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The role of exemplar typicality and encoding strategies in category retrieval-induced forgetting

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Selective retrieval practice of category exemplars often impairs the recall of related items, a phenomenon known as retrieval-induced forgetting (RIF). In Experiment 1 the role of item typicality (high, low) and presentation format of category exemplars (random, grouped) were analysed, while in Experiment 2 two encoding strategies (inter and intracategory) to modulate RIF were tested. Exemplar typicality was the critical factor underlying RIF. Competition during retrieval practice rendered RIF in the typical exemplars, but RIF did not appear when the exemplars were low typicality. The greater impairment of strong exemplars is in line with the inhibitory account of RIF and the notion of interference dependence. Inhibition appeared with random and grouped presentations suggesting that presentation format of the exemplars is not a critical factor in modulating RIF in a category-cued recall task. Distinctive processing instructions using sentences that connected items from different categories (intercategory strategy) and integration instructions by using size to organise the exemplars within categories (intracategory strategy) easily avoided competition and the need of inhibition processes in recall.

Keywords: Retrieval-induced forgetting (RIF); Category typicality; Encoding strategies; Recall.

Trying to retrieve information can impair later retention of associated information that competes for access during memory retrieval. This retrieval-induced forgetting (RIF) was evidenced using the retrieval-practice paradigm, originally presented by Anderson, Bjork, and Bjork (1994). Participants study lists of category–exemplar pairs (e.g., Fruit–Orange), practice retrieving half of the exemplars from half of the categories (e.g., Fruit–O____) and, following a distractor task, recall the studied exemplars from the studied categories. Facilitation (Rp > Nrp) is typically observed for the practised exemplars (Rp + ) and inhibition (Rp − < Nrp) is observed for the unpractised exemplars (Rp − ) relative to baseline recall of exemplars from the unpractised categories (Nrp). RIF is often assumed to reflect the effects of inhibitory processes engaged during retrieval practice to assist in the selective retrieval of target items (for non-inhibitory accounts of RIF, see Anderson & Bjork, 1994; MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003; Perfect et al., 2004).

Semantic categories represent instances of knowledge, associate sets of items that share relevant characteristics, and are arranged as a function of associative strength. These knowledge structures allow typical exemplars and other strongly associated elements to be generated fluidly. The automatic generation of related items from semantic memory during retrieval practice can cause episodic forgetting of the initially learned items. Sharing a certain degree of semantic relatedness can be sufficient for the retrieval of an item to induce forgetting of another item.
(Bäuml, 2002). More importantly, previous research supports the view that RIF is modulated by the amount of interference caused by competing items (see Anderson, 2003). Using semantic categories, it has been demonstrated that high-frequency exemplars suffer more inhibition than practising low-frequency exemplars (AhnAllen, Nestor, McCarley, & Shenton, 2007; Anderson et al., 1994; Bäuml, 1998). The exemplars most strongly associated with the category cue quickly access the mind during retrieval practice, compete more for recall and, to overcome this competition, they have to be suppressed (reviewed in Anderson, 2003). Nonetheless, a study by Williams and Zacks (2001) did not replicate this interference dependence effect, one of the critical proprieties of the inhibition account. They found inhibition with strong and weak items, and questioned the inhibitory processes of RIF. However, in their study the participants were instructed to relate the exemplars to the category name during the 8-second study time allowed for each exemplar. This may account for the increased associative strength of weak exemplars to categories, although the effect was not as strong as it was with the high-typicality exemplars. In a more recent study Jakab and Raaijmakers (2009) varied item strength by manipulating the position of the items within a category (Experiments 1 and 2) or considering the number of presentations during the study phase (Experiment 3) and, contrary to the competition account, stronger items did not show more RIF than weaker exemplars. Nevertheless, in this study all category exemplars were manipulated to have medium taxonomic frequencies. Even so, the empirical evidence may seem mixed, few studies have focused on analysing the relevance of exemplar typicality on RIF and further research is needed to ascertain whether strong category exemplars systematically suffer more RIF than weak or low-taxonomic frequency exemplars.

To this end, normative data from a previous study were used to determine the typicality of exemplars. Participants were given 30 seconds to write down as many exemplars of different categories as possible. High-typicality exemplars were defined as items mentioned by over 25% of the participants (M=54.74%) and, to discriminate from fuzzier medium-typicality exemplars, low-typicality exemplars were those listed by fewer than 10% of the participants (M=5.01%). In addition to analysing the role of typicality, we were also interested in determining whether the presentation format of the category exemplars (random, grouped) and explicit encoding instructions to interrelate items modulate RIF’s effects.

