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Script-driven processing affords protection from retrieval-induced forgetting in the recall of everyday activities

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Using the retrieval-practice paradigm, we examined the effects of script and selective retrieval on the recall of high- and low-typicality actions of everyday activities. The participants studied two activities, Getting up in the morning and Going to a restaurant, each consisting of high-typicality and low-typicality actions. They then practised half of the high- or low-typicality actions of an activity, with recall of the unpractised activity serving as baseline. Script-driven processing prompted the recall of high-typicality actions and produced more high-typicality than low-typicality intrusions. Selective retrieval practice of the high-typicality script actions did not have an adverse effect on the recall of high- or low-typicality actions, while practising low-typicality actions not representative of the scripts produced retrieval-induced forgetting of other low-typicality actions. Scripts provide the cognitive system with flexibility and economy, but side-effects such as high-typicality intrusions and poor memory for detail can also derive from script processing.

Keywords: Script-driven processing; Retrieval-induced forgetting (RIF); Everyday activities, Recall.

Selection is required during retrieval to recall events or facts from long-term memory, and forgetting may be needed to override interference from related traces. Forgetting is a broadly adaptive mechanism (Bjork, 1989, 2011) that allows us to recall more effectively by discarding competing information (see Anderson, 2003, for a review). This phenomenon, known as retrieval-induced forgetting (RIF; Anderson, Bjork, & Bjork, 1994), has been observed with a variety of experimental tasks and procedures that imply selective retrieval (e.g., fan effect, part-set cuing). RIF has become widely accepted as a general factor contributing to memory lapses in a broad range of contexts and materials (Anderson, 2003; Goodmon & Anderson, 2011), including semantic categories (Anderson et al., 1994), memory for factual knowledge (Anderson & Bell, 2001; Macrae & MacLeod, 1999), autobiographical experiences (Barnier, Hung, & Conway, 2004), and eyewitness memory (MacLeod, 2002; Shaw, Bjork, & Handal, 1995). However, in everyday life we should not constantly have to overcome interference from related items, a process that might even require
attention and executive control (Anderson, 2003; Román, Soriano, Gómez-Ariza, & Bajo, 2009). It seems more viable that many of our everyday activities are processed fluidly, without the need for attentional resources, by activating our previous knowledge. The knowledge schemes we use in our daily lives to understand, plan, organize, and execute everyday activities (Bower, Black, & Turner, 1979; Schank & Abelson, 1977) can prevent competition and RIF effects. In the present study, therefore, we examined whether RIF also occurs in the recall of daily experiences about which we have well-established prior knowledge acquired through experience.

One of the most common procedures for studying RIF is the retrieval-practice paradigm (Anderson et al., 1994). The experimental procedure is quite simple. Participants study lists of category-exemplar pairs (e.g., fruit–orange). They then perform cued recall retrieval practice on half of the exemplars from half of the categories (e.g., fruit–or____). After a distracter task, participants are given a final test to recall all of the studied exemplars. Facilitation (Rp+ > Nrp) is obtained in the recall of exemplars that receive retrieval practice (Rp+) relative to the recall of baseline exemplars from categories that receive no retrieval practice (Nrp). Retrieval-induced forgetting (Rp− < Nrp) is found for the recall of unpractised exemplars from practised categories (Rp−) relative to baseline recall. Presumably, in order to accurately recall the exemplars we really need, other strongly associated exemplars that compete for access to the conscience are suppressed, thus impairing their recall. The critical issue in the production of RIF in the retrieval-practice paradigm concerns the need to resolve competition between related contents and inhibition functions to overcome that competition (Anderson, 2003; Storm, 2011). In contrast, according to non-inhibitory mechanisms such as interference or blocking (MacLeod, Dodd, Sheard, Wilson, & Bibi, 2003; Perfect et al., 2004; Williams & Zacks, 2001), RIF is caused by retrieval practice, which strengthens the association between the retrieval cue and the practised Rp+ items, thus interfering with the later recall of the less accessible unpractised Rp− items.

