THE ROLE OF RESPONSE COMPETITION IN RETRIEVAL-INDUCED FORGETTING

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THE ROLE OF RESPONSE COMPETITION IN RETRIEVAL-INDUCED FORGETTING

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DECLARATION OF ORIGINALITY

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ABSTRACT

The Role of Response Competition in Retrieval-Induced Forgetting

Retrieving a target item raises its likelihood to be remembered at a later memory test. However, related but not retrieved items do not benefit and actually suffer from such a retrieval. The phenomenon that retrieval of target items weakens subsequent recall of items related to the target is known as “retrieval-induced forgetting” (Anderson, Bjork, & Bjork, 1994). There has been extensive debates about possible reasons why retrieving induces forgetting. Interference account of retrieval induced forgetting (RIF), for instance argues that successive retrieval strengthens association between cue and target, hence resulting in weakened recall of non-target items (e. g., Raaijmakers & Jakab, 2012; Raaijmakers & Jakab, 2013). Inhibitory account of RIF, on the other hand, posits that active suppression of competitors -while retrieving the targets- leads to poorer recall of competitors in subsequent recall (Anderson, Bjork, & Bjork, 1994; Anderson, & Spellman,1995). Basic premise of inhibitory account is the presence of competition among possible responses. In this study competition between possible responses (target and the competitors) was manipulated in order to examine role of response competition on RIF. In Experiment 1, the aim was to reduce competition by presenting category–exemplar study pairs in a category-wise blocked fashion (*Animal – Donkey, Animal - Lion*), thus enabling conceptual integration of target and competitors. In Experiment 2, the aim was to enhance competition by introducing a shared cue for target and competitor. In line with postulations of inhibitory account, RIF diminished with the alleviated competition and correspondingly it increased with the provoked competition.

ÖZET

Davranım Rekabetinin Hatırlama Yollu Unutmadaki Rolü

Bir öğeyi hatırlamak, bu öğenin daha sonraki bir hafıza testinde hatırlanma olasılığını arttırır. Ancak, öğe ile ilgili ama hatırlanmamış başka öğeler bu hatırlama işleminden fayda görmez hatta zarar görür. Bu olguya, yani hedeflenen öğenin hatırlanmasına bağlı olarak hedefte olmayan ama ilgili öğelerin sonraki hafıza testlerinde hatırlanmamasına, "hatırlama yollu unutma" denir (Anderson, Bjork ve Bjork, 1994). Bu olguya neyin yol açtığı hususunda geniş tartışmalar yapılmaktadır. Ket vurma görüşüne göre hatırlatıcı işaret ile hedef öğe arasında bağ tekrarlanan hatırlama esnasında kuvvetlenir, bu güçlenen bağ da hedefte olmayan rakip öğenin sonraki hafıza testlerinde hatırlanmasında güçlüğe sebep olur (örn., Raaijmakers ve Jakab, 2012; Raaijmakers ve Jakab, 2013). Baskılama görüşüne göre ise hatırlama esnasında hedefte olmayan rakip öğeler aktif olarak baskılanır, tekrarlanan baskılama da sonraki hafıza testlerinde rakip öğelerin hatırlanmasında güçlüğe yol açar (Anderson ve ark., 1994; Anderson ve Spellman, 1995). Baskılama görüşünün temel varsayımı öğeler (hedef ve rakip) arasında rekabet olduğudur. Biz bu çalışmada rekabeti farklı yöntemlerle manipüle ettik, böylelikle rekabetin hatırlama yollu unutma üzerinde etkisini inceledik. İlk deneyde, kategori-öğe eşliklerini öğretme aşamasında aynı kategori üyelerini (*Hayvan – Eşek, Hayvan – Aslan*) artarda göstererek, hedef ve rakip öğelerin bütünleşmesini sağladık. İkinci deneyde, hem hedef hem de rakip öğe için geçerli olabilecek hatırlatıcı işaret kullanarak hedef ve rakip rekabetini arttırdık. Baskılama görüşünün varsayımları doğrultusunda rekabetin azaldığı durumlarda hatırlamaya bağlı unutmanın yok olduğunu, rekabetin körüklendiği hallerde bu olgunun arttığını bulduk.

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CHAPTER 1

INTRODUCTION

Retrieval-induced forgetting refers to a forgetting phenomenon, in which retrieval practice of a group of items reduces the retrieval of related material (Anderson, Bjork and Bjork, 1994). A typical retrieval-induced forgetting study consists of three phases: a study phase, a retrieval practice phase, and a final memory test phase. In the study phase, participants study a mixed list of category-exemplar pairs (e.g., Fruit - Apple, Animal - Lion etc.). During retrieval practice, participants retrieve some of the study exemplars of some of the study categories (e.g., Fruit - Ap____). A critical component of this phase is that some study categories remain unpracticed (e.g., all items of the Animal category) and some exemplars of practiced categories also remain unpracticed (e.g., Fruit – Orange). After a distractor task, participants receive a final recall test on all exemplars of the study phase. Due to the retrieval practice manipulation, some of the to-be-remembered exemplars are practiced exemplars from practiced categories (Rp+), some are unpracticed exemplars from practiced categories (Rp-), and the remaining ones are unpracticed exemplars from unpracticed categories (Nrp). In their 1994 study, Anderson, Bjork, and Bjork were able to show that Rp+ items were significantly better recalled than the rest (retrieval-induced facilitation), but more importantly, that Rp- items were significantly less recalled than Nrp items (retrieval-induced forgetting). This was the case regardless of whether the final memory test was a category cued recall test or a category-plus-stem cued recall test. Thus, independent of output order, retrieval practice seemed to facilitate later recall of practiced items of a category (Rp+) and

impair recall of the unpracticed items of that category (Rp-). Numerous studies replicated these findings (for a review, see Anderson, 2003).

The goal of this study was to take a closer look at the mechanisms responsible for this type of forgetting. There are two competing perspectives regarding the mechanisms of retrieval-induced forgetting. One position, recently referred to by Hulbert, Shivde, and Anderson (2012) as the associative blocking hypothesis, claims that during retrieval practice, the relative associative strength of the link between a category and its member is weakened for the unpracticed exemplar of that same category, and strengthened for the one that is practiced, while leaving the associative strength for Nrp items unchanged. According to this position, response competition is not a necessary condition for the relative strengthening or weakening of the associative link between category-exemplar. The mere remembering of one member and not the other from a given category will lead to this differential associative strength change (cf. Raaijmakers & Shiffrin, 1981; Mensink & Raaijmakers, 1988; also see Raaijmakers & Jakab, 2012). The other position, known as the inhibition hypothesis, claims that a response competition mechanism is at work between Rp+ and Rp- items, which is resolved by suppressing the Rp- item, and hence weakening its representation, possibly in addition to weakening the category-exemplar associative link (cf. Anderson, Bjork, & Bjork, 1994; Anderson, 2003).

Thus, these two positions differ with respect to (1) *what* is weakened during retrieval practice (only the associative link between Rp- item and category vs. also the representation of Rp- item) and (2) *how* it is weakened (whether or not response competition plays some role in this process). In this thesis, we will concentrate on the "how" issue. In two experiments we manipulated amount of response competition to see

whether experimentally decreasing it would decrease retrieval-induced forgetting and increasing it would increase it.

1.1 Decreasing retrieval-induced forgetting by decreasing response competition: Semantic integration studies.

Anderson and McCulloch (1999) were able to show that semantic integration instructions during study eliminated retrieval-induced forgetting. Neither maintenance rehearsal instructions nor extra presentation trials were able to eliminate the effect (but see Verde, 2012). Instead, integrating the material during study somehow ensured later recall even of Rp- items. Anderson and McCulloch proposed that integrating Rp+ and Rp- items might reduce the competition between them and thus eliminate the detrimental effect of retrieval practice on Rp- items. Once Rp+ and Rp- items are sufficiently integrated, it is possible that retrieval practice of one might mediate covert practice of the other, which eventually would lead to full elimination of retrieval-induced forgetting. Various studies have confirmed the modulating effect of semantic integration (e.g., Anderson, Green, & McCulloch, 2000; Smith & Hunt, 2000).

In their 2011 study, Goodmon and Anderson used study items that were more or less semantically related with each other (e.g. Horse, Pony, Lion, Tiger, Duck, Goose). They assumed that semantic relation would lead to integration of competing items. Their findings showed that when the semantically less related category exemplars were pitted against each other as Rp+ and Rp- (e.g., Horse and Lion), a retrieval-induced forgetting effect emerged as usual. But when the semantically more related category exemplars were pitted against each other as Rp+ and Rp- (e.g., Horse and Pony), this effect disappeared.

The main difference between the two studies described above was that in the Anderson and McCulloch (1999) study participants were encouraged to actively integrate the material whereas in the Goodmon and Anderson (2011) study they were not. Instead, in Goodmon and Anderson, only the degree of pre-experimental semantic association between the Rp+ and Rp- items per category was manipulated. Most intriguingly, retrieval-induced forgetting was eliminated even in an incidental encoding setup (when participants were left uninformed about the subsequent memory tests), which implies that semantic integration happens inevitably. In Experiment 1 a very simple manipulation was used to further test this idea. Half of our participants received the category-exemplar pairs in a category-wise blocked instead of mixed fashion during study. Based on Goodmon and Anderson's (2011) study, we expected an elimination of the retrieval-induced forgetting effect in the category-wise blocked group because a consecutive presentation of exemplars of the same category (e.g., Animal-Lion, Animal-Sheep, Animal-Horse etc.) would lead to between-item semantic integration, even when participants were not explicitly told to integrate them. It is likely that once all same-category items are "safely" integrated with each other during study, participants may even be latently rehearsing the Rp- items with each practiced Rp+ item during the subsequent retrieval practice phase without having to suppress them. It was therefore expected that the blocked study order manipulation would facilitate semantic integration during study and hence reduce response competition at time of retrieval practice, which in turn would lead to a reduction or even elimination of retrieval-induced forgetting.

