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Both associative activation and thematic extraction count, but thematic false memories are more easily rejected

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The main aim of this study was to analyse the roles played by associative activation and thematic extraction in the explanation of false memories using the Deese, Roediger, McDermott (DRM) paradigm. Associative lists with two different types of critical items (CIs) were used: one, the associative CI, corresponded to the word most strongly primed by the associates in the list and another, the thematic CI, was the word that best described the theme of the list. Following three different types of encoding instructions (standard, warning or strategic), false recognition for these two types of CIs was analysed in either self-paced or speeded response recognition tests. The results showed considerable levels of false memories for both types of CIs. Even without the quality of being "good themes", associative CIs produced high levels of false recognition, which suggests that associative activation plays a prominent role in false memory formation. More interestingly, thematic CIs were more prone to be edited out, reinforcing the argument that thematic identifiability has a major role in the rejection of false memories.

Keywords: False memories; DRM paradigm; Theme identifiability; Associative activation; Thematic extraction.

Nowadays, false memories are no longer viewed as the irrelevant erroneous sub-product of an efficient memory system and have become the object of serious attention in modern psychological science. In particular, a well-controlled laboratory setting like the Deese, Roediger, McDermott (DRM) paradigm has proven to be a valid outlet not only for the empirical study of memory distortions but also for the fruitful contrast of different approaches and theories of memory. In the DRM paradigm, participants are presented with lists of associates (e.g., *table, sit, legs, seat*, etc.,) of a non-presented critical item (CI) (e.g., *chair*) and, when asked to recall or recognise the studied words, they frequently produce or endorse the CI as a presented word (Deese, 1959; Roediger & McDermott, 1995). The explanation of this effect has been of central interest to false memory research and, more broadly, to memory research in general (see a recent review by Gallo, 2010). A critical question is whether false memories stemming from this paradigm are the product of automatic associative activation, spreading from the studied words to the critical lures, or whether

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they are due to the extraction of the general meaning of the list. In an attempt to separately examine associative activation and thematic extraction, this study used lists with two different types of CIs: one that is associative, corresponding to the word most strongly primed by list associates, and another that is thematic, the word that best describes the theme of the list. As a central goal, this study aimed to analyse the contribution of both processes in the production and rejection of false memories.

The DRM phenomenon has been explained by prominent theories that agree with the idea that, for a false memory to occur, two different processes must be at work: one that corresponds to the inflated accessibility of the related but non-presented words and another that is responsible for the rejection of those same words as true memories. It is the dynamic interplay between those two processes that determines the final result—the production or not of the false memory. For example, the fuzzy trace theory (Brainerd & Reyna, 2005) assumes that memory representations involve two separate traces: a gist trace, which captures the semantic and relational information of the event, and a verbatim trace, which preserves the specific information in its exact surface form. This theory attributes the production of false memories to gist processing and the function of suppressing or rejecting false positives to verbatim processing.

The other most prominent theory, the activation-monitoring framework (Roediger, Balota, & Watson, 2001), argues that the first step towards producing a false memory is given by the summation of activation that converges on the CIs when the studied words are processed. This theory derives from spreading activation models (e.g., Collins & Loftus, 1975) which suggest that the processing of one word activates a corresponding node in our mental lexicon and that this activation spreads to surrounding concept nodes. This theory also argues that not every activated word or event is necessarily produced as a false memory. Relying on Johnson's concept of source monitoring (Johnson, Hashtroudi, & Lindsay, 1993), this theory assumes that if we correctly distinguish between the memory sources of the presented and CIs and attribute the origin of a false memory to an internal generation process rather than to an actual external world event, then false memory can be suppressed. A false memory only occurs if the source of the error-inflated memory is confused with the source of true memories.

Although each of these approaches uses different concepts and is based on different theoretical foundations, both of them are considered dual-process theories (Gallo, 2006) and, therefore, share the view that two different processes can occur in false memory formation: one, an error-inflating process (*gist-based* in fuzzy trace theory and *activation-based* in activation-monitoring theory) that results in the enhanced availability of distorted or non-experienced information, and another one, an error-editing process (*recollection rejection* in fuzzy trace theory and *monitoring* in activation-monitoring theory), that is responsible for the eventual rejection of a false memory (Arndt & Gould, 2006).

However, these theories disagree upon an important point that is directly linked to the factors responsible for the error-inflating process. According to activation-monitoring theory, the CIs are falsely recalled or recognised because words are mentally linked or associated with others, through contiguity, co-occurrence or taxonomic membership and also because of conceptual, orthographical or phonemic similarity (Howe, Wimmer, & Blease, 2009). In this view, lure activation processes are assumed to be relatively automatic, with backward associative strength (BAS)—the strength of association from the study words to the critical lure—being considered the main factor responsible for false memories (Roediger, Watson, McDermott, & Gallo, 2001). On the other hand, as defined by fuzzy trace theory, gist captures the semantic and relational information of the event, and it could be viewed as the abstraction of a common theme contained within the presented material (e.g., Cann, McRae, & Katz, 2011; Howe et al., 2009). The CIs are falsely recalled or recognised because they are consistent with the representation of the list's theme.

The literature contains data supporting both of these conceptions. The conception that false memories arise through associative activation has been supported by the following: (1) a positive correlation between the mean backward associative strength (MBAS) and false memories (Roediger, Watson et al., 2001); (2) the occurrence of false memories for lists that are other than semantic in nature, such as those composed of phonologically related items (Sommers & Lewis, 1999) or even series of non-words that overlap orthographically and phonologically (Zeelenberg, Boot, & Pecher, 2005); (3) the finding that lists with two homonymous CIs, i.e., with less overall thematic coherence, produced the same level of false recall

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as standard lists with one-meaning CIs (Hutchison & Balota, 2005) and (4) the finding that unrelated list items that were related to mediators which all converged upon a single non-presented item could produce false memories even in the absence of a semantic gist (Huff & Hutchison, 2011). On the other hand, the conception that false memories arise through thematic extraction has been supported by other findings: (1) thematic blocking of DRM lists produced higher levels of false memories than random presentation (Toglia, Neuschatz, & Goodwin, 1999); (2) the persistence of false memories after a delay fits well with the notion of a durable gist (Toglia et al., 1999); (3) interlist variability in false memories was tied to variability in semantic characteristics of CIs, such as familiarity and meaningfulness (Brainerd, Yang, Reyna, Howe, & Mills, 2008) and (4) semantic relations between list items and CIs, such as situation features, synonymy and taxonomic relations were consistently predictors of false recall and BAS (Cann et al., 2011).

Because of its potential relevance as a key aspect in the theoretical debate, it is important to pay attention to a few studies that have focused on the effects of theme extraction on false memories and have consistently shown that theme identification is an important variable that influences false memories. For example, Brainerd and Reyna (1998b) found that unstudied words that were estimated to be good themes for their lists were more likely to be falsely recognised than unrelated distractors, although not as likely as the standard associatively derived CIs. More recently, studies by Carneiro, Fernandez, and Dias (2009) and by Carneiro et al. (2012) have shown that CIs that are easily identified as the themes of the lists were, in general, less susceptible to becoming false memories than CIs that are difficult to identify as themes. Such a differential pattern can be even more pronounced when participants are warned that the study of those lists may produce memory errors (Jou & Foreman, 2007; Neuschatz, Benoit, & Payne, 2003). These findings can be interpreted from the perspective of the fuzzy trace theory, arguing that thematic words are, in first instance, good candidates for false recognition due to their facility in accessing a gist representation but are eventually more likely to be discounted as a result of a recollection–rejection process (Brainerd, Wright, Reyna, & Mojardin, 2001). Alternatively, the same findings could be explained from an activation-monitoring perspective by assuming the application of the identify-to-reject strategy, a specific case of the disqualifying monitoring previously described by Gallo (2006). According to this view, participants may identify the CIs at encoding and then mentally tag them as "not presented" in order to later discard them in a memory test. This account is supported by results highlighting the importance of consciously identifying the CIs in achieving false memory reduction (e.g., Bredart 2000; Huff, Coane, Hutchison, Grasser, & Blais, 2012; Jou & Foreman, 2007; Mukai, 2005; Multhaup & Conner, 2002) and by results showing that manipulations that reduce the possibility of identifying the missing CI during encoding or disrupt the possibility of using monitoring during retrieval eliminate the theme identifiability effect (Carneiro et al., 2012).