But does selective retrieval practice always produce RIF? Integration was originally proposed as a general boundary condition on RIF (Anderson & McCulloch, 1999). Simple instructions to integrate category exemplars reduced the strength-dependent competition, and more integrative rehearsal interrelating category exemplars (Anderson & McCulloch, 1999) or propositional interfering facts (e.g., Anderson & Bell, 2001) eliminated competition and the need for RIF. Moreover, people tend to use their knowledge and experience to organize and integrate items of all kinds, to bind the unstructured material into organized clusters, or to infer causal and explanatory relations between contents to improve memory and overcome interference (e.g., Migueles & García-Bajos, 2007; Myers, O’Brien, Balota, & Toyofuku, 1984; Smith, Adams, & Schorr, 1978). For example, Migueles and García-Bajos (2007) studied the effect of selective retrieval practice of actions in a robbery presented on a video, and no RIF was found for the actions of the event. The effects of prior knowledge in processing events of this type (e.g., García-Bajos & Migueles, 2003) protected them from RIF. In the real world we are more likely to encounter organized or integrated materials (e.g., events, texts, stories, or activities) than unorganized materials (e.g., random lists of objects or unrelated sequences of facts). In everyday situations we probably do not suffer competition between related contents and we do not really need inhibitory processes to overcome interference. For example, leading research on learning and text processing in educational settings has recently shown positive effects of testing and has even found retrieval-induced facilitation for contents not initially tested (Chan, McDermott, & Roediger, 2006; Roediger & Karpicke, 2006). However, when using materials that are difficult to integrate, such as unrelated activities in a story about touring a house (Stone, Barnier, Sutton, & Hirst, 2010), or sentences from a scientific text arranged in alphabetical order (Carroll, Campbell-Ratcliffe, Murnane, & Perfect, 2007, Experiment 2), and when working with novice participants who cannot integrate the studied material into a pre-existing framework (Carroll et al., 2007,
Experiment 1), we are vulnerable to the negative effects of selective practice.

For everyday life, the cognitive system has built knowledge structures that guide the processing of personal and social information (Bower et al., 1979; Hamilton & Sherman, 1994; Schank & Abelson, 1977). People actually use schematic knowledge all the time to enhance encoding and retrieval of virtually everything we experience in everyday life. The activation of these knowledge structures (for neurological evidence, see Krueger, Moll, Zahn, Heinecke, & Grafman, 2007; Wood, Knutson, & Grafman, 2005) can prevent RIF for typical information, as shown using stereotypes (Dunn & Spellman, 2003; García-Bajos & Migueles, 2009) as opposed to lists of unrelated traits (Macrae & MacLeod, 1999); when examining the actions constituting a robbery (Migueles & García-Bajos, 2007) as opposed to lists of stolen objects (Shaw et al., 1995); and when retrieving typical facts of a crime as opposed to low-typicality contents (García-Bajos, Migueles, & Anderson, 2009; Migueles & García-Bajos, 2006). Moreover, since prior knowledge operates automatically using virtually no attentive resources, this study will help us to better understand the side-effects of script-driven processing, such as intrusions arising from script activation in the recall of high-typicality information or the loss of low-typicality information not integrated in the scripts that may need attentive processing.

Does script-driven processing for the activities that shape our everyday lives prevent RIF? Our previous studies show that stereotypes about people (García-Bajos & Migueles, 2009) and script knowledge for common crimes (García-Bajos et al., 2009; Migueles & García-Bajos, 2006) guide processing and prevent RIF for typical information. However, related studies using schema-based materials, such as story grammars (Cuc, Koppel, & Hirst, 2007, Experiment 2) or schema-consistent episodes (Stone et al., 2010, Experiment 1) did find RIF. These different findings prompted us to examine the generality of script-driven processing and lack of RIF in everyday activities. The earlier findings from studies in our laboratory (García-Bajos & Migueles, 2009; García-Bajos et al., 2009; Migueles & García-Bajos, 2006) could be because stereotypes are popular beliefs about distinctive characteristics of social groups, and eyewitness events are emotional shocking experiences uncommon in everyday life. Thus, the absence of RIF for the typical contents in our studies may have been more an exception than a rule. However, there may be different explanations for the results of studies in which RIF has been observed with knowledge schemas (Cuc et al., 2007; Stone et al., 2010): no normative data were obtained to determine the typicality of the contents, their frequency of production or their probability of occurrence; the content presented was consistent but not representative of the schemas; or the stories used were not integrated as a logical sequence of events.

To study the effects of prior knowledge and RIF in the recall of everyday activities, we selected two activities: Getting up in the morning and Going to a restaurant. The two share few actions that could interfere with each other and both are popular in memory studies (e.g., Bower et al., 1979; Graesser, Woll, Kowalski, & Smith, 1980). The two everyday activities included high- and low-typicality actions identified through a previous normative study. This allowed us to study the effects of selective retrieval practice of high- or low-typicality actions of everyday script activities on the later recall of the remaining actions, whether high- or low-typicality. The high- and low-typicality actions for Getting up in the morning and Going to a restaurant were interleaved, maintaining the common chronological order of the actions in each activity. The sequence of high- and low-typicality actions followed the temporal order the participants generated in the normative data study.

