Journal of Memory and Language 94 (2017) 61–74

Contents lists available at ScienceDirect

Journal of Memory and Language

journal homepage: www.elsevier.com/locate/jml

When distraction benefits memory through semantic similarity ☆

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ARTICLE INFO

Article history:
Received 17 March 2016
revision received 11 November 2016

Keywords:
Semantic auditory distraction
Interference-by-process
Judgments of learning

ABSTRACT

The processing of the relation between targets and distracters which underpins the impairment in memory for visually presented words when accompanied by semantically related auditory distracters—the between-sequence semantic similarity effect—might also disambiguate category membership of to-be-remembered words, bringing about improved memory for these words at recall. In this series of experiments the usual impairment of the between-sequence semantic similarity effect is reversed: we show that related distracters can improve memory performance when multiple-category lists are studied and a category-cued recall test is used at retrieval. The results indicate not only that irrelevant speech distracters are routinely processed for meaning, but also that semantic information gleaned from this stream is retained until recall of the memoranda is cued. The data are consistent with a revised interaction-by-process framework.

Introduction

Performing difficult or challenging cognitive tasks requires focused attention, for which it is necessary to partition task-relevant information from the external environment and the distractions it presents. Complete disengagement, however, is less than desirable if a flexible system of attention is to be realized: the cognitive system should be equipped with means of monitoring most of the ensemble of environmental events so as to alert the individual to events particularly germane to the individual's overall goals. The logical consequence of such a system is distractibility. It means that even when a person is highly absorbed in performing a cognitive task, changes in environment are likely to affect cognitive performance.

One particularly interesting instance is the case of auditory distraction in a memory task (see reviews by Beaman, 2005; Hughes & Jones, 2003; Jones, Hughes, & Macken, 2010). A long tradition of research has examined how performance in tasks such as serial or free recall is impeded by the presence of auditory distraction in the form of either speech (e.g., Jones, Madden, & Miles, 1992; Salamé & Baddeley, 1982) or non-speech sounds (e.g., Hughes, Vachon, & Jones, 2007; Jones & Macken, 1993). An overall framework for understanding auditory distraction effects is one of interference-by-process (Jones & Tremblay, 2000), according to which the similarity between the processes engaged in performing the primary memory task and those used to register the environment determine the degree of interference observed in memory performance. Thus, if a memory task is one of visual serial recall which requires primarily the processing of order of the memoranda, an automatic process of seriation of a

☆ The research reported in this article was supported by Economic and Social Research Council (UK) grant ES/L00710X/1 awarded to Philip Beaman and Dylan Jones.
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http://dx.doi.org/10.1016/j.jml.2016.11.005
0749-596X/

sequence of auditory distracters impairs memory performance (Beaman & Jones, 1997, 1998). However, if a task is one of free recall which requires primarily the processing of the meaning of the memoranda, semantic processing of auditory distracters determines memory impairment (Marsh, Hughes, & Jones, 2008). Results such as these have been used to inform hypotheses about the structure and organization of memory (e.g., Jones, Beaman, & Macken, 1996; Jones, Hughes, & Macken, 2006; Neath, 2000; Page & Norris, 2003: Salamé & Baddeley, 1982) and the extent to which supposedly unattended information is processed (e.g., Jones, 1999; Macken, Tremblay, Houghton, Nicholls, & Jones, 2003).

In the present study our interest lies in auditory distraction processes observed in memory tasks that require memorizing and recalling semantically-rich materials in the form of words. These processes have most commonly been examined with a free recall task (e.g., Neely & LeCompte, 1999). The hallmark of interference-by-process in free recall is a finding of a *between-sequence semantic similarity effect* (also referred to as a *semantic auditory distraction effect*). When the task is to remember a list of words derived either from a single category (e.g., Beaman, Hanczakowski, Hodgetts, Marsh, & Jones, 2013; Marsh, Sörqvist, Hodgetts, Beaman, & Jones, 2015; Marsh et al., 2008), or up to four different semantic categories (Marsh, Hughes, & Jones, 2009; Marsh, Perham, Sörqvist, & Jones, 2014), ability to correctly recall suffers more in the presence of auditory distracters that are related to to-be-remembered (TBR) items. Thus memory based on semantic processing of TBR words is impeded by processing of semantic aspects of auditory distraction, a finding consistent with the interference-by-process framework. Where TBR words come from a single category, related to-be-ignored (TBI) auditory distracters – words from the same semantic category – produce an exaggerated memory impairment. Where TBR words are drawn from multiple categories, related TBI distracters are words from one of these categories and the exaggerated memory impairment relative to semantically unrelated distraction is found for TBR items that match the category of TBI items and also other items presented in the same TBR list (Marsh et al., 2009).

A number of possible specific mechanisms could potentially account for the between-sequence semantic similarity effect in free recall. These mechanisms are not mutually exclusive. According to the attentional shift hypothesis, presenting semantically related auditory distracters induces an attentional shift away from the focal memory tasks and towards processing of the distracters (Bell, Buchner, & Mund, 2008; Cowan, 1995; Parmentier, 2008). If fewer attentional resources are devoted to processing TBR items, subsequent memory performance is likely to suffer. The idea here is thus that participants' ability to ignore distracters is not perfect. As mentioned earlier, the attentional system needs not only to support performance in the focal task but it also needs to monitor the environment for germane events and auditory distracters that are related semantically to processed TBR items can be seen as such germane events that need to be attended to. Indeed, studies on distraction that manipulated the significance of auditory distracters, either by using distracters rich in emotional content (Buchner, Rothermund, Wentura, & Mehl, 2004) or by using participants' own names as auditory distracters (Röer, Bell, & Buchner, 2013), have found that presumably more significant distracters caused a greater memory impairment for TBR items, consistent with the attentional hypothesis.

The attentional shift hypothesis can be seen as an extension of theoretical frameworks that postulate that a finite level of resource or activation is shared between all current stimuli (Neath, 2000; Oberauer & Lange, 2008). This form of resource-sharing also gives rise to ideas of inhibition as a means of top-down control to avoid runaway or inappropriate activation levels. By an inhibitory mechanism, the between-sequence semantic similarity effect might then reflect an overhead cost incurred when recruiting inhibitory processes to resist related distracters in order to facilitate encoding of TBR words (Marsh, Sörqvist, Beaman, & Jones, 2013; Marsh et al., 2008). In this account also, the impairment to memory of TBR items arises when resources are devoted to processing of distraction instead of TBR items. However, whereas the attentional shift hypothesis postulates that resources are purposefully devoted to processing distraction when there is a chance it is germane to the main memory task (i.e. it is semantically related to TBR items), the inhibitory hypothesis postulates that resources are allocated to avoid further processing of distraction by means of inhibition. The main line of support for the inhibitory hypothesis comes from examining the after-effects of related auditory distraction in the form of negative priming in free recall: impaired memory performance when related TBI items become TBR items in the next memory list (Marsh, Beaman, Hughes, & Jones, 2012; Marsh, Hughes, Sörqvist, Beaman, & Jones, 2015). However, the contribution of inhibition to negative priming in free recall has recently been questioned by Hanczakowski, Beaman, and Jones (2016), who argued for a simpler proactive interference account of this effect, leaving the status of the inhibitory hypothesis unclear.

Another means by which related distraction can cause forgetting is via overwriting at, or immediately subsequent to, encoding (Nairne, 1990; Neath, 2000). Here it is argued that specific features of related distracters overwrite memory trace of a TBR item, displacing some or all of its individual or characteristic features. With missing features, the TBR item is later more difficult to reconstruct and thus memory performance suffers.

The attentional shift, inhibitory and overwriting hypotheses rely upon a hypothetical operation at encoding disturbing later recall but the primary locus of the between-sequence semantic similarity effect may lie not at encoding but rather at retrieval of TBR items more directly. Via a process of blocking, related TBI items encoded in memory might interfere with retrieval of TBR words by increasing the size of the sampling set and thus reducing the chances that each one of the TBR words is sampled (cf. Marsh et al., 2008). The blocking hypothesis links the semantic auditory distraction paradigm with numerous other memory paradigms, such as the part-set cuing paradigm (Rundus, 1973) or the retrieval practice

paradigm (Raaijmakers & Jakab, 2013). It is argued that similar non-target items can interfere with retrieval of target items within these paradigms. The blocking hypothesis is also consistent with the observation that related distracters tend to intrude when participants strive to recall TBR items (Beaman, 2004). However, it does not readily account for the dissociations observed between the patterns of correct recall of TBR items and the patterns of intrusions from the related distracters. The blocking hypothesis would predict a close correspondence between memory impairment and intrusions of related TBI items, yet Beaman (2004) found that only intrusions were related to working memory capacity measures and, further, Marsh et al. (2015) showed that warning participants about related distraction reduces intrusions while having no effect on memory impairment for TBR items. Marsh et al. (2008) also showed that varying the timing of distraction between encoding, retention and retrieval also has a strong effect on the rate of intrusions from related distracters but not on the pattern of correct recall.