The studies discussed above indicate that theme identification promotes error-editing, but there is also some evidence that this variable also promotes error-inflation. For example, participants who are not able to effectively use an editing process, as is the case with young children, actually produce more false memories with high-identifiable lists (Carneiro et al., 2009). Moreover, a very fast presentation rate of 50 ms produced higher levels of false memories for high-identifiable lists, whereas the identifiability effect was replicated at a standard rate of 2000 ms (Carneiro et al., 2012). The reversal of the effect at a fast presentation rate suggests that, in a first stage, high identifiability stimulates false memories, most probably because at this rate it is not possible to detect whether or not the theme word was in the list, precluding false memory rejection on the basis of presence/absence information. Following the same line of reasoning, a study by Carneiro and Fernandez (2013) showed that CIs of high-identifiable lists were more frequently generated than CIs of low-identifiable lists when participants were given inclusion-recall instructions, demanding both the recall of presented words and the generation of unstudied related words. Taken together, the results of these studies suggest that high-identifiable CIs, although more prone to being rejected in standard memory tests, were initially more accessible.

The preceding discussion of findings and theoretical accounts is of relevance because, in 2001, Roediger, Watson, McDermott and Gallo contended that the operational definition of gist for DRM word lists had never been appropriately specified, and they stressed the need for an independent specification of gist that could explain why some lists produce more false memories than

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others. Ten years later, Cann et al. (2011) operationalised gist in terms of theme extraction. In their study, gist extraction was measured as the number of participants who were able to elicit the non-presented CI in a task in which they were asked to generate "one word that was thought to best describe the lists of words". These authors stressed the importance of semantic relations between study items and CIs that would be represented by knowledge types such as situation features, synonyms and taxonomic relations. They concluded that these semantic relations promote gist extraction and contribute to false recall. As already reviewed, before the publication of this study by Cann et al. (2011) other studies had already manipulated theme identifiability, a variable that is computationally equivalent to gist extraction (Carneiro et al., 2009; Jou & Foreman, 2007; Neuschatz et al., 2003). However, although the authors of these previous studies emphasised that theme identifiability was a variable that should not be dismissed from false memory explanations in the DRM paradigm, they did not explicitly equate identifiability with gist as Cann et al. did.

It may be premature at this stage to take identifiability as a direct manifestation of gist for both theoretical and empirical reasons. Equating gist to the output of a theme extraction task could be an imperfect and simplistic characterisation of gist, at least considering the broad and complex definition of this concept in fuzzy trace theory (Brainerd & Reyna, 1998a, 2005). Additionally, although no explicit assumptions have been elaborated about the automatic or strategic nature of the processes involved in forming and using gist representations (Brainerd, Reyna, Forrest, & Karibian, 2006), the theory states that gist trace retrieval underlies the experience of familiarity with a previous event and that any item that matches gist traces is likely to be falsely recalled or recognised. This has led to the interpretation that false memory via gist processing is mainly due to familiarity-based processes (Arndt, 2012). However, the way that theme identifiability has been measured—extracting the word that best describes the theme of the list (Carneiro et al., 2009)—seems to be a conscious and an effortful process that requires the ability to organise the information and aggregate it into one word. Moreover, the way theme identifiability works in the identify-to-reject strategy (mentally tagging the theme word to make it more distinguishable during encoding and retrieval) seems to be more closely related to a strategic way than to an automatic way of avoiding false memories.

Nonetheless, beyond the need to solve these and other gist-characterisation questions, investigating the role that theme extraction/identification might play in the production of false memories is of critical importance for understanding DRM phenomena.

The major problem in teasing apart the processes of associative activation and thematic extraction when studying DRM lists is that BAS and theme identifiability are usually highly confounded. In an attempt to separate these processes, the present study used lists in which the associative critical items, although derived from associative norms, do not have the quality of being "good themes" for their lists. For these lists, other (non-presented) words were considered the best themes by participants in an independent theme-extraction task. Thus, in selecting lists for this study, we could use two different types of CIs: associative lures derived from free association norms and thematic lures derived from identifiability norms. The former lures were associates to list items and the latter lures were terms that best described the themes of the lists (e.g., for the list composed of the following words: lingered, snail, delayed, dilatory, quick, slug, laggard, lazy, laziness and calm, the associative lure is slow and the thematic lure is speed).

With materials of this type, this study seeks to analyse the contribution of thematic extraction and associative activation on error-inflation and on error-editing. Although we do not assume the total independence of these processes (for a discussion of this topic see Brainerd et al., 2008), we hypothesised that participants would rely more on one type of processing than on the other, depending on the particular demands of the task. We predicted that manipulations that promoted a more strategic process of encoding, based on the identification of the theme word, would mainly influence the false memory of thematic CIs. Because they are considered to be the best themes of the lists, thematic items might be more affected by any manipulation that calls for theme identification. The manipulations we used to induce a conscious effort to identify the converging word were instructions that presented theme identification as a way of enhancing veridical recall or as a way of avoiding false memories.

To understand the influence of these instructions on associative and thematic intrusions, their effects on error-editing processes must also be

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studied. With this aim, retrieval conditions during recognition tests were manipulated to obtain either speeded or self-paced responses. Based on the well-supported view that recognition responses involve a fast familiarity process as well as a relatively slower and more controlled process (e.g., Rotello & Heit, 2000), it was expected that speeded responses would reduce the influence of recollection or monitoring processes, while self-paced responses would allow for the operation of editing mechanism. In the three experiments reported here, encoding instructions and retrieval conditions were systematically varied to obtain a clear view of how they interacted in the creation of associative and thematic false memories.

EXPERIMENT 1

The specific aim of this first experiment was to analyse whether strategic manipulations that are thought to facilitate the editing process, such as warning the participants about the DRM effect, would differently affect false memories for associative and thematic CIs.

Previous research has shown that issuing warning instructions before study reduces false memories, although it does not eliminate them totally (Gallo, Roberts, & Seamon, 1997; McDermott & Roediger, 1998; Starns, Lane, Alonzo, & Roussel, 2007; Watson, McDermott, & Balota, 2004; Westerberg & Marsolek, 2006). Warning instructions may encourage disqualifying monitoring (Gallo, 2006), since participants can strategically identify the related lure during study and thereby avoid false memories at test (Neuschatz et al., 2003). Consequently, we expected that a strategy based on identifying the CI of the list in order to later discard it would be more effective in reducing false memories for thematic CIs than for associative CIs.

To disentangle the effects of warnings on error-inflation and on error-editing for both types of items, participants were tested under conditions permitting the operation of an editing mechanism (standard retrieval condition) and under conditions that were designed for preventing it (speeded retrieval condition). Thus, it was expected that warnings would be more effective in lowering false alarm rates for thematic items, but only under test conditions that allow time for monitoring (e.g., self-paced recognition).

The analyses of response times (RTs) for false alarms and for correct rejections of CIs could also provide evidence of distinct accessibility for these two types of items (Jou, Matus, Aldridge, Rogers, & Zimmerman, 2004). As thematic items might be more easily identified as non-presented themes of the lists, it is expected that the participants will take less time to reject these items than associative items. Previous research (Carneiro et al., 2009) showing that rejection confidence was higher for high-identifiable CIs also leads us to expect that participants will take less time in correctly rejecting thematic CIs in comparison to the associative CIs of this study. Moreover, the warning instruction might lead to a more careful inspection of test items than the standard instruction and, thus, it might produce an increase in RTs for the acceptance or rejection of CIs.

Method

Participants. Sixty-six Portuguese university students participated in this experiment (M_{age} = 21 years; 55 female, 11 male). For the study phase, 34 participants were assigned to a warning condition and 32 experienced a standard condition. For the recognition test, half of the participants in each of these two groups were assigned to a speeded retrieval condition and the other half to a self-paced retrieval condition. All of them received course credits for their participation.

Design. The experiment followed a 2 (CI: associative vs. thematic) × 2 (instruction: warning vs. standard) × 2 (retrieval time: speeded vs. self-paced) factorial design with repeated measures over the first factor.

