

## False recognition of instruction-set lures

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False remembering has been examined using a variety of procedures, including the Deese-Roediger-McDermott procedure, the false fame procedure and the two-list recognition procedure. We present six experiments in a different empirical framework examining false recognition of words included in the experimental instructions (instruction-set lures). The data show that participants' false alarm rate to instruction-set lures was twice their false alarm rate to standard lures. That result was statistically robust even when (1) the relative strength of targets to instruction-set lures was increased, (2) participants were warned about the instruction-set lures, (3) the instruction-set lures were camouflaged in the study instructions and (4) the instruction-set lures were presented verbally at study but visually at test. False recognition of instruction-set lures was only mitigated when participants were distracted between encountering the instruction-set lures and studying the training list. The results confirm the ease with which recognition succumbs to familiarity and demonstrate the robustness of false recognition.

**Keywords:** Recognition; False memory; Source monitoring.

Human memory is susceptible to a variety of errors including forgetting (McGeoch, 1932; Wixted, 2004), distortion (Estes, 1997; Zangwill, 1937), source misattribution (Johnson, Hashtroudi, & Lindsay, 1993), confabulation (Bartlett, 1932; Johnson & Raye, 1998) and false recollection (Deese, 1959; Roediger & McDermott, 1995). Although memory errors are troublesome, they are meaningful. Therefore, a complete account of human memory must include a coherent explanation of memory errors as well as successes.

The Deese-Roediger-McDermott (DRM) procedure is a well-known method to study false

remembering (Deese, 1959; Roediger & McDermott, 1995). In a standard DRM test, participants study and then recall a list of thematically related words. For example, participants might study the list *REST, BED, NAP, BLANKET* and so on. False remembering is observed when the participant later recalls or misrecognises a non-presented but implied theme word (i.e., *SLEEP*). One explanation for that result is that the study list primes the theme word, a condition that elicits false recognition at test (e.g., Anderson & Bower, 1972). A second explanation is that participants infer the theme word at study (e.g., "This list

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makes me think of sleeping") and, later, fail to distinguish the words they inferred from the words they studied (e.g., Johnson et al., 1993). A third explanation is that participants learn the study words as well as their collective semantic gist, with false recognition following from a match between the theme word and semantic gist (Brainerd & Reyna, 2002; cf. Arndt & Hirshman, 1998; Johns, Jones, & Mewhort, 2012). Independent of the explanatory debate, the DRM procedure is accepted as a meaningful demonstration of memory error and false remembering (see Gallo, 2006, 2010 for reviews).

False recognition is also examined using the false fame test (Jacoby, Kelley, Brown, & Jasechko, 1989; Jacoby, Woloshyn, & Kelley, 1989). In that procedure, participants read a list of non-famous names (e.g., *Sebastien Weisdorff*) and then are invited to sort famous from non-famous names. False recognition is observed when a participant misidentifies a re-presented non-famous name as famous. Researchers have explained the false fame effect as an example of familiarity misattribution: re-reading a non-famous name elicits familiarity that is, then, misattributed to famousness. The false fame effect is a second accepted laboratory method to examine false recognition.

False recognition is also examined using the two-list recognition procedure (e.g., Greene, 1999; Maddox & Estes, 1997; Tulving & Kroll, 1995). In these experiments, participants study two lists of words and, then, are tested for recognition of words from the second list only. False recognition is observed when a participant mistakenly recognises a word from the first list as having been presented in the second. Like the false fame effect, researchers explain the error as an example of familiarity misattribution.

Taken together, the DRM, false fame and two-list procedures provide clear and corroborative evidence of false recognition. However, all three procedures test false recognition of words presented in or implied by the experimental study list. The constraint opens questions about the empirical boundaries on false recognition. Do people falsely recognise words that they do not intentionally commit to memory? Do people falsely recognise words that they encounter incidental to the experimental test? In the work that follows, we answer those questions by testing participants' susceptibility to false recognition of words that are presented in the instructions to a recognition memory experiment (i.e., instruction-set lures).