According to schema theory (Bower et al., 1979; Schank & Abelson, 1977), the activation of scripts guides the processing of typical contents. In everyday life, goal-oriented activities comprise a series of typical events in a particular sequence (e.g., “order at the restaurant”, “eat the meal”, or “pay”) that are encoded and retrieved as a unique episode (Alba & Hasher, 1983; Grafman, 2002). This perspective coincides with the idea that competition can be eliminated when facts can be integrated into a
coherent mental model describing a situation (Chan, 2009; Radvansky, 1999). In other words, it makes sense that scripts and integration processes may lead participants to incorporate typical related contents into the same situation model or episode, thus reducing the overall competition and interference. On the contrary, low-typicality actions are difficult to integrate into the script. They are encoded and retrieved as independent episodes, and during retrieval practice related information stored in the many other situation models or episodes might compete for retrieval and suffer RIF (Chan, 2009; Grafman, 2002; Radvansky, 1999). Therefore, the main issue in this study was to examine the effects of script typicality and RIF in the recall of daily activities using the retrieval-practice paradigm. These ideas about script typicality are apparently contradictory to the results obtained in the recall of semantic categories: RIF was found for strong category exemplars and no RIF effects were found for weak category exemplars (Anderson et al., 1994). However, we should keep in mind that the key to the production of RIF is competition, not typicality. Strong category exemplars compete for recall during retrieval practice while typical contents of everyday activities are integrated in the scripts, preventing competition and RIF.

In summary, the use of previous knowledge and the selective retrieval of facts can help us to remember effectively in everyday life. To examine the interactions between these cognitive processes that often converge is one of the primary goals of this study. Using the retrieval-practice paradigm, we systematically manipulate script typicality for routine or daily activities to analyse controversial theoretical concepts in the literature, such as the effect of associative strength of the items (high, low) in memory retrieval and the supposed generalization of RIF to daily life memory contexts.

METHOD

Participants

Sixty-four psychology students from the University of the Basque Country, 54 women and 10 men (age, $M = 20.25$ years, $SD = 1.65$), took part in this experiment.

Material

In a previous study the normative data for the activities Getting up in the morning and Going to a restaurant were established. Seventy psychology students from the University of the Basque Country, 60 women and 10 men (age, $M = 21.95$ years; $SD = 2.05$), participated in this study. Thirty-five participants listed typical actions for the activity Getting up in the morning and the other 35 listed typical actions for Going to a restaurant. They were all given 10 min to complete the task. Production frequency was analysed and for each activity 20 actions were selected for the study phase: 10 high-typicality actions produced by more than 25% of the participants, and 10 low-typicality actions coherent with the activity but produced by fewer than 10% of the participants (Appendix). Eight of the 10 high- and low-typicality actions were experimental and two were used to control for primacy and recency effects.

Design

A $2 \times 3$ (Typicality of practised actions: high, low) x (Retrieval practice conditions: Rp+, Rp−, and Nrp) mixed factorial design was used, with Typicality as a between-participants factor and Retrieval practice as a within-participants factor. Correct answers, output interference, clustering, and intrusion errors were analysed in recall.

Procedure

Participants were tested individually or in small groups of up to eight people at a time. All of them were instructed to pay close attention because they would be evaluated afterwards. The 20 high- and low-typicality actions for each activity were presented sequentially, preceded by the name of the activity (Getting up in the morning or Going to a restaurant), on a $2.5 \times 2$ m screen for 5 s each.
using PowerPoint and a Mitsubishi XL5U video projector. The presentation followed the sequential order of the script produced by the participants in the normative study and no more than two high- or low-typicality actions were displayed consecutively. Clustering of high- and low-typicality actions within each activity sequence was calculated. Clustering refers to the tendency for items to take place next to one another in time. To quantify clustering we applied the adjusted ratio of clustering (ARC; Roenker, Thompson, & Brown, 1971), in which chance clustering is set at 0, perfect clustering at 1, and negative scores indicate clustering below chance. The ARC values were −.71 for the high-typicality and −.71 for the low-typicality actions in both activities, showing that high- and low-typicality actions were interleaved within the activities. The order of presentation was counterbalanced for the activities Getting up in the morning and Going to a restaurant. When participants completed the learning phase the experimenter distributed the practice booklets, in which each page displayed the name of the activity and the action to be practised. The eight high- and low-typicality actions of each activity were divided into two sets of four actions each to counterbalance them in the retrieval practice task. Following previous studies (e.g., García-Bajos et al., 2009; MacLeod, 2002; Shaw et al., 1995), the retrieval practice task increased in difficulty through the booklets to maximize practice effects and to allow alternatives to come to mind. The retrieval practice task consisted of two trials practising half of the high- or low-typicality actions from one of the activities (see Appendix) via cued recall. In the first trial, each page in the booklet contained enough information to elicit the action (e.g., Read the m____), while in the second trial only the slightest bit of information was given (e.g., Read______). For the distracter task the participants had 5 min to list the countries of the world. The order in which the activities Getting up in the morning and Going to a restaurant were recalled in the final recall phase was counterbalanced. The participants were told they had a total of 8 min to recall the actions, 4 min for each activity, but no instructions were given regarding the order of recall.

RESULTS

Retrieval practice performance

The retrieval practice success rate was 93.20% (SD = 4.80). There were no significant differences between the participants who practised high-typicality (94.13%) or low-typicality actions (92.28%).