Materials. Nine lists, with 10 items each, disposed in descending order of associative strength to the CI, were selected from the normative study for the identifiability of Portuguese backward associative lists (Carneiro, Ramos, Costa, Garcia-Marques, & Albuquerque, 2011). In that normative study, participants were presented with several lists and were asked to generate, for each list, a single word that best defined its overall theme. For most lists, the theme most frequently generated coincided with the associatively derived CI of the list. However, for a few lists, participants generated other words as themes with a higher frequency than the associative CIs. It was precisely this type of list that was appropriate for the present study because it possessed CIs of the two kinds (see Appendix A): one was an associative CI, derived from free association norms, and the

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other one was a thematic CI, derived from the identifiability norms. The associative and the thematic CIs differed significantly in identifiability percentages (7% vs. 20%, respectively) and in MBAS (.17 vs .03, respectively), reflecting that associative items, when compared to thematic items, received higher associative activation from the lists' words, but were less likely to be considered the themes of the lists. In order to control for potential confounding effects caused by other linguistic characteristics that could be differentially distributed between the two types of CIs, other variables were analysed. The results showed that these two types of CIs did not significantly differ in terms of length, frequency in the language or in dimensions such as concreteness, familiarity, meaningfulness or imagery (see Table 1).

The recognition test was composed of 60 words: 18 presented words, 2 from each study list (positions 1 and 8, following a similar procedure used in the paradigmatic study by Roediger & McDermott, 1995); the 9 associative CIs of the presented lists; the 9 thematic CIs of the presented lists and 24 unrelated words (selected from list items, associative CIs and thematic CIs of six other DRM associative lists not studied in the experiment).

Procedure. The participants were randomly assigned to one of the four different conditions (warning-speeded, warning-self-paced, standard-speeded and standard-self-paced). In the standard condition, participants were told to pay attention to the word lists because their memories of the words would be tested later (following the standard procedure of Roediger & McDermott, 1995). In the warning condition, the same information was given, but the participants were also informed about the DRM effect and told how to avoid false memories by using the identify-to-reject strategy. A one-list example was provided, following a procedure similar to the one used by McDermott and Roediger (1998). The warning was as follows:

> You'll notice that all the words in each list are related to another word that reflects the theme of the list but is never presented. Many people, after hearing the lists and when they are in the memory test, wrongly tend to consider that these binding words were in fact presented when, in fact, they were not. Try to prevent this from happening to you. To avoid errors, you should try to figure out what the word is that ties all the other words together. After that, you should try to keep these binding words in mind for later dismissal in the memory test. For example, if one of the presented lists consisted of *flour, eggs, sugar, birthday*, etc., (all of them linked to the nonpresented word *cake*) you must first identify the binding nonpresented word (*cake*) and then keep it in mind with the tag "not presented". In sum, you should be very careful not to commit such errors in the memory test.

Under both conditions, standard and warning, the nine lists were auditory and randomly presented at a rate of 2 sec/word and separated from each other by a beep signal, prompting the participants to be ready for the presentation of the next list. Following the presentation of all lists, a recognition test was administered. All the participants were instructed to give their responses on the computer keyboard, pressing one key for a "non-presented item" and another key for a "presented item". Test words were presented visually, one by one, on the computer screen in a unique random order for each participant, with an exposure time of 400 ms/word. Participants in the self-paced condition were also informed that they had no time limit for giving their responses, thus allowing them enough time to think carefully about them. After a response was given, another word was

TABLE 1
Mean scores of theme identifiability, frequency, length, concreteness, familiarity, meaningfulness, imagery and mean backwards associative strength (MBAS) for associative and thematic CIs

	Associative CIs		*Thematic CIs*			
	M	*SD*	*M*	*SD*	*t*	*p*
Theme identifiability	7.10	4.41	20.4	4.23	8.16	.00
Frequency	1973	1664	2309	2859	.55	.60
Length	5.44	1.42	6.44	1.88	1.25	.25
Concreteness	4.62	1.52	4.67	1.44	.27	.80
Familiarity	5.27	.64	5.23	.66	.16	.88
Meaningfulness	3.80	.47	4.22	.78	1.75	.12
Imagery	4.23	.90	4.63	1.00	2.00	.08
MBAS	.17	.06	.03	.06	4.42	.002

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immediately presented, until completion of the test sequence. Unknown to the participants, RTs were registered. Participants in the speeded condition were instructed to give their responses very quickly, within 800 ms for each test item (400 ms of exposure time for the presentation of each word plus 400 ms for response). A red-colour written message of "try to be quicker" was presented on the computer screen whenever a RT exceeded 800 ms. Responses given outside this time limit, although registered, were not included in the analyses (in accord with Heit, Brockdorff, & Lamberts, 2004). Two participants under the speeded retrieval condition (one from the warning condition and one from the standard condition) were excluded from the analyses because they responded out of the time limit to more than half the test items.

Results and discussion

Separate analyses were conducted on response-accuracy data and on response-time data.

Analysis of accuracy data. Table 2 displays the proportion of recognition responses for targets, associative CIs and thematic CIs under both types of study conditions (standard and warning) and both types of test conditions (self-paced and speeded) for this and subsequent experiments. Because preliminary analyses showed that the proportion of unrelated distractors incorrectly recognised was not similar across conditions,[1] a signal detection analysis was used to compute values of *d*' for both targets and CIs. To obtain the *d*' values for veridical recognition, the transformed mean proportions of the targets of presented lists were treated as hits and the mean proportions of the targets of non-presented lists were treated as false alarms. To obtain the *d*' values for false recognition, the transformed mean proportions of the critical lures of presented lists were treated as hits and the mean proportions of the critical lures of non-presented lists were treated as false alarms (separately calculated for associative and thematic CIs).

The *d*' scores for veridical and false recognition were analysed separately. A 2 (instruction: standard vs. warning) × 2 (retrieval time: self-paced vs. speeded) ANOVA was performed for *d*' values of veridical recognition. The results only showed a main effect of retrieval time, $F(1,60) = 33.76$, MSE = .51, $p = .00$, $\eta_p^2 = .36$, with the self-paced condition producing higher *d*' values for hit rates than the speeded condition ($M = 2.21$ vs. $M = 1.18$). No other main or interaction effects were found for veridical memory.

To analyse false recognition, a 2 (type of CI: associative vs. thematic) × 2 (instruction: standard vs. warning) × 2 (retrieval time: self-paced vs. speeded) mixed factorial ANOVA was performed for *d*' values of false recognition, with repeated measures over the first factor. In this and the following experiments, post hoc analyses (by Bonferroni tests, $p < .05$) were performed on all significant interactions. The results showed a main effect of CI, $F(1,60) = 13.08$, MSE = .36, $p = .001$, $\eta_p^2 = .18$ with associative items showing, in general, higher levels of false recognition than thematic items ($M = 1.42$ vs. $M = 1.04$). A significant CI × retrieval time interaction was also found, $F(1,60) = 9.65$, MSE = .36, $p = .003$, $\eta_p^2 = .14$, revealing that, for associative items, the proportion of false recognition was higher, although non-significant, under the self-paced condition than under the speeded condition ($M = 1.57$ vs. $M = 1.26$, $p = .16$), whereas for thematic items false recognition-was significantly higher under the speeded condition than under the self-paced condition ($M = 1.21$ vs. $M = .86$, $p = .05$). This interaction effect, represented by Figure 1, also showed that the difference between associative and thematic CIs was significant in the self-paced condition ($M_{\text{associative}} = 1.57$ vs. $M_{\text{thematic}} = .86$, $p = .00$) but non-significant in the speeded condition ($M_{\text{associative}} = 1.26$ vs. $M_{\text{thematic}} = 1.21$, $p = .72$). No other main or interaction effects were found.