1.2 Increasing retrieval-induced forgetting by increasing response competition

Anderson, Bjork and Bjork (1994) tested the response competition component of the inhibition hypothesis by using either weak or strong exemplars of a certain category. They predicted that the amount of retrieval-induced forgetting would depend on the category membership strength of the Rp- and Rp+ items. Compared to weak Rp- exemplars (e.g., Guava), strong Rp- exemplars (e.g., Apple) were expected to create more response competition during retrieval practice (e.g., when having to practice Fruit – Gu_____) and hence necessitate stronger inhibition compared to weak exemplars (e.g., when having to practice Fruit – Ap_____). The inhibition explanation therefore expects greater impairment (i.e., lower recall of Rp- items compared to Nrp items) when strong exemplars are used as Rp- and weak ones as Rp+, than when weak ones are used as Rp- and strong ones as Rp+. This was exactly what Anderson et al. (1994) found. A hidden assumption here is that once participants see the category name during retrieval practice, its strong members (e.g., Apple) will turn up in their minds even if the cue contradicts with it (e.g., Gu_____). One problem with this assumption is that there is no way to know whether this is undeniably the case. One also does not know -- if such involuntary remembering does in fact occur -- whether (1) all strong exemplars of that category, or (2) just some of them, or (3) just one of them turn up in their minds. In addition, these kind of uncontrolled processes are likely to change from category to category. In short, even though a difference in retrieval-induced forgetting is observed depending on the category membership strength of the Rp-and Rp+ items, many aspects of the underlying mechanism remain uncontrolled.

This is an issue of concern in all retrieval-induced forgetting studies. Given that unique word stems are provided for the to-be-retrieved exemplars during retrieval

practice (e.g. Fruit – Ap___), it seems questionable that an incorrect category exemplar such as Banana comes to mind during retrieval practice even if it is a strong candidate within that category.

In Experiment 2, the attempt was to increase response competition in a more direct and controlled way by using a setup that would more likely activate Rp- competitors during retrieval practice but still ensure that only Rp+ items were practiced. In particular, for half of the categories, Rp+/Rp- pairs were used that shared first letters but were of different word length (e.g., Fruit: Plum, Peach, Apple, Apricot, Coconut, Cranberry). RP+ items were cued during retrieval practice by providing not only the shared first letter but also the number of letters (e.g., Fruit – P _ _ _). If, as claimed by the inhibition hypothesis, it is the response competition between Rp+ and Rp- during retrieval practice that plays a crucial role in bringing about a suppression of the Rp- representation (thus leading to retrieval-induced forgetting), we should expect increased retrieval-induced forgetting for categories that had Rp+/Rp- pairs with shared first letters.

1.3 The present study

The literature review focused on the potential role of response competition in decreasing or increasing retrieval-induced forgetting. In Experiment 1, our goal was to decrease response competition. It was hypothesized that presenting category-exemplar pairs in a category-wise blocked fashion during study would lead to immediate semantic integration between the exemplars per category (as one would expect from Goodmon and Anderson's (2011) findings), which in turn would reduce or eliminate response competition and hence retrieval-induced forgetting.

In Experiment 2, our goal was to increase retrieval-induced forgetting by increasing response competition during retrieval practice. Response competition was manipulated by including Rp+/Rp- pairs that shared first letters but were of different word length (e.g., Fruit: Plum, Peach, Apple, Apricot, Coconut, Cranberry) for half of the categories. Correct retrieval practice was ensured by providing word length information (e.g., Fruit – P _ _ _). If, as claimed by the inhibition hypothesis, it is the response competition between Rp+ and Rp- during retrieval practice that plays a crucial role in bringing about a suppression of the Rp- representation (thus leading to retrieval-induced forgetting), one should expect increased retrieval-induced forgetting for categories that had Rp+/Rp- pairs with shared first letters.

CHAPTER 2

EXPERIMENT 1

2.1 Method

2.1.1 Participants

Sixty-four undergraduate students who were freshmen in Boğaziçi University took part in the study and received course credit for their participation.

2.1.2 Materials

Eight experimental categories (Fruits, Clothes, Animals, Professions, Vegetables, Musical Instruments, Metals, and Printed Materials) and two filler categories (Colors, Precious Stones) were selected from the Turkish category norms of Peynircioğlu (1988). The categories and exemplars (see Appendix A) were selected such that they would be familiar to today's college students and not evoke any negative affect (e.g., Insects, Weapons) since valence of material may effect magnitude of retrieval induced forgetting (Barber & Mather, 2012).

Exemplar selection was based on the listed response frequencies per category in Peynircioğlu (1988). All the category exemplars were moderate to high frequency exemplars (see Appendices B and C). The top two most frequent exemplars were always discarded in order to eliminate correct recall through guessing.

Study booklets contained eight experimental and two filler categories with six exemplars of each. Each page had a single category – exemplar pair printed in sentence case in the center of it. In the category-wise mixed booklets, category–exemplar pairs appeared in scrambled order such that the same category never appeared twice in a row.

In the category-wise blocked booklets, all category–exemplar pairs per category appeared in succession. The filler category – exemplar pairs in the mixed booklets appeared largely at the beginning. The filler category –exemplar pairs in the blocked booklets appeared as block at the beginning and at the end of the list. Fillers were used to eliminate primacy and recency effects.

Retrieval practice booklets contained a total of 12 category name-word stem pairs (e.g. Fruit – Ba____), with a total of three of six exemplars of four of the eight experimental categories. Each pair appeared singly per page and word stems always consisted of the first two letters of the to-be-retrieved exemplar. Counterbalancing was done across participants, such that each study category was used equally often as a practiced or nonpracticed category during retrieval practice, and each exemplar within each practiced category served equally often as Rp+ and Rp- items. Each experimental pair was repeated three times across the booklet to ensure sufficient retrieval practice, whereas filler pairs appeared only once. All booklets started and ended with the same 12 filler pairs. Thus, each retrieval practice booklet contained 48-pages of 12 filler and 36 experimental category-exemplar trials per page.

The distractor task (see Appendix D) consisted of a set of 25 arithmetic questions for which participants were given 20 minutes. The materials of the final recall phase were of two kinds. The category cued recall test booklet was a 9-page booklet, with a category name on top of each otherwise blank page. The first page always started with a filler category, followed by eight experimental category names, one per page, to serve as retrieval cues. The ordering of the experimental category cues was done semi-randomly to ensure that practiced and nonpracticed experimental categories would not cluster at

the beginning or end of the booklet. The ordering of practiced and nonpracticed categories was counterbalanced across participants.

The category-plus-stem cued recall test booklet was a 54-page booklet (48 experimental and six filler items) that had on each of its page a category name and the first letter of a specific exemplar on it (Fruit – A_____). Ordering was blocked by category. Filler categories appeared in the first parts of the booklet. Overall, the ordering of to-be-retrieved exemplars was done such that all three item types (Rp+, Rp- and Nrp) were scattered more or less evenly across the test list to prevent differential retrieval order effects. The ordering of practiced and nonpracticed categories was once again counterbalanced across participants. In addition, for the practiced categories, the Rp+/ Rp- alternation was fixed such that the first tested exemplar would always be an Rp- item for each participant (i.e., Rp-, Rp+, Rp-, Rp+ etc.). Hence the particular exemplar tested in first position had to differ depending on the items' retrieval practice condition to ensure that it would be an Rp- item.

2.1.3 Design and procedure

The design was a 3 (retrieval practice status: Rp+, Rp-, Nrp) x 2 (category-wise study order: blocked vs. mixed) mixed design with retrieval practice status as the within-participants variable. Number of correctly retrieved exemplars at the final category or category-plus-stem cued recall test served as the dependent measure.

Participants were tested individually or in groups of up to four. They were told that the study was about reasoning and memory (see Appendices E and F) and that they would receive a study booklet with category-exemplar pairs. Their task was to memorize the exemplars for a subsequent recall test. Participants were informed that they would

have 5 s per pair, after which a voice recording would tell them to turn the page until all 60 pairs were studied. Immediately after the study phase, participants were randomly assigned to one of the four counterbalancing retrieval practice groups. They were informed that they would receive a short retrieval practice session, in which they would receive category-word stem pairs (e.g., Fruit –Ba_____). Their task would be to retrieve the cued exemplar within 10 s, after which a voice recording would tell them to turn over the page for the next category-word stem pair. After this phase, participants were given a 20-min distractor task composed of 25 arithmetic questions.

In the final recall phase, participants received either a category cued recall test (e.g. Fruits:) or a category-plus-stem cued recall test (e.g. Fruit – B____). Participants assigned to the category cued recall test were given 30 s per category to list all the exemplars they could remember from the study phase. Participants assigned to the category-plus-stem cued recall test were given 5 s per category-stem pair to retrieve the cued target exemplar. After each five seconds a voice recording told them to turn the page and proceed to the next item.

2.2 Results

2.2.1 Retrieval practice performance

Retrieval success during retrieval practice was 96% for the category cued recall group and 93% for the category-plus-stem cued recall group. The independent t-test did not reveal a significant difference for mixed condition (M = .96, SD = .07) and for blocked condition (M = .96, SD = .07); $t(30) = .21$, $p > .10$, in category cued recall group as well as for mixed condition (M = .93, SD = .14) and for blocked condition (M = .93, SD=.12); $t(30) = 0.11$, $p > .10$, in category-plus-stem cued recall group.