A final account of the between-sequence semantic similarity effect is the strategy disruption hypothesis, which assumes that related distracters impede the creation or the execution of an efficient retrieval plan that would take into account category relationship and other similarities between TBR words (Marsh et al., 2009). The strategy disruption mechanism has been repeatedly invoked in the memory literature to account for findings as diverse as part-set cuing (Basden & Basden, 1995) or collaborative inhibition (Barber & Rajaram, 2011). It is generally assumed that at encoding participants try to establish a retrieval plan appropriate to the TBR items. When TBR items remain largely unrelated, a commonly used strategy is to encode and recall them serially (cf. Beaman & Jones, 1998; Bhatarah, Ward, & Tan, 2006; Grenfell-Essam & Ward, 2012; Hintzman, 2016) thus any manipulation that disrupts serial processing by making some items in a study list more distinctive than others leads to a subsequent impairment in memory performance for the non-distinctive items (see McDaniel & Bugg, 2008, for various examples). When TBR items are derived from several categories, participants are assumed to link items from the same categories and retrieve them by cluster. The measure of clustering in such a design is taken as the measure of effectiveness in creating a retrieval plan at encoding (see Mulligan & Peterson, 2013, for a recent example) or executing it at retrieval. Studies on semantic auditory distraction that used multiple-category lists in which auditory distracters were either unrelated or related to one of the categories have shown that related distraction impairs the categorical organization of retrieval processes as reflected by clustering measures (Marsh et al., 2009, 2014). Thus, one possibility is that distracters related to one category represented in the TBR list hinder the process of establishing categorical relationships amongst the TBR words at encoding by consistently priming only a single category and impeding the process of creating separate category clusters. Alternatively, related TBI items can intrude during recall and again prime a single category to which they all belong, detracting participants from the strategy of consistent category-by-category recall. Although it is not immediately clear whether the same mechanism could account for disruption of recall of single-category lists, one could argue that even single-category lists consist of clusters of interrelated items belonging to some distinctive sub-categories that can serve as a scaffolding for retrieval strategies (i.e., four-footed animals can include exotic animals such as lions and tigers and domestic animals such as sheep and cows). In this case, if recall attempts are driven by within-category semantic associations, then related distracters may impair memory performance by disrupting these associations, again either at encoding or at retrieval. Regardless, however, of whether the multiple-category and single-category paradigms reveal the operations of the same strategy disruption mechanism, research with multiple-category lists at the very least suggests that the category information conveyed by TBI words is an important aspect of the between-sequence semantic similarity effect.

All the mechanisms that have been postulated to provide a description of how semantic auditory distraction affects memory performance have one thing in common: unsurprisingly, given the experimental findings, they predict that related distracters should impair memory performance. However, we argue that the postulated mechanisms differ in respect to how unavoidable semantic distraction may be. The attentional, inhibitory, overwriting and blocking hypotheses predict that related auditory distraction occurs at the level of the item and has only negative effects on memory performance which, under certain conditions, can perhaps be mitigated. Driving resources away from processing TBR items, as envisioned by the attentional and inhibitory hypotheses, is highly unlikely to bring any possible benefits to memory for these items. Overwriting can only lead to loss of the details of the TBR words and blocking at retrieval is a mechanism that is evoked to explain various cases of forgetting but not memory improvement. We argue, however, that the strategy disruption hypothesis is distinctive inasmuch as it allows for related distraction to benefit memory performance for TBR items. If related distracters can disrupt strategy by priming inappropriate categories for TBR items when multiple categories are presented, then perhaps conditions can be created in which appropriate categories would be primed, yielding strategy enhancement if these categories are later necessary for successful memory retrieval and thus benefiting memory performance. In the present paper we aimed to test this possibility.

The present study takes the strategy disruption hypothesis as its starting point. The issue we pursue is whether categorical information conveyed by related distracters only harms recall performance—which has been the only reported outcome to date—or whether it may also improve performance if the context is one in which beneficial retrieval strategies are promoted by the presence of distracters. If related distracters are capable of conveying category information, it is possible to envisage settings in which the information could prove beneficial to retrieval of TBR words. The strategy disruption hypothesis suggests that category information conveyed by distracters impairs memory performance by precluding establishing semantic links between instances of categories included in the TBR

list or by disrupting effective cuing based on such semantic links at test. It follows that with only a single instance of a category in the TBR list, the negative effect of related distracters should be abolished. Furthermore, the strategy disruption hypothesis suggests that category information conveyed by distracters affects the category classification of TBR words. If category information is crucial for recalling TBR words, it follows that the related distracters that help to disambiguate the category membership of TBR words could actually yield benefits for memory performance. Unrelated distracters presented simultaneously with TBR words could hinder the process of categorization which would result in a memory trace lacking the details of a category to which this word belongs. In contrast, related distracters could facilitate the process of categorization, in which case category information could be established as a prominent feature of the memory trace for this TBR word. If a subsequent memory test required access to category information it would impose on participants the strategy of semantic retrieval based on category membership and TBR words from the related distraction condition could be advantaged compared to TBR words from the unrelated distraction condition.

Our strategy for investigating the potential benefits of related relative to unrelated distraction in the present study is as follows. First, the disruptive effects of related distraction for the process of structuring the study list by category needs to be abolished, which we achieve by presenting only one item per category in the TBR list. Second, retrieval conditions need to involve a requirement for accessing category information for TBR words. In other words, participants need to be forced to rely on category-based retrieval strategy. In the present paradigm, using only one item per category renders the spontaneous category-based retrieval unlikely so the inducement of such a strategy was achieved by administering a category-cued recall test instead of the more commonly-employed free recall test. Whereas performance in free recall can be driven through a variety of associations between words, category-cued recall should be particularly attuned to the process of categorizing TBR words. Third, the category information conveyed by related auditory distracters presented simultaneously with their corresponding TBR words needs to be highlighted in order to facilitate the categorization processes for TBR words. This was achieved by asking participants to provide judgments-of-learning (JOLs)—assessments of the probability that a given TBR word will be recalled at a later test—after the presentation of every TBR word.

The idea of using JOLs to highlight the relationship between TBR items and their related TBI counterparts is taken from a recent study by Soderstrom, Clark, Halamish, and Bjork (2015), where eliciting JOLs after study of word pairs led to better subsequent memory performance for these pairs as compared to a condition in which JOLs were not elicited. Importantly, such a pattern emerged only for related pairs, which indicates that JOLs served to highlight the semantic relationship between words within a pair. We reasoned that JOLs can thus serve also to augment processing of the category relationship between TBR and TBI items, yielding memory benefits if such processing leads to strategy augmentation. To preview: we included JOLs in the design of Experiments 1 and 2 but we omitted them from Experiments 3 and 4, which produced qualitatively similar results.

Experiment 1

In a typical experiment on semantic auditory distraction, in which costs of related distraction to memory performance are observed, participants study several lists of 15 or more words belonging either to single semantic category (Marsh et al., 2008) or four different semantic categories (Marsh et al., 2009). Individual distracters are presented either synchronously with the visually presented TBR words or between words. Following a single study list, correct free recall is lower, compared to quiet control, when unrelated distraction accompanies encoding and lower still when related distraction is played. This very general procedural plan was followed but a number of specific adjustments were introduced to establish the benefits rather than costs of related distraction. In Experiment 1, participants were presented with 15 study lists, each composed of 15 words. Three experimental conditions were used – quiet, unrelated distracters, related distracters. These conditions were varied within-list, with distracters presented synchronously with TBR words. After each word was presented, participants were asked to provide a JOL. A category-cued recall test followed each study list. We expected that under these conditions memory performance would benefit from the presence of semantically-related auditory distraction at study as compared to a condition of unrelated distraction.

Method

Participants

Twenty-three undergraduates of Cardiff University participated for course credit. The sample size was not predetermined. Instead, we used the Bayesian approach to analyzing the data (see the Results section) and thus participants were tested until satisfactory evidence – Bayes Factor of the magnitude of at least 3 – accrued for *either* of the assessed hypotheses.

Materials and design

Thirty categories were chosen from the category norms developed by Yoon et al. (2004). The categories were chosen to ensure minimal overlap. The materials used for the present set of experiments are included in the Appendix. Thirty chosen categories were divided into two sets of 15 categories, one used as a source of study words and related distracters and the other used as a source of unrelated auditory distracters. Thus, in the present experiment, all participants studied the same set of TBR words from the 15 categories. The labels of these categories were used as cues in a category-cued recall test. The labels were abbreviated versions of the labels included in category norms but they were sometimes modified to better suit the set of TBR words (e.g., the label 'fish' was modified to 'aquatic

animal' because 'whale' and 'dolphin' were included as TBR words).

From categories assigned to the first set, 30 words were chosen, of which 15 were used as study words and 15 were used as related auditory distracters. From categories assigned to the second set, 15 words were chosen to serve as unrelated auditory distracters. In general, a set of 30 of the most common exemplars, according to the data from young American participants, were chosen to randomly serve as study words and as auditory distracters. However, exemplars were omitted if they consisted of two words rather than one (e.g., 'abominable snowman' as an exemplar for the 'mythical creature' category), or they could be clearly classified as an exemplar of a different category from the chosen set.