Analysis of RT data. The analysis of RT was performed only for the self-paced condition. We did not perform RT analyses on the data from the speeded condition since with such severely restricted RTs relevant differences were not expected. RTs of the self-paced condition that were 15000 ms or longer, meaning that the participants had momentarily gotten distracted, were excluded from the analysis (in accord with Jou et al., 2004). This only happened for two responses from two different participants. RTs for false recognition and correct rejections of CIs are presented in Table 3. In general, participants took less time in making "yes" responses for associative CIs (false alarms: $M = 1103$ ms) than for the "no"

[1] The speeded condition produced a significantly higher rate of false alarms than the self-paced condition ($M = .24$ vs $M = .09$), $F(1,60) = 19.23$, $MSE = .02$, $p = .00$, $\eta_p^2 = .24$, and a tendency for lower levels of false alarms under the warning condition than under the standard condition ($M = .13$ vs $M = .20$), $F(1,60) = 3.81$, MSE = .02, $p = .056$, $\eta_p^2 = .06$.

TABLE 2
Mean proportion of recognition for targets, associative CIs, and thematic CIs as a function of the type of instruction [standard vs. warning and mode of response (speeded vs. self-paced] in Experiments 1, 2 and 3

	Speeded		*Self-paced*		*Speeded*		*Self-paced*	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Exp1	Standard				Warning			
Targets	.70 (1.18)	.14 (.84)	.76 (2.24)	.14 (.45)	.65 (1.17)	.16 (.83)	.73 (2.18)	.13 (.70)
Associative CI	.71 (1.02)	.21 (.74)	.66 (1.43)	.19 (.94)	.66 (1.50)	.22 (.98)	.70 (1.71)	.15 (.79)
Thematic CI	.50 (.99)	.21 (.81)	.44 (1.07)	.22 (.80)	.53 (1.42)	.21 (.54)	.33 (.64)	.19 (.62)
Exp2	Standard				Strategic			
Targets	.60 (1.14)	.21 (.81)	.75 (2.18)	.10 (.48)	.70 (1.29)	.15 (.77)	.82 (2.62)	.13 (.51)
Associative CI	.70 (1.27)	.21 (.88)	.76 (1.95)	.12 (.67)	.72 (1.41)	.17 (1.01)	.81 (2.30)	.14 (.62)
Thematic CI	.49 (1.11)	.24 (.98)	.43 (.96)	.20 (.68)	.61 (1.14)	.21 (1.05)	.49 (1.27)	.20 (.67)
Exp3	Warning				Strategic			
Targets	.66 (1.26)	.17 (.97)	.79 (2.31)	.13 (.75)	.70 (1.46)	.16 (.90)	.86 (2.44)	.12 (.74)
Associative CI	.72 (1.49)	.14 (.74)	.63 (1.63)	.19 (.80)	.79 (1.62)	.22 (.91)	.79 (1.97)	.15 (.81)
Thematic CI	.54 (1.27)	.27 (.85)	.38 (.65)	.22 (.81)	.68 (1.26)	.20 (.99)	.56 (1.62)	.19 (.57)

Note: Values in parentheses refer to *d*' values.

responses for the same items (correct rejections: *M* = 1538 ms) [$t(32) = 2.60$, $p = .01$], supporting the finding previously obtained by Jou et al. (2004), and showing faster responses for false alarms than for correct rejections. A significant difference was not obtained for thematic CIs.

In order to analyse whether the RTs for false recognition and the RTs for correct rejections differed as a function of the type of CI and instruction, analyses were performed separately for "yes" and "no" responses. Two ANOVAs, using a 2 (type of CI: associative vs. thematic) × 2 (instruction: standard vs. warning) statistical design, were performed for the two different types of responses.

The analysis of RTs for false recognition ("yes" responses) did not show any significant effects. The analysis of RTs for correct rejections ("no" responses) showed a main effect of instruction, $F(1,31) = 4.70$, MSE = 1327620, $p = .04$, $\eta_p^2 = .13$, with the warning instruction producing slower RTs than the standard instruction (*M* = 1682 vs. *M* = 1066). This significant effect of the type of instruction suggests that under the warning condition participants were more cautious about rejecting the CIs, and this might have slowed down the responses.

Moreover, a main effect of the type of item also emerged, $F(1,31) = 7.65$, MSE = 204800, $p = .009$, $\eta_p^2 = .20$, revealing faster RTs in correct rejections for the thematic items than for the associative items (*M* = 1220 vs. *M* = 1528). Participants needed less time to make the decision of rejecting

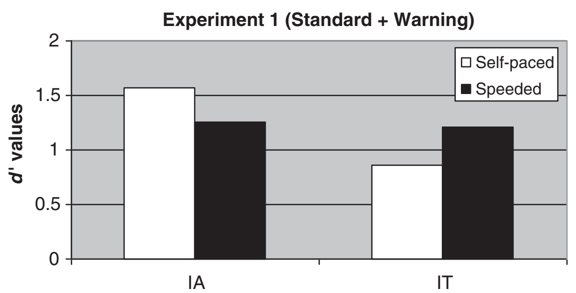

Figure 1. *d*' values of associative CIs and thematic CIs as a function of mode of response (self-paced vs. speeded) in Experiment 1.

TABLE 3
Means and standard deviations of RTs (ms) for false recognition (FA) and correct rejection (CR) of associative and thematic CIs, as a function of the type of instruction in Experiments 1, 2 and 3

			Associative CI		*Thematic CI*	
			M	*SD*	*M*	*SD*
Exp1	FA	Warning	1105	448	1047	471
		Standard	1100	626	1156	946
	CR	Warning	1857	1171	1506	968
		Standard	1199	677	933	498
Exp2	FA	Strategic	1028	497	1174	847
		Standard	997	511	1080	653
	CR	Strategic	2111	1684	1632	1164
		Standard	1528	1042	1233	650
Exp3	FA	Warning	1610	1068	1691	1068
		Strategic	974	408	1257	807
	CR	Warning	2791	1705	2298	1170
		Strategic	1876	1485	1480	771

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thematic items, which suggests that thematic items were more easily rejected than associative items.

In sum, considerable levels of false memories were found for both types of CIs. Although associative items did not have the quality of being good themes for their lists, they showed higher levels of false recognition than thematic items. This result indicates that associative activation plays a prominent role in false memory formation. Moreover, participants were more able to reject thematic items than associative items. This pattern of findings is consistent with the hypothesis that thematic items are more likely to be extracted as the binding words and then, if monitoring is allowed, more successfully rejected at test. The analysis of RTs, showing faster RT in correct rejections for thematic items than for associative items, corroborated the finding that thematic items were more easily rejected.

EXPERIMENT 2

To better understand the mechanisms leading to identifiability effects of the kind reported above, it would be interesting to analyse whether any instruction based on theme identification would lead to the rejection of the theme words. This is an important issue, since it would provide information about whether the first part of the strategy—theme identification—is sufficient for establishing the conditions that would eventually result in the rejection of the non-presented theme word. In other words, would rejection of CIs still be observed if participants were instructed to identify the binding words, without mentioning the possibility of using a rejection strategy at test? With the aim of providing an answer to this question, in the present experiment, participants were explicitly instructed to use the strategy of identifying the binding word of each list as an aid to better retain the studied items. Although the possibility of rejection is not to be mentioned in this strategic condition, it could be the case that, when monitoring is going to be later available, any theme identification effort at study would result in a spontaneous use of a rejection strategy at test. Also, and in line with the findings in Experiment 1, it was expected that any effects of the rejection strategy would be more apparent in the case of thematic CIs than in the case of associative CIs.

Method

Participants. Eighty-four Portuguese university students participated in this experiment ($M_{\text{age}} = 19$ years; 60 female, 24 male). Half the participants received the strategic instruction and the other half received the standard instruction at study. Under each condition, half of the participants undertook a speeded recognition test and the other half completed a self-paced recognition test. All of them received course credits for participating.

Design. The experiment followed a 2 (CI: associative vs. thematic) × 2 (instruction: strategic vs. standard) × 2 (retrieval time: speeded vs. self-paced) factorial design, with repeated measures over the first factor. Although the design was the same as in Experiment 1, instantiation of the second factor (instruction) was changed by using a strategic instruction rather than a warning instruction.