2.2.2 Category-cued recall test

A 2 (study order: mixed vs. blocked) x 3 (retrieval practice status: Rp+, Rp-, Nrp) mixed-design ANOVA revealed a main effect for both retrieval practice status, (F(2, 60) = 66.84, MSE= .77, p < .001, η_p^2 = .69). But since we were not interested in the general mean differences between Rp+, Rp- and Nrp items but rather, in the difference between Rp- and Nrp recall in each type of group, we did not apply a post hoc test. We also obtained a main effect for study group which indicated that the overall recall performance was higher in the blocked study order group (M = .72, SD = .13) compared to the mixed study order group (M = .63, SD = .20), F(1, 30) = 5.04, MSE= 1.21, p < .05, η_p^2 = .14. Importantly, we found an interaction effect between study order and retrieval practice status (i. e., Rp- vs. Nrp), which revealed a retrieval-induced forgetting effect (Rp- < Nrp) for the mixed but not blocked study order group, F(2, 60) = 4.07, MSE= .77, p < .001, η_p^2 = .12 (Figure 1). Since our main interest was in the retrieval-induced forgetting effect, i.e., an Rp- < Nrp difference, we ran paired t tests in each group. As expected, Rp- items (M = .47, SD = .12) were significantly less recalled than Nrp items (M =.57, SD = .13) in the mixed study group, t(15) = 2.86, p < .05. This difference was not significant in the blocked study group (M = .65, SD = .17 and M = .65 and SD = .23, for Nrp and Rp- items, respectively, t(15) = .74, p > .10).

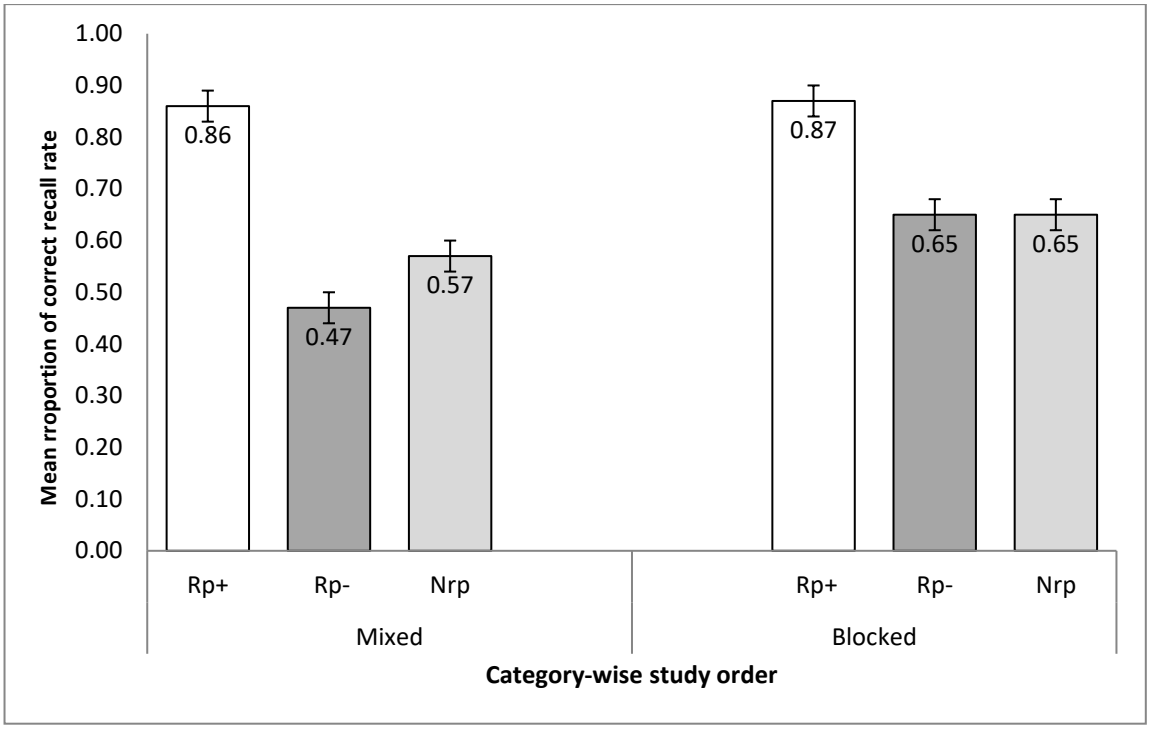

Figure 1. Mean proportion of correct recall (with standard error bars) at final category cued recall in Experiment 1 as a function of retrieval practice status and category-wise study order.

2.2.3 Category-plus-stem cued recall test

A 2 (study order: mixed vs. blocked) x 3 (retrieval practice status: Rp+, Rp-, Nrp) mixed-design ANOVA only revealed a main effect for retrieval practice status, (F(2, 60) = 51.36, MSE= .54, p < .001, η_p^2 = .63). As can be seen in Figure 2, this main effect was entirely caused by the number of recall Rp+ items, whereas the mean recall rates of Nrp and Rp- items was almost equal in both groups.

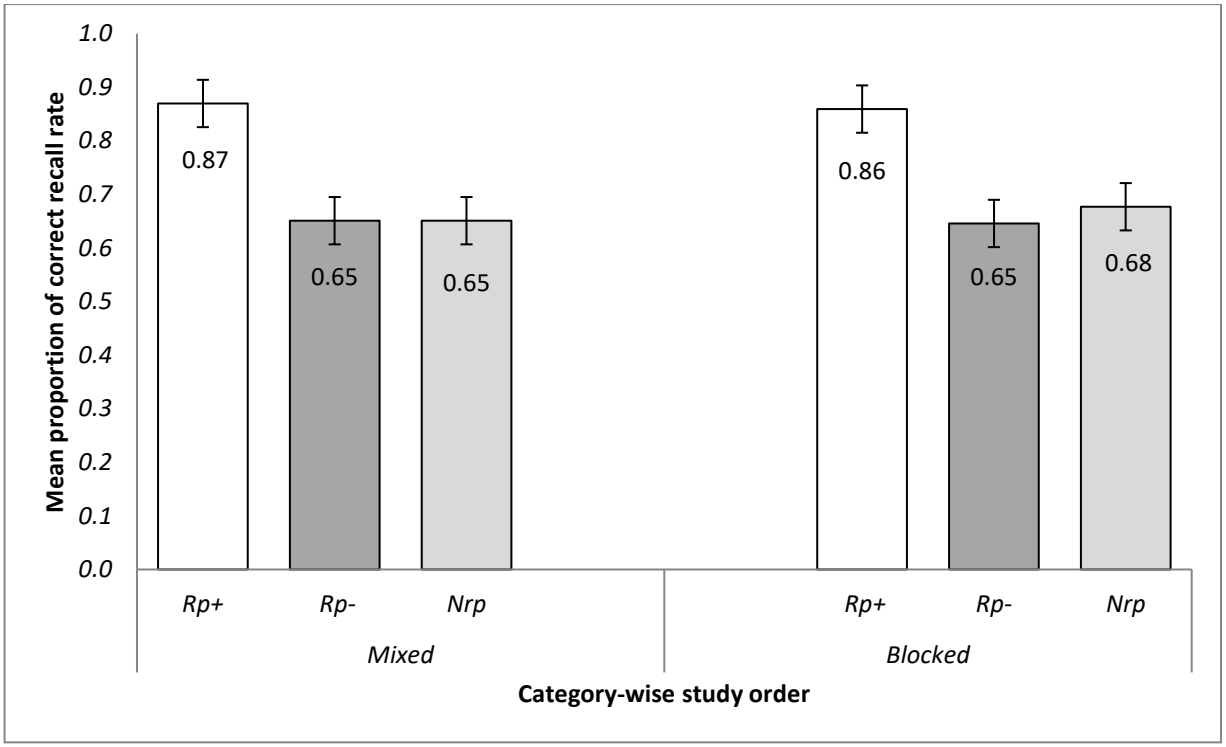

Figure 2. Mean proportion of correct recall (with standard error bars) at final category-plus-stem cued recall in Experiment 1 as a function of retrieval practice status and category-wise study order.

2.3 Discussion

Our findings in category cued recall using the conventional random presentation method during study replicated previous findings (e.g. Anderson, et al 1994) in that both a retrieval-induced facilitation effect (Rp+ > Nrp, with Nrp representing baseline recall) and a retrieval-induced forgetting effect (Rp- < Nrp) was observed. On the other hand, presenting exemplar items in a category-wise ordered fashion during study eliminated the retrieval-induced forgetting effect, while maintaining the facilitation effect (i.e., Rp+ > Rp- = Nrp). Given earlier studies that showed a similar disappearance of retrieval-induced forgetting through various processes of semantic integration (e.g., Chan, 2009,

Goodman & Anderson, 2011), this was exactly what we had expected. Our results showed that the mere categorization of study items without explicit integration instructions was sufficient to eliminate retrieval-induced forgetting. Most likely, when receiving the category-exemplar pairs in a category-wise ordered fashion during study, participants started integrating all within-category exemplars with each other since we know from the Goodmon & Anderson (2011) study that they do so even under incidental memory conditions. Since in our study participants were informed about the memory test, it is even more certain that such integration did take place. Once integrated, on the other hand, items are expected to no longer act as competitors during retrieval practice. Instead, the retrieval of Rp+ items during retrieval practice may even lead to latent rehearsal of the remaining Rp- items since they are well-integrated with each other and hence be strongly facilitating each others' recall without necessitating suppression. This finding of no retrieval-induced forgetting when using a category-wise ordered category-exemplar study list seems strongly in line with Goodmon & Anderson's (2011) finding that retrieval-induced forgetting disappeared for strongly related Rp+/Rp- pairs such as Horse and Pony, but not for less related ones such as *Lion* and *Eagle*.

On the other hand, when using a category-plus-stem cued recall test, retrieval-induced forgetting disappeared not only in the blocked presentation condition, which was as expected, but also in the random presentation condition. The purpose of testing retrieval-induced forgetting with a category-plus-stem cued recall test was to control for output order effects. Even though previous studies were able to show retrieval-induced forgetting with a category-plus-stem cued recall test (e.g., Anderson et al., 1994) we were not able to do so. It could have been that the way we structured our final recall phase was crucially different from the way it was structured in other studies. In

Anderson & McCulloch (1999), for instance, the items cued first during final test were kept constant which means that due to counterbalancing retrieval practice status, the cued targets were Rp- items in half of the cases, but Rp+ items in the other half of the cases. We, on the other hand, made sure that in the final recall test the first to-be-retrieved exemplars per category were always Rp- items, and the last to-be-retrieved exemplars per category were always Rp+ items. This way, we continuously maximized the likelihood of an Rp- item to be recalled at test per category and hence also in relation to Nrp items. It is worth noting that Butler, Williams, Zacks & Maki (2001), too, "lost" the effect when using a category-plus-stem cued recall instead of a category cued recall test. We do not know what exactly their item order was at final test but we think it is possible that it was as strict as ours to prevent lower Rp- recall due to output order.