Following the seminal work of Anderson et al. (1994), most of the research on RIF using semantic categories has been characterised by monitoring inter-item associations between category exemplars to systematically eliminate any possible connections between elements when selecting the exemplars. In fact the presence of strong pre-existing semantic associations linking retrieval-practice targets (e.g., horse Rp+) and their competitors (e.g., pony Rp−) clearly reduce RIF (Goodmon & Anderson, 2011). In addition to material selection, in the standard retrieval-practice paradigm participants are given lists of category–exemplar pairs in a sequence with a block format. In each block one item of each category is presented and the placement within a category is randomly determined. Although it is important to note that most of the information we find in our everyday life is organised, there is little information currently available on the impact of the presentation format in the retrieval-practice paradigm. No studies have examined whether the random presentation of exemplars to avoid integration processes is a requisite for RIF.

A critical factor of the emergence of RIF is the nature of the encoding operations that are undertaken on the study material. It is assumed that RIF is attenuated or removed when participants, either spontaneously or under explicit instruction to do so, form interconnections between items sharing a retrieval cue (Anderson & Bell, 2001; Anderson & McCulloch, 1999; Smith & Hunt, 2000). Thus, when participants are instructed to integrate the material, to think about the relative distinctiveness of the different items, or when they process self-relevant material, RIF is attenuated or even eliminated (e.g., Anderson & McCulloch, 1999; García-Bajos & Migueles, 2009; Macrae & Roseveare, 2002; Smith & Hunt, 2000). This reduction in the level of RIF appears if the encoding operations weaken or overcome the associate strength between the exemplars. On the contrary, strengthening manipulations of medium- or low-frequency words by varying the number of presentations of the items did not show more RIF (Jakab & Raaijmakers, 2009), because categorical associative strength, not list strength, is responsible for semantic competition and inhibition. It therefore follows that distinctive encoding and integration processes of the exemplars should prevent interference.
processes of semantic categorical knowledge during episodic retrieval.

The two experiments reported here studied the role of item strength and the influence of encoding strategies in RIF. In Experiment 1 we examined the effects of typicality (high, low) and presentation format (random, grouped) of semantic category exemplars on RIF. In Experiment 2 we analysed the effectiveness of two mnemonic techniques (inter and intracategory) to modulate RIF's effects.

**EXPERIMENT 1: TYPICALITY AND RIF FOR SEMANTIC CATEGORIES**

In Experiment 1 we manipulated item strength and presentation format of the category exemplars. If retrieval practice with semantic category exemplars generates the activation of typical exemplars that compete for retrieval, we expect to find RIF only for the high-typicality exemplars. The lower associative strength for low-typicality exemplars should reduce both competition and inhibition. In our study presentation format was either standard random, with one item from each category in each set, or grouped by categories. In contrast to standard random presentation, grouped presentation by category might facilitate the study task, promote inter-items associations between exemplars and, theoretically, foster the necessary \(R_p^+\) to \(R_p^-\) associations that modulate and reduce inhibition. However, it is also plausible that this manipulation will not prevent RIF in the high-typicality exemplars, since sequential presentation of all elements of the same category can foster activation spreads from the category node along network members, increasing competition between elements and triggering inhibitory processes.

**Method**

**Participants.** A total of 80 psychology students from the University of the Basque Country, 68 women and 12 men (age, \(M = 20.99\) years, \(SD = 3.63\)), took part in this experiment. The participants were divided into two groups of 40 students each.

**Materials.** Normative data were obtained to establish the production frequency of the category exemplars used in this experiment (see Appendix). A group of 123 psychology students from the University of the Basque Country (102 women and 21 men), none of whom participated in the experiment, were given 30 seconds (see procedure in Battig & Montague, 1969) to write down as many exemplars as possible for the categories beverages, birds, fruit, furniture, hobbies, professions, tools, trees, types of plants, and types of houses. Production frequency was analysed and beverages, fruit, furniture, and tools were selected as the categories to be used in the experiment. These four categories were chosen because they share no elements, are distinctive from one another, have been used in earlier studies, and were suitable for the purposes of this study. From each of the categories, six high-typicality items with a production frequency higher than 25% and six low-typicality items with a production frequency of less than 10% were selected. To prevent the effects of semantic integration, exemplars directly related to other members in the category (e.g., orange–apple, table–chair) were discarded. To control primacy and recency effects during learning and retrieval practice two filler categories, types of plants and types of houses, with six exemplars each were used.