Materials and procedure. The same nine lists from Experiment 1 were used in Experiment 2, and the recognition test was also composed of the same words. The participants were randomly assigned to one of the four different conditions (strategic instruction at study and speeded responses at test, strategic instruction at study and self-paced responses at test, standard instruction at study and speeded responses at test and standard instruction at study and self-paced responses at test). The procedure was also the same as in the previous experiment, with the important exception of the contents in the strategic instruction. Specifically, the strategic instruction given at study time included the information given in the standard condition plus advice on how to better memorise the list items by finding its theme (literally: "As you will notice, all the words in each list are related to each other. The best way to memorize lists of related words is trying to see what they share in common, and trying to find a keyword that defines the theme of the list, serving as a clue to later facilitate remembering the other words in the list. The more you use this strategy to memorize, the more words from each list you will be able to remember. So, as far as possible, try using this strategy. For example, if one of the presented lists consists of *flour*, *eggs*, *sugar*, *birthday*, etc., you could generate the word *cake* as the theme of the list in order to facilitate your later

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retrieval of the related items presented in that list"). Instructions in the standard condition at study and the administration of the self-paced and speeded recognition tests were identical to Experiment 1.

Results and discussion

Analysis of accuracy data. The proportion of recognition responses and *d*' values for targets, associative CIs and thematic CIs, for both types of instructions (standard and strategic) and both types of retrieval times (self-paced and speeded) are displayed in Table 2. As in Experiment 1, the analyses were performed separately for *d*' values of veridical and false recognition. The results in the case of veridical recognition showed two main effects: a main effect of retrieval time, $F(1,80) = 67.53$, MSE = .44, $p = .00$, $\eta_p^2 = .46$, indicating that the self-paced condition produced higher *d*' values for hit rates than the speeded condition ($M = 2.40$ vs. $M = 1.22$), replicating the results obtained in Experiment 1, and a main effect of type of instruction, $F(1,80) = 4.30$, MSE = .44, $p = .04$, $\eta_p^2 = .05$, indicating that the strategic instruction produced higher *d*' values than the standard instruction ($M = 1.96$ vs. $M = 1.66$). This last result indicates that the strategic instruction was indeed followed by the participants, and that it was effective in improving memory for the studied items, in line with the well-known fact that the organising items around a shared feature leads to improved memory (Mandler, 1967). No interaction effects were found for veridical memory.

In the case of false recognition, analyses of *d*' scores showed a main effect of CI, $F(1,80) = 37.88$, MSE = .42, $p < .001$, $\eta_p^2 = .32$, with associative items, in general, showing higher levels than thematic items ($M = 1.73$ vs. $M = 1.12$), a replication of the findings in Experiment 1. Moreover, the results also showed a main effect of retrieval time, $F(1,80) = 6.31$, MSE = .98, $p = .01$, $\eta_p^2 = .07$, with the self-paced condition producing higher rates of false recognition than the speeded condition ($M = 1.62$ vs. $M = 1.24$). Importantly, a significant CI × retrieval time interaction was found, $F(1,80) = 15.83$, MSE = .42, $p <. 001$, $\eta_p^2 = .17$, indicating that false recognition for associative items was higher in the self-paced test than in the speeded test ($M = 2.12$ vs. $M = 1.34$, $p = .001$), whereas this difference for thematic items was non-significant ($M = 1.13$ vs. $M = 1.11$, $p = .95$). This interaction effect, represented by Figure 2, also

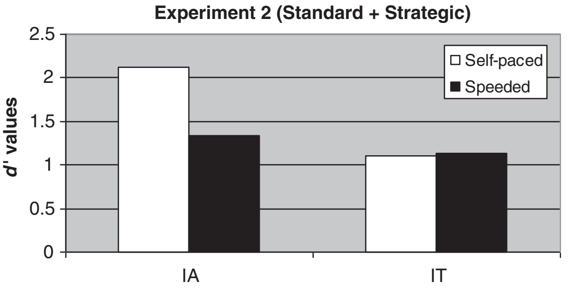

Figure 2. *d*' values of associative CIs and thematic CIs as a function of mode of response (self-paced vs. speeded) in Experiment 2.

showed that the difference between associative and thematic CIs was significant in the self-paced condition ($M_{\text{associative}} = 2.12$ vs. $M_{\text{thematic}} = 1.11$, $p = .001$) but non-significant in the speeded condition ($M_{\text{associative}} = 1.34$ vs. $M_{\text{thematic}} = 1.13$, $p = .13$). No other significant effects were found in the analysis.

Analysis of RT data. Analyses of RTs in the self-paced conditions (see Table 3) showed that for both types of CIs, participants took less time in the "yes" responses (false recognition) than in the "no" responses (correct rejections) (for associative CIs: $M = 1069$ vs. $M = 1797$, $t(38) = 3.74$, $p = .001$; for thematic CIs: $M = 1126$ vs. $M = 1346$, $t(40) = 2.17$, $p = .04$).

The results of a 2 (type of CI: associative vs. thematic) × 2 (instruction: standard vs. strategic) ANOVA conducted for the reaction times of "yes" responses (false recognition) did not show any significant effects. The results of the reaction time for "no" responses (correct rejections) only showed a main effect of the type of item, $F(1,37) = 5.68$, MSE = 511579, $p = .02$, $\eta_p^2 = .13$, revealing faster correct rejections for thematic items than for associative items ($M = 1433$ vs. $M = 1820$).

In sum, strategic instructions increased the overall level of veridical recognition, a result that, on the one hand, seems to indicate that the participants of this condition followed the instruction and, on the other hand, that the strategy is an efficient strategy for better memorising lists of related items. The results of this experiment corroborate the high level of false recognition for associative items. Moreover, *d*' values of false recognition of associative items increased from the speeded condition to the self-paced condition, whereas false recognition for thematic items remained stable across these two conditions. This result seems to indicate that, in general, the participants did not reject associative CIs. If false

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recognition of these items arises from associative activation stemming from automatic processes, the items may have been highly activated, and yet participants were unaware that they had not been presented. Regarding the thematic items, there was no reduction of false recognition from the speeded condition to the self-paced condition, as has occurred in Experiment 1. Contrary to what happened in the warning condition of Experiment 1, the theme identification effort sparked by the strategic instruction did not result in later spontaneous rejection of CIs (neither associative nor thematic) at test. The pattern of RT results is in line with the results of Experiment 1, suggesting that thematic items were in general more readily rejected in the memory test than associative items.

EXPERIMENT 3

The results of the previous experiment suggest that the strategic instruction does not contribute to the monitoring process, even in the case of thematic items. However, the absence of a significant interaction between the three independent variables on Experiment 1 does not provide an unambiguously clear answer to the question of whether participants under the warning instruction were more able to reject the thematic items when monitoring was feasible. In an attempt to better understand the extent to which error-inflation and error-rejection are affected by instructions that share an emphasis on theme identification but diverge on the use of thematic information, a manipulation that directly contrasted warning instructions with strategic instructions was done in this third experiment. With the aim of increasing statistical power, the number of participants was higher than in the previous experiments.

Method

Participants. One hundred and thirty Portuguese university students participated in this experiment (M_{age} = 22 years; 97 female, 33 male). Half of the participants received the warning instruction (N = 33 in the speeded retrieval and N = 32 in the self-paced retrieval) and the other half received the strategic condition (N = 35 in the speeded retrieval and N = 30 in the self-paced retrieval). All of them received course credits for participating.

Design. The experiment followed a 2 (CI: associative vs. thematic) x 2 (instruction: warning vs. strategic) × 2 (retrieval time: speeded vs. self-paced) factorial design, with repeated measures over the first factor.

Materials and procedure. The materials were the same as in the previous experiments. The warning condition followed the same procedure used in Experiment 1, and the strategic condition followed the same procedure used in Experiment 2.

Results and discussion

Analysis of accuracy data. The proportion of recognition and *d*' values for targets, associative CIs and thematic CIs with both types of instructions (warning and strategic) and both types of retrieval times (self-paced and speeded) are displayed in Table 2. The *d*' analyses were performed separately for veridical and false recognition.

The results for veridical recognition showed a main effect of retrieval time, $F(1,126) = 45.95$, MSE = .72, p = .00, $\eta_p^2 = .27$, indicating that the self-paced condition produced higher hit rates than the speeded condition (M = 2.37 vs. M = 1.36), as previously found in Experiments 1 and 2. No other effects were found for veridical memory.