Study words, related distracters and unrelated distracters were combined to create triplets. Categories that served as the source of study words (and related distracters) and unrelated distracters were yoked so that unrelated distracters for words from a single category were also derived from a single category. A study word was accompanied by a related distracter from a given triplet, an unrelated distracter from this triplet or silence, depending on the experimental condition. Fifteen study lists were created by randomly assigning one study word from each of the 15 categories used as the source of study words to a single list. One thing to note is that this construction of study and distracter lists ensured that none of the items were repeated for a given participant.

Three experimental conditions were included in the design. For each list, 5 study words were presented with no auditory distracter (quiet condition), 5 study words were presented with their yoked related distracters (related condition) and 5 study words were presented with their yoked unrelated distracters (unrelated condition). The assignment of words to experimental conditions was counterbalanced across participants so that each word was accompanied equally often by the yoked related distracter, yoked unrelated distracter or silence. The presentation of words at study from these three experimental conditions within a given list was randomized.

Auditory distracters were recorded in a female voice and edited to auditory files lasting 750 ms.

Procedure

Participants were tested in groups of up to three at a time. All participants wore noise-canceling headphones throughout the procedure. Before study, participants were informed that their task was to memorize words presented on the screen. They were also informed that auditory distracters would accompany some of the study words and that they should ignore these distracters as they would never be tested on them. After instructions were delivered, participants were presented with 15 lists of words to study in a random order. Each word was presented for 750 ms in the center of the screen and auditory distracters were played synchronously with visual presentation of TBR words. Immediately after a TBR word was presented, participants were asked to provide their JOL on a scale from 0 to 100. Participants typed in their JOL and pressed *Enter* to move to the next word. The time for providing JOLs was not limited. After the JOL for the last study word in a list was provided, a category-cued recall test for this list was administered. Category labels corresponding to all 15 studied categories were presented in a random order and participants were asked to type in words from these categories that had been included in the preceding list. Participants had up to 10 s to respond to each category cue. Only one response for a given cue was possible and participants could press Enter to move to the next cue without typing any response. Participants were asked not to worry about the exact spelling of the words. The words were scored as correct only if they were produced for their corresponding category label and if they were produced in response to a different label they were scored as within-list intrusions. Moreover, words were scored as correct only if they contained the lexeme of the correct TBR word.

Results and discussion

Descriptive means for correct recall are presented in Table 1. Across the study, JASP software (Love et al., 2015) with its default setting for priors was used to analyze the results. We used Bayes factors as the means of analyses,[1] comparing the quiet and unrelated distraction conditions to assess the effect of meaningful sound on both correct recall and JOLs. More importantly for our purpose, unrelated and related distraction conditions were also compared to assess the effect of category information conveyed by related distracters. Given that this was the first experiment examining the problem outlined in the Introduction, we contrasted null hypotheses with bidirectional hypotheses stating that contrasted means were not equal. Bayes factor statistics are on a continuous scale representing the strength of evidence in favor of a given hypothesis relative to a stated alternative. The Bayes factor thus indicates the relative strength of evidence for a hypothesis on a continuous scale (and values should be viewed as such). It would be a mistake to view a particular Bayes factor value as a "cut-off" (analogous to $p = .05$) but even though Bayes factors are unambiguously a continuous scale, it is sometimes useful to summarize the Bayes factor in terms of discrete categories of evidential strength simply for descriptive purposes and Bayes factors of above the value of 3 have long been considered moderate evidence for either the experimental (B_{10}) or the null (B_{01}) hypotheses (Jeffreys, 1961; Wetzels & Wagenmakers, 2012, see also Nuijten, Wetzels, Matzke, Dolan & Wagenmakers, 2015 for an update on Jeffreys' (1961) verbal classification scheme designed to give a qualitative indication of the strength of the evidence).[2]

The Bayes factors for the quiet-unrelated comparison showed that both memory performance, $B_{10} = 12.38$, and JOLs, $B_{10} = 19.30$, differed across quiet and unrelated distraction conditions. This result replicates the usual finding

[1] All comparison presented in the present paper are also significant at $\alpha = .05$ when using standard t tests. However, the use of t test is not appropriate in this case because sample sizes were not predetermined.

[2] Additionally, assuming a hypothesis (e.g., the null) is true, increasing the sample size results in the t-value of a standard test performing a random walk around the "true" value (zero) whereas the Bayes factor is systematically driven in the same direction with increasing sample size (Dienes, 2008; Savage, 1962).

Table 1
The means of correct recall and judgments of learning presented as a function of distraction condition in Experiments 1–6. Standard errors of the means are given in parentheses.

	Correct recall			JOLs		
	Quiet	Related distraction	Unrelated distraction	Quiet	Related distraction	Unrelated distraction
Experiment 1	.43 (.02)	.43 (.03)	.37 (.02)	35.36 (3.03)	35.31 (3.26)	32.23 (2.85)
Experiment 2	–	.43 (.03)	.38 (.03)	–	41.47 (3.66)	39.37 (3.35)
Experiment 3	–	.32 (.02)	.29 (.02)	–	–	–
Experiment 4	–	.42 (.02)	.39 (.02)	–	–	–
Experiment 5	–	.35 (.02)	.35 (.02)	–	30.75 (2.77)	29.08 (2.58)
Experiment 6	–	.46 (.02)	.50 (.03)	–	–	–

of impaired performance when auditory distraction is present for this slightly unusual testing procedure and demonstrates also that JOLs are sensitive to this decrement in subsequent performance. The Bayes factors for the unrelated-related comparison revealed evidence that once again both memory performance, $B_{10} = 30.60$, and JOLs, $B_{10} = 6.26$, differed across related and unrelated distraction conditions. Table 1 shows that the crucial difference in memory performance is a reversal of the usual semantic distraction effect: in the present experiment performance was higher for study words accompanied by related rather than unrelated distracters. Indeed, memory performance in the related distraction condition was numerically identical to performance in the quiet condition, a conspicuous lack of the auditory distraction effect. The JOLs reflected accurately the difference in memory performance between related and unrelated distraction conditions with participants predicting better performance when related distracters accompanied encoding.

Although the primary focus of the present experiment was on correct recall, we also looked at intrusions made in our cued recall task. The intrusion data is presented in Table 2. Intrusions were classified into three different types: distracter intrusions were made when an auditory distracter played with a given TBR item was recalled at test instead of the TBR item, within-list intrusions were made when a studied item from a given list was incorrectly recalled for a wrong category label, and other intrusions encompassed all other erroneous responses (the majority of these were prior-list intrusions). The most common type of intrusions was other, with the mean rate of .12 across all experimental conditions. Distracter and within-list intrusions were extremely rare. Distracter intrusions were made only in the related distraction condition, which is unsurprising given that only in this condition did distracters match the retrieval category cue. Even then, however, distracter intrusions accounted for a mere .023 of responses. The mean rate of within-list intrusions was .02 across all experimental conditions. Given these very low rates of intrusions, we did not perform any statistical tests to assess differences between conditions. We return to the consequences of these rates of intrusions for the theoretical underpinnings of our main results in the General Discussion.

The present experiment is, as far as we are aware, the first to demonstrate that memory performance can be better when encoding is accompanied by related rather than unrelated auditory distracters. Using a paradigm not much different from the one commonly used to explore semantic auditory distraction we have shown that related distracters from a supposedly unattended source convey category information that can be used to inform subsequent memory tests, and that assessments of future memory performance reflect this. However, given that it is the first observation of this reversal of a usual pattern, we conducted a second, similar experiment to replicate this novel finding.

Experiment 2

The purpose of Experiment 2 was to replicate the main finding of Experiment 1: memory benefits arising from presenting related rather than unrelated auditory distraction at study. In the present experiment, two changes were introduced. First, the quiet condition was omitted. Second, materials were changed so that the number of lists and the number of items per list was reduced to fourteen. Also, categories that were used only as the source of unrelated distracters in Experiment 1 were included as the source of study words in the present experiment.

Method

Participants

Twenty undergraduates of Cardiff University participated for course credit.

Materials, design, and procedure

Twenty-eight categories from Experiment 1 were used in the present study. They were divided into two sets of 14 categories. Categories from these two sets were yoked in pairs. Twenty-eight words were chosen from each of the categories, with 14 serving as study words and 14 serving as auditory distracters. Each participant studied words from one set of categories, with related distracters coming from this set. The other set was not studied by this participant and it served only as a source of unrelated auditory distracters for yoked categories. The assignment of sets used as the sources of study words and unrelated distracters was counterbalanced across participants.

