



Department of Psychology

Retrieval-Induced Forgetting in a Cross-Language Design

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Bachelor's thesis

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Abstract

Retrieval-induced forgetting refers to the notion that remembering may sometimes cause forgetting of related but currently irrelevant items. This thesis aimed at investigating if this phenomenon generalizes to a cross-language design. The hypothesis was that retrieval-induced forgetting is induced also when performing retrieval-practice in a second language. Results confirmed the hypothesis but also indicated a trend of forgetting attributable to output-interference or contextual factors. The author discusses the possibility that the inhibitory mechanism of retrieval-induced forgetting might be working within a dimensional scale rather than exclusively on a conceptual item level.

Imagine yourself boarding an airplane or bus headed for that vacation you longed and dreamed for during all those dark winter nights; giving you the opportunity to spend four relaxing weeks meeting people from other corners of the world. To talk with them about things unheard of; giving you fresh ideas, hearing previously untold tales. After four refreshingly entertaining weeks (sadly), imagine yourself boarding the same airplane, heading for home. Relaxing your tight grip of the armrest during the slightly stressful landing you finally enter the arrivals hall to meet family and friends. Suddenly, when switching back to your native tongue, you experience several tip of the tongue, blocking of certain words or maybe, only the same words in the recently spoken second language keep popping up in your mind. I believe many of us have experienced this phenomenon in one way or another but why this happens is harder to explain. How can a couple of weeks or sometimes only hours of a different language have such an impact on the one you have been using since your first utterings as a child, even though you recover quite quickly? This article aims to investigate this phenomenon, using the theory of retrieval-induced forgetting and the related design first created by Anderson (Anderson, Bjork & Bjork, 1994); also replicated in several other studies in various settings which will be described later (see Anderson, 2003; Andersson & Levy, 2002, for reviews). What makes it viable to use this design when investigating this phenomenon I believe is motivated by the very description of retrieval-induced forgetting: *remembering causes forgetting*. When retrieving something from our memory banks, other related, but not retrieved, items becomes suppressed, which gives us a harder time remembering these very same related items. What makes this even more interesting is the notion of cue-independence which suggests that it is the actual concepts in memory that become inhibited, not their cues or the connections to these (Anderson & Spellman, 1995; however, see Perfect, Stark, Tree, Moulin, Ahmed & Hutter, 2004; Butler, Williams, Zacks & Maki, 2001, for some conflicting results). With the term concept I refer to basic low-level memory representations (i.e. the concept banana, not the lexical or perceptual feature representation) below lexical or perceptual representations (e.g. visual features). Relating this to the experience described in the very beginning above, language could be seen as a victim of retrieval-induced forgetting. When retrieving a second language, a more demanding effort compared to retrieving your native language, it could be that the brain has to inhibit and push away the heavily competing native tongue. Thus, allowing the to-be-retrieved second language to surface and be processed and used at the cost of the native language.

The primary aim of this study, as stated earlier, is to investigate retrieval-induced forgetting in an, according to the author's knowledge, previously untested condition: the

context of language. I will start this article by presenting existing material concerning retrieval-induced forgetting. I will not present and discuss language theory since this is beyond the scope of this article and should be seen as a discipline in itself due to the quite extensive body of literature. However, several studies and reviews about how language is constructed and represented have been published (Poeppel & Hickok, 2004; Kang-Kwong, Ho-Ling, Yo-Yo, Yung-Liang & Li Hai, 2002; Vigliocco, 2000; Pulvermüller, 1999; Hickok & Poeppel, 2003); also discussing to some extent if language is separated from conceptual items or how concepts could be distributed. This motivates this study to be conducted in its own way since (retrieval) induced forgetting only should be obtained if the same category-item concepts are targeted. My hypothesis then, is that retrieval-induced forgetting can be induced in a cross-language design; retrieval of atypical second-language items will interfere with and cause retrieval-induced inhibition at the cost of typical native-language items.

Retrieval-induced Forgetting

As mentioned earlier, retrieval-induced forgetting is when remembering causes forgetting. In 1994 Andersson and colleagues published an article presenting data strongly supporting this relatively recent theory on interference (Anderson et al., 1994). The experiment conducted used a *retrieval-practice paradigm* consisting of categories and exemplar words. The paradigm was separated into three distinct phases: learning, retrieving and a final memory test. The basic idea was that when participants first studied all items (e.g. fruit-orange) a strengthening of these would occur in memory in terms of availability. When, in the next phase, half of the items of half of the categories were exposed to retrieval from memory, this retrieval-process was thought to suppress competing items (not receiving retrieval-practice) belonging to the same category but not items belonging to the studied-only category. To measure this effect the results of the final memory test could be divided into no retrieval-practice items (nrp), retrieval-practiced items (rp+) and items belonging to the same category as retrieval-practiced items but which did not receive any retrieval-practice (rp-). In this way the rp- (that should become inhibited according to Anderson's hypothesis) items could effectively be compared with baseline (nrp) items in terms of scores on the memory test. Findings confirmed the hypothesis, but were not consistent over all types of items. One part of the design was that half of the items in each category were typical and half were not. When talking about item typicality the retrieval-practice paradigm was constructed using material from the Battig and Montague category norms (Battig & Montague, 1969), giving the