The results of false recognition showed two main effects: one of CI, $F(1,126) = 36.68$, MSE = .40, p = .00, $\eta_p^2 = .23$, with associative items, in general, producing higher levels of false recognition than thematic items (M = 1.68 vs. M = 1.20), thus corroborating the previous results of Experiments 1 and 2, and another of type of instruction, $F(1,126) = 8.81$, MSE = .96, p = .004, $\eta_p^2 = .07$, indicating higher levels of false recognition for the strategic instruction than for the warning instruction (M = 1.62 vs. M = 1.23).

The results also showed three significant interaction effects. First, a significant instruction × retrieval-time interaction emerged, $F(1,126) = 5.96$, MSE = .96, p = .02, $\eta_p^2 = .05$, showing that with strategic instructions *d*' scores significantly increased from the speeded to the self-paced conditions (M = 1.44 vs. M = 1.80, p =. 04), whereas with warning instructions the difference between the retrieval conditions was non-significant and in the opposite direction (M = 1.38 vs. M = 1.14, p = .16). Second, a significant CI × retrieval-time interaction was also found, $F(1,126) = 5.59$, *MSE* = .40, p = .02, $\eta_p^2 = .04$, indicating that the self-paced condition showed a tendency to

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produce higher *d*' levels than the speeded condition for associative items (*M* = 1.80 vs. *M* = 1.56, *p* = .09), while there was a non-significant trend in the opposite direction for thematic items (*M* = 1.14 vs. *M* = 1.27, *p* = .37). These two interactions were qualified by a significant CI × instruction × retrieval-time interaction, $F(1,126) = 6.06$, MSE = .40, $p = .02$, $\eta_p^2 = .05$, showing that only for thematic items in the warning condition false recognition significantly decreased from the speeded condition to the self-paced condition (*M* = 1.63 vs. *M* = .65, *p* = .003) (see Figure 3). For the other comparisons (thematic items with a strategic instruction or associative items with both instructions), the differences between speeded and self-paced conditions were reversed and not significant.

Analysis of RT data. As was the case in Experiment 2, participants took less time in giving the "yes" responses for both types of CIs than in giving the "no" responses for the same items (for associative CIs: *M* = 1308 vs. *M* = 2349, $t(57) = 5.71$, $p = .001$; for thematic CIs: *M* = 1470 vs. *M* = 1900, $t(58) = 2.97$, $p = .004$) (see Table 3).

The ANOVA results for RTs in false recognition ("yes" responses) showed a main effect of the type of instruction, $F(1,57) = 6.46$, MSE = 1307116, $p = .01$, $\eta_p^2 = .10$, indicating slower "yes" responses under the warning condition than under the strategic condition (*M* = 1651 vs. *M* = 1116). This result seems to indicate that participants were more careful in accepting CIs as presented when they were warned about the DRM effect than when they were instructed to use the theme word to better memorise the items in the list. A marginal effect was also found for the type of item, $F(1,57) = 3.20$, MSE = 304152, $p = .08$, $\eta_p^2 = .05$, suggesting faster "yes" responses for associative CIs than for thematic CIs (*M* = 1292 vs. *M* = 1474). The results of RT for correct

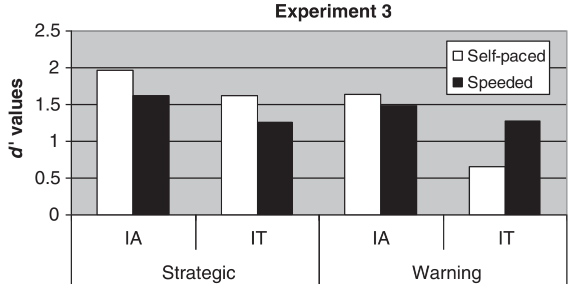

Figure 3. *d*' values of associative CIs and thematic CIs as a function of the type of instruction (strategic vs. warning) and mode of response (self-paced vs. speeded) in Experiment 3.

rejections ("no" responses) were in line with the results of Experiment 1. They showed two main effects: a main effect of instruction, $F(1,56) = 8.11$, MSE = 2683161, $p = .006$, $\eta_p^2 = .13$, indicating slower RTs for correct rejections in the warning instruction than in the strategic instruction (*M* = 2545 vs. *M* = 1678) and a main effect of CI, $F(1,56) = 6.50$, MSE = 880531, $p = .01$, $\eta_p^2 = .10$, indicating that the thematic items were rejected faster than the associative items (*M* = 1889 vs. *M* = 2334).

In sum, the results of this experiment clarify and reinforce the results of the two previous experiments by showing: first, higher levels of false memories for associative items than for thematic items; second, that the thematic items were in general more likely and faster to be rejected than the associative items when monitoring was encouraged; third, that participants were using the identify-to-reject strategy with faster correct rejections only in the warning condition and fourth, that associative items were never rejected, even when participants were advised of the DRM effect.

The results of this experiment also showed that, in general, the warning instruction produced a lower level of false memories than the strategic instruction. This finding seems to suggest that under the warning condition participants are, in general, more cautious about accepting any item as presented, whereas in the strategic condition participants are less likely to adopt this conservative criterion, probably because they were not explicitly advised to avoid errors.

GENERAL DISCUSSION

In this study, considerable levels of false recognition were obtained for associative and thematic CIs, suggesting that associative activation and thematic extraction both help to explain false memories production. The associative CIs, without the quality of being "good themes" for their lists, showed, nonetheless, high levels of false recognition. This result, demonstrated first here with the double-CI list methodology, corroborates previously reported findings (e.g., Huff & Hutchison, 2011) that associative activation, even in the absence of a thematic identifier for a list, can lead to the generation of strong and reliable false memories. Interestingly, the results also showed that thematic extraction has an important role to play. Thematic CIs, in spite of receiving very little automatic spreading activation from the studied

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items, showed considerable levels of false recognition. In so far as theme identifiability could represent a valid measure of gist, the finding of false recognition for both types of CIs could be interpreted as consistent with a consensual view between the activation-monitoring framework and the fuzzy trace theory.

But, more importantly, the innovative methodology of this study shed light on the differential contribution of both types of processes at the time of the recognition test, demonstrating that only thematic extraction plays a role on memory-editing. Associative activation has almost no function on false memory rejection. This pattern of results reinforces the argument, supported by the results of previous studies (Carneiro et al., 2009, 2012; Carneiro & Fernandez, 2013; Neuschatz et al., 2003), that thematic identifiability plays a major role in the rejection of false memories. It is worth noting the similarity between the thematic CIs in this study and the high-identifiability CIs in recent previous studies (Carneiro et al., 2012; Carneiro & Fernandez, 2013), with their false recognition being modulated, in both cases, by the opportunity to use monitoring strategies. And also the similarity between the associative CIs in this study and the low-identifiability CIs in the above-mentioned studies, in both cases, showing independence from monitoring mechanisms. Although a definitive interpretation of these parallelisms in the behaviour of the different types of CIs might require additional empirical evidence, the available findings, when taken together, are consistent with the idea that error-editing processes of the kind assumed to intervene here rely on the operation of an identify-to-reject monitoring strategy (Gallo, 2006).

In this study, rejection of thematic CIs was more pronounced when participants were warned about the DRM effect and instructed to use the identify-to-reject strategy. Importantly, the mere instruction to look for theme words to better memorise the studied items (strategic instruction) did not lead participants to use the identify-to-reject strategy. Although a necessary step in the warning conditions, theme identification does not seem to be sufficient to elicit the application of this editing strategy. The explicit advice to reject the identified theme-words is what seems to be crucial for the efficient application of this strategy. This conclusion is, at first sight, in conflict with the previous finding that lists with high-identifiable items showed reduced levels of false memory (Carneiro et al., 2009), in the absence of any warning. The contradiction could be dismissed, though, if, noting that the identifiability of theme CIs was more than three times higher in Carneiro et al. than in the present study, it is assumed that spontaneous adoption of the identify-to-reject strategy is more likely to succeed when themes are very easy to identify. A second possibility is that, the emphasis on the benefits of integration of words and theme, absent in the more standard encoding conditions of Carneiro et al. might turn the theme word into a virtual list item, making the tagging of the theme as a to-be-rejected word a difficult operation. These are, obviously, speculative accounts and would have to be submitted to the verdict of new data.

