? A promising task is sentence recall. This task relies heavily on conceptual information (e.g., Potter & Lombardi, 1990; Jefferies, Lambon Ralph, & Baddeley, 2004) but surface information, such as phonological information, plays a role when the task is *verbatim* recall (e.g., Alloway, 2007; Rummer & Engelkamp, 2001, 2003; Schweppe, Rummer, Bormann, & Martin, 2011). A false memory paradigm which allows for a manipulation of item positions and a manipulation of the relevance of surface information is the intrusion paradigm originally introduced by Potter and Lombardi (1990), supplemented by adding a manipulation of the task: verbatim vs. gist recall.

The Potter-Lombardi Intrusion Paradigm and its use in testing the contribution of surface information to sentence recall

The Potter-Lombardi intrusion paradigm was originally designed to test the conceptual regeneration hypothesis which states that a “sentence is generated in immediate recall from a representation of its meaning using recently activated words” (Potter & Lombardi, 1990, p. 633). In order to test the contribution of these two types of information (i.e., propositional-conceptual and lexical-semantic information), subjects were presented with a word list and a sentence in each experimental trial. Sentences and word lists were presented using rapid serial visual presentation (RSVP). Participants’ main task was to recall each sentence as accurately as possible. To make sure that the words of the unrelated lists were actively processed, participants were additionally presented with a probe word. For this probe word they had to decide whether or not it had appeared in the word list. The critical experimental manipulation concerned the words presented within the word lists. Half of the lists included a word with a meaning similar to a *target word* in the sentence (termed *lure word*), and half of the lists included a word that was conceptually unrelated to this target word instead (termed *control word*). The sentences were composed so that participants tended to select the lure word instead of the target word during recall. The following example illustrates the trial structure of the immediate recall version of the intrusion paradigm as used by Rummer and Engelkamp (2003). (The lure, the target, and the control word are highlighted.)

Word list with/without lure:	“turtle recipe booth <i>castle</i> /vowel medal”
Sentence presentation:	“The knight rode around the <i>palace</i> searching for a place to enter.”
Sentence recall:	“The knight rode around the <i>palace/castle</i> searching for a place to enter.”
Probe word:	SHOWER

Potter and Lombardi (1990) observed two kinds of lure intrusions: First, participants produced *spontaneous lure intrusions*, that is, even if the lure word was not included in the word list, participants tended to replace the target word with the lure word, which was assumed to fit the sentence context better than the target word. Second, the lure word replaced the to-be-remembered target word more often if it was included in the list (*induced intrusions*) than if the control word was included. That is, participants produced more often sentences like “The knight rode around the *castle* searching for a place to enter” if “castle” had actually been presented. The difference between induced and spontaneous intrusions is termed *intrusion effect*. Lure words and target words differed with respect to their

phonological (and graphemic) surface and, therefore, could have been discriminated easily if phonological information contributed to sentence regeneration. Thus, these results were interpreted as evidence against the contribution of phonological information to sentence recall.

Since then, the lure intrusion paradigm has been used to test several aspects of sentence retention. Rummer and Engelkamp (2003), for instance, used it to demonstrate modality differences. They presented their materials (sentences and word lists) either auditorily or via RSVP. In addition, they varied the sequential order of list and sentence presentation within the trials of the experiment: Half of the participants heard or read the sentence before the list; half of them heard or read the list before the sentence. They assumed that surface information (in particular phonological information) contributes to sentence recall if it is available. Rummer and Engelkamp's (2003) study was based on two presuppositions: first, they argued that phonological information only has a chance to "survive" with immediate recall (i.e., when the list precedes the sentence) but not with delayed recall. When a list has to be processed between sentence presentation and sentence recall, phonological information for the sentence should have decayed by the time of recall, which should thus mainly depend on conceptual information (cf. Sachs, 1967; Jarvella, 1971). The second presupposition concerns the modality of presentation: Rummer and Engelkamp (2003) assumed that RSVP should prevent phonological recoding because processing speed is higher than regular articulation rate (cf. Potter, 1999). Based on these two arguments, they predicted that phonological information should only be available in the auditory immediate recall condition. Assuming that the availability of phonological information regarding the sentence should prevent lure intrusions, they predicted a lure intrusion effect in both RSVP conditions and in the briefly delayed auditory condition, but no lure intrusion effect in the auditory immediate recall condition. This was exactly what they observed. The size of the intrusion effect can thus be interpreted as an indicator of the degree to which (a certain type of) surface information for the sentence is available. When there is no intrusion effect or a substantially reduced one, surface information must have been available on the basis of which the subject was able to discard the lure word as having been part of the sentence.