material empirically derived categories and typicality values. Anderson and colleagues found that the setting that caused the strongest retrieval-induced forgetting was when atypical items were designated as rp+ items and typical as rp-. These results have been interpreted in terms of interference between memory representations; when retrieval is performed on atypical items the brain has to inhibit the typical, now equally competing items to attenuate interference and thus be able to filter out the to-be-retrieved items. The power with this design is also that it makes it possible to distinguish between strength-dependence effects and retrieval-induced forgetting as well as controlling for output-interference (Anderson et al., 1994; Anderson & Spellman, 1995; Anderson, 2003) which is two of the greatest confounders in this paradigm. These issues are not entirely resolved which leads us to also present some of several articles probing them in a more detailed manner. The investigation of cue-independence concerning retrieval-induced forgetting is of great importance when differentiating this model from strength-dependent models and will thus be our next topic.

Cue Independence

With cue-independence I refer to the specific and unique property of retrieval-induced forgetting which is that it is not the associated cues or the connections between cues and competitor items that in any way cause the effect. It is the actual concepts of the competing objects that become inhibited. If study and retrieval-practice are performed on atypical items (rp+ items, e.g. Kiwi) using the category cue Fruit, retrieval-induced forgetting of competing related typical items (rp- items, e.g. Fruit-Strawberry) should still be observed when cued by a new independent cue (e.g. Red). Retrieval-induced forgetting would thus be an inhibitory mechanism performed at a conceptual level since cue-dependent theories would not be able to account for this phenomenon. This was also what Anderson and Spellman found when investigating cue-independence (Anderson & Spellman, 1995; however, again see Perfect et al., 2004 for conflicting results).

Semantic versus episodic memory and retrieval-induced forgetting

Studies have shown that retrieval-induced forgetting occur in both semantic (Anderson et al., 1994) and episodic (Ciranni & Shimamura, 1999) learning contexts. Bäuml (2002) examined if semantic generation could cause inhibition on episodic memories by using a modified version of the retrieval-practice paradigm. In this experiment the learning and test

phases were separated with distractor tasks by a semantic generation phase, still using the same basic paradigm as in earlier experiments. The main difference was that no retrieval practice was performed, but was instead replaced with a semantic generation task. This experiment also reached a significant inhibiting effect which supports the importance of semantic relatedness among items at the same time as it gives rise to thoughts on how retrieval-induced forgetting might affect us in social and everyday life context. If meeting someone working in a certain profession (episodic) and later discuss his or her traits with someone (semantic generation), this might influence what will come to mind and also influence how we rate this person the next time we meet.

Effects on social contexts and eye-witness memories

Another type of studies that have been conducted is the investigation of whether or not retrieval-induced forgetting could be elicited in a social context. Storm, Bjork & Bjork (2005) investigated if the retrieval-practice paradigm could elicit a retrieval-induced forgetting effect in a context of person memory and impressions. In short, the experiments were based on Anderson's retrieval-practice paradigm but used positive, negative or neutral traits instead of words which were assigned to target-persons ("categories"). Retrieval was then performed on neutral traits (rp+) to see if retrieval-induced forgetting would lower (induce forgetting) the availability of negative/positive traits. Inhibition was detected on targeted traits (rp-) in the same way as in the original experiment conducted by Anderson and colleagues (1994). However, no effects were observed on likeability ratings (performed by participants) on the target individuals.

Another study conducted in a social context was done by Dunn and Spellman (2003) where the authors tried to induce retrieval-based forgetting in stereotypes by rehearsing other aspects of identity. Participants in this experiment rehearsed a number of stereotypical aspects (empirically derived in a pilot study) of one identity and then performed retrieval on a number of these. The authors hypothesized that if one aspect was retrieved, other interfering stereotypical properties of the same identity would be inhibited. Results showed successfully induced forgetting in the stereotypical context. Interestingly, another aspect not expected, was that the amount of forgetting induced depended on how strong the participant believed in the stereotype. A strong belief in a stereotype typically reduced the effect of inhibition, causing stereotypical aspects to persist in memory. If retrieval-induced forgetting has the possibility to

explicitly affect our daily life, one important field that needed investigation was the context of eye-witness memory which leads us to the next article written in a social context.