People are susceptible to false recognition. However, experimental precedents cast some uncertainty about whether participants mistake instruction-set lures for study words. A first class of evidence comes from work in lexical decision. Oliphant (1983) compared speed of lexical decision for words that were primed in the experimental series versus the task instructions. Whereas reading a word in the experimental series benefitted lexical decision, reading a word in the task instructions did not. Oliphant concluded that participants must be aware that words are repeated in the experimental series in order to benefit from the repetition. For our purposes, the contrast suggests that instruction-set lures have a different memorial status than words encountered in the experimental series. Coane and Balota (2010) recently corroborated Oliphant's results. However, unlike Oliphant, Coane and Balota reported a slight benefit in lexical decision for uncommon and thus distinctive (e.g., INTERPOLATED) but not common and thus indistinctive (e.g., TABLE) instruction-set lures. Based on that difference, they argued that indistinctive but not distinctive words are bound to the context in which they are encountered.<sup>1</sup> In summary, if instruction-set lures have little to no influence on lexical decision, they may also have little to no influence on false recognition (see also MacLeod & Masson, 2000).

A second class of evidence comes from work on context-dependent memory (e.g., Godden & Baddeley, 1975; Thomson & Tulving, 1970). For example, Zacks and Tversky (2001) have argued that people segment and hierarchically organise their experiences to support selective and context-specific retrieval. Radvansky and Copeland (2006; see also Radvansky, Krawietz, & Tamplin, 2011; Radvansky, Tamplin, & Krawietz, 2010) have presented a related account in their Event Horizon Model that supposes memory for events encountered in one environmental context (e.g., a room) are stored in memory separately from events encountered in other environmental contexts (e.g., other rooms). Given evidence for context-dependent memory, it is conceivable that

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<sup>1</sup> Coane and Balota (2010) also tested some of their participants for recognition of the instruction-set lures. Unlike the lexical decision results, participants recognised the instruction-set lures. Critically, however, Coane and Balota told their participants to recognise words from *both* the task instructions and the task series. Thus, in their experiments, recognition of a word from the task instructions represented a correct rather than false recognition.

participants might keep memory of the words they encountered in the experimental study list separate from memory for words encountered in the preceding task instructions. If true, participants should be capable of retrieving selectively from their memory of the study list, thereby eliminating or at least attenuating their susceptibility to false recognition of instruction-set lures.

In the work that follows, we present data from several experiments aimed at measuring and resolving the uncertainties associated with false recognition of instruction-set lures. In all of the experiments, participants read instructions, studied a list of words, and were tested for recognition of the words they studied (i.e., targets), words they did not study (i.e., foils) and words presented in the task instructions (i.e., instruction-set lures). We measured veridical recognition by comparing participants' hit rates for targets against their false alarm rates for foils. We measured false recognition by comparing participants' false alarm rates for instruction-set lures against their false alarm rates for foils. To the extent that familiarity is contextually unconstrained and memory for source inaccurate (Johnson et al., 1993), participants should falsely recognise the instruction-set lures at a higher rate than foils.

## EXPERIMENT 1

Experiment 1 was conducted to index participants' false recognition of instruction-set lures and to serve as a point of departure for the work that follows. Participants read instructions for the study phase of the experiment and then studied 40 words. Following the study phase, they were tested for recognition of the 40 words they studied (i.e., targets), 40 words they did not study (i.e., foils) and the four instruction-set lures (the procedure for embedding the instruction-set lures is described in the Method section). We predicted that participants would discriminate the words they studied from the words they did not but that they would also false alarm to the instruction-set lures more than the foils.

### Method

**Participants.** Thirty students from the University of Manitoba participated in the experiment. Participants received course credit in exchange for their time.

**Apparatus.** The experiment was administered on eight personal computers. Each computer was equipped with a 22-inch monitor, a standard keyboard and a standard mouse.

**Materials.** Each participant was presented with 84 randomly selected words. Forty of the words served as targets, 40 served as foils and four served as instruction-set lures. The words were randomly sampled from the Toronto Word Pool, an online database of 1000 words falling within regular ranges for print frequency, imageability and concreteness (Friendly, Franklin, Hoffman, & Rubin, 1982).

**Procedure.** Participants were tested in groups of eight or fewer in the same room. Each participant was seated at a different table and workstation.