So to test whether acoustic and/or phonemic and graphemic information are retained, it is possible to manipulate presentation and recall modalities in the intrusion paradigm. The absence of an intrusion effect in certain conditions suggests the availability (and use) of surface information, since a surface level representation of the sentence's wording would help to reject the acoustically/phonologically distinct lure word. If the modality manipulations influence the size of the intrusion effect, we may thus draw conclusions as to the state of activation of the respective representations. The present experiments applied Rummer and Engelkamp's (2003) immediate recall procedure with an additional manipulation of recall mode (oral vs. written recall). Consequently, sentences (and lists) were either presented via RSVP or auditorily; sentence recall was either written or oral. In order to test our assumptions as to when a modality effect occurs and when a modality congruency effect is observed, we tested for these effects in four conditions: In Experiments 1 and 2, the target word was always the most recent word of the sentence (testing for a modality effect); in Experiments 3 and 4, the target word was always in a mid position (testing for a modality congruency effect). In Experiments 1 and 3, verbatim recall was instructed (i.e., participants were instructed to recall the exact wording of a sentence); in Experiments 2 and 4, gist recall was instructed (i.e., participants were instructed to recall the message of a sentence, irrespective of the wording).

We expect a standard modality effect (i.e., fewer lure intrusions with auditory sentence presentation) when the target word is the most recent word of the sentence. This effect should be found with both oral and written recall. As reported above, it might be more

pronounced with written than with oral recall (Harvey & Beaman, 2007). Since acoustic information is assumed to be available independently of the instructed task, the standard modality effect should occur with verbatim recall (Experiment 1) and gist recall (Experiment 2) as well.

When the target word is in mid position (Experiments 3 and 4), we expect a different pattern. Here, a modality congruency effect should be found (i.e., fewer lure intrusions when input and output modality are congruent), but solely when the recall task addresses surface representations (Experiment 3). As the modality congruency effect is assumed to be due to phonemic and graphemic representations in the active part of long-term memory that need to be kept activated by means of attentional resources (cf. Cowan, 1995, 1999), it should occur solely when the instructed task benefits from the use of this information. In other words, graphemic and phonemic representations should only be useful when recall is verbatim, and no modality congruency effect should be found with gist recall (Experiment 4), since surface information is negligible when recalling the content of a sentence.

Experiment 1

Method

Participants—56 students from Saarland University, all of them native speakers of German, participated in the experiment. They were paid or received credit points for participation. A quarter of the individuals (i.e., 14) were randomly assigned to each of the four experimental groups (i.e., visual presentation – written recall; visual presentation – oral recall; auditory presentation – written recall; auditory presentation – oral recall).

Materials—20 sentences, word lists, and probe words had been constructed. Each sentence included a target noun which was always its most recent word. (Thus, target words belonged to that region of the sentences for which acoustic information is assumed to be available.) For each sentence, a list including five unrelated words was constructed. In the lure condition, a word that was semantically similar to the target word replaced one of the unrelated words on the list. Analogously to Potter and Lombardi's (1990) material construction, lure words were chosen in such a way that, in the experimenters' judgment, they appeared more suitable in the context of the sentence than the target word itself. The sentences and the lure words are provided in the APPENDIX. The following example illustrates the construction of the materials:

Word list with lure:	"Schildkröte Flasche Kalender <i>Pause</i> Hut"
[English Translation:	"turtle bottle calendar <i>break</i> hat"]
Sentence presentation:	"Nach der langen und anstrengenden Sitzung baten einige Mitarbeiter um eine <i>Unterbrechung</i> ."
[English Translation:	"After the long and exhausting meeting some of the staff asked for a <i>pause</i> ."]
Probe word:	"FLASCHE"
[English Translation:	["BOTTLE"]

Sentences, word lists, and probe words were presented either visually via RSVP or auditorily. Presentation time with RSVP was 250 ms per word in the list and 200 ms per word in the sentence, auditory presentation times were approximately the same.

Procedure—In all experimental groups, half the sentences were presented in combination with a list including a lure word; the other half were presented with a control list that did not include a lure word. Across participants, each sentence appeared equally often with a list

including a lure word and with a list without a lure word. The assignment of the lists to one of these conditions was determined at random as was the presentation order of the 20 sentence-list combinations.

Each trial was started by pressing the space bar of the computer keyboard. Three asterisks then appeared for 300 ms at the center of the screen followed by a blank screen for 350 ms. Then the word list was presented either auditorily via loudspeakers or via RSVP. After an interval of 250 ms the sentence was presented, in auditory modality or via RSVP. After sentence presentation, participants had to recall the sentence as accurately as possible. Half of the participants were instructed to recall the sentences aloud (oral recall condition), the other half was instructed to write the sentences down on a sheet of paper (written recall condition). (Written recall took slightly longer than oral recall.) Finally, the probe word was presented auditorily or visually (depending on the modality of list and sentence presentation) for 500 ms and participants had to respond via keystroke whether or not it had been part of the word list. Each session lasted about 20 minutes.

Results

Two dependent variables are reported, first, the proportion of lure intrusions per condition, and second, the proportion of correctly recalled words (in percent).