Final recall

Recall was scored by two judges and the few discrepancies were resolved by a third independent judge blind to the experimental conditions. Recall was scored by assigning one point for every correctly recalled action. Correction was rigorous and generic actions that did not include relevant details (e.g., to eat) were not evaluated, although close synonyms were accepted. In the final recall only the 16 experimental actions for each activity were assessed, excluding the two primacy and the two recency actions (see Appendix). There were no significant differences in recall between the activities Getting up in the morning and Going to a restaurant. The order of presentation and the order of recall of the activities were not significant, nor were there significant differences between the two high- and low-typicality sets of practice in any of the measures of retrieval practice conditions: Rp+, Rp−, or Nrp. Table 1 gives recall performance for high- and low-typicality Rp+ practised actions, Rp− high and Rp− low-typicality unpractised actions, Nrp high and Nrp low-typicality unpractised actions of the unpractised activity, and facilitation and RIF effects both for high- and low-typicality actions. First we sought to determine the effects of facilitation and impairment of selective retrieval practice in the recall of high- and low-typicality actions of the activities Getting up in the morning and Going to a restaurant.

To analyse the facilitation effect in the recall of the practised activities, a 2 (Facilitation: Rp+, Nrp) × 2 (Typicality of practised actions: high, low) mixed analysis of variance (ANOVA) was performed, with Typicality of practised actions as the between-participants factor. Facilitation was significant, F(1, 62) = 22.25, p < .001, η_p^2 = .26.
The participants recalled a greater proportion of practised actions (Rp+ = .83) than unpractised actions (Nrp = .67). The typicality factor was also significant, $F(1, 62) = 4.12, \, p = .047, \, \eta^2_p = .06$. The participants recalled a greater proportion of high-typicality actions ($M = .79$) than low-typicality actions ($M = .71$). The Facilitation x Typicality interaction was not significant.

To assess the negative effects of selective retrieval practice on the recall of the unpractised actions, a 2 (RIF: Rp-, Nrp) x 2 (Typicality of practised actions: high, low) x 2 (Typicality of unpractised actions: high, low) mixed ANOVA was performed, with Typicality of the practised actions as the between-participants factor. RIF was significant, $F(1, 62) = 9.43, \, p < .01, \, \eta^2_p = .13$. The participants recalled a smaller proportion of unpractised actions from the practised activity (Rp− = .62) than from the unpractised baseline activity (Nrp = .68), showing the negative effects of selective retrieval practice. The Typicality of the practised actions factor was not significant, but the Typicality of the unpractised actions factor was significant, $F(1, 62) = 44.13, \, p < .001, \, \eta^2_p = .42$. The participants recalled a greater proportion of high-typicality unpractised actions ($M = .72$) than low-typicality unpractised actions ($M = .59$). Three interactions were significant: RIF x Typicality of practised actions, $F(1, 62) = 4.01, \, p = .05, \, \eta^2_p = .06$, RIF x Typicality of unpractised actions, $F(1, 62) = 5.08, \, p = .028, \, \eta^2_p = .08$, and Typicality of practised actions x Typicality of unpractised actions, $F(1, 62) = 10.87, \, p < .01, \, \eta^2_p = .15$. The participants who practised high-typicality actions did not present significant RIF (Rp− = .67, Nrp = .69), while the participants who practised low-typicality actions had poorer recall performance for unpractised actions from the practised activity (Rp− = .57) than from the unpractised baseline activity (Nrp = .68), $t(31) = -3.46, \, p = .002, \, d = 0.61$. RIF was not found for unpractised high-typicality actions (Rp− = .72, Nrp = .72), but the RIF effect was observed for unpractised low-typicality actions (Rp− = .53 < Nrp = .65), $t(31) = -3.81, \, p < .001, \, d = 0.48$. Practising high- or low-typicality actions produced no significant differences in the recall of high-typicality actions (.72, .72). However, practising low-typicality actions produced poorer recall for low-typicality actions than practising high-typicality actions (.53 < .65), $t(62) = -3.03, \, p = .004, \, d = 0.76$.

### Output interference

We examined whether the RIF effects observed in this experiment may have been attributable to interference in the final recall. Initiating recall with more accessible Rp+ practised actions can interfere with the retrieval of Rp− unpractised actions. We classified the participants according to whether they began recall with Rp+ practised actions or Rp− unpractised actions, and assigned them to either group via a median split (see procedure in Macrae & MacLeod, 1999). A score of 1 was given to the first Rp action recalled, 2 to the second, and so on. The mean position was then calculated for the recall of Rp+ practised actions and Rp− unpractised actions. Lastly, for each participant we subtracted the average recall position of Rp+ from Rp− actions. Positive values indicate that participants commence recall with Rp+ items and negative values show they begin with Rp− items. There were no differences in the precedence of Rp+ practised actions over Rp− unpractised actions either when Rp+ high-typicality actions