**Design.** A \(2 \times 2\) (exemplar typicality: high, low) \(\times 2\) (presentation format: random, grouped) mixed factorial design was used, with exemplar typicality as a within-participants factor and presentation format as a between-participants factor. Recall performance was evaluated for \(R_p^+\) high and \(R_p^-\) low-typicality practised items, \(R_p^+\) high and \(R_p^-\) low-typicality unpractised items from practised categories, and for \(N_{rp}\) high and \(N_{rp}\) low-typicality items from unpractised categories, which served as baseline.

**Procedure.** To perform the experiment eight subgroups were created consisting of 10 participants each. Four subgroups were randomly assigned to each of the two presentation formats, random and grouped, to implement four practice counterbalancing conditions in each presentation group.

In the learning phase the participants were randomly shown six sets of six items each using a PowerPoint presentation. Half of the items were high-typicality category exemplars and half were low-category exemplars. The items were presented sequentially for 4 seconds each. The name of the category appeared in the middle of the screen coupled with an exemplar (e.g., Beverage – Beer).
The presentation format for the items in the sets was manipulated. Presentation was either standard random, with one item from each category in each set, or grouped according to categories, with all six items from each category in each set. In the random presentation the first and last items in each set were fillers. In the grouped presentation the first and last sets served as fillers. The exemplars were presented in the same order for the random and grouped presentations. The participants were asked to study the category-exemplar pairs because they would later be evaluated.

After the presentation all of the participants conducted two practice trials retrieving half of the high-typicality and low-typicality exemplars from half of the categories, e.g., three high-typicality beverage items and three low-typicality pieces of furniture, or three high-typicality types of fruit and three low-typicality tools. Two sets of exemplars for each category were created by dividing the categories into two sets of three exemplars each. All items served as Rp+, Rp-, and Nrp items equally often, and subgroups of 10 participants received each counterbalanced sets of the exemplars. In addition, the two filler categories were used to control for primacy and recency effects. The participants received a booklet that randomly displayed category-initial pairs from a presented exemplar (e.g., Beverage – Be_____) on each page. They were told to complete the items, the first time prompted by a two-letter cue, and the second time prompted by only one letter to increase the difficulty and effort of retrieval. After the retrieval practice task, all of the participants were given 5 minutes to write down countries that began with the different letters of the alphabet.

The final test phase was a category-plus-stem-cued recall test, which avoids output interference effects (Anderson, 2003). This test allowed us to control for the order in which Rp+ and Rp− items were output at the time of the test. In other words it prevents highly accessible Rp+ items from diminishing recall performance of less-accessible Rp− items. Trials were presented in the same way as in the second retrieval cycle. Participants were provided with the first letter of each studied word together with its category cue (e.g., Beverage – B_____) and had 5 seconds to write down each appropriate word in a test booklet. Each item on the final test, as in the retrieval practice, was tested on a single page. Using the first letter of an exemplar to direct the participant’s search enabled us to test Rp− items first, followed by Nrp and Rp+ practised items. Thus, recall for unpractised items from practised categories was first evaluated, intermixing high- and low-typicality exemplars (Rp− high and Rp− low), followed by high- and low-typicality items from unpractised categories (Nrp high and Nrp low), which served as control items, and finally practised items (Rp+ high and Rp+ low). The order of the categories was counterbalanced across participants. The use of control items for high- and low-typicality exemplars was necessary to circumvent baseline deflation.

Results and discussion

The retrieval practice success rate was 82.17% (SD = 17.72). The only significant difference was obtained in the typicality of the category exemplars, $F(1, 78) = 36.43$, $p < .001$, $\eta^2_\varepsilon = .32$. Even though the participants were provided with relatively obvious cues in the first retrieval practice task, high-typicality items (89.99%) yielded higher recall than low-typicality items (74.35%). The fluid semantic generation and associative strength may have contributed to the greater retrieval performance for high-typicality than for low-typicality items. The random vs grouped presentation did not affect the retrieval practice success rate.

Final recall was scored by assigning one point to every correctly remembered exemplar for each category. Neither the order of exemplar presentation, nor the order of category recall, affected recall performance. There were no significant differences in final recall in any measure of retrieval practice (Rp+, Rp−, Nrp) in the comparisons of the four sets used for practice.