Two experimental conditions were included in the design, again manipulated within lists. In the related distraction condition, study words were accompanied by distracters taken from the same category, whereas in the unrelated distraction condition, study words were accompanied by distracters taken from the yoked category from

Table 2
The mean rates of intrusions presented as a function of distraction condition at study in Experiments 1–4. Intrusions were classified as within-list (a correct word recalled for a wrong category label), distracter (an intrusion from the auditory distracter that accompanied the target word produced in response to the cue for this target word), and other. Standard errors of the means are given in parentheses.

	Quiet		Related distraction			Unrelated distraction		
	Other	Within-list	Other	Within-list	Distracter	Other	Within-list	Distracter
Experiment 1	.11 (.02)	.02 (.00)	.12 (.03)	.02 (.00)	.02 (.00)	.13 (.03)	.02 (.00)	0
Experiment 2	–	–	.11 (.02)	.02 (.00)	.03 (.01)	.13 (.03)	.03 (.01)	0
Experiment 3	–	–	.13 (.02)	.03 (.00)	.03 (.00)	.13 (.02)	.02 (.00)	0
Experiment 4	–	–	.13 (.02)	.03 (.00)	.03 (.00)	.13 (.02)	.02 (.00)	0

the second set. All other aspects of the design and procedure were the same as in Experiment 1.

Results and discussion

Descriptive means for correct recall and JOLs are presented in Table 1 and the intrusion data are presented in Table 2. We used Bayes factors to assess whether the crucial results of Experiment 1 replicate and we thus compared hypotheses that both recall performance and JOLs were higher in the related distraction condition against null hypotheses of no differences between conditions. The Bayes factors revealed evidence that both memory performance, $B_{10} = 45.46$, and JOLs, $B_{10} = 3.75$, were higher in the related compared to the unrelated distraction condition. These results replicate the effect observed in Experiment 1. In the present paradigm, memory performance benefits from encoding accompanied by related as compared to unrelated distracters, and JOLs are sensitive to this effect.

Since materials used in the present experiment differed from materials used in Experiment 1, we again looked at the intrusion data. Again, the most common type of intrusions were other, which accounted for .12 of responses across experimental conditions. Distracter intrusions were again only committed in the related distraction condition and accounted for .026 of responses. The within-list intrusions were equally rare with the rates of .03 across experimental conditions. Thus, as in Experiment 1, intrusion errors were rare and thus their rates were not analyzed statistically.

Experiment 3

The results thus far show that related distracters presented at encoding can convey information that benefits subsequent cued recall performance. In Experiments 1 and 2 this effect emerged when participants were asked to provide JOLs at encoding. The fact that JOLs were higher when related rather than unrelated distracters were present is consistent with the idea that participants would use the category information conveyed by distracters. It is possible that the act of eliciting JOLs itself acted to alert participants to the category information conveyed by related distracters. The question therefore arises whether the same effect of related distraction on memory performance would obtain if JOLs were not elicited. Experiment 3 aims to assess this issue by eliminating JOLs from the experimental procedure.

Method

Participants

Forty-two undergraduates of Cardiff University participated for course credit.

Materials, design, and procedure

All elements of the experimental procedure were the same as in Experiment 2, except that the JOL question was no longer asked and it was replaced by a 500 ms inter-stimulus interval (ISI) separating consecutively presented words at study.

Results and discussion

Descriptive means for correct recall are presented in Table 1 and the intrusion data are presented in Table 2. We used Bayesian analysis to assess whether the memory performance pattern of Experiments 1 and 2 replicates and we thus compared a hypothesis that recall performance was higher in the related distraction condition against the null hypothesis of no difference between related and unrelated distraction conditions. The Bayes factor revealed that memory performance was better in the related than unrelated distraction condition, $B_{10} = 5.35$. These results replicate the effects observed in Experiments 1 and 2 and again show that cued recall performance can benefit when encoding is accompanied by related as compared to unrelated distracters. Importantly, the effect observed in Experiment 3 is notably smaller than the effects documented in Experiments 1 and 2. Whereas the effect sizes in Experiments 1 and 2 for the comparison of memory performance between related and unrelated distraction conditions were $d_z = 0.74$ and $d_z = 0.76$, respectively, the corresponding effect size observed here, in the procedure without JOLs, was $d_z = 0.42$. These finding are consistent with the idea that JOLs alert participants to category information conveyed by related distracters. However, one could also argue that eliminating JOLs increased the overall rate of presentation of the stimuli, precluding participants from fully benefiting from processing related distracters. A comparison of performance levels across experiment reveals notably lower performance in Experiment 3, giving credence to this idea. Experiment 4 tested this possibility by reducing the rate of word presentations.

Experiment 4

The present experiment aimed at assessing whether a slower overall rate of presentation would allow partici-

pants to benefit fully from processing related distracters. The procedure of Experiment 3 was repeated here but the length of the ISI was increased from 500 ms to 1500 ms. The distractors themselves were presented for the same amount of time as in previous experiments and any benefit would therefore have to arise from the extension of the intervals between stimuli, arguably allowing more time for post-encoding consolidation of stimuli, which might include distracters as well as target items.

Method

Participants

Forty-four undergraduates of Cardiff University participated for course credit.

Materials, design, and procedure

All elements of the present experiment were the same as in Experiment 3, except for ISI separating study words which was increased to 1500 ms.

Results and discussion

Descriptive means for correct recall are presented in Table 1 and the intrusion data are presented in Table 2. A Bayesian analysis was used again to compare a hypothesis that recall performance is higher in the related distraction condition against the null hypothesis of no difference between related and unrelated distraction conditions. The Bayes factor revealed evidence that memory performance was better in the related distraction condition, $B_{10} = 8.76$. This result replicates the effects observed in Experiments 1–3 and again shows that cued recall performance can benefit when encoding is accompanied by related as compared to unrelated distracters. As can be seen in Table 1, slowing the rate of presentation generally raised the level of memory performance as compared to Experiment 3, which was now similar to levels of performance observed in Experiments 1 and 2. Despite this similar overall level of performance, the size of the effect obtained here, $d_z = 0.44$, is comparable to that of Experiment 3 and thus notably smaller than the effects documented in Experiments 1 and 2 which both included JOLs in the study phase. It seems thus that JOLs, although not necessary for revealing the benefits of related distraction, may nevertheless serve to augment this effect by highlighting the category information conveyed by related distracters.

Experiment 5

When designing the procedure to investigate the presumed benefits of related distraction, we assumed that benefits are likely to emerge when category information conveyed by related distracters is firstly salient at encoding and secondly useful at retrieval. The present experiment deals with the second assumption.

In the paradigm used for Experiments 1–4, category-cued recall tests were administered because encoding of category information for each study word should be beneficial when category information is also used to explicitly cue memory at a subsequent test. It follows that benefits of related distraction should not emerge, or at least should be of smaller magnitude, in a memory test that does not *require* access to category information. The present experiment puts this idea to the test by including a free rather than category-cued recall test after each list. Although category clustering is a feature of free recall, to the extent that multiple competing ways of measuring such clustering have been proposed (see Murphy, 1979, for a review) such clustering is not a necessary requirement for free recall and is not displayed by all participants (e.g., Gershberg & Shimamura, 1995), nor under all possible conditions. In particular, Marsh et al. (2009) showed that category clustering can be disrupted by the presence of auditory distracters, and especially so by semantically-related distracters. It follows that the mere presence of auditory distracters could discourage a category-based organization for recall and hence remove any benefit that might otherwise arise from using "irrelevant" speech distracters as category cues.

Method

Participants

Twenty-eight undergraduates of Cardiff University participated for course credit.

Materials, design, and procedure

All elements of the present experiment were the same as in Experiment 2, including the procedure for eliciting JOLs, except for the change of a category cued recall test to a free recall test. In a free recall test, participants were given up to 60 s to recall and type in words from the preceding list.

Results and discussion

Descriptive means for correct recall and JOLs are presented in Table 1 and the intrusion data are presented in Table 3. The Bayes factors revealed evidence supporting the null hypothesis of no difference between related and unrelated distraction conditions in terms of correctly recalled items, $B_{01} = 4.41$. By contrast, the Bayes factor for the comparison of JOLs between two distraction conditions provided evidence that these were not equal, $B_{10} = 3.09$. The effect observed for JOLs replicates Experiments 1 and 2 by showing that participants expected better performance when related distracters accompanied encoding. This finding again indicates that participants factored category information conveyed by related distracters into their assessments of the extent of their learning. It also suggests that the encoding processes in the present experiment proceeded in the same way as in previous experiments, at least as far as participants were consciously aware. In the present experiment, however, these encoding processes were not translated into better performance in a subsequent memory test. By eliminating category cues from the final test the benefits of related distracters to memory performance were also eliminated. This finding indicates that category information conveyed by related distracters is useful only when performance in a subse-

Table 3
The mean rates of intrusions in Experiments 5 and 6. For Experiment 5, intrusions were classified as related distracter, unrelated distracter or other. For Experiment 6, intrusions from unrelated distracters did not occur as they did not fit the category of the study list. Although participants could provide any number of other intrusions in free recall tests, for the sake of comparability the rates for other intrusions were derived by dividing the raw numbers of intrusions by the overall number of studied words. Standard errors of the means are given in parentheses.