Lure intrusions—Table 1 reports the proportion of lure intrusions as a function of the three independent variables *modality of presentation*, *mode of recall*, and *lure condition*. Figure 1a presents the lure intrusion effect (induced – spontaneous intrusions) as a function of modality of presentation and modality of recall.

As evident in Table 1, there were overall greater lure intrusions for RSVP (11.2%) than auditory presentation (1.6%). Also, as is evident in Figure 1a, the difference between induced and spontaneous intrusions was greater for visual (15.6% vs. 6.8%) than auditory presentation (1.4% vs. 1.9%, respectively), but as predicted there was no modality congruence effect as the difference in the lure intrusion effect between auditory and RSVP presentation was similar for both recall modalities. Statistical analyses confirmed these impressions. There was a significant main effect for the modality of presentation, $F(1, 52) = 33.35$, $MSE = 76.14$, $p < .001$; $F(1, 19) = 13.12$, $MSE = 60.75$, $p < .01$; $CI = \pm 3.2$ and presentation modality interacted significantly with lure condition, $F(1, 52) = 12.66$, $MSE = 46.86$, $p < .001$; $F(1, 19) = 8.94$, $MSE = 20.54$, $p < .01$. Neither the main effect for recall mode (all F s < 1.5) nor the interaction between recall modality and lure condition reached significance ($F(1, 52) = 2.08$, $MSE = 46.86$, $p > .1$; $F(1, 19) = 3.23$, $MSE = 6.31$, $p > .08$). More importantly, there was neither a significant three-way interaction of the factors modality of presentation, recall modality and lure condition (all F s < 1) nor a significant two-way interaction between mode of recall and modality of presentation, all F s < 1 .

Recall accuracy—We report the percentage of correctly reproduced words excluding the target word. Statistical analyses were based on a two-factorial design with two conditions each (auditory presentation vs. RSVP and oral vs. written recall). Table 2 reports recall data as a function of reading modality and recall modality.

Recall was more accurate with auditory presentation (93%) than with RSVP (89%). The ANOVAs revealed a (marginally) significant main effect for presentation modality, $F(1, 52) = 6.02$, $MSE = 46.33$, $p < .05$; $F(1, 19) = 8.99$, $MSE = 26.29$, $p < .01$. The main effect for recall modality ($F < 1$; $F(1, 19) = 3.09$, $MSE = 14.35$, $p > .09$) and the two-way interaction between recall modality and modality of presentation failed to reach significance ($F < 1$; $F(1, 19) = 2.42$, $MSE = 15.84$, $p > .1$).

Discussion

This first experiment was conducted to test the standard modality hypothesis which suggests an advantage for auditory over visual presentation rather than an advantage for congruent over incongruent recall conditions. The source of the effect is the use of acoustic information which should be available only for the most recent item position(s) of lists or sentences. Hence we predicted a recall advantage for the most recent words of auditorily presented sentences. As the most recent word of each sentence was the target word, this should be indicated by a lower proportion of lure intrusions and a lower intrusion effect. In other words, a lower intrusion effect for auditorily presented sentences than for sentences presented via RSVP should be found independently of whether the sentences were recalled orally or in a written mode. The findings were in line with our expectations. In the oral and in the written recall conditions, the intrusion effect was stronger with RSVP than with auditory presentation.

With recall accuracy we also observed a standard modality effect. Based on our assumption that the standard modality effect is restricted to the most recent item position this result seems puzzling. However, unlike lists, the words within a sentence are not recalled independently of one another. An acoustic representation of the final word does not help recall of the other items on an unrelated word list. In contrast, better memory for the most recent word of a sentence can support regeneration of the rest of the sentence. As a consequence, a standard modality effect in sentence recall is not necessarily restricted to a sentence's end position (see also Rummer, Schweppe, Fürstenberg, Scheiter, & Zindler, 2011, for the discussion of modality effects in sentences).

Experiment 2 tests whether the standard modality effect found in the first study can also be found with gist recall. We test the assumption that acoustic information is automatically provided. Hence it should contribute even when recall is not verbatim.

Experiment 2

Method

Participants—76 students from the University of Erfurt, all of them native speakers of German, participated in this study. They were paid or received credit points for participation. A quarter of the individuals (i.e., 19) were randomly assigned to each of the four experimental groups.

Materials and Procedure—This study was a replication of Experiment 1. The same materials were presented using the same experimental procedures. The only difference was that, instead of a *verbatim* recall task, *gist* recall was instructed. To this end, participants were instructed to recall the sentences such that the content was preserved. They were allowed but not advised to use the original wording. (The translation of the German instruction is like this: “You are allowed but not instructed to be verbatim. It is important to recall the gist of the sentence as accurately as possible.”)

Results

Two dependent variables are reported, first, the proportion of lure intrusions per condition, and second, the proportion of correctly recalled words (in percent).