### Table 1. Mean proportion of actions recalled, facilitation and retrieval-induced forgetting (RIF)

<table>
<thead>
<tr>
<th>Practised</th>
<th>Rp+</th>
<th>Rp− high</th>
<th>Rp− low</th>
<th>Nrp high</th>
<th>Nrp low</th>
<th>Facilitation</th>
<th>RIF high</th>
<th>RIF low</th>
</tr>
</thead>
<tbody>
<tr>
<td>High typicality</td>
<td>.86</td>
<td>.72</td>
<td>.62</td>
<td>.71</td>
<td>.67</td>
<td>.15*</td>
<td>.01</td>
<td>−.05</td>
</tr>
<tr>
<td>Low typicality</td>
<td>.80</td>
<td>.71</td>
<td>.43</td>
<td>.73</td>
<td>.62</td>
<td>.18*</td>
<td>−.02</td>
<td>−.19**</td>
</tr>
</tbody>
</table>

*Notes: * $p < .01$, ** $p < .001$. Rp+, actions that received retrieval practice. Rp− high and Rp− low, unpractised actions of the practised activity. Nrp high and Nrp low, unpractised actions of the unpractised activity.
were practised (Rp– high = –0.07, Rp– low = –0.23) or when Rp+ low-typicality actions were practised (Rp– high = –0.38, Rp– low = –1.30). No differences were observed in the level of RIF for high- or low-typicality actions as a function of precedence in the recall of Rp+ practised actions, $F(1, 62) = 0.01; \rho = .91, \eta_p^2 = .00$. Nor were there significant differences, $F(1, 30) = 1.98; \rho = .17, \eta_p^2 = .06$, when a comparison of the first and last quartiles was conducted to provide a stronger test of the role that output interference might play. Thus, the order in which everyday activities were recalled was not affected by retrieval practice and the RIF found in this experiment does not seem to be due to output interference from commencing recall with practised activities.

**Clustering in recall**

Recall protocols were examined for evidence of clustering in output (Roenker et al., 1971). Clustering of high- or low-typicality actions in final recall cannot explain the facilitation and forgetting effects either, since the ARC scores (see Procedure) were below zero (below chance level), for high- (–.59) and low-typicality actions (–.78). The participants interleaved high- and low-typicality actions in the final recall task much the same way as they were clustered within the activity itself (–.71). Even so, the clustering of high-typicality actions was greater in recall than in the study sequence (–.59 < –.71), $t(63) = –3.31, \rho = .002, d = 0.17$. Recalling more high-typicality than low-typicality actions may have increased the likelihood of more consecutive high-typicality than low-typicality actions in recall.

To further examine the impact of script-driven processing in recall, we also assessed whether the participants reproduced the temporal order of the script in the final recall or whether they followed a different sequence pattern to recall the activities *Getting up in the morning* and *Going to a restaurant.*

To assess temporal continuity within the recall of the activities we used the ARC measure proposed by Pellegrino and Hubert (1982), with 1 representing perfect script sequencing and 0 a total temporal discontinuity of the actions in recall. Temporal continuity within the scripts occurs when the prior action depicts facts that immediately precede or are concurrent with those in current action (e.g., *Read the menu, Order food*) and temporal discontinuity occurs when there is a temporal break in the script sequence (e.g., *Pay the bill, The waiter brings the starters*). With the ARC scores, a 2 (Typicality of practised actions: high, low) × 2 (Practice conditions: practised activity, unpractised activity) ANOVA was performed. Results showed that the Typicality of the practised actions factor was significant, $F(1, 62) = 11.06, \rho = .001, \eta_p^2 = .15$. There was a higher degree of script clustering in the recall of the activities when the participants practised high-typicality ($M = .80; SD = .18$) than low-typicality ($M = .67; SD = .21$) actions. But there were no significant differences in recall sequencing between the practised and unpractised activities. Neither the interaction between Typicality of practised actions × Practice conditions was significant. Furthermore, the correlation between ARC clustering scores and RIF was not significant (Pearson’s $r = .12; \rho = .33$). Although practising low-typicality actions produced more temporal discontinuities than practising high-typicality actions, recall order was consistent with the script organization. The ARC scores were higher than .5 random chance, both when participants practised high- and low-typicality actions ($\rho < .001$), showing the spontaneous use of the scripts structure in recall.

**Intrusion errors in recall**

The intrusions were recalled actions that had not been presented in the study phase. Based on the normative data, intrusions were classified as high-typicality (e.g., “Ask the waiter for the check” for the *Going to a restaurant* script) or low-typicality (e.g., “Play music” for the *Getting up in the morning* script). The number of intrusions was low ($M = 1.41, SD = 0.79$). To analyse the intrusions, a 2 (Typicality of practised actions: high, low) × 2 (Practice conditions: practised activity, unpractised activity) × 2 (Error typicality: high, low) ANOVA was used, with Typicality of practised actions as the between-participants factor.
Results showed that only the Error typicality factor was significant, $F(1, 62) = 12.38$, $p < .01$, $\eta_p^2 = .17$. The participants had more high-typicality actions ($M = 0.87$) than low-typicality intrusions ($M = 0.54$). The interactions Typicality of practised actions $\times$ Error typicality, $F(1, 62) = 4.88$, $p = .031$, $\eta_p^2 = .07$, and Practice conditions $\times$ Error typicality, $F(1, 62) = 7.71$, $p < .01$, $\eta_p^2 = .11$, were also significant. When the participants practised high-typicality actions there were more high-typicality intrusions ($M = 0.51$) than low-typicality intrusions ($M = 0.23$), $t(31) = 4.42$, $p < .001$, $d = 0.78$, but when they practised low-typicality actions there were no significant differences between the number of low- and high-typicality intrusions (0.36, 0.31). In the practised activity there were no significant differences in the number of high- and low-typicality intrusions (0.37, 0.33), whereas in the unpractised activity there were more high-typicality than low-typicality intrusions (0.5 > 0.21), $t(63) = 4.40$, $p < .001$, $d = 0.55$. Therefore, although intrusions were minimal, high-typicality intrusions were more frequent when the script was activated; that is, when practising high-typicality actions and when recalling the unpractised activity.