	Other	Related distracter	Unrelated distracter
Experiment 5	.03 (.01)	.01 (.00)	.01 (.00)
Experiment 6	.01 (.00)	.03 (.01)	0

quent memory tests is strongly – and explicitly – dependent on category information.

Experiment 6

Experiments 1–5 document a novel and analytically powerful effect of benefits to memory performance arising from presenting study words with related rather than unrelated auditory distracters. This is a reversal of a usual pattern of costs associated with related distracters observed in numerous previous studies (e.g., Hanczakowski et al., 2016; Marsh et al., 2008, 2009; Neely & LeCompte, 1999) raising the possibility that there is something unique to the current set of materials which results in this effect. In the final experiment, we show that our materials and procedures are fully capable of obtaining this usual effect of semantic auditory distraction. To this end, we employed our materials and specific procedures but we reversed the changes originally introduced to the standard paradigm by using single-category lists, the type of distraction manipulated across rather than within lists, and free recall tests.

Method

Participants

Nineteen undergraduates of Cardiff University participated for course credit.

Materials, design, and procedure

All elements of the present experiment were the same as in Experiment 3 (with no JOLs), except for the fact that study words were rearranged to form 14 lists of 14 exemplars of a single category and free recall tests (as in Experiment 5) substituted the category-cued recall tests. The distraction condition (related vs. unrelated) were manipulated across lists.

Results and discussion

Descriptive means for correct recall are presented in Table 1 and the intrusion data are presented in Table 3. A Bayesian analysis was used to assess whether the memory performance pattern of Experiments 1–4 was reversed by comparing a hypothesis that recall performance is lower in the related distraction condition against the null hypothesis of no difference between related and unrelated distraction conditions. The Bayes factor revealed evidence supporting the alternative hypothesis, $B_{10} = 13.79$. Thus, in contrast to the results of all previous experiments, recall performance here was higher when encoding was accompanied by unrelated rather than related distracters. This result serves to demonstrate that the usual effect of semantic auditory distraction is easily replicable with these materials and these specific procedural choices (such as presentation times), when conditions are created in which category information conveyed by related distracters is superfluous in the context of single-category lists. One caveat is that using the standard semantic distraction paradigm meant that here the type of distraction was manipulated across lists whereas Experiments 1–5 all used a manipulation of distraction within list. It remains thus to be established whether benefits of semantic distraction (or lack of costs, as in Experiment 5) can also be obtained in between-lists designs.

General discussion

In the present study, we set out to investigate possible benefits to memory performance conferred by related as compared to unrelated distracters accompanying study of visually presented words. The logic of our procedure was based on creating conditions in which category information conveyed by related distracters could be utilized to support performance in a later memory test and is consistent with previous suggestions that not all nominally "irrelevant" sound is treated as such (Beaman, 2005). We used study lists in which every item was derived from a different semantic category and included category-cued recall tests in which knowledge about category membership is crucial. Under these conditions, Experiments 1–4 revealed reliable benefits of presenting related rather than unrelated distracters synchronously with study presentations. These benefits were absent when a free recall test, less reliant on the categorization of study words, was administered in Experiment 5 although participants retained their confidence in their ability to recall more accurately those words which were associated with related distracters. As a test of materials, a reverse effect of costs associated with related rather than unrelated distracters was observed when a free recall test with study lists composed of exemplars from a single category (Experiment 6).

The study provides, to the best of our knowledge, the first demonstration of reversed between-sequence semantic similarity effect. The usual effect, termed also semantic auditory distraction (e.g., Beaman et al., 2013) is one of worse performance when study is accompanied by related rather than unrelated distraction (e.g., Marsh, Sörqvist, & Hughes, 2015; Neely & LeCompte, 1999). Our study demonstrates that the usual framing of semantic auditory distraction effects as interference is dependent on the

experimental conditions used in a standard paradigm. In our study, manipulating semantic relationship between study items and auditory distracters revealed all three possible patterns of effect as predicted: a memory benefit (Experiments 1–4), no effect (Experiment 5) and a memory impairment (Experiment 6). This clearly shows that a generalization according to which semantically related distraction only ever harms memory performance is unwarranted and the effects are task-specific. These results have a number of implications for theoretical accounts of semantic distraction effects and also for the processing of "irrelevant" or "unattended" sound.

As previously discussed, the standard effect of semantic auditory distraction can be interpreted variously in terms of blocking or interference at retrieval (Hanczakowski et al., 2016), overwriting (Nairne, 1990; Neath, 2000; Oberauer & Lange, 2008), attentional shifts (Bell et al., 2008), overhead costs from inhibitory processes (Marsh et al., 2012) or strategy disruption (Marsh et al., 2009). We argue that the reversed effect is most readily accounted for within the framework of strategy disruption.

Frameworks that make reference to interference at encoding (attentional shift and overwriting) or retrieval (blocking), or make use of concepts of inhibition, are less consistent with our findings. These accounts all assume interference by the auditory distraction with the memory for individual items at a lexical or sub-lexical level. The attentional shift account postulates that encoding of TBR words is impaired by related distracters diverting attention away from the focal memory task, whereas overwriting postulates the loss of the details of TBR items. The same mechanisms of attentional shifts and overwriting should, however, operate in our paradigm. To account for our findings, it is necessary to assume a further mechanism by which noting the relationship between memoranda and distracters more than compensates for depleted attention or overwriting which must presumably still occur (see Beaman & Jones, 2016, for similar arguments). Interference at retrieval assumes that related distracters become encoded and then they constitute a match to category cues used at retrieval, blocking memory access to TBR words. Once again, the same mechanisms of interference should still be in operation here. If related distracters become encoded, they should match category cues used in a category-cued recall test, blocking access to TBR words. Finally, there is nothing in the inhibitory account that would suggest it also should not produce effects in our present paradigm. Presenting related distracters simultaneously with to-be-remembered words should trigger inhibition and thus memory for to-be-remembered words should suffer due to overhead of recruiting inhibitory processes (Marsh et al., 2013). Contrary to the assertion that inhibition operates on an item-by-item basis one could argue that a single distracter related to a single TBR word is insufficient to trigger inhibition, which may require multiple TBR and TBI exemplars from a single category, as used in the retrieval practice paradigm commonly employed to examine inhibitory processes (Anderson, Bjork, & Bjork, 1994; Anderson & Spellman, 1995; Hanczakowski & Mazzoni, 2013). However, signatures of inhibitory processes in the retrieval practice paradigm have also been also found with a single TBR item and a single competitor (Keresztes & Racsmány, 2013), rendering this explanation less appealing. To conclude, both interference and inhibition mechanism should operate in our paradigm, giving rise to the usual negative rather than positive between-sequence similarity effect, which is clearly inconsistent with our results.

In contrast, according to a strategy disruption account, meaningful distracters typically reduce the use of "secondary organization", that is the semantic categorization of the to-be-recalled material and the probability that a *category* is recalled (Marsh et al., 2009, p. 28), either because of a failure at encoding, or at retrieval, to establish or use higher-order semantic encodings which would enable intra- or inter-category transitions. This possibility is supported by the observation that lexical retrieval cued by a semantic category name is also impaired by semantically-related distracters (Jones, Marsh & Hughes, 2012). Where multiple-category lists are presented for recall and related distracters belong to one of the categories from which study items are taken, category information conveyed by related distracters disrupts the process of assigning study words to the appropriate category. This is consistent with the observation that related distraction reduces the rate of category clustering in a subsequent free recall test (Marsh et al., 2009, 2014). However, when only one item per category is included in each study list and the presentation of related distracters coincides with the presentation of a TBR item (as here), the transparent relationship between the two concurrent stimuli (as demonstrated by the JOL results in the current series) negates this confusion and ensures that category information conveyed by related distracters aids the categorization of TBR words. In other words, related distracters can be used to highlight the category to which the TBR item belongs and this category information becomes an important feature contained in a memory trace for this item. The benefits of facilitated categorization are revealed in a subsequent category-cued recall test which relies on participants' ability to match studied words to their respective categories. If category information features prominently in the memory trace of an item accompanied by a related distracter, then this memory trace matches the category cue better, yielding benefits to recall performance.