CHAPTER 3

EXPERIMENT 2

The goal of the second experiment was to test the inhibition hypothesis more directly. Although Anderson et al.'s (1994) findings suggests that retrieval practice leads to inhibition of unpracticed items from practiced categories, we cannot be sure to what extent response competition is really happening. This remains to be a major weakness of inhibition-based retrieval-induced forgetting studies since the inhibition hypothesis crucially depends on the assumption that competing Rp- exemplars are remembered but then inhibited while recalling Rp+ items during retrieval practice (e.g. Anderson et al., 1994). Although some studies (e.g. Anderson & Spellman, 1995; Saunders & MacLeod, 2006) provide evidence that the representation of Rp- items are inhibited (or suppressed), some studies (e.g. Williams & Zacks, 2001, Raaijmakers & Jakab, 2012) seem to show otherwise.

The present study addressed the response competition component of the inhibition hypothesis in a more direct way than has been done so far. This was done by using a setup that would almost guarantee response competition processes to occur during retrieval practice, i.e., by including categories which had pairs of exemplars starting with the same first letter (e.g., items for the category Fruit would be Plum, Peach, Apple, Apricot, Coconut, Cranberry), something that has so far intentionally been avoided in retrieval-induced forgetting studies. At retrieval practice, only the first letter of the Rp+ exemplar was provided but together with word length information to prevent wrong retrieval (e.g., Fruit – P_ _ _, Fruit - A_ _ _ _ _ _; Fruit- C_ _ _ _ _ _ _ _). This setup not only increased the probability and degree of response competition, but it also

allowed us to know which specific exemplar would act as an Rp- competitor to the Rp+ item (e.g., Peach for Plum).

Finally, keeping the other half of the categories as usual, i.e., with exemplars that did not share first letters, gave a unique opportunity to compare the amount of retrieval-induced forgetting for these two different conditions. To control for output order effects a category-plus-stem cued recall test was used as a final test. Since we were not able to find a retrieval-induced forgetting effect with this type of test, we predicted to replicate this null-finding (i.e. Rp- = Nrp), with the different-letter exemplars but expected to find the RIF effect (i.e. Rp- < Nrp) with the same-letter exemplars because of the fortified response competition during retrieval practice.

3.1 Method

3.1.1 Participants

Forty-eight undergraduate students from Boğaziçi University took part in the study and received course credit for their participation.

3.1.2 Materials

Eight experimental categories (Fruits, Clothes, Colors, Sports, Vegetables, Musical Instruments, Animals, Spices) and two filler categories (Relatives and Precious Stones) were selected from the Turkish category norms of Peynircioğlu (1988). Care was taken to keep the experimental material, both in terms of category and category exemplars, as similar as possible to the ones used in Experiment 1. Hence, similar to Experiment 1, each category had six exemplars of similar rank order and taxonomic frequency. Two parallel (see Appendix G) sets were constructed for all eight categories to ensure that

each category appeared both in the same and different first letter conditions across participants. In one set of study booklets (Set A), half of the categories consisted of pairs of exemplars with same first letters (e.g., Fruits, Clothes, Animals, Spices) whereas the other half consisted of exemplars with unique first letters (e.g., Colors, Sports, Vegetables, Musical Instruments). In the other set of study booklets (Set B), the categories which had same first letter exemplars in the first group (e.g., Fruits, Clothes, Animals, Spices) had this time unique first letter exemplars and those that had unique first letter exemplars (e.g., Colors, Sports, Vegetables, Musical Instruments) had same first letter exemplars.

For each study set, two different retrieval practice booklets were constructed to counterbalance retrieval practice status across participants. Thus, each of the eight categories appeared equally often as a practiced category with same first letter exemplars, a practiced category with different first letter exemplars, a nonpracticed category with same first letter and a nonpracticed category with different first letter exemplars.

Retrieval practice booklets contained category-exemplar pairs in which the first letter of a to-be-practiced exemplar was succeeded by short dashes to indicate word length of the target (e.g., Fruit – A_ _ _ _ _ _). For half of the categories there were always two possible candidates per trial starting with that letter (e.g., Apple and Apricot) but word length information restricted the target to only one correct answer (i.e., Apricot).

Even though category-norm frequency values (see Appendices H and I) were matched as much as possible, in the few cases in which the two same-first-letter exemplars differed to a larger extent, the less frequent category exemplar was used as

Rp+. This was to ensure the remembering of the higher frequency Rp- competitor (e.g., Apple) during retrieval practice (which, of course, would subsequently have to be suppressed because of word length mismatch).

At the end of the retrieval practice booklets, there were questions asking participants whether they had experienced any difficulties in retrieving an item and whether alternative responses (i.e. same-first-letter competitors) came to their minds during retrieval practice. The distractor task was the same as in Experiment 1.

The final test booklet was a category-plus-stem cued recall test booklet, which had eight versions because in addition to counterbalancing the ordering of practiced and not practiced categories and keeping Rp-/Rp+ ordering fixed across participants (as described in Experiment 1), we also counterbalanced the ordering of the categories in terms of their category-exemplar type.

3.1.3 Design and procedure

The design was a 3 (retrieval practice status: Rp+, Rp-, Nrp) x 2 (category-exemplar type: categories with same or different first letter exemplars) all repeated measures design. The dependent variable was correct recall in a final category-plus-stem cued recall test

The study phase was the same for the mixed study order group in Experiment 1. Participants then received the retrieval practice booklet. They were told that on each page of the booklet they would have to retrieve the correct exemplar cued with its category name and its first letter. Besides, they were told that the short dashes indicated number of letters the word contained and that they should be careful not to violate word

length information because those cases would count as errors. Participants were given 15 s for each retrieval practice item.

The distractor phase was the same as in Experiment 1 and was followed by a final category-plus-stem cued recall test phase, which was delivered in the same way as in Experiment 1.

3.2 Results

3.2.1 Retrieval practice performance

Participants' mean retrieval success rate during retrieval practice was lower in Experiment 2 (78%). This was not surprising since the retrieval practice session was more challenging this time: only the first letter instead of the first two letters of the to-be-retrieved exemplar was provided; word length information was provided which in itself created an extra processing load; and most important, for half of the cases, word length information was the key factor to decide which of the same-first-letter candidates was the one to be retrieved. We observed an average retrieval success rate of 78% for categories which had exemplars with different first letters and of 77% for categories which had exemplars with same first letters. Unlike in Experiment 1, in which Rp+ items were consistently and correctly retrieved on each of the three trials, in Experiment 2, we counted a one-time correct recall (which was almost always on the third appearance) as retrieval success. This might explain why the difference between the same and different first letter exemplar conditions was negligible.

3.2.2 Category-plus-stem cued recall

A 3 (retrieval practice status: Rp+, Rp-, Nrp) x 2 (category-exemplar type: categories with same or different first letter exemplars) repeated measures ANOVA on participants' correct recall rates in the final category-plus-stem cued recall test revealed a significant main effect for retrieval practice status ($F(2, 94) = 30.95$, $MSE = .03$, $p < .001$, $\eta_p^2 = .40$). Bonferroni post hoc tests of comparison with an α-value set at .05 revealed significant differences between all three item types with Rp- items producing the lowest recall rates ($M = .62$, $SD = .19$). We also found a main effect for category-exemplar type ($F(1, 45) = 14.92$, $MSE = .03$, $p < .001$, $\eta_p^2 = .24$) , showing that category exemplars with different first letters were overall better recalled ($M = .74$, $SE = .18$) than those with same first letters ($M = .67$, $SD = .17$).

Of primary interest was to see whether there was an interaction between retrieval practice status and category-exemplar type.

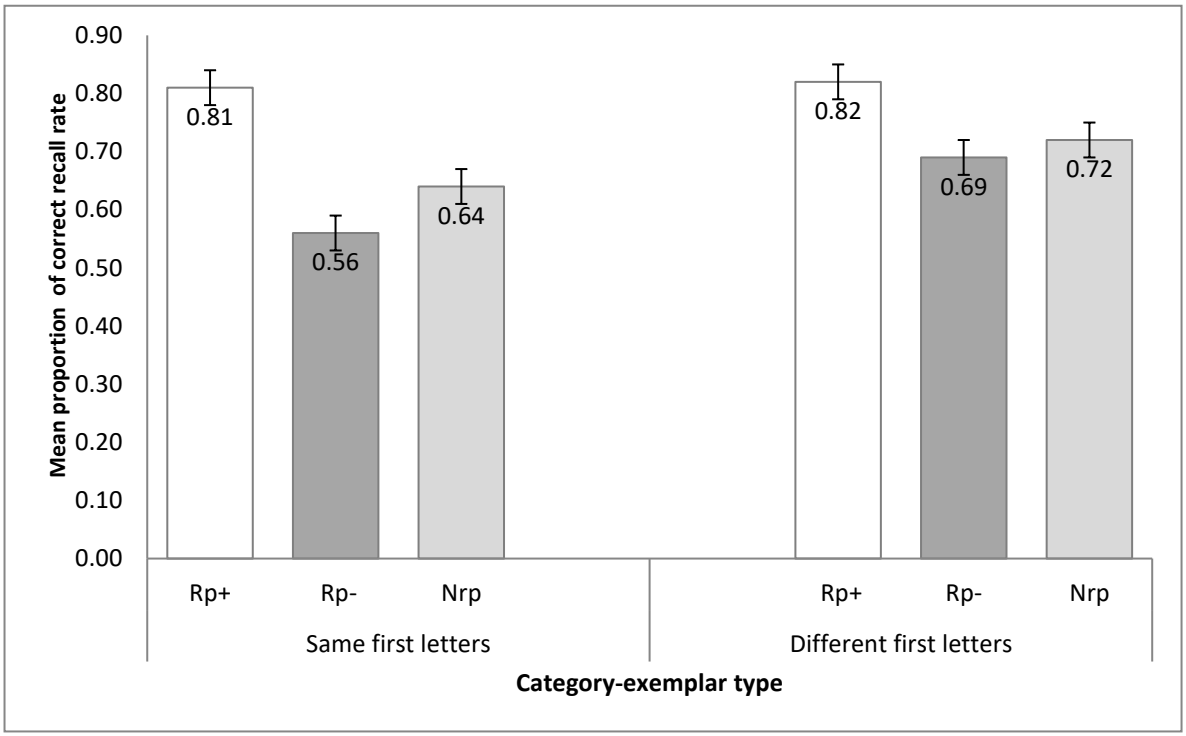

Figure 3. Mean proportion of correct recall (with standard error bars) at final category-plus-stem cued recall in Experiment 2 as a function of retrieval practice condition and category-exemplar type.