After the participant signed a consent form, he or she was asked to read the instructions printed on his or her computer screen:

This is a recognition experiment. First, you will commit words to memory, such as:

INSTRUCTION-SET LURE #1  
INSTRUCTION-SET LURE #2  
INSTRUCTION-SET LURE #3  
INSTRUCTION-SET LURE #4

Next, we will show you old words and novel words. Your objective is to say whether you recognise each word from the list you memorised. If you have a question, ask the experimenter to clarify. Click OK when you are ready

The instruction-set lures, which differed for each participant, were presented in all capitals and in the same font, font size and font colour as the study and test words.

When the participant clicked the "OK" button, the 40 study words were presented, each word for 750 ms. The screen was cleared for 500 ms between words.

Following the study phase, instructions for the test phase were presented:

Now we will test your recognition of the words you just memorised. On each trial, we will show you a word. We will ask whether you recognise the word from the list you memorised. When you are ready, click OK.

When the participant clicked "OK", the first test word was presented at the centre of the screen. The question "Do you recognise this word?" was presented beneath the test word. Two response alternatives labelled "Yes" and "No" were presented beneath the question. A button labelled

"OK" was presented beneath the response alternatives. Participants provided a response by clicking one of the response alternatives and then clicking "OK".

When the participant clicked "OK", the screen was cleared. One second later, the next test word was presented. If the participant clicked "OK" before selecting a response, a pop up message reminded the participant to select a response.

The procedure was repeated until all 84 of the test words had been presented and the participant had provided a response to each one.

## Results and discussion

The mean percentages of "yes" responses for targets, foils and instruction-set lures are presented in the first row of **Table 1**. Standard errors are presented in parentheses. The mean for targets is a hit rate; the means for foils and instruction-set lures are false alarm rates.

The results confirmed both of our predictions. The hit rate for targets was substantially higher than the false alarm rate for foils,  $t(29) = 18.63$ ,  $p < .0001$ , and the false alarm rate for instruction-set lures was two times larger than the false alarm rate for foils,  $t(29) = 4.24$ ,  $p = .0002$ . The data confirm that participants are indeed susceptible to false recognition of instruction-set lures. In Experiment 2, we test whether strengthening participants' memory of the words in the studied list mitigates the effect.

## EXPERIMENT 2

In Experiment 1, participants studied each word for 750 ms. Although 750 ms was sufficient to support recognition, it might not have been sufficient

to establish a strong trace. If true, memorial strength for studied words and instruction-set lures might not have differed by an adequate margin to support familiarity-based discrimination.

To examine the issue, we re-tested recognition performance giving participants 3000 rather than 750 ms to study each word in the training list. We predicted that the extra study time would strengthen memory for the studied words and, by way of contrast, aid participants in rejecting the instruction-set lures.

## Method

*Participants.* Thirty students from the University of Manitoba participated in the experiment. Participants received course credit in exchange for their time.

*Apparatus and materials.* See Experiment 1.

*Procedure.* The procedure was identical to Experiment 1, except that each study word was presented for 3000 rather than 750 ms.

## Results and discussion

The hit and false alarm rates for Experiment 2 are presented in the second row of **Table 1**. As shown, the results are consistent with Experiment 1. The hit rate for targets was once again greater than the false alarm rate for foils,  $t(29) = 15.98$ ,  $p < .0001$ , and the false alarm rate for instruction-set lures was once again two times greater than the false alarm rate for foils,  $t(29) = 3.63$ ,  $p = .0011$ .

To formally compare the results in Experiments 1 and 2, we conducted a  $3 \times 2$  mixed-factors analysis of variance (ANOVA) with probe