Lure intrusions—Table 1 reports the proportion of lure intrusions as a function of the three independent variables *modality of presentation*, *mode of recall*, and *lure condition*. Figure 1b depicts the size of the intrusion effect (i.e., induced minus spontaneous intrusions) as a function of modality of presentation and recall mode.

As evident in Table 1, there were overall greater lure intrusions for RSVP (10.5%) than auditory presentation (1.8%). Also, as is evident in Figure 1b, there was a large difference between spontaneous and induced intrusions in the visual condition (7.75% vs. 17.75%, respectively) and no difference at all in the auditory condition (4.25% vs. 5.75%, respectively). As predicted, the difference in the lure intrusion effect between auditory and RSVP presentation was similar for both recall modalities (i.e., there was no modality congruency effect).

There was a significant main effect for the modality of presentation, $F(1, 72) = 5.62$, $MSE = 240.01$, $p < .05$; $F(1, 19) = 27.56$, $MSE = 0.92$, $p < .001$. As expected, presentation modality interacted significantly with lure condition $F(1, 72) = 6.16$, $MSE = 117.37$, $p < .05$; $F(1, 19) = 6.45$, $MSE = 0.99$, $p < .05$. Neither the main effect for recall mode (all $F_s < 1$) nor the interaction between recall modality and lure condition reached significance (all $F_s < 1$). More importantly, there was neither a significant three-way interaction of the factors modality of presentation, recall modality and lure condition (all $F_s < 1$) nor a significant two-way interaction between mode of recall and modality of presentation, all $F_s < 1$.

Recall performance—We report the percentage of correctly reproduced words excluding the target word. Statistical analyses were based on a two-factorial design with two conditions each (auditory presentation vs. RSVP and oral vs. written recall). Table 2 reports recall data as a function of reading modality and recall modality.

Recall was more accurate with auditory presentation (88.1%) than with RSVP (80.5%). The ANOVAs revealed a significant main effect for presentation modality $F(1, 72) = 6.80$, $MSE = 154.63$, $p < .05$; $F(1, 19) = 8.19$, $MSE = 62.85$, $p < .01$. The main effect for recall modality was significant only in the subject analysis $F(1, 72) = 4.63$, $MSE = 154.53$, $p < .05$; but not in the item analysis $F_2 < 1$. The two-way interaction between recall modality and modality of presentation failed to reach significance, (all $F_s < 1$)

Discussion

The findings of this experiment perfectly replicate the findings of Experiment 1. As expected, we observed a standard modality effect. The only difference between Experiment 1 and 2 concerned the general frequency of lure intrusions under all experimental conditions. Trivially, the proportion of intrusions was higher when the task was to recall the sentences' content than when it was to recall the sentences word-by-word.

A comparable result was observed with respect to the general recall performance (words correct per sentence). Since no verbatim recall had been instructed, recall performance was generally less accurate in the second than in the first study, an interpretation which is supported by a joint analysis of the recall data from both experiments (main effect for the instructed task, $p < .001$). In addition, and as in the first study, we observed better recall for auditorily than for visually presented sentences. It seems that better memory for the most recent word of a sentence really supports regeneration of the rest of the sentence and, thus, a standard modality effect in sentence recall is not restricted to a sentence's most recent word (cf. Rummer et al., 2011).

In sum, the findings of the first two studies clearly support the assumptions based on the theories that account for the modality effect: Acoustic information is available and contributes to recall independently from whether the recall task explicitly addresses surface information or not. As for the characteristics of acoustic representations, our findings support the idea that these are made and kept available without cognitive effort.

Experiments 3 and 4 aimed at testing the modality congruency assumption, which suggests a reduced intrusion effect when modality of presentation and modality of recall are in a congruent rather than in an incongruent relation. This effect should be observed solely for weakly activated items. Thus, the target words in Experiments 3 and 4 are not located at the peripheral positions (i.e., at the end or the beginning) but in the middle of the sentences. In contrast to the standard modality effect (which was found independently from whether verbatim or gist recall had been instructed), we expect the modality congruency effect to be found solely when the recall task addresses surface representations. This hypothesis can also be derived from Nairne's (2002) position that an encoding-retrieval match is solely beneficial when the respective information can be used to distinguish targets from competitors. If the task does not require such a distinction (because the competitors are as adequate as the targets), congruency between input and output modality should no longer affect the presence or absence of intrusions. Thus, unlike the modality effect, a modality congruency effect should be found with verbatim recall (Experiment 3) but not with gist recall (Experiment 4).

Analogously to the first experiments, Experiment 3 required verbatim sentence recall and Experiment 4 required gist recall. For verbatim recall, we predict a three-way interaction between modality of presentation, mode of recall, and lure condition based on the modality congruency hypothesis: There should be a higher intrusion effect when the relation between presentation modality and mode of recall is incongruent (i.e., auditory-written or visual-oral) than when it is congruent (i.e., auditory-oral, visual-written). For gist recall, this three-way interaction should be reduced or eliminated.