To analyse the results obtained in the final recall of category exemplars (Table 1) two mixed analyses of variance were performed, one to study facilitation: ANOVA 2 (Rp+ > Nrp) × 2 (exemplar typicality: high, low) × 2 (presentation format: random, grouped); and another to examine inhibition: ANOVA 2 (Rp− < Nrp) × 2 (exemplar typicality: high, low) × 2 (presentation format: random, grouped). In both analyses typicality was used as a within-participants factor and presentation format as a between-participants factor.

Facilitation was significant, $F(1, 78) = 52.06$, $p < .001$, $\eta^2_\varepsilon = .40$. In other words participants’ recall was better for practised exemplars (Rp+...
strategies and RIF for semantic categories

Results from Experiment 1 illustrated that inhibition is determined by the typicality of category exemplars. The key idea is that retrieval practice of high-typicality exemplars essentially produces semantic generation of exemplars that compete for access to recall and inhibitory processes allow us to overcome interference from related exemplars. However, RIF did not vary reliably according to whether items were presented in random fashion or blocked by category. Grouping the presentation of the exemplars in each category served to facilitate recall but did not prevent RIF of high-typicality exemplars. Although it is assumed that RIF is attenuated or even eliminated when participants form, spontaneously or under explicit instructions, interconnections between Rp+ and Rp− items during encoding, it seems that the grouped presentation and study instructions were not sufficient to promote effective integration processes. Therefore in this experiment two encoding strategies, one intercategory and one intracategory, were designed to avoid the need of inhibitory processes.

The intercategory encoding strategy encouraged participants to form associations between exemplars of different categories within an organised context. The strategy promoted distinctive processing by using sentences that connected items from different categories in a logical manner. If Rp− items are encoded in relation to different concepts they should be encoded distinctively, elicit better recall, have less competition between them, and therefore less need for inhibition. The second mnemonic technique is an intracategory encoding strategy that promotes integration processes encouraging participants to inter-relate Rp+ and Rp− items. Participants were explicitly required to consider every exemplar in relation to every other exemplar in order to arrange items within categories by size. If participants form direct associations between items that will eventually be practised (Rp+) and their competitors (Rp−), they will be protected from the disruptive effects of inhibition during retrieval practice (see Anderson & Green, 2001; Anderson & MacCulloch, 1999; Goodman & Anderson, 2011). These mnemonic techniques may offer an effective means of transcending from simple categorical encoding to a more
distinctive and integrative encoding. To analyse these aspects, in this experiment the six items from each set were presented simultaneously, instead of the sequential presentation used in Experiment 1.

**Method**

**Participants.** A total of 64 new psychology students from the University of the Basque Country took part in this experiment, 48 women and 16 men (age, $M = 21.50$ years, $SD = 3.66$). The participants were divided into four groups of 16 students each.

**Materials.** The experimental material consisted of high-typicality exemplars of the categories used in Experiment 1, i.e., the six high-typicality exemplars from the categories beverages, fruit, furniture, and tools. The six items from the categories types of houses and types of plants were used as filler material to control primacy and recency in the study and retrieval practice phases (see Appendix).

**Design.** We used a multigroup design with four groups. The participants had four exemplar presentation and study conditions: random paired-associate presentation, random presentation + sentence scene (between category) encoding, grouped presentation, and grouped presentation + size (within category) encoding.

**Procedure.** All of the participants received six sets of six items each through a PowerPoint presentation. The items in the sets were presented as associated category–exemplar pairs (e.g., Beverage–Beer). The four groups received simultaneously the six items of each set on a screen for 30 seconds. Two presentation conditions were manipulated: random, in which each item in the set belonged to a different semantic category, or grouped, in which all six items from each category were in the same set. A further two conditions were added to the random and grouped presentations to facilitate the study of the categories. The random presentation included a sentence which represented a scene containing the six items of the set. Thus the sentence tried to help connect items from different categories in a logical manner (intercategory: random + scene distinctive strategy). For example, the sentence *I used the hammer to assemble the bookshelf in the loft, and then I watered the ficus and ate some cherries,* encouraged participants to form associations between exemplars of different categories. For the grouped presentation participants were instructed to arrange the items in each category by size (intracategory: grouped + size integration strategy). The filler categories houses and plants were used to control for primacy and recency effects. Thus they were the first and last items in each set in the random presentations and the first and last set of items in the grouped presentations. The four groups received the same study instructions. The participants were told to try to remember the items because they would later be assessed. The participants assigned to the random + scene condition were told that the sentences accompanying each set might help them to remember the items and that in the 30-second presentation they could change them around to make them more personal. The participants assigned to the grouped + size condition were told that arranging the items in each category by size, from smallest to largest, and in the case of beverages, from lowest to highest alcohol content, might help them to remember the items.