The strategy enhancement perspective on our results raises the question about the relative importance of encoding and retrieval processing in producing the benefits of related distraction. The strategy disruption mechanism is known to exert its impairing influence on memory performance both at encoding, as in the case of negative repetition effect (Mulligan & Peterson, 2013), and at retrieval, as in the case of collaborative inhibition (Barber & Rajaram, 2011). Clearly, the interplay of encoding and retrieval is also necessary to fully understand the benefits of related distraction. The patterns of JOLs suggest that encoding is sensitive to related distraction as implemented in our study but at the same time Experiment 5 clearly shows the importance of category cues provided at retrieval for the discussed pattern of results. It is clear that category information needs to figure prominently at retrieval for the benefits of related distraction to emerge. However,

the question remains whether related distraction facilitates processing of category relationships only at encoding, or whether the memory of related distracters still helps to disambiguate category membership at retrieval. This latter case would be important if participants were confused at retrieval as to which category a remembered item belongs. In this case, remembering both the TBR and TBI item could serve to facilitate categorization in the related condition, revealing strategy enhancement at retrieval. This, however, seems an unlikely mechanism for the documented effect for two reasons. First, the categories chosen for our study were fairly distinct and although some words could be miscategorized (e.g., a type of boat can be classified as the means of transportation), such miscategorizations should generally be rare, especially after extensive training with categories used across multiple lists in the experiment. Second, we specifically looked at cases in which words were wrongly categorized at retrieval (instances of within-list intrusions). Such errors were extremely rare, constituting less than 3% of responses, and with apparently similar rates across experimental conditions although appearance of these responses was obviously at floor. These results do not support the contention that related distraction helps disambiguate categories at retrieval, rather they are more consistent with the idea that the disambiguation process that promotes strategy enhancement occurs at encoding.

The intrusion data is interesting for one more reason: the very low incidence of intrusions coming from related distracters, also lower than 3% of responses. On the one hand, this result may be less than surprising as, after all, participants were explicitly told to ignore auditory distracters. One could alternatively argue that if related distraction yields benefits for memory performance, then participants would be inclined to attend to auditory distracters. The possibility that participants ignore instructions and direct attention toward TBI words cannot be excluded in any type of the distraction paradigm. This argument that participants purposefully attend to "distraction" when there is information to be gleaned from TBI items has been used previously to account for some of the findings in the serial recall paradigm (Bell, Mund, & Buchner, 2011). We do not deny that related distracters were capable of potentially capturing participants' attention in our paradigm. However, it would seem to us that deliberate processing of distraction should result in strong episodic traces of TBI items, traces mostly rich with semantic features for which these TBI were clearly processed. It seems unlikely that, with such deliberate semantic processing, participants would be able to simultaneously monitor the source of information so well as to almost completely avoid distracter intrusions at recall. Thus, while there may be some place for the attention in explaining the observed patterns of results as yet to be explored, there is no *a priori* reason to expect the current results from an attentional account and there is no independent evidence for a strategic use of attention in direct contradiction of experimental instructions which the low intrusion rates suggest is in any case unlikely in the present studies.

The intrusion data point to a scenario in which participants quite successfully avoid encoding auditory distracters and thus any benefits which related distracters endow subsequent memory tests have their origin at encoding, when category congruency of TBR and TBI words facilitate the process of categorization. However, one should note that the study by Marsh et al. (2008) revealed the negative effects of semantic auditory distraction also when distracters were only played at test. How does our encoding explanation fit with the findings of Marsh et al.?

The first thing to note is that although we argue for the encoding mechanism of the benefits of semantic distraction, we cannot exclude the possibility that such benefits could also emerge were we to present related and unrelated distracters at test, that is, simultaneously with the corresponding category cues. For this to happen, related distracters would need to prime the words they were presented with at study more effectively than unrelated words. Whether such an effect would emerge is clearly an empirical question but we do not think this plausible given our argument that related distracters are unlikely to be effectively encoded and thus to play much of a role at retrieval. Second, while we have argued that semantic distraction can either facilitate or impair the process of categorization at study, depending on the particular encoding conditions, it seems likely that the disruptive effects would be more prominent at retrieval. For example, related distracters could prevent participants from using appropriate cues in the free recall tests commonly used to reveal the costs of semantic distraction but such distracters cannot increase the chances that appropriate cues are used when a category-cued recall test is used to reveal the benefits of semantic distraction. This is because, in such a test, participants are simply not given the freedom to choose whatever retrieval strategy they would like to adopt. This potential difference underscores the fact that benefits and costs of semantic distraction are likely to be sensitive to different factors and work is now needed to describe the interplay between these two faces of distractibility.

The present study focused on between-sequence semantic similarity effect which is a hallmark of interference-by-process approach to understanding distractibility (Jones & Tremblay, 2000; Marsh et al., 2008). According to interference-by-process, semantic features of auditory distraction affect memory performance in a free recall test because learning and recalling long lists of words requires semantic processing of memoranda. Our results are fully consistent with the interference-by-process framework if one agrees that "interference" should be considered quite generally, as encompassing effects that are either negative or positive for memory performance. A more appropriate term for this theoretical framework is, arguably, interaction-by-process.

The interference-by-process approach predicts that different features of distraction should matter only when memory tasks focus on processing those dimensions of the memoranda. For example, when TBR lists are composed of phonological associates, phonological similarity between sequences determines memory performance (Marsh, Vachon, & Jones, 2008). We suggest that phonological aspects of auditory distraction may also benefit rather than hamper performance in a similar manner to that demonstrated here. This suggestion remains consistent

with some published studies. For example, Oberauer, Farrell, Jarrold, Pasiecznik, and Greaves (2012) have shown that in the complex span task, in which participants need to process visually-presented distracters presented in-between TBR elements, phonological similarity of distracters to the immediately preceding TBR elements affects performance in a serial reconstruction task, with better performance for similar rather than dissimilar distracters. In this study, TBR items were non-words which presumably afforded phonological encoding strategy and thus the beneficial role of phonological similarity of distracters remains broadly consistent with the interaction-by-process framework. Furthermore, in a paradigm which closer corresponds to the present study, with auditory distraction used for visually presented memoranda, Tolan and Tehan (2002) examined how phonological features of auditory distracters interact with TBR items from short four-item lists studied under conditions of proactive interference. In their study, participants were presented with trials consisting of two lists of four words. Both lists included one instance of a category that was subsequently used as a cue in an immediate test (e.g., *dog* for the first list and *cat* for the second). Participants' task was to retrieve the matching exemplar from the last studied list (i.e., *cat*). Crucially, during a short retention interval before a test, participants were presented with auditory distracters that included phonological features of either the semantic foil from the first list (i.e., *dog*) or the target. Under these conditions, performance was better when distracters were similar to the target rather than the foil, indicating benefits from distraction accruing either for the target or for the foil. This pattern suggests that phonological features of auditory distraction can yield benefits for retrieval, just as semantic features do in our study. Interestingly, this pattern emerged in a paradigm using semantically rich materials such as words, which, according to the interaction-by-process framework, would suggest a prominent role of phonological information in memory for very short lists of words.

One feature of the current series that merits additional discussion is the inclusion of JOLs in our novel paradigm. Experiments 1, 2, and 5 used JOLs to direct participants' attention toward category information conveyed by related distracters. That this manipulation was effective is indicated firstly by the fact that JOLs were reliably higher for words accompanied by related distraction and secondly because a positive between-sequence semantic similarity effect was generally larger in the presence of JOLs (Experiments 1 and 2) compared to a procedure in which these judgments were not elicited (Experiments 3 and 4). The finding of higher JOLs in the presence of related auditory distracters is important inasmuch as this self-assessment did not always reflect the results obtained in recall tests. Although the difference in JOLs correctly reflected the recall patterns observed with category-cued recall tests of Experiments 1 and 2, JOLs were dissociated from the recall pattern of Experiment 5, in which no between-sequence semantic similarity effect was observed. The dissociation observed in Experiment 5 demonstrates how conditions that do not map onto memory performance can nevertheless impact robustly upon predictions of performance (see Besken & Mulligan, 2014; Rhodes & Castel, 2008, 2009, for similar observations). Together, the results of Experiments 1, 2, and 5 demonstrate that conditions of a test have important implications for the accuracy of metacognitive judgments. In our case, JOLs correctly reflected memory patterns under category-cued recall testing (Experiments 1–2) but not under free-recall testing (Experiment 3). The observation that participants do not take into account the type of the test when making metacognitive judgments at encoding would seem trivial but for the fact that our procedure used multiple study-test cycles. One cannot reasonably expect participants to predict the type of the test in a one-cycle procedure which can contribute to inaccuracies commonly observed for JOLs (cf. Zawadzka, Krogulska, Button, Higham, & Hanczakowski, 2016). However our study shows that even prolonged experience of a given type of test, in which a certain effect does not occur, does not prevent the expectation of such an effect appearing in JOLs. This demonstrates that metacognitive judgments are not fully updated using available information (cf. Mueller, Dunlosky, & Tauber, 2015).

In the present series, the between-sequence semantic similarity effect tended to be larger in the presence rather than absence of JOLs. This highlights another feature of metacognitive judgments. Although such judgments are commonly used to gain insight into participants' appraisals of their own cognitive processes, it seems that the very act of eliciting these judgments alters the cognitive process that is under scrutiny. This measurement-affects-process perspective on metacognition has been first described in reference to delayed JOLs, which trigger covert retrieval, subsequently benefiting memory performance in the way described by a testing effect mechanism (Spellman & Bjork, 1992). There is a growing understanding that eliciting metacognitive judgments can change not only the quantitative, but also the qualitative patterns observed in memory performance (see Mitchum, Kelley, & Fox, 2016; Soderstrom et al., 2015). For example, Sahakyan, Delaney, and Kelley (2004) showed that eliciting aggregate judgments in the directed forgetting paradigm for the first studied list can promote changes in encoding strategy for the second list, altering the usual pattern of directed forgetting benefits. The results of the present study are consistent with this line of research.