**DISCUSSION**

To the best of our knowledge this is the first demonstration that script typicality modulates RIF when the scripts are themselves routine and involve everyday activities. The activation of previous knowledge about everyday activities prevented RIF for typical contents. Only specific low-typicality facts were vulnerable to RIF. The same pattern of results has been found with events that are more emotional and shocking, such as a bank robbery (García-Bajos et al., 2009), or with social beliefs such as stereotypes (Dunn & Spellman, 2003; García-Bajos & Migueles, 2009). Thus, our study strongly supports the idea that previous knowledge affords protection from RIF.

Script activation promotes inter-item connections between actions, and we know that integration processes during encoding reduces temporary forgetting (Anderson, 2003; Anderson & McCulloch, 1999). But, under what conditions does high-typicality integration provide protection from RIF? First, to promote script activation the study material should contain representative actions of the script. If the typicality of the contents is not systematically manipulated and representative contents of the schemas are mixed with atypical or more specific events (Cuc et al., 2007; Gómez-Ariza, Lechuga, Pelegrina, & Bajo, 2005; Stone et al., 2010) the RIF effect is expected. Second, the to-be-remembered material should present a coherent situation maintaining the chronological order of the event and the causal and temporal relationships between contents. By presenting the script actions in random order (Gómez-Ariza et al., 2005; Migueles & García-Bajos, 2012), the sequential and causal structure of the script will break down, the integration will be lost and instead of a global representation there will be competing actions triggering RIF. Third, since the presentation of the items that instantiate a schema is not always enough to activate the underlying schema, participants have to be aware of the relevant schema at the time they encode the material. For example, García-Bajos and Migueles (2009) worked with social stereotypes. The participants selectively practised high- or low-typicality, or control traits associated with the name of a stereotype (athlete, scientist) or with the name of a person (Mikel, Jon). With the person name the traits produced no evidence of stereotype activation, they were processed as independent features and generated RIF, but stereotype activation during encoding facilitated the integration of high-typicality traits, avoiding RIF. In other words, any manipulation that hinders or impedes the activation of the schema or that destroys the logical organization of the script will reduce the positive effects of script-driven processing for typical contents.

In the present study, the selective retrieval practice of high-typicality actions of everyday activities did not impair the recall of other unpractised actions regardless of whether they were high- or low-typicality. The results show that practising
high-typicality actions enhanced script-driven processing and, as expected, the activation of the scripts did not generate competition between typical actions. Both activities, *Getting up in the morning* and *Going to a restaurant*, were made up of organized sequences of actions interconnected spatially and temporally from beginning to end. It is possible that other typical actions of the script came to mind simultaneously during retrieval practice or that participants spontaneously generated a list of high-typical items consistent with the script and then recognized the item that fitted the cue. However, neither of the two alternatives means that there was competition between typical actions because the activation of the script may have allowed rapid, fluid, effortless access to all the contents without RIF. In addition, one of the most important ideas behind theories of scripts and schemas is the notion of reconstruction during retrieval. Reconstruction processes increase the chances that high-typical actions will be remembered by participants through script activation rather than through episodic retrieval. Although the number of intrusions was very low and participants were accurate in recall, it remains possible that, to some degree, reconstruction may have masked the lack of RIF in high-typicality information. How to discern whether a memory comes from the activation of prior knowledge or from a vivid recollection of an episodic experience is a challenge for memory research.

Similarly, typical actions of scripted activities are assumed to be encoded and retrieved as a unique episode (Alba & Hasher, 1983; Grafman, 2002), and since typical actions are integrated into a single representation or episode, they are fluently accessed without competing with each other (Chan, 2009; Radvansky, 1999), eliminating the need for RIF. This is in line with the concept of *episodic inhibition* (Racsmány & Conway, 2006), which proposes that episodic memories retain copies of semantic knowledge structures. The key idea is that the nature and patterns of activation/inhibition of conceptual knowledge contained in an episodic memory will determine later recall. Thus, evidence for RIF is not detected when items are accessed in a conceptual or semantic network, while specific episodic representations suffer RIF. At this point, we should mention the controversy about RIF with strong category exemplars and no trace of RIF effects with high-typicality script information. Using semantic categories, Anderson et al. (1994) found that high-frequency exemplars suffer more RIF than low-frequency exemplars in the retrieval-practice paradigm. But it should be noted that in the manipulation of taxonomic frequency inter-item associations between category exemplars were systematically eliminated to avoid integration processes during encoding, while in our study it is the integrated nature of high-typicality actions within the script that affords protection from RIF.