Following the study phase all of the participants completed the retrieval practice task. They practised twice retrieving half of the items from two different categories (e.g., fruit and furniture) plus a primacy item and a recency item from the categories houses or plants. As in Experiment 1, all experimental items served as Rp +, Rp −, and Nrp items equally often. To elicit better results in the retrieval practice task the participants were given the first two letters to prompt recall of the exemplars in the first trial, and only one letter in the second trial to increase the difficulty. After the retrieval practice phase the participants performed a distractor task. They were given 5 minutes to list countries around the world from A to Z. In the recall phase they were given a piece of paper with the names of the four experimental categories, counterbalancing their order of presentation within each group. They were told they had 5 minutes to recall all of the exemplars. They were then asked to write down what strategies they used both to learn the items in the study phase and to recall them in the retrieval phase.

**Results and discussion**

The overall success rate for the retrieval practice was 94.27% ($SD = 9.14$). There were no significant
significant facilitation effects were observed in the size presentation (4.69).

\[ F(7, 26) = 75.26, p < .001, \eta^2_p = .95, \]

and the random group (16.67), recall was worse in the random and nonpractised categories; Nrp = exemplar from nonpractised categories.

\[ \eta^2_p \]

The group factor was also significant, \( p < .01, \eta^2_p = .13, \) and the random group (15) was 93.8% of the participants to use an integrative rehearsal strategy, intracategory association and rehearsal of previous items for each category (see Anderson et al., 1994) in the study phase and category retrieval in the recall task. As expected, in each group via a median split (see procedure in Macrae & MacLeod, 1999). Output precedence was higher for Rp+ exemplars (M = 1.94; SD = 0.49) than for Rp− exemplars (M = 0.10; SD = 0.71), F(1, 56) = 162.60, p = .001, \( \eta^2_p = .74. \) Nonetheless, the early Rp+ groups did not produce greater RIF (M = -9.05; SD = 22.59) than the early Rp− groups (M = -7.69; SD = 17.83), F(1, 56) = 2.39, p = .13, \( \eta^2_p = .04. \) The recall order did not affect the degree of inhibition. There were no significant differences in the level of RIF between the participants who commenced recall with Rp+ practised categories and those who commenced recall with Nrp nonpractised categories. Recall order did not affect the degree of inhibition. Therefore the RIF effects observed in this experiment are unlikely to be a consequence of output interference during the final recall test.

Encoding and retrieval strategies. The participants were asked to write down the strategies they used to study and recall the items. As expected, in the random presentation a majority of the participants (81.3%) pointed out they had used an integrative rehearsal strategy, intracategory association and rehearsal of previous items for each category (see Anderson et al., 1994) in the study phase and category retrieval in the recall task. Adding the scene sentences in the random presentation led 93.8% of the participants to use

\[ \eta^2_p \]

The interaction of inhibition \( \times \) groups was also significant, \( F(3, 56) = 3.21, p = .029, \eta^2_p = .14. \) Inhibition was significant in the groups random (−19.79), \( t(15) = -3.21, p < .01, d = 0.80, \) and grouped (−10.41), \( t(15) = -2.77, p = .014, d = 0.69, \) with no significant differences between them, but no significant effects were observed \( (p > .05) \) in the groups random + scene sentences (−0.52) or grouped + size encoding (−2.60). Thus the two mnemonic techniques used contributed to preventing the inhibitory effects of retrieval practice.

Output interference. When RIF is observed, the question arises whether it is caused by inhibitory processes during retrieval practice or by interference in the final free recall due to initiating recall with highly accessible Rp+ practised items, which can interfere with the retrieval of related material. To rule out this explanation we classified participants by the extent to which they commenced their recall sequences with Rp+ or Rp− exemplars, and then assigned them to either group via a median split (see procedure in Macrae & MacLeod, 1999). Output precedence was higher for Rp+ exemplars (M = 1.94; SD = 0.49) than for Rp− exemplars (M = 0.10; SD = 0.71), F(1, 56) = 162.60, p = .001, \( \eta^2_p = .74. \) Nonetheless, the early Rp+ groups did not produce greater RIF (M = -9.05; SD = 22.59) than the early Rp− groups (M = -7.69; SD = 17.83), F(1, 56) = 2.39, p = .13, \( \eta^2_p = .04. \) The recall order did not affect the degree of inhibition. Therefore the RIF effects observed in this experiment are unlikely to be a consequence of output interference during the final recall test.