This interaction turned out to be significant, $F(2, 90) = 3.66$, $MSE = .03$, $p < .05$, $\eta_p^2 = .07$, as can be seen in Figure 3. A paired t-test for exemplars with different first letters did not reveal a difference between Rp- and Nrp items ($M = .69$, $SD = .21$ and $M = .72$, $SD = .15$, respectively, $t(47) = 1.00$, $p > .10$), which replicates our null finding in the mixed study order condition for category-plus-stem cued recall in Experiment 1. But for exemplars with same first letters, we did observe a retrieval-induced forgetting

effect, i.e., significantly fewer Rp- items were correctly recalled than Nrp items (*M* =.56, *SD* = .17 and *M* =.64, *SD* = .15, respectively, $t(47) = 2.72$, $p < .01$).[1]

3.3 Discussion

The main purpose of this experiment was to further look into the inhibition hypothesis which focuses on the competition between Rp+ and Rp- items during retrieval phase as an explanation for the retrieval-inducing forgetting phenomenon. According to this hypothesis, in the retrieval practice phase Rp- items come to the edge of being recalled but are then inhibited to deliver the correct response, which is the Rp+ item. A basic assumption here is that category names are strong enough to evoke all studied (probably even unstudied) category members during retrieval phase even if they directly conflict with the stem provided as a cue. But why should Animal - Li_____ evoke Tiger at all?

In our experiment we aimed at directly addressing this paradox by having half of our categories include exemplars which shared first letters. (e.g., Animal – L_ _ _ _ _ _ , with the category involving both Leopard and Lion). By providing word length information during retrieval practice we made sure participants would still practice the exemplar assigned as Rp+. Presenting Animal - L_ _ _ _ _ _ was now much more likely to trigger a competition with another studied exemplar, Lion, which though would have to be ruled out due word length mismatch. By keeping the other half of our categories as usual, i.e., as categories with exemplars that did not share first letters, we gained a unique opportunity to compare the amount of retrieval-induced forgetting for

[1] We also looked at whether word frequency could have played a partial role in finding RIF in the same first letter but not different first letter conditions. The 7.4% RIF effect (Nrp - Rp- = %64 - %56, see Fig. 3) remained even when controlling for the effect of word frequency. The estimated β values for the effect of word frequency on recall performance were .46 for Nrp items (p=.012) and .45 for Rp- items (p=.013), revealing an almost *identical* positive influence of word frequency on recall performance for Nrp and Rp- items.

categories with the conventional different-letter exemplars with the amount of retrieval-induced forgetting for those with the same-letter exemplars. Based on our findings from Experiment 1, we expected no retrieval-induced forgetting for Rp- items that had different-letter competitors. But based on the inhibition hypothesis, we did expect to find a retrieval-induced forgetting effect for Rp- items that had same-letter competitors due to enhanced Rp+ and Rp-item competition during retrieval practice. Our predictions were supported. We replicated our null finding with different-first-letter exemplars when using a category-plus-stem (i.e., an output order controlling) type of final recall test. But more importantly, we were able to obtain a retrieval-induced forgetting effect for Rp- items that had same-first-letter competitors. In other words, by increasing the degree of response competition during retrieval practice by using Rp+/Rp- items with same first letters, retrieval-induced forgetting occurred even with a memory test that controls output-order.

CHAPTER 4

GENERAL DISCUSSION

The aim of this research was to look at the effect of response competition during retrieval on later recall of items. In two experiments we either decreased this response competition by grouping all category-exemplar study pairs by category (Experiment 1), increase it by using same-first-letter cues during retrieval practice (Experiment 2). As predicted by the inhibition account (Anderson, 2003), RIF disappeared in the former setup and observed in the latter.

According to Anderson (2003), response competition is a prerequisite for inhibition. Furthermore, inhibition is only to occur as a result of retrieval instead of restudy or reexposure ("retrieval specificity", see Anderson, Björk & Björk, 2000). While there are some studies which revealed RIF-like forgetting after restudy, reexposure or a non-competitive retrieval practice paradigm (Jonker & MacLeod, 2012; Jonker, Seli, & MacLeod, 2013; Raaijmakers & Jakab, 2012; Rupprecht & Bäuml, 2017) quite a large number of studies suggest the opposite (Anderson, Bjork, & Bjork, 2000; Bäuml & Aslan, 2004; Ciranni & Shimamura, 1999).

In an interesting study, Jonker and MacLeod (2012) used a subordinate generation task to differentiate between retrieval practice per se as opposed to retrieval practice of *relevant* target items. After studying category-exemplar pairs (e. g., Pet-Dog) participants had to generate subordinate category members to some of the studied basic level categories (e. g., Dog – Cocker). In this task, generated subordinate category members (e.g., Cocker) were treated as Rp+ items and remaining (not generated)

exemplars of the same category as Rp-items. Consistent with the retrieval specificity criterion of the inhibitory account, no RIF was detected.

Effect of re-exposure on final memory tests was examined in some recent studies. In a study by Rupprecht and Bäuml (2016), subjects were asked to rate pleasantness of previously studied items, hence they were re-exposed to a subset of those studied material. Consistent with the inhibitory account, no RIF was observed in a subsequent recognition test. Similarly, in a study by Buchli, Storm and Bjork (2016), subjects were asked to engage in a mental imagery task after re-exposure, again no RIF was observed.

Chan and colleagues tested the effect of response competition by doing a slight alteration in the retrieval practice paradigm (Chan, Erdman & Davis, 2015). In the high competition condition, the actual retrieval practice phase was preceded by repetitive retrieval practice on Rp- items hence making them more accessible as competitors during the real retrieval practice phase. In contrast, in the low competition condition, there were no competing Rp- items. As expected, RIF was eliminated in the low competition condition and enhanced in the high competition condition.

In the literature, it is a well-established fact that semantic similarity between Rp+ and the Rp- exemplars attenuate the retrieval induced forgetting (e.g. Bäuml & Hartinger, 2002; Goodman & Anderson, 2011). Increased semantic relatedness between Rp+ (e. g., Animal – Lion) and Rp- (e.g., Animal – Tiger) items decrease the competition among them. In other words, when competing exemplars belong to same subcategory (Animal, Predator) both benefit from retrieval practice (Bäuml & Hartinger, 2002). This assumption is congruent with arguments of an inhibitory account, since according to that account, with the target and non-target being closely associated with

each other, such inhibition of the non-target representation may not be possible (see Anderson & Spellman, 1995). In the classical experiment by Anderson et al. (1994), exemplars of same semantic category were studied in random order, which precluded participants from relating them with each other consciously. In Bäuml and Hartinger's 2002 experiment, subcategory was explicitly stated (e.g. Animal – Predator - Tiger) to make interrelatedness between Rp+ and Rp- exemplars salient. In our study, by presenting same category members in succession we made the interrelatedness salient, thereby turning Rp+/Rp- competition into Rp+/Rp- "cooperation". Successive presentation of same category exemplars facilitated semantic integration of those same category exemplars which in turn attenuated the competition among them in retrieval practice phase, and hence abrogated retrieval induced forgetting even in free recall. In the second phase of this experiment, we adopted a category-plus-stem method in final recall, expecting to find similar findings. However, we "lost" the RIF effect even under the mixed presentation condition. There are two possible explanations for these unexpected results. First, in previous studies (e.g. Anderson et al., 1994; Anderson & McCulloch, 1999; Anderson, et al., 2000), Rp- items appeared half of the times in first position (e. g., Rp-, Rp+, Rp+, Nrp, Rp- etc.) in the final category-plus-stem recall tests, and half of the times in second position (e. g., Rp+, Rp-, Rp-, Nrp, Rp+ etc.). We, on the other hand, presented Rp- items always in first order to eliminate the possibility of obtaining a RIF effect simply due to low recall of Rp- items as a result of output interference.

Second, we selected study material from exemplars with the frequency of moderate to high instead of moderate to low frequency values. It could have been that the final cued recall test became convenient enough for guessing rather than recollecting.

In previous studies, implicit tests did not lead to RIF effects, i. e., when familiarity is enough to solve a test, then RIF effect disappears. In the speeded recognition test of Verde and Perfect's (2011) study, for instance, since the familiarity was enough for correct response RIF disappeared. Whereas when they encouraged recollection and subjects were instructed to solve the test in a self-paced fashion, RIF reappeared.

The two main theories to explain the mechanism of RIF were strength-based theories and inhibition-based theories. Originally this study was not designed to refute strength-based theories which focuses on the dyadic association between item pairs in relative terms. According to these theories, cue – target associations (e. g., Animal – Tiger) are strengthened after rounds of retrieval practice that cue – competitor associations (e. g., Animal – Leopard) are weakened compared to them, which inevitably decreases the recall probability of competitor items attached to the same cue. Inhibition-based theories do not focus on this cue – target relation but focus on the competition among target and non-targets. According to these theories, competition between target competitors results in inhibited representation of competitor. In this study we specifically attempted to test critical role competition by manipulating degree of target-competitor competition. Congruent with inhibitory account predictions, increased competition led to greater retrieval induced forgetting. However, there has been a more recent third approach to explain the possible mechanism underlying RIF which is a context-based account.