**TABLE 1**  
Percent "yes" responses as a function of probe type, experiment and condition within experiments

| Experiment | Condition    | Targets    | Foils      | Instruction-set lures |
|------------|--------------|------------|------------|-----------------------|
| 1          |              | 61.3 (3.2) | 21.3 (2.4) | 44.2 (5.7)            |
| 2          |              | 73.3 (2.3) | 18.2 (2.7) | 38.3 (6.5)            |
| 3          |              | 63.8 (2.7) | 17.3 (2.2) | 37.5 (5.8)            |
| 4a         | Experimental | 66.8 (2.2) | 19.0 (1.8) | 32.7 (3.6)            |
| 4b         | Control      | 65.9 (2.2) | 18.8 (2.0) | 23.2 (3.9)            |
| 5          |              | 68.4 (2.3) | 16.7 (2.2) | 34.5 (4.7)            |
| 6          |              | 67.9 (2.8) | 16.8 (2.8) | 29.8 (5.9)            |

Values in parentheses are standard errors.

type as a within-subjects factor (i.e., targets, foils and instruction-set lures) and experiment as a between-subjects factor (i.e., Experiments 1 and 2). According to that analysis, participants who studied words for 3000 ms discriminated targets from foils better than participants who studied words for 750 ms,  $F(1, 58) = 13.91, p = .0004$ . However, the additional study time had no corresponding influence on participants' correct rejection of instruction-set lures relative to foils,  $F(1, 58) = 0.13, p = .7240$ .<sup>2</sup>

In summary, presenting each study word for an additional 2250 ms benefitted participants' recognition of targets and rejection of foils without benefitting participants' rejection of instruction-set lures. We conclude that false recognition of instruction-set lures in Experiment 1 was not conditional on participants having only weak memory of studied targets.

In experiments with the two-list recognition procedure, participants study two lists of words and, then, are asked to endorse words from list two only. False recognition is measured by participants' failure to reject list-one words (e.g., Greene, 1999; Maddox & Estes, 1997; Tulving & Kroll, 1995). At first glance, our procedure is very similar to the standard two-list test. However, our procedure differs in three important ways. First, whereas participants in the two-list procedure encounter the critical lures at study, participants in our procedure do not. Second, whereas participants in the two-list procedure deliberately memorise the critical lures, participants in our procedure do not. Third, whereas participants in the two-list procedure know they will be tested for false recognition of critical lures, participants in our procedure are naïve to the test for false recognition. Although we expect that all three differences would influence recognition, the third difference is particularly compelling and opens a straightforward question: Can participants' attenuate false recognition of instruction-set lures by deliberate source monitoring?

<sup>2</sup> It should be noted that the false alarm rate to instruction-set lures did decrease from Experiment 1 to Experiment 2; in fact, it numerically decreased more than the false alarm rate to standard lures. However, the change is confounded with precision: false alarm rates for foils are based on 40 observations per subject, whereas false alarm rates for instruction-set lures are based on four observations per subject. Unfortunately, the problem is a general one in studies of false remembering (e.g., in a DRM task, there are many targets corresponding to a single critical lure).

In Experiment 3, we adopted the source-monitoring component of the two-list procedure. Namely, we told our participants that they would be tested for false recognition of the instruction-set lures and that they should reject those lures at test. Based on previous work in the related DRM (Gallo, Roediger, & McDermott, 2001) and source-monitoring procedures (Johnson et al., 1993), we expected that warning participants about the instruction-set lures would help them to attenuate or even eliminate their false recognition of instruction-set lures.

## EXPERIMENT 3

Experiment 3 was a near replication of Experiment 1. Participants read study instructions, studied 40 words and were tested for recognition of targets, foils and instruction-set lures. However, in difference to Experiment 1, we told participants that they would be tested for false recognition and that they should reject the instruction-set lures at test.

### Method

*Participants.* Thirty students from the University of Manitoba participated in the experiment. Participants received course credit in exchange for their time.

*Apparatus and materials.* See Experiment 1.

*Procedure.* The experimental procedure was identical to Experiment 1, except that participants were instructed that they would be tested for false recognition of the instruction-set lures:

This is a recognition experiment. First, you will commit words to memory such as:

INSTRUCTION-SET LURE #1  
INSTRUCTION-SET LURE #2  
INSTRUCTION-SET LURE #3  
INSTRUCTION-SET LURE #4

Next, we will show you old words, novel words, and the four examples above. Your objective is to say whether you recognise each word from the list you memorised.

You should NOT say you recognise the four examples above. If you have a question, ask the experimenter to clarify. Click OK when you are ready.