Experiment 3

The only difference between Experiment 1 and this study concerned the position of the target word. In Experiment 1 the target word was always the most recent word of the sentence, in Experiment 3 it was placed in the middle of each sentence. Like Experiment 1, the present study was based on a $2 \times 2 \times 2$ design with the factors “modality of presentation” (auditory presentation vs. RSVP) and “mode of recall” (oral recall vs. written recall) serving as between-subjects variables, and the factor “lure condition” (list includes a semantically related lure word vs. list includes an unrelated control word) serving as within-subjects variable.

Method

Participants—72 students from Saarland University, all of them native speakers of German, participated in the experiment. They were paid or received credit points for participation. A quarter of the individuals (i.e., 18) were randomly assigned to each of the four experimental groups.

Materials & Procedure—Twenty sentences, word lists, and probe words were constructed. Each sentence included a target noun in mid position (e.g. “The knight rode around the *palace* searching for a place to enter.”). For each sentence, a list including five unrelated words was constructed. In the lure condition, a word that was semantically similar to the target word replaced one of the unrelated words on the list. The materials were taken from Rummer and Engelkamp (2003). (A complete list of the materials can be found in Rummer & Engelkamp, 2001, p. 464f, Experiment 1.) The experimental procedure was exactly the same as in Experiment 1.

Results

As dependent variables, we report the proportion of lure intrusions (in percent) and – as a control variable – the proportion of correctly recalled words per sentence (excluding the target word).

Lure intrusions—Table 1 reports the proportion of lure intrusions as a function of the three independent variables *modality of presentation*, *mode of recall*, and *lure condition*. In Figure 1c, the size of the intrusion effect (i.e., induced minus spontaneous intrusions) is depicted as a function of modality of presentation and recall mode.

In those conditions with congruent presentation and recall modalities hardly any intrusion effect was observed. With visual presentation and written recall, there were only slightly more intrusions when the lure was in the list than when it was not, and with auditory presentation and oral recall, there were actually slightly fewer lure intrusions when the lure was present. On the other hand, with an incongruent relationship between presentation and recall modality there was a substantial lure intrusion effect: Both for auditory presentation and written recall and for RSVP and oral recall, the difference between intrusions with lure present and with lure absent was 7.2% ($CI=\pm 4.45$ and $CI=\pm 5.06$, respectively).

The ANOVAs revealed that the main effect for presentation modality did not reach significance, $F(1, 68) = 1.18$, $MSE = 47.51$, $p > .1$; $F(1, 19) = 2.2$, $MSE = 28.39$, $p > .1$. The main effect for recall modality was significant only in the subject analysis, $F(1, 68) = 4.22$, $MSE = 47.51$, $p < .05$; $F(1, 19) = 2.28$, $MSE = 97.91$, $p > .1$. In addition, none of the two-way interactions reached significance, all F s < 1.2 ; all F 2s < 2.9 .

Crucially, however, the expected three-way interaction was significant, $F(1, 68) = 12.17$, $MSE = 48$, $p < .001$; $F(1, 19) = 5.95$, $MSE = 81.02$, $p < .05$.

Recall accuracy—We recorded the proportion of correctly reproduced words per sentence. The target word was excluded from analysis. Under all recall conditions accuracy was very high. Overall accuracy was not influenced by modality: there were neither significant main effects for presentation or recall modality nor a significant interaction between the two factors (all F s < 1). The results of the recall accuracy data are given in Table 2.

Discussion

The data of this experiment are in line with the modality congruency hypothesis: They demonstrate that an intrusion effect (i.e., more induced than spontaneous lure intrusions) was only present when there was a mismatch between presentation and recall modalities. The modality congruency effect is thus not restricted to recall of DRM lists but can also be found with respect to sentence recall. However, there is one puzzling aspect in the data: It seems as though the baseline (indicated by the proportion of spontaneous intrusions) is higher in the visual-written group than in all other groups. Although we do not have a plausible explanation for this finding, in combination with Rummer et al.'s DRM data, the present results support the modality congruency hypothesis.

As was the case in our DRM experiment (Rummer et al., 2009) and in Kellogg's (2001, Experiment 1) study, the modality congruency effect is restricted to the intrusion data.. No influence of presentation modality, recall modality, and their relationship has been observed with recall accuracy, neither in the DRM experiment nor in the present sentence recall intrusion experiment. In nearly all experiments based on the Potter-Lombardi paradigm lure intrusions were more sensitive to the experimental manipulations than the true recall data.

That is the case in our study as well. Like Potter and Lombardi (1990), we focus on the intrusion data. In line with the modality congruency hypothesis, our results show that 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, at least for weakly activated items. We suggest that this is due to the fact that modality-specific linguistic information (i.e., phonemic and graphemic representations) can primarily be accessed when input modality and output mode are congruent (see also Kellogg, 2001; McLeod & Posner, 1984).