In contrast with the results of high-typicality, partial retrieval practice of low-typicality actions produced RIF, but only in low-typicality actions. It may have been difficult to integrate the low-typicality actions into the scripts because low-typicality actions are specific events which are encoded and retrieved as independent episodes or situations that compete with each other, and selective retrieval practice impairs later recall (Chan, 2009; Radvansky, 1999). Although the activities *Getting up in the morning* and *Going to a restaurant* included low-typicality actions interleaved with other high-typicality actions, both contents (typicality) and structure (time sequence and causal relationships) appear to be relevant to processing guided by prior knowledge. Specific contents, lack of previous knowledge about a domain, or materials that are difficult to integrate may have been responsible for the RIF found in many previous studies (e.g., Anderson & Bell, 2001; Carroll et al., 2007; Cuc et al., 2007; Macrae & MacLeod, 1999; Stone et al., 2010). Consequently, RIF was not found when participants were experts in a domain of knowledge (Carroll et al., 2007), when materials developed an ordered sequence of events (Migueles & García-Bajos, 2007), or when using standard study materials, in which case retrieval-induced facilitation was even found for non-tested information (Chan et al., 2006).

One alternative explanation of our result of RIF in low-typicality actions and the lack of forgetting in high-typicality actions might be interference.
The interference account of RIF asserts that rather than suppression or inhibition of competing items, it is the strengthening of the association between Rp+ practised actions and the retrieval cue that causes the forgetting effect in the final recall task (see MacLeod et al., 2003; Perfect et al., 2004; Williams & Zacks, 2001). In other words, RIF for low-typicality actions might have occurred because highly accessible Rp+ practised actions were recalled earlier in the final recall task than the less accessible Rp− unpractised actions, diminishing recall performance on these actions. It is assumed that the best way to reduce the influence of output interference in the retrieval-practice paradigm is to use a cued recall procedure whereby the Rp− items are cued first, thus overcoming output interference. However, in everyday life people remember in a narrative format and a cued recall test eliminates the natural and spontaneous organization of memory retrieval.

Three results in the present study run counter to the output interference interpretation. First, our data demonstrate no effect of output interference in the final recall task. Initiating recall with more strengthened Rp+ practised actions did not interfere with the retrieval of Rp− unpractised actions. In none of the conditions did the early Rp+ group produce greater RIF than the early Rp− group. This result is in line with post hoc output order analyses in other studies (García-Bajos et al., 2009; MacLeod, 2002). Second, the way participants organized their recall contradicts the explanation based on retrieval interference. In our study the participants interleaved high- and low-typicality actions in their final recall task much the same way as they were clustered within the activities themselves during encoding (see García-Bajos et al., 2009, for similar results). More relevant here, the group that practised high-typicality actions and did not suffer RIF showed even more clustering of high-typicality actions in recall than in the study phase. Finally, there were also no significant differences when a comparison of the first and last quartiles was conducted to provide a stronger test of the role of output interference.

Another related alternative view of inhibition is the strategy disruption component (e.g., Dodd, Castel, & Roberts, 2006). Having participants practise low-typicality actions may apparently disrupt to some degree the original organization of the studied material and change the order of recall in a way that impairs the recall of other low-typicality actions. Practising low-typicality actions produced more temporal discontinuities in recall than practising high-typicality actions, but in both cases participants followed the chronological order of the script and the ARC scores of script clustering in recall did not predict the level of RIF. Although it remains possible that output interference or strategy disruption may mask forgetting in recall, the RIF found in this experiment with everyday activities appears unlikely to be a consequence of retrieval interference.