The RT data corroborated the accuracy data showing, across the three experiments, faster correct rejections for thematic CIs than for associative CIs. This is consistent with the idea that the thematic items were mentally tagged as non-presented theme words, and participants took less time to reject them in the memory test. This result is especially interesting if we take into consideration the fact that, in general, there were no differences in the reaction times of “yes” responses (false alarms) between the two types of items (only a marginal effect was found in Experiment 3, but this had the opposite direction to correct rejections). Together with the accuracy recognition data, this finding constitutes a powerful evidence that participants found easier to reject thematic than associative CIs.

The identify-to-reject strategy had almost no utility for associative CIs. However, it is worth noting that the associative CIs of this study are qualitatively different from the usual CIs normally used in other studies because they lack the quality of being “good themes” (despite being strongly primed by the word’s associates). The behaviour of associative CIs of the present study, a product of mere associative activation, is very much in accordance with Underwood’s (1965) notion of implicit associative responses and his hypothesis that spontaneous associations at study cause false memory for strongly associated words. Additionally, their lack of thematic property could explain why they were not easily rejected at test. As associative CIs were not the best themes of the lists, they were less likely to be mentally tagged when a strategy based on theme identifiability was given to participants. This finding seems to provide a powerful argument in favour of the view that instructions such as warnings facilitate the rejection of false memories through a previous

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identification of the CI, i.e., through the use of disqualifying monitoring (Gallo, 2006).

As noted in the introduction, an account based on the application of fuzzy trace theory was offered as an explanation of findings that are reminiscent, and clearly a precursor, of the ones reported here. In such a view, the fact that thematic CIs tend to be falsely recognised to a lesser extent than associative CIs can be explained as the result of the former showing higher levels of phantom recollection and semantic similarity than the latter (Brainerd et al., 2001). It is tempting to assume that this account of thematic effects, based on the analysis of a considerable database of empirical findings, could be directly applied to the present set of findings. However, there are reasons to prudently withhold this decision. For example, the dissociation between the two types of critical words in the present study (associative CIs and thematic CIs) and the dissociation between the two types of related distractors (critical distractors and list associates) is not equivalent, due to differences in the way these critical items were defined and operationalised. For the goal of the present study, only the method used in the normative study of theme identifiability by Carneiro et al. (2009) is appropriate. Specifically, for the selection of lists used in the present study, it was crucial to know whether the associative CIs are or not good themes of the lists and whether they represent the themes of the lists in a better or worse manner than the thematic CIs. Additionally, there are old and new findings that might require consideration as reliable modulators of false recognition, such as lure awareness, strategic processes, warnings or the use of deliberate monitoring strategies at encoding and retrieval (as evidenced by metamemory questionnaire data in Carneiro and Fernandez, 2013).

Although providing a way of teasing apart associative activation and thematic extraction, our approach is not without shortcomings. The conclusion that associative activation plays a higher role than thematic extraction on the production of false memories should be carefully considered. Although this is a consistent result across the three experiments, we do think that the present methodology is not perfect in determining with certainty the relative influence of thematic extraction versus spreading activation, because associative and thematic items are not totally independent indicators and are not equivalent in the levels of associative activation and thematic identifiability, respectively. For example, thematic items of this study have been identified only by a quarter of participants in normative studies, which makes us wonder whether the same results would be obtained if the mean level of thematic identifiability of these items was higher. The ideal list would be one in which the thematic CI would be higher in theme identifiability but lower in BAS and the associative CI would be higher in BAS but lower in theme identifiability. Even being careful about this conclusion, this research importantly advances the theoretical understanding of false memories since: (1) it shows that even when critical items do not have the quality of being "good themes" of the lists, they show high levels of false memory; (2) it shows the separate contribution of each factor to error-inflation and error-editing; (3) and it shows, in the same study, that theme identifiability contributes both to error-inflation and error-editing, thus providing a strong evidence of the dual function of theme identifiability.

In closing, it should be noted that the standard CIs of the DRM lists used in the majority of studies contain these two components that produce false memories: they receive high automatic activation spreading from studied items and they are also considered to be the best themes for the lists. This study provides evidence that these two components are dissociable and that they play specific roles in false memory phenomena. Whereas associative activation provides a great contribution to the error-inflation process, thematic extraction has a dual function: although it can inflate false memories, thematic extraction seems to be especially useful in the error-editing process. Until now, these two components have been highly confounded in DRM lists, leading to the situation where any attempt to isolate the influences of each, becomes an almost impossible task. By teasing apart the contribution of these two components and operationalising them in two different CIs, this study provides a possible answer in this direction for the very first time.

REFERENCES

Arndt, J. (2012). False recollection: Empirical findings and their theoretical implications. *Psychology of Learning and Motivation*, *56*, 81–124. doi:10.1016/B978-0-12-394393-4.00003-0

Arndt, J., & Gould, C. (2006). An examination of two-process theories of false recognition. *Memory*, *14*, 814–833. doi:10.1080/09658210600680749

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Brainerd, C. J., & Reyna, V. F. (1998a). Fuzzy-trace theory and children's false memories. *Journal of Experimental Child Psychology*, *71*, 81–129. doi:10.1006/jecp.1998.2464

Brainerd, C. J., & Reyna, V. F. (1998b). When things that were never experienced are easier to "remember" than things that were. *Psychological Science*, *9*, 484–489. doi:10.1111/1467-9280.00089

Brainerd, C. J., & Reyna, V. F. (2005). *The science of false memory*. New York, NY: Oxford University Press.

Brainerd, C. J., Reyna, V. F., Forrest, T. J., & Karibian, D. (2006). Development of false-memory illusion. *Developmental Psychology*, *42*, 962–979. doi:10.1037/0012-1649.42.5.962

Brainerd, C. J., Wright, R., Reyna, V. F., & Mojardin, A. H. (2001). Conjoint recognition and phantom recollection. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 307–327. doi:10.1037/0278-7393.27.2.307

Brainerd, C. J., Yang, Y., Reyna, V. F., Howe, M. L., & Mills, B. A. (2008). Semantic processing in "associative" false memory. *Psychonomic Bulletin & Review*, *15*, 1035–1053. doi:10.3758/PBR.15.6.1035

Bredart, S. (2000). When false memories do not occur: Not thinking of the lure or remembering that it was not heard? *Memory*, *8*, 123–128. doi:10.1080/096582100387669

Cann, D. R., McRae, K., & Katz, A. N. (2011). False recall in the Deese–Roediger–McDermott paradigm: The roles of gist and associative strength. *The Quarterly Journal of Experimental Psychology*, *64*, 1515–1542. doi:10.1080/17470218.2011.560272

Carneiro, P., & Fernandez, A. (2013). Retrieval dynamics in false recall: Revelations from identifiability manipulations. *Psychonomic Bulletin & Review*, *20*, 488–495. doi:10.3758/s13423-012-0361-4

Carneiro, P., Fernandez, A., & Dias, A. R. (2009). The influence of theme identifiability on false memories: Evidence for age-dependent opposite effects. *Memory & Cognition*, *37*, 115–129. doi:10.3758/MC.37.2.115

Carneiro, P., Fernandez, A., Diez, E., Garcia-Marques, L., Ramos, T., & Ferreira, M. B. (2012). "Identify-to-reject": A specific strategy to avoid false memories in the DRM paradigm. *Memory & Cognition*, *40*, 252–265. doi:10.3758/s13421-011-0152-6

Carneiro, P., Ramos, T., Costa, R. C., Garcia-Marques, L., & Albuquerque, P. (2011). Identificabilidade dos temas de listas associativas *backward*: Contributos para o estudo das memórias falsas [Theme identifiability of backward associative lists: Contribution to false memory research]. *Laboratório de Psicologia*, *9*, 23–34.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, *82*, 407–428. doi:10.1037/0033-295X.82.6.407

Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, *58*(1), 17–22. doi:10.1037/h0046671

Gallo, D. A. (2006). *Associative illusions of memory: False memory research in DRM and related tasks*. New York, NY: Psychology Press.