As suggested above, the phonemic and graphemic representations responsible for the modality congruency effect are assumed to only contribute to sentence recall when verbatim recall has been instructed. To test this assumption, Experiment 4 was conducted which replicated Experiment 3 with gist recall. As outlined above, we do not expect any effects of presentation or recall modality on the intrusion rates here.

Experiment 4

Method

Participants—68 students from Saarland University, all of them native speakers of German, participated in the experiment. They were paid or received credit points for participation. A quarter of the individuals (i.e., 17) were randomly assigned to each of the four experimental groups. One of the participants was excluded from the analysis due to technical problems.

Materials and Procedure—The materials and the experimental procedure exactly replicated that of Experiment 3. The only difference concerned the recall instruction. In contrast to Experiment 3, participants were instructed to recall the content of the sentences. That is, gist recall (like in Experiment 2) was requested instead of verbatim recall.

Results

As dependent variables, we report the proportion of lure intrusions (in percent) and – as a control variable – the proportion of correctly recalled words per sentence (excluding the target word).

Lure intrusions—Table 1 reports the proportion of lure intrusions as a function of the three independent variables *modality of presentation*, *mode of recall*, and *lure condition*. Figure 1d depicts the size of the intrusion effect as a function of presentation modality and recall modality.

There were more lure intrusions when a lure word was presented than when a control word was presented (10.15% vs. 5.69%). This main effect for lure condition was the only significant effect revealed by the ANOVAs, $F(1,63) = 11.91$, $MSE = 53.63$, $p < 0.01$; $F(1,19) = 5.65$, $MSE = 15.32$, $p < 0.05$. The other main effects as well as the two- and three way interaction did not reach significance, all F s < 1 .

Since we predicted a null effect with respect to the interaction between lure condition, presentation modality and recall modality, we additionally computed the probability of the null hypothesis being true, given the obtained data ($p(H_0|D)$) according to Masson (2011). Positive evidence that the null hypothesis is true is obtained when this probability value is above .75; strong evidence is obtained with probability values above .90 (Masson, 2011). The obtained $p(H_0|D)$ value for the critical three-way interaction was .88. This analysis, therefore, provides additional support for the conclusion that the modality congruency effect does not show up with gist recall.

Recall accuracy—We recorded the proportion of correctly reproduced words per sentence. The target word was excluded from analysis. The results of the recall accuracy data are given in Table 2.

With auditory presentation, participants reproduced more words per sentence than with visual presentation (88.85% vs. 82.34%, respectively). Statistical analyses confirmed this (main effect for presentation modality, $F(1, 63) = 8.78$, $MSE = 84.10$, $p < 0.01$; $F(1, 19) = 20.74$, $MSE = 53.80$, $p < .01$). The main effect for recall modality reached significance only in the item analysis, $F(1, 63) = 2.28$, $MSE = 84.10$, $p = .12$; $F(1, 19) = 6.37$, $MSE = 61.33$, $p < .05$. The interaction between presentation and recall modality failed to reach significance, $F < 1$.

Discussion

As expected, no modality congruency effect was found with gist recall. The intrusion effect was not influenced by presentation or recall modality. This finding is in line with our assumption that the modality congruency effect is based on linguistic surface representations which need to be kept in a state of activation deliberately. As predicted, keeping linguistic surface representations activated until the representations can be used in (modality congruent) recall solely takes place when this information is assumed to be beneficial for the instructed task. This is only the case with verbatim but not with gist recall. In addition, sentence recall was again better with auditory than with visual presentation. Based on the findings of Experiment 2 it is plausible to explain this effect in terms of an auditory recency effect which is independent of the instructed task and due to which the rest of the sentence can be regenerated more easily. Analogously to the first two experiments, we compared the recall data for Experiments 3 and 4, which again revealed a main effect for recall task ($p < .01$). This suggests that recall was indeed less verbatim when verbatim rather than gist recall was instructed.

General Discussion

In sum, the four experiments imply that the modality-specific linguistic information responsible for the modality congruency effect is not equivalent to the acoustic information responsible for the standard modality effect. It can thus be concluded that auditory presentation and visual presentation do not only differ with respect to the sensory codes they provide but also with respect to a further type of information. As suggested in the introduction, this type of information is linguistic in nature: graphemic information in the visual input and output lexicons and phonemic information in the auditory input and output lexicons. According to our modality congruency hypothesis – and in line with theories such as transfer-appropriate processing (Roediger, 1990), encoding specificity (Tulving & Thomson, 1973), and others (Kellogg, 2001; McLeod & Posner, 1984) – there are privileged pathways between auditory input and spoken output and between visual input and output lexicons.