In addition to the warning in the study instructions, we re-warned participants just prior to test:

Now we will test your recognition of the words you just memorised. On each trial, we will show you a word. We will ask whether you recognise the word from the list you memorised. Remember, do NOT say you recognise the four example words from the original instructions. When you are ready, click OK.

## Results and discussion

Hit and false alarm rates are presented in row 3 of Table 1. Despite the source-monitoring instruction, the pattern of means is consistent with Experiments 1 and 2. The hit rate for targets was once again greater than the false alarm rate for foils,  $t(29) = 16.62, p < .0001$ , and the false alarm rate for instruction-set lures was once again two times greater than the false alarm rate for foils,  $t(29) = 3.35, p = .0023$ .

For completeness, we compared performance in Experiments 1 and 3 using a  $3 \times 2$  mixed-factors ANOVA, treating probe type as a within-subjects factor (i.e., target, foil and instruction-set lure) and experiment as a between-subjects factor (i.e., Experiments 1 and 3). According to that analysis, instructing participants to reject the instruction-set lures had no impact on performance. Whereas the main effect of probe type was statistically significant,  $F(2, 116) = 74.54, p < .0001$ , the main effect of experiment was not,  $F(1, 58) = 0.49, p = .4851$ . Critically, the interaction of probe and experiment was not significant,  $F(2, 116) = 0.88, p = .4161$ .

Although we cannot say with certainty, we suspect that participants memorised the instruction-set lures so they could reject them at test. However, after studying the targets, they were unable to remember if they encountered the instruction-set lures in the study instructions of the study list. Whereas the failure to reject instruction-set lures under explicit instruction appears perplexing, the result is consistent with other published data (e.g., Gallo, Bell, Beier, & Schacter, 2006; Johnson et al., 1993).

## EXPERIMENT 4

In all three preceding experiments, the instruction-set lures were presented focally and prominently in the task instructions. In Experiment 4, we tested participants' false recognition of

instruction-set lures that are presented inconspicuously in the task instructions. To evaluate the question, we presented participants with the following task instructions:

This is a recognition experiment. First, you will *commit* words to memory. Next, we will show you old words and *novel* words. Your *objective* is to say whether you recognise each word from the list you memorised. If you have a question, ask the experimenter to *clarify*. Click OK when you are ready.

After reading the instructions, participants were tested for false recognition of four instruction-set lures: COMMIT, NOVEL, OBJECTIVE and CLARIFY. The instruction-set lures were not presented in italics. We expected that participants' would *not* falsely recognise the inconspicuously embedded instruction-set lures.

## Method

*Participants.* Eighty-four students from the University of Manitoba participated in the experiment. Half served in an experimental group and half served in a control group (see below). All participants received course credit in exchange for their time.

*Apparatus and materials.* See Experiment 1.

*Procedure.* The procedure for the experimental group was identical to Experiment 1, except for the critical change in the study instructions (see above).

In addition to the experimental group, we tested a control group to obtain an empirical baseline for the false alarm rate to the four instruction-set lures. The addition of a control group was necessary because the four instruction-set lures were held constant over participants; in previous experiments, the instruction-set lures were drawn randomly for each participant from the same pool of words from which targets and foils were randomly drawn.

The procedure for the control group was nearly identical to that of the experimental group. The only difference was that participants assigned to the control condition read a different set of task instructions that excluded the four instruction-set lures:

This is a recognition experiment. First, you will study words. Next, we will show you additional words. You must say whether you recognise each

word from the list you memorised. If you have a question, ask the experimenter. Click OK when you are ready.

## Results and discussion

Hit and false alarm rates for the experimental and control groups are shown in rows 4a and 4b of **Table 1**. We analysed the data using a  $3 \times 2$  mixed-factors ANOVA model with probe as a within-subjects factor (i.e., target, foil and instruction-set lure) and instruction condition as a between-subjects factor (i.e., experimental and control). The main effect of probe type was statistically significant,  $F(2, 164) = 256.97, p < .0001$ . Participants responded yes to targets more than foils and instruction-set lures. The main effect of group was null,  $F(1, 82) = 1.49, p = .2260$ . Despite other differences, participants in the experimental and control groups responded yes equally often over the test phase.