4.1 Context-induced forgetting and the present study

For the context account, retrieval and competition are not necessary but context change is (Jonker et al, 2013; Soares, Polack, & Miller, 2016). Proponents of context-based

forgetting postulate that context shift between study and practice, and reinstatement of practice context in final test are responsible from the impaired recall of Rp- items in final recall (Jonker et al., 2013). Yet, there is no clear operational definition of context shift. Retrieval in itself was proposed as the reason of context shift, since during retrieval practice participants engage in active search for correct responses leading to internal context shift from passive to active (Soares et al, 2016). In some studies, change in physical environment in which learning and testing took place was also used to manipulate context shift (see Jonker et al., 2012; .Migues et al, 2014; Rupprecht & Bäuml, 2017; Soares et al, 2016). In Jonker et al.'s (2013) study, a video was presented during the study phase, and some other video was presented during the practice phase. If the latter video (i.e. practice video) was played during final test, RIF was observed, whereas if the former one (i.e., study video) was played, RIF decreased. According to premises of context account, reinstatement of practice context in final would impair recollection of Rp- items but not of Nrp items whereas reinstatement of study context would aid recollection of Rp- items, thereby eliminating RIF. Research testing these assumptions produced conflicting results. Soares et al. (2016) did not replicate the findings of Jonker et al. (2013). They found no RIF when final context and retrieval context were similar, and both were different from final test. Furthermore, they found RIF effects even when study context was reinstated at final test. There is also a number of recent studies (Migues et al, 2014; Rupprecht & Bäuml, 2017) which showed that context shift and subsequent reinstatement were sufficient neither for increasing nor for decreasing forgetting of unstudied related material.

Our study was not designed for test assumptions of the context-based account. Nevertheless, we would like to discuss to what extent a context-based assumption may

explain our findings. First of all, inasmuch as there were internal context shifts between study and retrieval, these remained constant across manipulations (blocked vs mixed presentation, and same vs different cue) in all the three experiments. However, whether or not, study context was reinstated in final recall has importance according to arguments of context-based account. In the learning phase, participants heard a recording of a male voice saying "next page" every five seconds. In the practice phase, participants heard the same "next page" call every 10 seconds. In the first study, we did not use this recording in final recall. An ordinary beep designated transition between categories every 30 seconds. This lack of reinstatement could have been and alternative or additional reason for the impaired recall of Rp- items. In Experiment 2, where there was no free recall test but only a category-plus-stem cued recall test in the end, we had to use again the same "next page" recording every five seconds. If that same recording had helped the reinstatement of study context in final test, it might explain why there was no RIF in both mixed and blocked condition. However, if context reinstatement were sufficient for elimination of RIF, then it should also have disappeared in same first letter condition of Experiment 2.

As stated, this study was not particularly designed to test the context-based account, therefore we refrain ourselves from making further inferences. Nevertheless we may argue that context-based and inhibitory accounts are not mutually exclusive for explaining the mechanism of forgetting. Context of Rp- items were inhibited alongside of Rp- (Gomez-Ariza, Fenandez, & Bajo, 2012). Recollection of context, on the other hand, improved memory retention (Whiffen, & Karpicke, 2017). Based on such finding, we may as well argue that both theories are not mutually exclusive and context reinstatement may act as a buffer against forgetting.

Finally, we would like to emphasize that the inhibitory account does not require task specificity, which boost its external validity. Effects of inhibition may manifest themselves in creative problem solving task (Angello Storm, & Smith, 2015, Gómez-Ariza, Del Prete, del Val, Valle, Bajo, & Fernández , 2017) or learning new association (Vadillo, Orgaz, Luque, Cobos, Lopez, & Matute, 2013). Context-based account, on the other hand, can only account for memory test type settings and hence has only limited outreach.

4.2. Conclusion

As McGeoch (1932) had argued long time ago, activities that fill the delay between learning and recalling may deteriorate performance in recalling. Relatedly, he emphasized that interpolated activities, especially the repetition of the studied material, might constitute a boundary against recalling of the material itself and formulated his ideas in these words “Forgetting is active blocking rather than a passive decay” (p.364). Similarly, Anderson et al. (1994) affirmed that “remembering can cause forgetting”, yet added that practicing items is beneficial for their later recall after, however related but unpracticed material suffers from this practice, thus having impaired recall rate in subsequent recall. The impairment of those materials with respect to recall rate was assessed in accordance with the items from unpracticed groups (i.e. baseline). Although Anderson and colleagues identified this phenomenon using semantic categories and category – exemplar association, later several studies replicated RIF with reading material (e.g. Chan, 2009), feature item association (Raajimakers & Jakab, 2012), shape –location association (Ciranni & Shimamura, 1999), semantically unrelated items that lack associations (Abel & Bauml, 2012), lexical decision tasks (Veling & van

Knippenberg, 2004), suggesting some generality of the RIF phenomenon. Yet, the exact mechanisms behind this phenomenon have remained unresolved.

APPENDIX A

STUDY LIST FOR EXPERIMENT 1

Set A			Set B		
MEYVE *(Fruit)*	Erik *(Plum)*	Vişne *(Cherry)*	SEBZE *(Vegetable)*	Kereviz *(Celery)*	Lahana *(Cabbage)*
	Çilek (Strawberry)	Şeftali *(Peach)*		Fasülye *(Bean)*	Domates *(Tomato)*
	Kayısı *(Apricot)*	Üzüm *(Grape)*		Patlıcan *(Eggplant)*	Enginar *(Artichoke)*
GİYİM *(Cloth)*	Gömlek *(Shirt)*	Palto *(Overoat)*	MÜZİK ALETİ *(Musical Instrument)*	Flüt *(Flute)*	Davul *(Timpani)*
	Çorap *(Socks)*	Ceket *(Jacket)*		Saz *(Saz)*	Keman *(Fiddle)*
	Hırka *(Cardigan)*	Eldiven *(Glove)*		Bateri *(Drums)*	Org *(Organ)*
HAYVAN *(Animal)*	İnek *(Cow)*	Eşek *(Donkey)*	METAL *(Metal)*	Bakır *(Copper)*	Gümüş *(Silver)*
	Aslan *(Lion)*	Koyun *(Sheep)*		Kurşun *(Lead)*	Çinko *(Zinc)*
	Deve *(Camel)*	Tilki *(Fox)*		Sodyum *(Sodium)*	Pirinç *(Brass)*
MESLEK *(Occupation)*	Avukat *(Lawyer)*	Mühendis *(Engineer)*	MATBUA *(Printed Material)*	Dergi *(Journal)*	Kitap *(Book)*
	Dişçi *(Dentist)*	Tüccar *(Merchant)*		Şiir *(Poem)*	Hikaye *(Story)*
	Öğretmen *(Teacher)*	Psikolog *(Psychologist)*		İlan *(Bill)*	Makale *(Article)*

Categories of either set A or set B were used during retrieval practice. Within each category, columns indicate which subset received retrieval practice and which one did not, and vice versa during counterbalancing.

APPENDIX B

FREQUENCY[2] OF EXEMPLARS IN EXPERIMENT 1 ACCORDING TO NEW AND OLD NORMS

Category	Exemplar	New	Old	Exemplar	New	Old
FRUIT	Plum	0.48	0.45	Cherry	0.33	0.25
	Strawberry	0.73	0.42	Peach	0.43	0.58
	Apricot	0.28	0.32	Grape	0.38	0.45
CLOTH	Shirt	0.54	0.61	Overcoat	0.10	0.53
	Socks	0.44	0.52	Jacket	0.38	0.38
	Cardigan	0.31	0.20	Glove	0.20	0.30
ANIMAL	Cow	0.64	0.54	Donkey	0.39	0.51
	Lion	0.55	0.47	Sheep	0.45	0.39
	Camel	0.12	0.18	Fox	0.10	0.18
OCCUPATION	Lawyer	0.45	0.36	Engineer	0.64	0.61
	Dentist	0.40	0.17	Merchant	0.02	0.22
	Teacher	0.79	0.51	Psychologist	0.18	0.14
VEGETABLE	Celery	0.21	0.44	Cabbage	0.31	0.64
	Bean	0.26	0.39	Tomato	0.61	0.44
	Eggplant	0.63	0.37	Artichoke	0.17	0.20
MUSICAL INSTRUMENT	Flute	0.62	0.57	Timpani	0.46	0.49
	Saz	0.39	0.31	Fiddle	0.74	0.45
	Drums	0.32	0.23	Organ	0.24	0.32
METAL	Copper	0.52	0.72	Silver	0.32	0.51
	Lead	0.05	0.15	Zinc	0.21	0.39
	Sodium	0.09	0.10	Brass	0.03	0.14
PRINTED MATERIAL	Journal	0.80	0.82	Book	0.92	0.63
	Poem	0.04	0.14	Story	0.03	0.19
	Bill	0.00	0.12	Article	0.08	0.13
MEAN		*0.39*	*0.38*		*0.32*	*0.38*

[2] Frequencies refer to number of appearances across 400 participants in “old” Peynircioğlu (1988) and Eraltan & Mungan norms (”new”).