To conclude, the present study is the first to demonstrate the benefits of studying words with related rather than unrelated auditory distracters. This pattern shows that the current perspective on the effects of distraction as ubiquitously harmful for memory performance is lacking. The novel pattern is consistent with the account of semantic distraction effect stressing categorical information conveyed by auditory distracters, as well as a revised interference/interaction-by-process framework, but it points to deficits in other postulated mechanisms, such as interference and inhibition.

Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jml.2016.11.005.

References

Anderson, M. C., Bjork, R. A., & Bjork, E. L. (1994). Remembering can cause forgetting: Retrieval dynamics in long-term memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*, 1063–1087. http://dx.doi.org/10.1037/0278-7393.20.5.1063.

Anderson, M. C., & Spellman, B. A. (1995). On the status of inhibitory mechanisms in cognition: Memory retrieval as a model case. *Psychological Review, 102*, 68–100. http://dx.doi.org/10.1037/0033-295X.102.1.68.

Barber, S. J., & Rajaram, S. (2011). Collaborative memory and part-set cuing impairments: The role of executive depletion in modulating retrieval disruption. *Memory, 19*, 378–397. http://dx.doi.org/10.1080/09658211.2011.575787.

Basden, D. R., & Basden, D. H. (1995). Some tests of the strategy disruption interpretation of part-list cuing inhibition. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 1656–1669. http://dx.doi.org/10.1037/0278-7393.21.6.1656.

Beaman, C. P. (2004). The irrelevant sound phenomenon revisited: What role for working memory capacity? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 30*, 1106–1118. http://dx.doi.org/10.1037/0278-7393.30.5.1106.

Beaman, C. P. (2005). Auditory distraction from low-intensity noise: A review of the consequences for learning and workplace environments. *Applied Cognitive Psychology, 19*, 1041–1064. http://dx.doi.org/10.1002/acp.1134.

Beaman, C. P., Hanczakowski, M., Hodgetts, H. M., Marsh, J. E., & Jones, D. M. (2013). Memory as discrimination: What distraction reveals. *Memory & Cognition, 41*, 1238–1251. http://dx.doi.org/10.3758/s13421-013-0327-4.

Beaman, C. P., & Jones, D. M. (1997). The role of serial order in the irrelevant speech effect: Tests of the changing state hypothesis. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 459–471. http://dx.doi.org/10.1037/0278-7393.23.2.459.

Beaman, C. P., & Jones, D. M. (1998). Irrelevant sound disrupts order information in free recall as in serial recall. *Quarterly Journal of Experimental Psychology, 51A*, 615–636. http://dx.doi.org/10.1080/027249898391558.

Beaman, C. P., & Jones, D. M. (2016). The items versus the object in memory: On the implausibility of overwriting as a mechanism for forgetting in short-term memory. *Frontiers in Psychology*. http://dx.doi.org/10.3389/fpsyg.2016.00341.

Bell, R., Buchner, A., & Mund, I. (2008). Age-related differences in irrelevant-speech effects. *Psychology & Aging, 23*, 377–391. http://dx.doi.org/10.1037/0882-7974.23.2.377.

Bell, R., Mund, I., & Buchner, A. (2011). Disruption of short-term memory by distractor speech: Does content matter? *The Quarterly Journal of Experimental Psychology, 64*, 146–168. http://dx.doi.org/10.1080/17470218.2010.483769.

Besken, M., & Mulligan, N. W. (2014). Perceptual fluency, auditory generation, and metamemory: Analyzing the perceptual fluency hypothesis in the auditory modality. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 40*, 429–440. http://dx.doi.org/10.1037/a0034407.

Bhatarah, P., Ward, G., & Tan, L. (2006). Examining the relationship between free recall and immediate serial recall: The effect of concurrent task performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32*, 215–229. http://dx.doi.org/10.1037/0278-7393.32.2.215.

Buchner, A., Rothermund, K., Wentura, D., & Mehl, B. (2004). Valence of distractor words increases the effects of irrelevant speech on serial recall. *Memory & Cognition, 32*, 722–731. http://dx.doi.org/10.3758/bf03195862.

Cowan, N. (1995). *Attention and memory: An integrated framework. Oxford Psychology Series (No. 26)*. New York: Oxford University Press.

Dienes, Z. (2008). *Understanding psychology as a science: An introduction to scientific and statistical inference*. New York: Palgrave.

Gershberg, F. B., & Shimamura, A. P. (1995). Impaired use of organizational strategies in free recall following frontal lobe damage. *Neuropsychologia, 33*, 1305–1333. http://dx.doi.org/10.1016/0028-3932(95)00103-a.

Grenfell-Essam, R., & Ward, G. (2012). Examining the relationship between free recall and immediate serial recall: The role of list length, strategy use, and test expectancy. *Journal of Memory and Language, 67*, 106–148. http://dx.doi.org/10.1016/j.jml.2012.04.004.

Hanczakowski, M., Beaman, C. P., & Jones, D. M. (2016). Negative priming in free recall reconsidered. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42*, 686–699. http://dx.doi.org/10.1037/xlm0000192.

Hanczakowski, M., & Mazzoni, G. (2013). Contextual match and cue-independence of retrieval-induced forgetting: Testing the prediction of the model by Norman, Newman, and Detre (2007). *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*, 953–958. http://dx.doi.org/10.1037/a0030531.

Hintzman, D. L. (2016). Is memory organized by temporal contiguity? *Memory & Cognition, 44*, 365–375. http://dx.doi.org/10.3758/s13421-015-0573-8.

Hughes, R. W., & Jones, D. M. (2003). Indispensable benefits and unavoidable costs of unattended sound for cognitive functioning. *Noise and Health, 6*, 63–76.

Hughes, R. W., Vachon, F., & Jones, D. M. (2007). Disruption of short-term memory by changing and deviant sounds: Support for a duplex-mechanism account of auditory distraction. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 1050–1061. http://dx.doi.org/10.1037/0278-7393.33.6.1050.

Jeffreys, H. (1939/1961). *The Theory of Probability* (1st/3rd ed.). Oxford: Oxford University Press.

Jones, D. M. (1999). The cognitive psychology of auditory distraction: The 1997 BPS Broadbent Lecture. *British Journal of Psychology, 90*, 167–187. http://dx.doi.org/10.1348/000712699161314.

Jones, D. M., Beaman, C. P., & Macken, W. J. (1996). The object-oriented episodic record model. In S. E. Gathercole (Ed.), *Models of short-term memory*. Hove: Psychology Press.

Jones, D. M., Hughes, R. W., & Macken, W. J. (2006). Perceptual organization masquerading as phonological storage: Further support for a perceptual-gestural view of short-term memory. *Journal of Memory & Language, 54*, 265–281. http://dx.doi.org/10.1016/j.jml.2005.10.006.

Jones, D. M., Hughes, R. W., & Macken, W. J. (2010). Auditory distraction and serial memory: The avoidable and the ineluctable. *Noise and Health, 12*, 201–209. http://dx.doi.org/10.4103/1463-1741.70497.

Jones, D. M., & Macken, W. J. (1993). Irrelevant tones produce an irrelevant speech effect: Implications for phonological coding in working memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 369–381. http://dx.doi.org/10.1037/0278-7393.19.2.369.

Jones, D. M., Madden, C., & Miles, C. (1992). Privileged access by irrelevant speech to short-term memory: The role of changing state. *Quarterly Journal of Experimental Psychology, 44A*, 645–669. http://dx.doi.org/10.1080/14640749208401304.

Jones, D. M., Marsh, J. E., & Hughes, R. W. (2012). Retrieval from memory: Vulnerable or inviolable? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 905–922. http://dx.doi.org/10.1037/a0026781.

Jones, D. M., & Tremblay, S. (2000). Interference by process or content? A reply to Neath (2000). *Psychonomic Bulletin & Review, 7*, 550–558. http://dx.doi.org/10.3758/bf03214370.

Keresztes, A., & Racsmány, M. (2013). Interference resolution in retrieval-induced forgetting: Behavioral evidence for a nonmonotonic relationship between interference and forgetting. *Memory & Cognition, 41*, 511–518. http://dx.doi.org/10.3758/s13421-012-0276-3.

Love, J., Selker, R., Marsman, M., Jamil, T., Dropmann, D., Verhagen, A. J., ... Wagenmakers, E. -J. (2015). JASP (Version 0.7)[Computer Software].

Macken, W. J., Tremblay, S., Houghton, R. J., Nicholls, A. P., & Jones, D. M. (2003). Does auditory streaming require attention? Evidence from attentional selectivity in short-term memory. *Journal of Experimental Psychology: Human Perception & Performance, 29*, 43–51. http://dx.doi.org/10.1037/0096-1523.29.1.43.