Most critical for our examination of false recognition, the interaction between probe type and instruction group was marginally significant,  $F(2, 164) = 2.72, p = .0689$ . The interaction confirmed that participants in the experimental and control groups responded to the three types of probes differently. A comparison of the false alarm rates for foils versus instruction-set lures as a function of instruction group confirmed the key result. Participants in the experimental group falsely recognised the inconspicuous instruction-set lures at a rate greater than the control group,  $F(1, 82) = 4.50, p = .0369$ .

## EXPERIMENT 5

In all of the preceding experiments, instruction-set lures were presented visually at both study and test. The circumstance opens the possibility that perceptual fluency facilitated or played a causal role in driving false recognition (e.g., Jacoby & Whitehouse, 1989; Whittlesea, 1993; Whittlesea, Jacoby, & Girard, 1990). The perceptual fluency hypothesis is particularly relevant to Experiments 1 through 3 where the instruction-set lures were presented identically at study and test (i.e., in the same font, font size, capitalisation and colour). It is also relevant in light of data from Dodson and Schacter (2001) who showed that presenting words differently at study and test mitigates false recognition in the DRM test (see also Israel & Schacter, 1997; Smith & Hunt, 1998).

We tested the perceptual fluency hypothesis in Experiment 5 using the same general empirical procedure from Experiment 4. However, in difference to Experiment 4, the instruction-set lures were presented verbally at study and visually at test. If false recognition of instruction-set lures depends on perceptual match, the manipulation should attenuate or even eliminate the false recognition effect from the preceding experiments.

## Method

**Participants.** Twenty-nine students from the University of Manitoba participated in the experiment. Participants earned course credit in exchange for their time.

**Apparatus and materials.** See Experiment 1.

**Procedure.** The procedure was identical to Experiment 4, except that the experimenter read the study instructions to participants and the instructions differed slightly to accommodate the shift from written to verbal presentation:

This is a recognition experiment. First, you will *commit* words to memory. Next, I will show you old words and *novel* words. Your *objective* is to say whether you recognise each word from the list you memorised. If you have a question, ask me to *clarify*. Turn on your monitor and click OK when you are ready.

Despite those changes, participants were tested with the same four instruction-set lures from Experiment 4: COMMIT, NOVEL, OBJECTIVE and CLARIFY.

## Results and discussion

Hit and false alarm rates are presented in row 5 of **Table 1**. Despite verbal presentation of the instruction-set lures, the pattern of results is consistent with previous experiments. The hit rate for targets was greater than the false alarm rate for foils,  $t(28) = 18.23, p < .0001$ . The false alarm rate for instruction-set lures was two times greater than the false alarm rate for foils,  $t(28) = 4.48, p = .0001$ .

To evaluate false recognition against an appropriate empirical control, we conducted a  $3 \times 2$  mixed-factors ANOVA that compared performance by participants in the current experiment

against performance by participants in the control group from Experiment 4. Both the main effect of probe type,  $F(2, 69) = 213.79, p < .0001$ , and the interaction between probe and condition,  $F(2, 69) = 3.64, p = .0288$ , were statistically significant. The main effect of instruction condition (i.e., experimental versus control) was not,  $F(1, 69) = 1.41, p = .2395$ . As in the previous experiments, and to rule out influences of response bias, we compared the false alarm rates for foils and instruction-set lures as a function of condition. The test confirmed that participants in the present experiment falsely recognised instruction-set lures relative to foils at a greater rate than participants in the control group from Experiment 4,  $F(1, 69) = 7.63, p = .0074$ . Presenting words verbally at study but visually at test did not attenuate false recognition of instruction-set lures.

We conclude that the high rate of false recognition observed in the preceding experiments did not depend on a perceptual match between the instruction-set lures as presented at study and test. The result is particularly compelling in light of evidence that presenting words differently at study and test can mitigate false recognition in the DRM test (Dodson & Schacter, 2001; Israel & Schacter, 1997; Smith & Hunt, 1998).