APPENDIX C

FREQUENCY[3] OF EXEMPLARS IN EXPERIMENT 1 ACCORDING TO NEW AND OLD NORMS

(TURKISH)

Category	Exemplar	New	Old	Exemplar	New	Old
MEYVE	Erik	0.48	0.45	Vişne	0.33	0.25
	Çilek	0.73	0.42	Şeftali	0.43	0.58
	Kayısı	0.28	0.32	Üzüm	0.38	0.45
GİYSİ	Gömlek	0.54	0.61	Palto	0.10	0.53
	Çorap	0.44	0.52	Ceket	0.38	0.38
	Hırka	0.31	0.20	Eldiven	0.20	0.30
HAYVAN	İnek	0.64	0.54	Eşek	0.39	0.51
	Aslan	0.55	0.47	Koyun	0.45	0.39
	Deve	0.12	0.18	Tilki	0.10	0.18
MESLEK	Avukat	0.45	0.36	Mühendis	0.64	0.61
	Dişçi	0.40	0.17	Tüccar	0.02	0.22
	Öğretmen	0.79	0.51	Psikolog	0.18	0.14
SEBZE	Kereviz	0.21	0.44	Lahana	0.31	0.64
	Fasülye	0.26	0.39	Domates	0.61	0.44
	Patlıcan	0.63	0.37	Enginar	0.17	0.20
MÜZİK ALETİ	Flüt	0.62	0.57	Davul	0.46	0.49
	Saz	0.39	0.31	Keman	0.74	0.45
	Bateri	0.32	0.23	Org	0.24	0.32
METAL	Bakır	0.52	0.72	Gümüş	0.32	0.51
	Kurşun	0.05	0.15	Çinko	0.21	0.39
	Sodyum	0.09	0.10	Pirinç	0.03	0.14
MATBUA	Dergi	0.80	0.82	Kitap	0.92	0.63
	Şiir	0.04	0.14	Hikaye	0.03	0.19
	İlan	0.00	0.12	Makale	0.08	0.13
MEAN		*0.39*	*0.38*		*0.32*	*0.38*

[3] Frequencies refer to number of appearances across 400 participants in “old” Peynircioğlu (1988) and Eraltan & Mungan norms (”new”).

APPENDIX D

DISTRACTOR TEST

Sizden aşağıdaki aritmetik sorularını cevaplamanızı istiyoruz. Soruları cevaplamak için toplam 20 dakikanız var.
(We would like you to answer the following arithmetic questions. You have 20 minutes to answer)

1. $[(1/2)^{-4} - 1] \div 5 = ?$

2. $(3/5)^2 \cdot (1/5)^{-3} = ?$

3. $(3/7 + 1/14) \div (3/7 - 1/14) = ?$

4. $0{,}2 - (0{,}12 \cdot 0{,}1) = ?$

5. $4^{-3} + 4^{-3} + 4^{-3} + 4^{-3} = ?$

6. $(9)^2.(-3)^4.3^{-4} = ?$

7. $2^2.(4{,}5)^2 = ?$

8. $(2/5 \cdot 21) \div (1+2/5) = ?$

9. $\sqrt[4]{4} \cdot \sqrt[6]{8} \cdot \sqrt[8]{16} = ?$

10. $(2^3 + 2^3 + 2^3 + 2^3) \div (4^2 + 4^2) = ?$

11. $(0{,}8).10^{20}) + (0.02.10^{21}) = ?$

12. 18, x, 7, 4, 3, y, 2 dizisideki x + y toplamı kaçtı?
(What is the sum of x + y in the sequence of 18, x, 7, 4, 3, y, 2?)

13. $(2^{10}.3^9 + 3^9.2^9) \div 6^{24} = ?$

14. $2 + 1 \div 10 + 2 \div 10^3 = ?$

15. $(181^2.364^3) \div 9 = ?$

16. $(3^{85} - 3^{84}) \div 9^{42} = ?$

17. $3/2^{-2} - 1/12^{-1} = ?$

18. (2a-5)÷4+a = (3a+6)÷3 ise a'nın değeri kaçtır? *(What is value of a?)*

19. $9^x + 9^{x+1} + 9^{x+2} = 273$ ise x'in değeri kaçtır? (What is value of x?)

20. Ardışık dört çift sayının toplamı 60 tır. Bu sayıların <u>en büyüğü</u> kaçtır?
(*If the sum of four consecutive even integers is 60, what is the largest of the four integers?)*

21. 964*998 – 963*999 =?

22. $(\sqrt{108} + \sqrt{12}) \div \sqrt{48} = ?$

23. $a + 1/a = \sqrt{5}$ ise $(a - 1/a)^2$ kaçtır?
(if $a + 1/a = \sqrt{5}$ *then what is value of* $(a - 1/a)^2$ *?)*

24. $3*5^a + 2*5^{a+1} - 5^{a+2} = -300$ ise a'nın değeri kaçtır? *(What is value of a?)*

25. $3^{2a} + 3^{2a+2} + 3^{2a+4} = 273$ ise a'nın değeri kaçtır? *(What is value of a?)*

APPENDIX E

INFORMED CONSENT FORM

Title of Study:	Processes Affecting Long Term Memory
Name of Researcher:	Şirin Ezgi Eraltan (Graduate Student)
Name of Advisor:	Assistant Professor Dr. Esra Mungan
Address:	Boğaziçi University Psychology Department Bebek 34342 Istanbul

The purpose of this study is to understand the processes that affect individuals' long-term memory.

The study will consist of four phases. In the first phase, you will receive a list of words to be studied for a later memory test. In the second phase, you will be given a short memory test about the words you have studied. There will be an arithmetic test with simple numerical operations and a final memory test on the words from the first phase. The experiment will last approximately 40 minutes. You will be given 1 credit either for the PSY 101 or for PSY 241 course in return for your participation in the experiment..

If you have any further questions, please do not hesitate to contact the person who is conducting the experiment.

I have read and I understood the provided information. I received the necessary information from the researcher about the parts I did not understand.

I do/do not want a copy of this form.

Participant's name: Signature: Date:
Address, telephone:

This research is being conducted for scientific purposes, the information will be processed with confidentiality and the participant has the right to withdraw from the study at any time.

For questions:

Şirin Eraltan
sirin.eraltan@boun.edu.tr

Asst. Professor Dr. Esra Mungan
esra.mungan@boun.edu.tr tel: (212) 359 70 52

APPENDIX F

INFORMED CONSENT FORM

(TURKISH)

Araştırmanın adı:	Uzun süreli hafızayı etkileyen süreçler
Araştırmacının adı:	Şirin Ezgi Eraltan (Master öğrencisi)
Danışmanın adı:	Yrd. Doç. Dr. Esra Mungan
Adresi:	Boğaziçi Üniversitesi Psikoloji Bölümü Bebek 34342 Istanbul

Bu deneyin amacı kişilerin uzun dönem hafızalarını etkileyen süreçleri anlamaktır. Deney dört aşamadan oluşacaktır. İlk aşamada size öğrenmeniz için çeşitli kelimeler gösterilecektir. İkinci aşamada öğrendiğiniz bu kelimelerle ilgili size kısa bir hafıza testi verilecektir. Üçüncü aşamada ise size basit rakamsal işlemler yapmanızı istediğimiz bir aritmetik işlem testi ve bu testi takip eden dördüncü yani son aşamada ise size öğrendiğiniz kelimelerle ilgili yine bir hafıza testi verilecektir. Deney, ortalama 40 dakika sürecektir. Deneye katılmanız karşılığında size aldığınız PSY 101 ya da PSY 241 dersi için 1 kredi verilecektir.

Sormak istediğiniz bir soru varsa lütfen deneyi yapan kişiye çekinmeden sorunuz.

Yukarıdaki bilgileri okudum ve anladım. Anlamadığım kısımlar hakkında araştırmacıdan gerekli bilgileri aldım.

Formun bir örneğini aldım/almak istemiyorum.

Katılımcının Adı: İmzası: Tarih:
Adres, telefon:

Bu araştırmanın bilimsel amaçla yapılmaktadır, bilgilerin gizliliği esas alınmıştır ve katılımcının istediği an geri çekilme hakkı mevcuttur.

Sorular için:

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APPENDIX G

STUDY LIST FOR EXPERIMENT 2

Study Booklet 1

Set A – Categories with same first letter exemplars			Set B – Categories with different first letter exemplars		
MEYVE *(Fruit)*	Ananas *(Pineapple)*	Ayva *(Quince)*	SEBZE *(Vegetable)*	Domates *(Tomato)*	Lahana *(Cabbage)*
	Kiraz *(Cherry)*	Karpuz *(Watermelon)*		Fasülye *(Bean)*	Patlıcan *(Eggplant)*
	İğde *(Oleaster)*	İncir *(Fig)*		Enginar *(Artichoke)*	Kereviz *(Celery)*
GİYİM *(Cloth)*	Anorak *(Parka)*	Atlet *(Vest)*	MÜZİK ALETİ *(Musical Instrument)*	Kanun *(Zither)*	Zurna *(Clarion)*
	Şapka *(Hat)*	Şort *(Shorts)*		Akordeon *(Accordion)*	Trompet *(Trumpet)*
	Kravat *(Tie)*	Kaban *(Coat)*		Bateri *(Drums)*	Mandolin *(Mandolin)*
HAYVAN *(Animal)*	Zebra *(Zebra)*	Zürafa *(Giraffe)*	SPOR *(Sport)*	Yelken *(Sailing)*	Halter *(Weight Lifting)*
	Maymun *(Monkey)*	Manda *(Buffalo)*		Judo *(Judo)*	Bisiklet *(Cycling)*
	Tavşan *(Rabbit)*	Tilki *(Fox)*		Golf *(Golf)*	Kayak *(Skiing)*
BAHARAT *(Spice)*	Kimyon *(Cumin)*	Kekik *(Thyme)*	RENK *(Color)*	Bordo *(Maroon)*	Mavi *(Blue)*
	Safran *(Saffron)*	Sumak *(Sumac)*		Pembe *(Pink)*	Turuncu *(Orange)*
	Tuz (*Salt)*	Tarçın *(Cinnamon)*		Yeşil *(Green)*	Sarı *(Yellow)*