Marsh, J. E., Beaman, C. P., Hughes, R. W., & Jones, D. M. (2012). Inhibitory control in memory: Evidence for negative priming in free recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1377–1388. http://dx.doi.org/10.1037/a0027849.

Marsh, J. E., Hughes, R. W., & Jones, D. M. (2008). Auditory distraction in semantic memory: A process-based approach. *Journal of Memory and Language, 58*, 682–700. http://dx.doi.org/10.1016/j.jml.2007.05.002.

Marsh, J. E., Hughes, R. W., & Jones, D. M. (2009). Interference by process, not content, determines semantic auditory distraction. *Cognition, 110*, 23–38. http://dx.doi.org/10.1016/j.cognition.2008.08.003.

Marsh, J. E., Hughes, R. W., Sörqvist, P., Beaman, C. P., & Jones, D. M. (2015). Erroneous and veridical recall are not two sides of the same coin: Evidence from semantic distraction in free recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*, 1728–1740. http://dx.doi.org/10.1037/xlm0000121.

Marsh, J. E., Perham, N., Sörqvist, P., & Jones, D. M. (2014). Boundaries of semantic distraction: Dominance and lexicality act at retrieval. *Memory & Cognition, 42*, 1285–1301. http://dx.doi.org/10.3758/s13421-014-0438-6.

Marsh, J. E., Sörqvist, P., Beaman, C. P., & Jones, D. M. (2013). Auditory distraction eliminates retrieval induced forgetting. *Experimental Psychology, 60*, 368–375. http://dx.doi.org/10.1027/1618-3169/a000210.

Marsh, J. E., Sörqvist, P., Hodgetts, H. M., Beaman, C. P., & Jones, D. M. (2015). Distraction control processes in free recall: Benefits and costs to performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*, 118–133. http://dx.doi.org/10.1037/a0037779.

Marsh, J. E., Sörqvist, P., & Hughes, R. W. (2015). Dynamic cognitive control of irrelevant sound: Increased task-engagement attenuates semantic auditory distraction. *Journal of Experimental Psychology: Human Perception and Performance, 41*, 1462–1474. http://dx.doi.org/10.1037/xhp0000060.

Marsh, J. E., Vachon, F., & Jones, D. M. (2008). When does between-sequence phonological similarity promote irrelevant sound disruption? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 34*, 243–248. http://dx.doi.org/10.1037/0278-7393.34.1.243.

McDaniel, M. A., & Bugg, J. M. (2008). Instability in memory phenomena: A common puzzle and a unifying explanation. *Psychonomic Bulletin & Review, 15*, 237–255. http://dx.doi.org/10.3758/pbr.15.2.237.

Mitchum, A. L., Kelley, C. M., & Fox, M. C. (2016). When asking the question changes the ultimate answer: Metamemory judgments change memory. *Journal of Experimental Psychology: General, 145*, 200–219. http://dx.doi.org/10.1037/a0039923.

Mueller, M. L., Dunlosky, J., & Tauber, S. K. (2015). Why is knowledge updating after task experience incomplete? Contributions of encoding experience, scaling artifact, and inferential deficit. *Memory & Cognition, 43*, 180–192. http://dx.doi.org/10.3758/s13421-014-0474-2.

Mulligan, N. W., & Peterson, D. J. (2013). The negative repetition effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 39*, 1403–1416. http://dx.doi.org/10.1037/a0031789.

Murphy, M. D. (1979). Measurement of category clustering in free recall. In C. R. Puff (Ed.), *Memory organization and structure*. San Diego (CA): Academic Press.

Nairne, J. S. (1990). A feature model of immediate memory. *Memory & Cognition, 18*, 251–269. http://dx.doi.org/10.3758/bf03213879.

Neath, I. (2000). Modeling the effects of irrelevant speech on memory. *Psychonomic Bulletin & Review, 7*, 403–423. http://dx.doi.org/10.3758/bf03214356.

Neely, C. B., & LeCompte, D. C. (1999). The importance of semantic similarity to the irrelevant speech effect. *Memory & Cognition, 27*, 37–44. http://dx.doi.org/10.3758/bf03201211.

Nuijten, M. B., Wetzels, R., Matzke, D., Dolan, C. V., & Wagenmakers, E.-J. (2015). A default Bayesian hypothesis test for mediation. *Behavior Research Methods, 47*, 85–97. http://dx.doi.org/10.3758/s13428-014-0470-2.

Oberauer, K., Farrell, S., Jarrold, C., Pasiecznik, K., & Greaves, M. (2012). Interference between maintenance and processing in working memory: The effect of item-distractor similarity in complex span. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 665–685. http://dx.doi.org/10.1037/a0026337.

Oberauer, K., & Lange, E. B. (2008). Interference in verbal working memory: Distinguishing similarity-based confusion, feature overwriting, and feature migration. *Journal of Memory & Language, 58*, 730–745. http://dx.doi.org/10.1016/j.jml.2007.09.006.

Page, M. P., & Norris, D. (2003). The irrelevant sound effect: What needs modelling and a tentative model. *Quarterly Journal of Experimental Psychology, 56A*, 1289–1300. http://dx.doi.org/10.1080/02724980343000233.

Parmentier, F. B. R. (2008). Towards a cognitive model of distraction by auditory novelty: The role of involuntary attentional capture and semantic processing. *Cognition, 109*, 345–362. http://dx.doi.org/10.1016/j.cognition.2008.09.005.

Raaijmakers, J. G. W., & Jakab, E. (2013). Rethinking inhibition theory: On the problematic status of the inhibition theory for forgetting. *Journal of Memory and Language, 68*, 98–122. http://dx.doi.org/10.1016/j.jml.2012.10.002.

Rhodes, M. G., & Castel, A. D. (2008). Memory predictions are influenced by perceptual information: Evidence for metacognitive illusions. *Journal of Experimental Psychology: General, 137*, 615–625. http://dx.doi.org/10.1037/a0013684.

Rhodes, M. G., & Castel, A. D. (2009). Metacognitive illusions for auditory information: Effects on monitoring and control. *Psychonomic Bulletin & Review, 16*, 550–554. http://dx.doi.org/10.3758/pbr.16.3.550.

Röer, J. P., Bell, R., & Buchner, A. (2013). Self-relevance increases the irrelevant sound effect: Attentional disruption by one's own name. *Journal of Cognitive Psychology, 25*, 925–931. http://dx.doi.org/10.1080/20445911.2013.828063.

Rundus, D. (1973). Negative effects of using list items as recall cues. *Journal of Verbal Learning and Verbal Behavior, 12*, 43–50. http://dx.doi.org/10.1016/s0022-5371(73)80059-3.

Sahakyan, L., Delaney, P. F., & Kelley, C. M. (2004). Self-evaluation as a moderating factor of strategy change in directed forgetting benefits. *Psychonomic Bulletin & Review, 11*, 131–136. http://dx.doi.org/10.3758/bf03206472.

Salamé, P., & Baddeley, A. D. (1982). Disruption of short-term memory by unattended speech: Implications for the structure of working memory. *Journal of Verbal Learning and Verbal Behavior, 21*, 150–164. http://dx.doi.org/10.1016/s0022-5371(82)90521-7.

Savage, L. J. (1962). *The foundations of statistical inference*. New York: Metheun & Co. Ltd.

Soderstrom, N. C., Clark, C. T., Halamish, V., & Bjork, E. L. (2015). Judgments of learning as memory modifiers. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41*, 553–558. http://dx.doi.org/10.1037/e528942014-409.

Spellman, B. A., & Bjork, R. A. (1992). When predictions create reality: Judgments of learning may alter what they are intended to assess. *Psychological Science, 3*, 315–316. http://dx.doi.org/10.1111/j.1467-9280.1992.tb00680.x.

Tolan, G. A., & Tehan, G. (2002). Testing feature interaction: Between-stream irrelevant speech effects in immediate recall. *Journal of Memory and Language, 46*, 562–585. http://dx.doi.org/10.1006/jmla.2001.2820.

Wetzels, R., & Wagenmakers, E.-J. (2012). A default Bayesian hypothesis test for correlations and partial correlations. *Psychonomic Bulletin & Review, 19*, 1057–1064. http://dx.doi.org/10.3758/s13423-012-0295-x.

Yoon, C., Feinberg, F., Hu, P., Gutchess, A. H., Hedden, T., Chen, H.-Y. M., ... Park, D. C. (2004). Category norms as a function of culture and age: Comparisons of item responses to 105 categories by American and Chinese adults. *Psychology and Aging, 19*, 379–393. http://dx.doi.org/10.1037/0882-7974.19.3.379.

Zawadzka, K., Krogulska, A., Button, R., Higham, P. A., & Hanczakowski, M. (2016). Memory, metamemory, and social cues: Between conformity and resistance. *Journal of Experimental Psychology: General, 145*, 181–199. http://dx.doi.org/10.1037/xge0000118.