In relation to recall performance three findings are noteworthy. In the first place, we found retrieval-facilitation. That is, better recall for the recovered actions in the initial retrieval practice in relation to the recall for the unpractised activity. Prior retrieval practice enhanced memory for reviewed actions, whether high- or low-typicality. Thus, accessing previously learned information consolidates memory: What is retrieved is remembered (Bjork, 1988, 2011). This beneficial effect of selective retrieval practice can have important repercussions in applied areas such as education (Roediger & Karpicke, 2006) or eyewitness memory (Migueles & García-Bajos, 2007). Second, as a measure of cognitive processing efficiency (e.g., Schank & Abelson, 1977), script activation favoured the recall of typical actions while recall performance for low-typicality actions, with little representation in the scripts, was poorer. Third, although intrusions were minimal, much like previous studies (Bower et al., 1979; García-Bajos & Migueles, 2003), intrusions were more frequent in high-typicality information than in low-typicality actions, showing that the same previous knowledge that helps us encode and recall facts can also generate errors. In addition, when the script was activated by practising high-typicality actions, the incidence of high-typicality intrusions in recall was higher than when low-typicality actions were practised. These results indicate that scripts guided encoding, retrieval practice and recall.
To sum up, our data suggest that script-driven processing is flexible and economic. Inhibitory processes need not be activated in order to retrieve part of the most representative and typical actions of a script, while successful retrieval of specific actions requires only the suppression of other low-типicality actions. Moreover, the forgetting derived from selective retrieval practice and the natural loss of low-типical information not integrated in scripts may have important repercussions in real situations. This does not mean that all of the low-типicality or specific contents in an event are somehow vulnerable to RIF. Atypical contents incongruent to a situation, conspicuous details, and minor signs of danger or self-relevant information may attract attention, promote distinctive processing and reinforce the organization of an experience, reducing the negative effects caused by selective retrieval practice and preventing RIF. Analysing these aspects using different procedures and paradigms that generate RIF may be relevant to better understanding of the effects of prior knowledge and the impact of inhibitory processes on memory in the real world.

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REFERENCES


Table A1. Empirical script norms

<table>
<thead>
<tr>
<th>Getting up in the morning</th>
<th>%</th>
<th>Going to a restaurant</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primacy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wake up</td>
<td>2.85</td>
<td>Park the car</td>
<td>2.85</td>
</tr>
<tr>
<td>Get out of bed</td>
<td>37.14</td>
<td>Enter the restaurant</td>
<td>37.14</td>
</tr>
<tr>
<td><strong>High typicality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn off the alarm clock</td>
<td>37.14</td>
<td>Sit at the table</td>
<td>74.28</td>
</tr>
<tr>
<td>Take a shower</td>
<td>88.57</td>
<td>Read the menu</td>
<td>42.85</td>
</tr>
<tr>
<td>Go to the kitchen</td>
<td>37.14</td>
<td>Order food</td>
<td>74.28</td>
</tr>
<tr>
<td>Make breakfast</td>
<td>37.14</td>
<td>Talk while food arrives</td>
<td>34.28</td>
</tr>
<tr>
<td>Wash the breakfast dishes</td>
<td>28.57</td>
<td>Eat dessert</td>
<td>60.00</td>
</tr>
<tr>
<td>Get dressed</td>
<td>97.14</td>
<td>Have coffee</td>
<td>62.85</td>
</tr>
<tr>
<td>Comb your hair</td>
<td>45.71</td>
<td>Pay the bill</td>
<td>85.71</td>
</tr>
<tr>
<td>Prepare your purse or backpack</td>
<td>51.42</td>
<td>Get up from the table</td>
<td>34.28</td>
</tr>
<tr>
<td>M</td>
<td>52.85</td>
<td>M</td>
<td>58.56</td>
</tr>
<tr>
<td>SD</td>
<td>25.69</td>
<td>SD</td>
<td>19.55</td>
</tr>
<tr>
<td><strong>Low typicality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn on the heater</td>
<td>5.71</td>
<td>Greet when entering</td>
<td>5.71</td>
</tr>
<tr>
<td>Put on deodorant</td>
<td>8.57</td>
<td>Hang up jacket</td>
<td>2.85</td>
</tr>
<tr>
<td>Get the biscuits</td>
<td>2.85</td>
<td>Pass bread around</td>
<td>5.71</td>
</tr>
<tr>
<td>Read the newspaper</td>
<td>8.57</td>
<td>The waiter brings the starters</td>
<td>2.85</td>
</tr>
<tr>
<td>Put your pyjamas away</td>
<td>2.85</td>
<td>Taste the wine</td>
<td>5.71</td>
</tr>
<tr>
<td>Look in the mirror</td>
<td>5.71</td>
<td>Fidget with the silverware</td>
<td>2.85</td>
</tr>
<tr>
<td>Put your watch on</td>
<td>2.85</td>
<td>Fold the napkin</td>
<td>2.85</td>
</tr>
<tr>
<td>Grab the mobile phone</td>
<td>5.71</td>
<td>Wait for the change</td>
<td>5.71</td>
</tr>
<tr>
<td>M</td>
<td>5.35</td>
<td>M</td>
<td>4.28</td>
</tr>
<tr>
<td>SD</td>
<td>2.38</td>
<td>SD</td>
<td>1.52</td>
</tr>
<tr>
<td><strong>Recency</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leave the house</td>
<td>60.00</td>
<td>Leave the restaurant</td>
<td>85.71</td>
</tr>
<tr>
<td>Go down the stairs</td>
<td>2.85</td>
<td>Walk toward the car</td>
<td>2.85</td>
</tr>
</tbody>
</table>

Notes: Percentage of participants mentioning in the normative study each high- and low-typicality action of the activities *Getting up in the morning* and *Going to a restaurant* used in the experiment. Italics indicate the half of the high- and low-typicality actions used in the retrieval practice task.