Eye-witness memory has been thoroughly researched by psychologists since peoples' accounts can be of crucial importance in for example courts or in historical perspectives. One article published by MacLeod (2002) discusses the impact of inhibitory processes during retrieval and how they might affect eye-witness memories. The study used realistic and meaningful stimuli consisting of pictures taken of objects normally found at peoples' homes. These objects were related to a house and were presented as stolen items which participants were to remember since their account might be needed in a later investigation. Interestingly, retrieval of items caused inhibition of related items (for example stolen items). Also worth mentioning from this article is that even though the objects were not as clearly categorically related as for example Anderson's more semantic material, participants formed categorical relations including a difference in salience of these newly acquired objects in memory.

As a last example of retrieval-induced forgetting in this context I present a study conducted by Groom and Grant (2005). The authors of this article were interested in correlating the amount of retrieval-induced forgetting with a measure of everyday memory failures. Thus they first measured the individual amount of inhibition, using Anderson's paradigm (Anderson et al., 1994) and later also measured individual scores on the Cognitive Failure Questionnaire (CFQ). The analysis revealed a correlation between inhibition and everyday cognitive failures; a lower susceptibility to retrieval-induced forgetting was related to a greater amount of cognitive failures according to the CFQ.

Inhibition at the implicit level

The abovementioned studies have only investigated the effects of inhibition on explicit memory tests. A study conducted in Rotterdam by Camp, Pecher and Smith (2005) tried to establish if it was possible to find inhibition on an implicit memory test. The experiment was conducted using the same design as Anderson and Spellman (1995) used when investigating cue-independence. This design includes not only a set of explicit categories but also some hidden categories embedded in the material, which made it possible to test participants on earlier unknown cues and thus making the unrelated test phase into an implicit memory test. An added twist to this experiment was that a questionnaire on test awareness also was included. Findings indicated that implicit retrieval-induced forgetting did occur, but only when participants were aware of the relation between test and earlier phases. The authors

also debate that contextual factors of the experiment could have had some effects, masking inhibitory effects.

I will also mention two other studies on implicit inhibition; one conducted by Perfect and colleagues (Perfect, Conway, Moulin, & Perry, 2002) and the other by Veling and Knippenberg (2004). The first of these studies comprised five experiments investigating if retrieval-induced forgetting could be observed on an implicit level. If this could be established, additional support to the notion that it is the actual memory-concepts that become inhibited would be generated since explicit higher order processes would not be able to account for an implicit forgetting. Results obtained showed that retrieval-induced forgetting occurred when using implicit experiments designed to target concepts (e.g. generating the first items of a certain category coming to mind or identifying if items belong to a certain category), but the effect did not manifest itself in designs where perceptual or lexical representations could be tapped to identify items (e.g. completing word stems or identifying items using perceptual features). Perfect and colleagues thus concluded that retrieval-induced forgetting occurred in an implicit design and seemed only to be observable when using designs testing conceptual memory performance.

Veling and Knippenbergs study was similar to Perfect et al's, and measured response latencies in a cue-independent retrieval practice-paradigm, using no cues during the test phase. The results indicated a more robust implicit effect than that observed by Perfect and colleagues.

Retrieval-induced forgetting in a clinical setting

Some studies have been conducted in this area with a more clinical approach. One article examined retrieval based inhibition in schizophrenic patients (Nestor, Piech, Allen, Niznikiewicz, Shenton, & McCarley, 2005) with the hypothesis that since these patients exhibit a deficit in inhibitory control filtering out correct memories or actions, maybe an effect could be observed compared to normal controls concerning retrieval-induced forgetting. This was not the case; no differences were observed in Anderson's paradigm. Another article with a similar approach investigated the functionality of retrieval-induced forgetting in patients with Alzheimer disease but did also not find any differences compared to controls (Moulin, Perfect, Conway, North, Jones & James, 2001).

Also worth mentioning is the more neurochemical approach used by Edginton and Rusted (2003) when investigating the effects of scopolamine and nicotine on performance in

this paradigm. They found that scopolamine, which is usually associated with disinhibition, did not in any way mediate retrieval-induced forgetting. Nicotine on the other hand, seemed to increase the effect, which could give some support for the notion that nicotine enhances concentration.