## EXPERIMENT 6

Introducing a task between study and test impairs recognition (e.g., Hockley, 1992). In Experiment 6, we tested whether a filled delay between presentation of the instruction-set lures and initiation of the study phase would cause participants to forget the instruction-set lures and, thereby, attenuate the false recognition effect observed in our preceding experiments.

### Method

*Participants.* Twenty-six students from the University of Manitoba participated in the experiment. All participants received course credit in exchange for their time.<sup>3</sup>

*Apparatus and materials.* See Experiment 1.

<sup>3</sup>One additional group of eight participants was excluded from the experiment because they failed to follow instructions.

*Procedure.* The experimental procedure was identical to Experiment 5, except for one critical difference. After participants were seated at computer stations and the experimenter had read the study instructions to them, participants were invited to read and consider a two-page consent form. After 3 minutes, participants were asked to sign their consent form, turn on their computer and begin the study phase.

## Results and discussion

Hit and false alarm rates are presented in row 6 of Table 1. As shown, the results are somewhat consistent with previous experiments. As in previous experiments, the hit rate for targets was greater than the false alarm rate for foils,  $t(25) = 13.19, p < .0001$ , and the false alarm rate for instruction-set lures was once again greater than the false alarm rate for foils,  $t(25) = 2.86, p = .0083$ . However, a  $3 \times 2$  mixed-factors ANOVA failed to confirm that the difference in false alarm rates between foils and instruction-set lures was greater than was observed in the data of the control group from Experiment 4,  $F(1, 66) = 2.74, p = .1025$ .

The experimental group did falsely recognise the instruction-set lures at a rate numerically greater than the control group. However, the difference failed to reach statistical significance. Arguing in favour of the null hypothesis on the basis of this failure is, of course, not a strong inference. However, given that false recognition of instruction-set lures has been extraordinarily robust in the preceding five experiments, we tentatively conclude that introducing the filled delay appeared to mitigate false recognition of instruction-set lures without affecting participants' discrimination of targets from foils.

## GENERAL DISCUSSION

Our experiments show that people are susceptible to false recognition of instruction-set lures. The work fits in with a number of related empirical results including the DRM effect (Deese, 1959; Roediger & McDermott, 1995), the false fame effect (Jacoby, Kelley, et al., 1989; Jacoby, Woloshyn, et al., 1989) and false recognition in the two-list recognition test (Greene, 1999). Our data are also consistent with related illusions of familiarity including the illusion of truth in which

participants interpret their familiarity for a statement as evidence of its truth (Hasher, Goldstein, & Toppino, 1977) and the mere exposure effect in which participants interpret their familiarity for a stimulus as evidence that they prefer it (Zajonc, 1968).

Our data are best characterised as an example of familiarity misattribution (e.g., Johnson et al., 1993; Roediger & McDermott, 2000; Roediger, Watson, McDermott, & Gallo, 2001). Re-reading an instruction-set lure at test elicits familiarity that is, in turn, misattributed to the study list. Critically, the familiarity-misattribution explanation explains the apparent contradiction in false recognition versus lexical decision of instruction-set lures. Whereas priming is relevant to both recognition and lexical decision, familiarity attribution is only relevant to recognition, where participants must determine the source of their familiarity.

Critically, our results are not well explained as an example of repetition priming (e.g., Anderson & Bower, 1972). Firstly, false recognition was not affected when words were presented differently at study and test—an outcome that contradicts the fact that repetition priming is sensitive to perceptual match. Secondly, priming of instruction-set lures has been shown to be difficult to observe and only in restricted cases (Coane & Balota, 2010; Oliphant, 1983). Thus if false recognition were due to priming, we should not have observed false recognition of instruction-set lures.

Our data provide a novel contribution to the empirical database regarding source-monitoring and recognition memory. Firstly, the data provide evidence that people are susceptible to false recognition, even when they deliberately attempt to mitigate that susceptibility. Secondly, our data demonstrate that people are susceptible to false recognition of words encountered outside the study list and incidental to the recognition test. Thirdly, our data show that false recognition is robust to a number of manipulations aimed at mitigating false recognition (e.g., changing the perceptual presentation of words between study and test). Fourthly, our final experiment provides some evidence that introducing a filled delay after presenting the instruction-set lures and before initiating the study phase can mitigate false recognition.