Unlike the modality effect, the modality congruency effect seems to be restricted to false memories, more precisely to cases in which a semantically related and conceptually adequate lure word has to be rejected in a monitoring process. This monitoring process relies on surface information for the sentence (or, in case of DRM, the list) such as phonological, acoustic, phonemic and graphemic representations. Therefore, it is easier to reject the lure word when any of these surface representations are available at the time of recall. However, access to phonemic and graphemic representations does not seem to aid retrieval of items actually presented in the sentence or on the DRM list. This might be a reason why list recall studies failed to find a modality congruency effect.

The standard modality effect and the modality congruency effect do not only differ with respect to the representations on which they are based (and the item positions for which they can be observed) but also with respect to the processes involved. While acoustic codes are available and, consequently, a modality effect can be observed independently of the task, phonemic and graphemic representations need to be actively kept available, when they are useful for the task and, consequently, a modality congruency effect can only be observed when the task requires the use of surface information.

The findings of the experiments reported in the present paper are in line with the prediction made on the basis of Crowder and Morton's (1969) and Penney's (1989) models. Our findings can also be related to Cowan's (1995, 1999) embedded processes model which conceptualizes working memory as embedded in long term memory. Cowan's model includes three main components: long term memory, a central executive, and a brief sensory store. Long-term memory is a general memory system in which three states of activation can be distinguished. Representations can be inactive, pre-activated, or in the focus of attention. "The focus of attention is controlled conjointly by voluntary processes (a central executive system) and involuntary processes (the attentional orienting system)" (Cowan, 1999, p. 62). Executive control is a function of the individual's processing goals which are mainly based on the characteristics of the task at hand. The brief sensory store provides sensory information for a short period of time. Information stored in this system cannot be subject of the central executive. Thus, memory effects based on this component should not be controllable by strategic processes. In contrast, representations activated in long term memory (such as phonemic and graphemic representations) can be kept activated by the central executive to counteract the influences of interference and decay. Since functioning of the central executive depends on the task, surface representations such as phonemic and graphemic representations (i.e., information that need not be kept available for conceptual processing) should solely be kept in a state of activation when retention of these representations is required, for instance when *verbatim* recall is instructed. Since, according to Cowan (1999), sensory information is only briefly available (for about 250 ms), the modality effects found in the Experiments 1 and 2 cannot be attributed to the brief sensory store.

However, within Cowan's model, the difference between the standard modality effect and the modality congruency effect in terms of task-dependency can be explained in yet another way: The task-independence of the standard modality effect and the task-dependence of the modality congruency effect can be the consequences of similarity-based interference. As interference is stronger for (here: acoustically) more similar representations, surface representations of the words in the middle of a sentence suffer from interference to a far stronger degree than those of the final word because mid-sentence representations are subject to interference from the subsequent words spoken in the same voice but the word at the end of the sentence is not. In the absence of interference, auditory representations in long term memory can persist for many seconds. The auditory representation of the sentence-final word should thus remain highly activated without being focused by the central executive, whereas the mid-sentence words' surface representations need to be focused in order to remain sufficiently activated until recall. As we assume that surface representations are solely kept activated when it is required, a modality (congruency) effect for mid sentence word should only show up with *verbatim* recall. What is not captured by Cowan's (1999) model is the fact that access to surface representations varies as a function of input and output modality overlap. We suggest that this is because the two modality effects rely on different types of representations (acoustic vs. phonemic and graphemic).

The present experiments demonstrated that the contribution of phonemic and graphemic representations to sentence recall depends on the requirement to recall the exact wording of

the sentences. In combination with the effect of the serial position manipulation and the modality congruency effect's restriction to the suppression of false memories, this finding supports our assumption that different representations with different processing characteristics cause the standard modality effect and the modality congruency effect.

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APPENDIX

Materials of Experiments 1 and 2

German sentences (lure words in brackets) and English glosses

1. Damit die alte Dame nicht länger stehen musste, erhob er sich von seinem *Stuhl* (Platz). He stood up to offer his *chair* (seat) to the old lady so she did not have to stand any longer.
2. Auf seine ungewöhnliche Frage erwartete der Professor für Geschichte ungeduldig eine *Erwiderung* (Antwort). The history professor waited impatiently for a *response* (answer) to his unusual question.
3. Während der Mann nach Fischen Ausschau hielt, glitt das Kanu über den *Teich* (See). As the man was keeping an eye out for fish, the canoe glided across the *pond* (lake).
4. Erst nachdem der Bericht von vier Leuten geprüft worden war, bemerkte jemand den *Irrtum* (Fehler). It was only after the message had been checked by four people that somebody noticed the *fault* (mistake).
5. Um einen geeigneten Eingang zu suchen, ritt der Ritter um die *Festung* (Burg). In order to find a convenient entrance, the knight rode around the *fortress* (castle).
6. Um einige Kisten mit Spielzeug durchzuwühlen, gingen sie hinunter zum *unteren Geschoss* (Keller). So that they might rummage through some boxes with toys, they went downstairs to the *cellar* (basement).
7. Der Abend war sehr kalt, deshalb trug er beim Fußballspiel seine *Weste* (Jacke). He wore his *vest* (coat) during the football game because it was very cold outside.
8. Er suchte nach dem zuvor telefonisch reservierten Tisch in dem neuen *Lokal* (Restaurant). He was looking for the table they had reserved by phone in the new *venue* (restaurant).
9. In den hinteren Teil der Kammer stopften sie fast alle *Pakete* (Kartons). They packed away most of the *parcels* (boxes) in the back of the room.
10. Nach der interessanten Lesung hoffte die Frau auf ein Autogramm des *Autors* (Schriftsteller). After the interesting reading, the woman was hoping to get her copy of the book signed by the *author* (writer).
11. Bevor sie anfang zu spülen, warf sie die Essensreste in den *Papierkorb* (Mülleimer). Before she started doing the dishes, she tossed away the leftovers in the *wastebasket* (trash bin).