Gallo, D. A. (2010). False memories and fantastic beliefs: 15 years of the DRM illusion. *Memory & Cognition*, *38*, 833–848. doi:10.3758/MC.38.7.833

Gallo, D. A., Roberts, M. J., & Seamon, J. G. (1997). Remembering words not presented in lists: Can we avoid creating false memories? *Psychonomic Bulletin & Review*, 4, 271–276. doi:10.3758/BF03209405

Heit, E., Brockdorff, N., & Lamberts, K. (2004). Strategic processes in false recognition memory. *Psychonomic Bulletin & Review*, *11*, 380–386. doi:10.3758/BF03196586

Howe, M. L., Wimmer, M. C., & Blease, K. (2009). The role of associative strength in children's false memory illusions. *Memory*, *17*, 8–16. doi:10.1080/09658210802438474

Huff, M. J., Coane, J., Hutchison, K. A., Grasser, E. B., & Blais, J. E. (2012). Interpolated task effects on direct and mediated false recognition: Effects of initial recall, recognition, and the ironic effect of guessing. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *38*, 1720–1730. doi:10.1037/a0028476

Huff, M. J., & Hutchison, K. A. (2011). The effects of mediated word lists on false recall and recognition. *Memory & Cognition*, *39*, 941–953. doi:10.3758/s13421-011-0077-0

Hutchison, K. A., & Balota, D. A. (2005). Decoupling semantic and associative information in false memory: Explorations with semantically ambiguous and unambiguous critical lures. *Journal of Memory and Language*, *52*, 1–28. doi:10.1016/j.jml.2004.08.003

Johnson, M. K., Hashtroudi, S., & Lindsay, D. S. (1993). Source monitoring. *Psychological Bulletin*, *114*, 3–28. doi:10.1037/0033-2909.114.1.3

Jou, J., & Foreman, J. (2007). Transfer of learning in avoiding false memory: The roles of warning, immediate feedback, and incentive. *The Quarterly Journal of Experimental Psychology*, *60*, 877–896. doi:10.1080/17470210600831184

Jou, J., Matus, Y. E., Aldridge, J. W., Rogers, D. M., & Zimmerman, R. L. (2004). How similar is false recognition to veridical recognition objectively and subjectively? *Memory & Cognition*, *32*, 824–840. doi:10.3758/BF03195872

Mandler, G. (1967). Organization and memory. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 1, pp. 328–372). New York, NY: Academic Press.

McDermott, K. B., & Roediger, H. L. (1998). Attempting to avoid illusory memories: Robust false recognition of associates persists under conditions of explicit warnings and immediate testing. *Journal of Memory and Language*, *39*, 508–520. doi:10.1006/jmla.1998.2582

Mukai, A. (2005). Awareness of the false memory manipulation and false recall for people's names as critical lures in the Deese-Roediger-McDermott paradigm. *Perceptual and Motor Skills*, *101*, 546–560.

Multhaup, K. S., & Conner, C. A. (2002). The effects of considering nonlist sources on the Deese-Roediger-McDermott memory illusion. *Journal of Memory and Language*, *47*, 214–228. doi:10.1016/S0749-596X(02)00007-4

Neuschatz, J. S., Benoit, G. E., & Payne, D. G. (2003). Effective warnings in the Deese-Roediger-McDermott false-memory paradigm: The *role* of identifiability. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*, 35–41. doi:10.1037/0278-7393.29.1.35

Roediger, H. L., Balota, D. H., & Watson, J. M. (2001). Spreading activation and the arousal of false memories. In H. L. Roediger, J. S. Nairne, I. Neath, & A. M. Surprenant (Eds.), *The nature of remembering: Essays in honor of Robert G. Crowder* (pp. 95–115). Washington, DC: American Psychological Association.

Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *21*, 803–814. doi:10.1037/0278-7393.21.4.803

Roediger, H. L., Watson, J. M., McDermott, K. B., & Gallo, D. A. (2001). Factors that determine false recall: A multiple regression analysis. *Psychonomic Bulletin & Review*, *8*, 385–407. doi:10.3758/BF03196177

Rotello, C. M., & Heit, E. (2000). Associative recognition: A case of recall-to-reject processing. *Memory & Cognition*, *28*, 907–922. doi:10.3758/BF03209339

Sommers, M. S., & Lewis, B. P. (1999). Who really lives next door: Creating false memories with phonological neighbors. *Journal of Memory and Language*, *40*, 83–108. doi:10.1006/jmla.1998.2614

Starns, J. J., Lane, S. M., Alonzo, J. D., & Roussel, C. C. (2007). Metamnemonic control over the discriminability of memory evidence: A signal detection analysis of warning effects in the associative list paradigm. *Journal of Memory and Language*, *56*, 592–607. doi:10.1016/j.jml.2006.08.013

Toglia, M. P., Neuschatz, J. S., & Goodwin, K. A. (1999). Recall accuracy and illusory memories: When more is less. *Memory*, *7*, 233–256. doi:10.1080/741944069

Underwood, B. J. (1965). False recognition produced by implicit verbal responses. *Journal of Experimental Psychology*, *70*, 122–129. doi:10.1037/h0022014

Watson, J. M., McDermott, K. B., & Balota, D. A. (2004). Attempting to avoid false memories in the Deese/ Roediger-McDermott paradigm: Assessing the combined influence of practice and warnings in young and old adults. *Memory & Cognition*, *32*, 135–141. doi:10.3758/BF03195826

Westerberg, C. E., & Marsolek, C. J. (2006). Do instructional warnings reduce false recognition? *Applied Cognitive Psychology*, *20*, 97–114. doi:10.1002/acp.1170

Zeelenberg, R., Boot, I., & Pecher, D. (2005). Activating the critical lure during study is unnecessary for false recognition. *Consciousness & Cognition*, *14*, 316–326. doi:10.1016/j.concog.2004.08.004

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APPENDIX A.

Portuguese lists used in the three experiments, each with an associative critical item (AI) and a thematic critical item (TI) (English-translation provided as illustration).

	Portuguese list	*English translation*		*Portuguese list*	*English translation*		*Portuguese list*	*English translation*
AI	**deus**	**god**	AI	**quente**	**hot**	AI	**raiva**	**anger**
TI	**crença**	**belief**	TI	**inverno**	***winter***	TI	**emoções**	**emotions**
	fé	faith		aquecedor	heater		ira	ire
	religião	religion		cobertores	blankets		fúria	fury
	dádiva	gift		lareira	fireplace		cólera	wrath
	cristo	christ		temperatura	temperature		ódio	hate
	rezar	pray		cachecol	scarf		nervos	nerves
	jesus	jesus		verão	*summer*		agressividade	aggressiveness
	ateu	atheist		camisola	sweater		zangado	annoyed
	igreja	church		casaco	coat		irritante	irritant
	pagão	pagan		fogo	fire		maldade	evilness
	crente	credulous		frio	cold		desespero	despair
AI	**escrever**	**write**	AI	**branco**	**white**	AI	**sujo**	**dirty**
TI	**escola**	**school**	TI	**dentista**	**dentist**	TI	**lixo**	**garbage**
	caneta	pen		dente	tooth		porco	pig
	ler	read		paz	peace		borrão	smudge
	papel	paper		tinta	ink		poluído	polluted
	lápis	pencil		papel	paper		poluição	pollution
	esferográfica	ballpoint		algodão	cotton		porcaria	filth
	carta	missive		puro	pure		lixeira	dumpster
	caderno	notebook		preta	black		nojo	disgust
	letras	letters		médico	doctor		resíduos	waste
	folha	sheet		cor	colour		higiénico	hygienic
	mão	hand		osso	bone		sujidade	filthiness
AI	**alto**	**tall**	AI	**cadeira**	**chair**	AI	**lento**	**slow**
TI	**altura**	**height**	TI	**sala**	**room**	TI	**velocidade**	**speed**
	baixo	short		sentar	sit		vagaroso	lingered
	prédio	building		mesa	table		caracol	snail
	escadote	ladder		assento	seat		demorado	delayed
	pico	peak		sofá	couch		devagar	dilatory
	magro	skinny		banco	stool		rápido	quick
	gigante	giant		móvel	furniture		lesma	slug
	monte	mountain		madeira	wood		molengão	laggard
	som	sound		objecto	object		preguiçoso	lazy
	inatingível	unachievable		aulas	classes		preguiça	laziness
	grande	big		cadeia	chain		calmo	calm

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