Most of our experiments were designed to mitigate false recognition of the instruction-set lures. Although most of our manipulations failed, the filled delay manipulation in Experiment 6 was successful. Our preferred explanation for the result is that reading the consent form introduced

retroactive interference for the task instructions and, thereby, caused participants to forget the instruction-set lures. The retroactive interference explanation is consistent with known facts and offers a clear and simple summary of our results (McGeoch, 1932).

Another explanation is that turning participants' attention towards the consent form established an episodic boundary that sequestered memory for the study list from memory of the task instructions. The explanation is consistent with a theoretical framework that proposes people segment their experiences (e.g., Zacks & Tversky, 2001). If true, the attenuated false recognition observed in Experiment 6 might be explained as an example of episodic knowledge partitioning combined with context-specific retrieval (e.g., Lewandowsky, Roberts, & Yang, 2006; Swallow, Zacks, & Abrams, 2009).

Although we find the explanation by knowledge partitioning and context-specific retrieval intriguing, it does not offer a coherent account of our data. Firstly, if participants' false recognition of the instruction-set lures was due to effective knowledge partitioning, participants should have been able to reduce or even eliminate their false recognition, particularly in response to the deliberate source-monitoring instructions in Experiment 3. Secondly, if participants engaged in highly selective context-specific retrieval, we should not have observed very much false recognition at all—participants would have retrieved selectively from the study list in all of our experiments. In contrast, the forgetting explanation offers a simple and principled explanation for our results as well as a new avenue for theoretical and empirical investigation of event segmentation and familiarity-based false recognition.

Although we set out to examine false recognition of instruction-set lures, our data also speak to a few other issues including a controversy over the meaning of the list-length effect in recognition. In a list-length experiment, participants are tested for recognition of words from lists of varying lengths. The list-length effect is observed when recognition performance declines as list length increases (e.g., Gronlund & Elam, 1994; Strong, 1912). Although the number of words presented in the study list constitutes the objective definition of list length, our data suggest that the psychological definition of list length might be harder to pin down. In short, if memory for a study list of 40 words includes memory for study instructions (as our data show), one must ask how

many words are in the participant's compared to the experimenter's study list. If they are unequal, list length is ill defined.

We are not the first to raise the issue. For example, Murdock and Kahana (1993) proposed that list-length effects are complicated by the fact that memory for a study list is continuous with the events that precede it (see also Dennis & Humphreys, 2001; Osth, Dennis, & Kinnell, 2014):

M [memory] cannot be initialized to zero at the start of each list; if it were, performance on a final recognition test would be at chance. Not only that, but subjects would not even be able to remember the task instructions, that they were in an experiment, or what their own name was. This seems rather unlikely.

Instead, it seems more reasonable to assume that memory is continuous. The memory vector is not initialized to zero at the start of each list or event the start of the experiment. (For evidence, see Estes, 1991.) Instead, it is continuous from the past to the present, and the fact that there is a definite starting time for the experimental situation does not alter this. The information entered in memory is different, and subjects can discriminate pre-experimental from experimental events, but both types of information are contained in the common memory vector. (please see Murdock and Kahana, 1993, p. 691)

Our experiments also have commonalities with the repetition lag procedure in recognition memory. In that procedure, participants study words. At test, they are presented with the words that they studied and words that they did not study. Critically, some of the foils are presented twice at test. The participants' task is to reject the twice-presented foils (Fischler & Juola, 1971; Koriat, Ben-Zur, & Sheffer, 1988; Underwood & Freund, 1970). In experiments reported by Jennings and Jacoby (1997), false recognition of a repeated foil was lower if the word had been presented recently than if the word had been presented much earlier in the series. Although we did not design our experiments by analogy to the repetition lag procedure, our instruction-set lures might be conceptualised as foils repeated at a very long lag (i.e., before the study list). Thus, we might expect that participants would reject instruction-set lures if they were presented early rather than late in the test series.

In conclusion, our experiments show that people are susceptible to false recognition of instruction-set lures. Our data also show that peoples' susceptibility to false recognition is remarkably robust,

even under experimental manipulations that ought to mitigate the error.

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