12. Um herauszufinden, was "fragil" bedeutet, schaute er in sein *Lexikon* (Wörterbuch). He looked up 'fragile' in the *lexicon* (dictionary) to figure out its meaning.
13. Ihre Eltern mit dem Gartenschlauch nass zu spritzen, machte ihnen viel *Freude* (Spaß). It was *delightful* (fun) to spray water on their parents using the garden hose.
14. Weil Herbert sie bei jeder Feier zum Besten gab, lachte niemand mehr über seine *Scherze* (Witze). Because Herbert would make the same *jests* (jokes) every time, nobody laughed at them anymore.
15. Nach dem langen Tag hatte der Parkwächter schon ganz blaue Finger vor lauter *Frost* (Kälte). After his long work day, the car park attendant's fingers were quite blue because of the *frost* (cold).
16. Um ihren Schreibtisch aufzuräumen, lochte sie alle Zettel und packte sie in einen *Hefter* (Ordner). To clean up her desk, she punched holes in all of her notes then put them together in a *folder* (binder).
17. Nach der langen und anstrengenden Sitzung baten einige Mitarbeiter um eine *Unterbrechung* (Pause). After the long and exhausting meeting, some of the employees asked for a *pause* (break).
18. Als sie aus der Disco zurück kamen, fuhren sie mit überhöhter Geschwindigkeit vor eine *Wand* (Mauer). On their way back from the party, they drove into a *facade* (wall) at high speed.
19. Zu Weihnachten backte die Oma mit ihren Enkeln jedes Jahr *Kekse* (Plätzchen). Each year, grandma baked *biscuits* (cookies) with her grandchildren for Christmas.
20. Während sie auf einen freien Tisch warteten, setzten sie sich an die *Bar* (Theke). While they were waiting for a table, they sat down at the *counter* (bar).

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(a) Verbatim Recall (Experiment 1, Target in End Position)

(b) Gist Recall (Experiment 2, Target in End Position)

(c) Verbatim Recall (Experiment 3, Target in Mid Position)

(d) Gist Recall (Experiment 4, Target in Mid Position)

Figure 1.

The size of the intrusion effect (difference between induced and spontaneous intrusions) as a function of modality of presentation, mode of recall, target position, and recall task.

Mean percentage of lure intrusions as a function of modality of presentation, modality of recall, and lure condition. The table reports the findings for all experiments.

TABLE 1

	Auditory Presentation		Visual Presentation	
	Without Lure	With Lure	Without Lure	With Lure
Verbatim Recall	Experiment 1 (Target Word Located at End of the Sentences)			
	Oral Recall	3.7	1.4	8.3
	Written Recall	0	1.4	5.2
Gist Recall	Experiment 2 (Target Word Located at End of the Sentences)			
	Oral Recall	4.4	5.6	11.9
	Written Recall	4.1	6.4	5.45
Verbatim Recall	Experiment 3 (Target Word Located in the Middle of the Sentences)			
	Oral Recall	3.9	1.7	1.7
	Written Recall	2.8	10.0	6.1
Gist Recall	Experiment 4 (Target Word Located in the Middle of the Sentences)			
	Oral Recall	3.8	7.5	3.1
	Written Recall	7.1	10.6	8.8

TABLE 2

Mean percentage of correctly reproduced words per sentence (excluding the target word) as a function of modality of presentation and modality of recall. The table reports the findings for all experiments.

		Auditory Presentation	Visual Presentation
Experiment 1 (Verbatim Recall)	Oral Recall	93	89
	Written Recall	93	90
Experiment 2 (Gist Recall)	Oral Recall	92	84
	Written Recall	85	78
Experiment 3 (Verbatim Recall)	Oral Recall	89	90
	Written Recall	91	88
Experiment 4 (Gist Recall)	Oral Recall	86	81
	Written Recall	91	84