**TABLE 2**

<table>
<thead>
<tr>
<th>Group</th>
<th>Rp +</th>
<th>Rp −</th>
<th>Nrp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random</td>
<td>86.46</td>
<td>50.00</td>
<td>69.79</td>
</tr>
<tr>
<td>Random + Scene</td>
<td>88.54</td>
<td>61.45</td>
<td>61.98</td>
</tr>
<tr>
<td>Grouped</td>
<td>90.62</td>
<td>77.08</td>
<td>87.50</td>
</tr>
<tr>
<td>Grouped + Size</td>
<td>93.75</td>
<td>86.46</td>
<td>89.06</td>
</tr>
</tbody>
</table>

Rp + = practised exemplars; Rp − = nonpractised exemplars from practised categories; Nrp = exemplar from nonpractised categories.

\[ \eta^2_p \]

The recall order did not affect the degree of inhibition. There were no significant differences in the level of RIF between the participants who commenced recall with Rp+ practised categories and those who commenced recall with Nrp nonpractised categories. Recall order did not affect the degree of inhibition. Therefore the RIF effects observed in this experiment are unlikely to be a consequence of output interference during the final recall test.

**Encoding and retrieval strategies.** The participants were asked to write down the strategies they used to study and recall the items. As expected, in the random presentation a majority of the participants (81.3%) pointed out they had used an integrative rehearsal strategy, intracategory association and rehearsal of previous items for each category (see Anderson et al., 1994) in the study phase and category retrieval in the recall task. Adding the scene sentences in the random presentation led 93.8% of the participants to use

\[ \eta^2_p \]
intercategory instead of intracategory strategies in the study phase and sentence-scene retrieval in the recall task. In the grouped presentation all of the participants used intracategory integration in the study phase and category retrieval in the recall task. With the grouped + size presentation, all of the participants reported using intracategory integration based on size, but only 56.3% of the participants reported specifically using size in recall. This does not mean that the rest did not use size to recall the exemplars.

**GENERAL DISCUSSION**

It is broadly assumed that strong category exemplars suffer more RIF than weak or low taxonomic frequency items; however, few studies have focused on analysing the relevance of exemplar typicality on RIF. In the present study, as in the original study by Anderson et al. (1994) and later studies (AhnAllen et al., 2007; Bäuml, 1998), item strength was the decisive factor in RIF. Competition during retrieval practice rendered inhibition in the typical or highly accessible exemplars, but RIF did not appear when the exemplars were low typicality. RIF arises only if related memories interfere during the retrieval practice of the targets. This greater impairment produced by selective retrieval practice of stronger items is in line with the predictions from inhibition theory and the notion of interference dependence (Anderson, 2003). Williams and Zacks (2001) called this idea into question since they observed inhibition in strong and weak exemplars. The confluence of several interventions may have caused this effect. The participants were instructed to relate the exemplars to the category name during the 8-second study time for each exemplar, as opposed to the 5-second study in the original research by Anderson et al. (1994). In this study instructions and additional time might have strengthened the association of weak exemplars to categories. Although weak exemplars did not reach the degree of inhibition of strong exemplars, it seems that not only is the cognitive system prepared to fluidly use prior knowledge such as categories, it also shows plasticity in terms of incorporating specialised representations and new values (Markman & Ross, 2003).

The research on RIF using semantic categories has been characterised by controlling interitem associations between category exemplars when selecting the study material and by presenting the exemplars in random sequence. Both strategies show the efforts made by authors to avoid integration processes during the study phase, so that the effects of the retrieval practice cue could be isolated, independent of integration (Anderson et al., 1994). Presentation format may be associated with varying levels of inter-exemplars integration; however, our results support the assumption that in a category cued recall task the presentation format does not significantly affect RIF. When participants studied the strong exemplars grouped according to category either in a sequential presentation (Experiment 1) or with all items from each set presented simultaneously (Experiment 2), they showed similar positive and negative effects derived from selective retrieval practice as they did with a standard random presentation (Experiment 1). This result might be explained because both random and grouped presentations foster activation spreads from the category node along network members, increasing competition between elements and triggering inhibitory processes. In addition our results in self report integration strategies suggest that participants without specific encoding instructions tried to spontaneously inter-relate elements. However, even with blocked presentation, it seems that they were unable to form effective interconnections between Rp+ and the competing Rp — items, thereby leading to RIF. Even so, more studies using different memory tasks are needed to clarify the real impact of presentation format on RIF.