Study Booklet 2

Set A – Categories with different first letter exemplars			Set B – Categories with same first letter exemplars		
MEYVE *(Fruit)*	Vişne *(Cherry)*	Kayısı *(Apricot)*	SEBZE *(Vegetable)*	Karnabahar *(Cauliflower)*	Kereviz *(Celery)*
	Çilek (Strawberry)	Şeftali *(Peach)*		Bezelye *(Pea)*	Biber *(Peppers)*
	Üzüm *(Grape)*	Erik *(Plum)*		Patlıcan *(Eggplant)*	Pırasa *(Leek)*
GİYİM *(Cloth)*	Kaban *(Coat)*	Atlet *(Vest)*	MÜZİK ALETİ *(Musical Instrument)*	Mızıka *(Harmonica)*	Mandolin *(Mandolin)*
	Şapka *(Hat)*	Bluz *(Blouse)*		Kanun *(Zither)*	Klarnet *(Clarinet)*
	Çizme *(Boots)*	Hırka *(Cardigan)*		Bağlama *(Baglama)*	Bateri *(Drums)*
HAYVAN *(Animal)*	Koyun *(Sheep)*	Eşek *(Donkey)*	SPOR *(Sport)*	Beyzbol *(Baseball)*	Bisiklet *(Cycling)*
	Aslan *(Lion)*	İnek *(Cow)*		Hokey *(Hockey)*	Halter *(Weight Lifting)*
	Deve *(Camel)*	Tilki *(Fox)*		Koşu *(Running)*	Kayak *(Skiing)*
BAHARAT *(Spice)*	Köri *(Curry)*	Zencefil *(Ginger)*	RENK *(Color)*	Bej *(Beige)*	Bordo *(Maroon)*
	Tuz (*Salt)*	Nane *(Mint)*		Mor *(Purple)*	Mavi *(Blue)*
	Sumak *(Sumac)*	Fesleğen *(Basil)*		Siyah *(Black)*	Sarı *(Yellow)*

APPENDIX H

FREQUENCY[4] OF EXEMPLARS IN EXPERIMENT 2

Study Booklet 1

Categories with same first letter exemplars *(M_{new}=.24;M_{old}= .23)*						
		New	Old		New	Old
FRUIT	Pineapple	0.39	0.25	Quince	0.26	0.27
	Cherry	0.50	0.58	Watermelon	0.50	0.58
	Oleaster	0.00	0.00	Fig	0.11	0.19
CLOTH	Parka	0.00	0.03	Vest	0.17	0.11
	Hat	0.18	0.18	Shorts	0.27	0.14
	Tie	0.06	0.11	Coat	0.18	0.16
ANIMAL	Zebra	0.18	0.11	Giraffe	0.32	0.22
	Monkey	0.05	0.08	Buffalo	0.05	0.11
	Rabbit	0.18	0.14	Fox	0.10	0.18
SPICE	Cumin	0.70	0.55	Thyme	0.71	0.55
	Saffron	0.03	0.01	Sumac	0.20	0.11
	Salt	0.30	0.28	Cinnamon	0.33	0.52
Categories with different first letter exemplars *(M_{new}=.31; M_{old}= .33)*						
		New	Old		New	Old
VEGETABLE	Tomato	0.61	0.44	Cabbage	0.31	0.64
	Bean	0.26	0.39	Eggplant	0.63	0.37
	Artichoke	0.17	0.20	Celery	0.21	0.44
MUSICAL INSTRUMENT	Zither	0.14	0.10	Clarion	0.16	0.13
	Accordion	0.10	0.14	Trumpet	0.09	0.15
	Drums	0.32	0.23	Mandolin	0.06	0.21
SPORT	Sailing	0.04	0.07	Weight Lifting	0.05	0.11
	Judo	0.03	0.11	Cycling	0.04	0.07
	Golf	0.11	0.04	Skiing	0.12	0.19
COLOR	Maroon	0.23	0.20	Blue	0.95	0.94
	Pink	0.68	0.50	Orange	0.67	0.45
	Green	0.88	0.85	Yellow	0.67	0.91

[4] Frequencies refer to number of appearances across 400 participants in "old" Peynircioğlu (1988) and Eraltan & Mungan norms ("new").

Study Booklet 2

Categories with different first letter exemplars *(M_{new}=.31; M_{old}= .31)*						
		New	Old		New	Old
FRUIT	Cherry	0.33	0.25	Apricot	0.28	0.32
	Strawberry	0.73	0.42	Peach	0.43	0.58
	Grape	0.38	0.45	Plum	0.48	0.45
CLOTH	Coat	0.18	0.16	Vest	0.17	0.11
	Hat	0.18	0.18	Blouse	0.21	0.29
	Boots	0.03	0.10	Cardigan	0.31	0.20
ANIMAL	Sheep	0.45	0.39	Donkey	0.39	0.51
	Lion	0.55	0.47	Cow	0.64	0.54
	Camel	0.12	0.18	Fox	0.10	0.18
SPICE	Curry	0.17	0.03	Ginger	0.11	0.16
	Salt	0.43	0.28	Mint	0.71	0.46
	Sumac	0.20	0.11	Basil	0.07	0.00

Categories with same first letter exemplars *(M_{new}=.32; M_{old}= .28)*						
		New	Old		New	Old
VEGETABLE	Cauliflower	0.37	0.36	Celery	0.21	0.44
	Pea	0.14	0.17	Peppers	0.42	0.17
	Eggplant	0.63	0.37	Leek	0.40	0.72
MUSICAL INSTRUMENT	Harmonica	0.13	0.06	Mandolin	0.06	0.21
	Zither	0.07	0.10	Clarinet	0.16	0.13
	Baglama	0.22	0.05	Drums	0.32	0.23
SPORT	Baseball	0.07	0.05	Cycling	0.04	0.07
	Hockey	0.03	0.04	Weight Lifting	0.05	0.11
	Running	0.20	0.15	Skiing	0.12	0.19
COLOR	Beige	0.10	0.19	Maroon	0.23	0.20
	Purple	0.89	0.85	Blue	0.95	0.94
	Black	0.85	0.86	Yellow	0.92	0.91

APPENDIX I

FREQUENCY[5] OF EXEMPLARS IN EXPERIMENT 2

(TURKISH)

Study Booklet 1

Categories with same first letter exemplars *(M_{new}=.24; M_{old}= .23)*						
		New	Old		New	Old
MEYVE	Ananas	0.39	0.25	Ayva	0.26	0.27
	Kiraz	0.50	0.58	Karpuz	0.50	0.58
	İğde	0.00	0.00	İncir	0.11	0.19
GİYSİ	Anorak	0.00	0.03	Atlet	0.17	0.11
	Şapka	0.18	0.18	Şort	0.27	0.14
	Kravat	0.06	0.11	Kaban	0.18	0.16
HAYVAN	Zebra	0.18	0.11	Zürafa	0.32	0.22
	Maymun	0.05	0.08	Manda	0.05	0.11
	Tavşan	0.18	0.14	Tilki	0.10	0.18
BAHARAT	Kimyon	0.70	0.55	Kekik	0.71	0.55
	Safran	0.03	0.01	Sumak	0.20	0.11
	Tuz	0.30	0.28	Tarçın	0.33	0.52
Categories with different first letter exemplars *(M_{new}=.31; M_{old}= .33)*						
		New	Old		New	Old
SEBZE	Domates	0.61	0.44	Lahana	0.31	0.64
	Fasülye	0.26	0.39	Patlıcan	0.63	0.37
	Enginar	0.17	0.20	Kereviz	0.21	0.44
MÜZİK ALETİ	Kanun	0.14	0.10	Zurna	0.16	0.13
	Akordeon	0.10	0.14	Trompet	0.09	0.15
	Bateri	0.32	0.23	Mandolin	0.06	0.21
SPOR	Yelken	0.04	0.07	Halter	0.05	0.11
	Judo	0.03	0.11	Bisiklet	0.04	0.07
	Golf	0.11	0.04	Kayak	0.12	0.19
RENK	Bordo	0.23	0.20	Mavi	0.95	0.94
	Pembe	0.68	0.50	Turuncu	0.67	0.45
	Yeşil	0.88	0.85	Sarı	0.67	0.91

[5] Frequencies refer to number of appearances across 400 participants in "old" Peynircioğlu (1988) and Eraltan & Mungan norms ("new").

Study Booklet 2

Categories with different first letter exemplars (M_{new}=.31; M_{old}= .31)						
		New	Old		New	Old
MEYVE	Vişne	0.33	0.25	Kayısı	0.28	0.32
	Çilek	0.73	0.42	Şeftali	0.43	0.58
	Üzüm	0.38	0.45	Erik	0.48	0.45
GİYSİ	Kaban	0.18	0.16	Atlet	0.17	0.11
	Şapka	0.18	0.18	Bluz	0.21	0.29
	Çizme	0.03	0.10	Hırka	0.31	0.20
HAYVAN	Koyun	0.45	0.39	Eşek	0.39	0.51
	Aslan	0.55	0.47	İnek	0.64	0.54
	Deve	0.12	0.18	Tilki	0.10	0.18
BAHARAT	Köri	0.17	0.03	Zencefil	0.11	0.16
	Tuz	0.43	0.28	Nane	0.71	0.46
	Sumak	0.20	0.11	Fesleğen	0.07	0.00

Categories with same first letter exemplars (M_{new}=.32; M_{old}= .28)						
		New	Old		New	Old
SEBZE	Karnıbahar	0.37	0.36	Kereviz	0.21	0.44
	Bezelye	0.14	0.17	Biber	0.42	0.17
	Patlıcan	0.63	0.37	Pırasa	0.40	0.72
MÜZİK ALETİ	Mızıka	0.13	0.06	Mandolin	0.06	0.21
	Kanun	0.07	0.10	Klarnet	0.16	0.13
	Bağlama	0.22	0.05	Bateri	0.32	0.23
SPOR	Beyzbol	0.07	0.05	Bisiklet	0.04	0.07
	Hokey	0.03	0.04	Halter	0.05	0.11
	Koşu	0.20	0.15	Kayak	0.12	0.19
RENK	Bej	0.10	0.19	Bordo	0.23	0.20
	Mor	0.89	0.85	Mavi	0.95	0.94
	Siyah	0.85	0.86	Sarı	0.92	0.91

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