Breaking down or weakening competition of high-typicality exemplars may be quite easy. The distinctive episodic encoding proposed in Experiment 2, using six scenes composed of exemplars from different categories (intercategory encoding), and the encoding strategy based on organisation of the items in each category by size (intracategory integration), were two easy ways to eliminate interitem competition, interference between typical category exemplars, and the need to activate inhibitory processes. Distinctive processing diminished RIF, making Rp — items more distinctive by directing participants to form specific relations between items and organising them within a logical context. Participants were also allowed to change the situations to make them more personal, rendering the information more self-relevant (see Macrae & Roseveare, 2002; Smith & Hunt, 2000). In fact, participants who reported having changed the sentences suffered
less RIF. In relation to integration processes, it has been proposed that competition can be eliminated when Rp+ and Rp− items are integrated into a reasonable and coherent mental model describing a situation (Chan, 2009; Radvansky, 1999), and the results obtained in our study strongly support the assumption that novel episodically encoded associations between practised items and competitors moderate and avoid RIF.

Two mechanisms can operate in the study of category exemplars. The first mechanism is automatic, operates through semantic generation of prior knowledge, generates typical candidates, and the competition between them produces inhibition. A retrieval cue, such as a category (e.g., Fruit), activates a network of associates from which the targets or needed items are identified and selected. For the desired items to be retrieved, inhibitory mechanism are necessary to suppress activated interfering items (Anderson, 2003). The second alternative is a controlled mechanism in charge of novel associations, integration processes, and distinctive encoding. Distinctive encoding processes can promote elaboration, modify the original structure of semantic categories, make competitors more distinctive, and prevent semantic associative interference. Integration of high-typicality exemplars can weaken or break down competition by fostering novel relationships between Rp+ and Rp− exemplars. In our study these encoding strategies decreased interference and rendered unpractised items easier to remember. The results suggest that exemplars of different categories included in a scene or items arranged by size could be organised into a single representation or mental model (Chan, 2009; Radvansky, 1999). In both cases the retrieval of any exemplar could elicit recall of other items in the same representation, they could be fluently and easily accessed, but without competition or interference among them.

To sum up, our study supports the notion of interference dependence and the inhibitory account of RIF, since the expected RIF effect for strong highly accessible items but not for low-typicality exemplars was replicated. However, contrary to the standard procedure of random presentation of exemplars, our results suggest that the presentation format of the items is not a critical variable in modulating RIF in a letter-stem-cued recall task. Random, sequential, or grouped presentations of exemplars produced competition between elements. Conversely, distinctive processing of the material and integration instructions focused on encouraging participants to inter-relate Rp+ and Rp− items through specific associations reduced RIF. Regardless of the type of instruction (inter or intracategory), they broke the strong categorical relationship between typical elements, escaped from competition and avoided RIF.

REFERENCES


**APPENDIX**

High-typicality and low-typicality items from the categories beverages, fruit, furniture, and tools. Italics and exemplars in normal type indicate half of the items used for retrieval practice. The filler items appear last.

**High typicality**
- Beverages: beer, *gin*, *juice*, rum, water, *wine*
- Fruit: bananas, *cherries*, oranges, *peaches*, *strawberries*, watermelon
- Furniture: *bed*, bookshelf, *sofa*, stool, table, *wardrobe*
- Tools: drill, hammer, nails, *pliers*, *saw*, *screwdriver*

**Low typicality**
- Beverages: anisette, champagne, *must*, port, *sangria*, tonic
- Fruit: avocados, blackberries, *coconut*, figs, loquats, pomegranates
- Furniture: bunk, *clothes-rack*, corner-unit, divan, glass-cabinet, rocking-chair
- Tools: bit, handsaw, *ladder*, sander, tongs, washers

**Fillers**
- Types of houses: apartment, attic, chalet, duplex, flat, loft
- Types of plants: carnations, ficus, geraniums, impatiens, roses, tulips