From an item specific to a context oriented effect

In the study conducted by Perfect and colleagues, also referred to earlier (Perfect et al., 2004), the independent probe technique used by Anderson and Spellman (1995) was further investigated. The reason for this was that in the previous study by Anderson, only lexical category cues were used, which could not, according to Perfect and colleagues, be seen as totally independent cues. The argument here lies in that independent novel lexical cues used during recall still have a pre-established association with items that would be tested. This study created a new independent probe, using pictures of faces as episodic, unrelated and novel cues during the study phases. It was argued that if retrieval-induced forgetting truly was cue-independent, the effect should be obtained irrespective of the cue used during final testing. Results showed that no effect could be observed when using totally independent cues (new faces). However, when combining faces and category cues, inhibition did seem to occur. Since no inhibitory effect was observed when using the novel face cue, a lexical episodic cuing technique was tried using unrelated word pairs during the initial study instead (for example using the category fruit, items were cued zinc-apple with zinc as the unrelated independent cue). Retrieval was then cued by using the previously unused category name (fruit) and the memory test was conducted in both conditions (category cue or unrelated cue). Forgetting was only induced when using the original category cues and not when using the novel unrelated cues, giving rise to a debate concerning if retrieval-induced forgetting truly is cue-independent. Perfect and colleagues (2004) theorize that the effects obtained could be caused by contexts. Without delving too deep, they argue that it might be that the relations between contexts of different phases explain these results, adding a dimension to an inhibitory account of forgetting. For example, each phase in the study can also be seen as a context and as such possibly be used as cues by participants. If relations exist between contexts and items, an overlap between phases is possible, since, for example, an entire experiment could be seen as a context. The authors thus point out that context might mediate item-level forgetting by affecting accessibility of items and categories across design; if contexts become cues,

relations between items and categories could become affected and retrieval-induced forgetting might not be observed (although possibly could occur at a contextual level).

Output Interference

Output interference is an effect that can account for results when using free recall since the recall order of items cannot be controlled. Effects related to this are thought to be that an item's chance to be recalled declines in correlation with its position in the testing sequence. Thus, reporting other items first might interfere and cause equally available items to not be reported, which would not be the same as the inhibitory retrieval-induced effects argued by Anderson. Summarizing, output interference could, if left unchecked, account for retrieval-induced forgetting (for a more detailed explanation and discussion concerning output interference, see Anderson et al., 1994; Anderson, 2003).

To briefly recapitulate, unpracticed typical items (rp-) interfere during selective retrieval of atypical items (rp+) from the same category. To resolve this interference, the unpracticed typical items (rp-) become inhibited. Thus, a greater amount of forgetting can be observed in typical items compared to studied-only baseline items (nrp). The aim of this study is to investigate if retrieval-induced forgetting can be obtained when retrieval-practice is performed in a second language. My hypothesis is that retrieval-induced forgetting will occur when performing retrieval-practice in a second language. This is because, at retrieval practice, native language typical items will interfere with the retrieval of atypical second-language items and thus the native language items will be inhibited in order to overcome that interference.

Method

Participants

Thirty students were recruited by knocking at doors at two dormitories as well as asking students at Lund University campus. Most of the participants came from the same area but there had been no or minimal contact between subjects before the experiment. The distribution was exactly balanced concerning sex in the sample as a whole but no consideration was taken to this when assigning individuals to groups for counterbalancing

purposes. Participants were between 20 to 31 years old with a mean age of 22.9 years and studied in various disciplines (from medical to engineering and economics). Participants were only recruited if they spoke Swedish as their native language and English as their second. A reward in the form of a lottery ticket together with the chance of winning tickets to the local movie theater was used as an encouraging compensation for the time taken to participate. Recruiting could have been conducted in a more random fashion but due to the scope, budget and timeframe limitations of this work, restraints were necessary. This was expected to have an impact on generalizability and reliability of the results obtained but the phenomenon investigated was still thought to be, to some extent, observable as such. Participants were also allowed to choose the most fitting time to participate. The reason for this was because the experiment would be done in a group setting, with a total of six groups of five persons each.

Material

A laptop running Microsoft Powerpoint and a projector were used for presenting instructions and materials. Thirty booklets were manufactured with a cover containing basic questions concerning age, sex and language experience and also a brief presentation of the experiment. Remaining pages were blank except for a title stating what phase each page was affiliated with. The two blocks were separated by a page with written instructions stating that part one now had ended and asked participants to prepare for part two. In the relearning mode the blank pages were a total of seven where the first was “relearning” followed by six pages titled memory test. The same layout was used in the retrieval mode except for the first page which instead was labeled “retrieval”. The last page in the booklets contained an English test with all English words used during the experiment listed. The experiment was conducted at the Department of Psychology, Lund University, in a quiet room with no outside view. Participants were seated at separate desks where booklets, pen and a separate blank (for covering purposes when performing written practice) paper were supplied.

Overall Design

The experiment was a 2*2*3 within subjects design based on two main blocks (relearning/retrieving) where each block contained two conditions (pure language/mixed language). The relearning items were coded nrl, rl+ and rl- whereas the retrieval items used the original coding (nrp, rp+, rp-). Each condition then consisted of items which in turn could

be of three different types (nrl/nrl, rp/rl+, rp/rl-). See figure 1 for a graphical layout of this design.

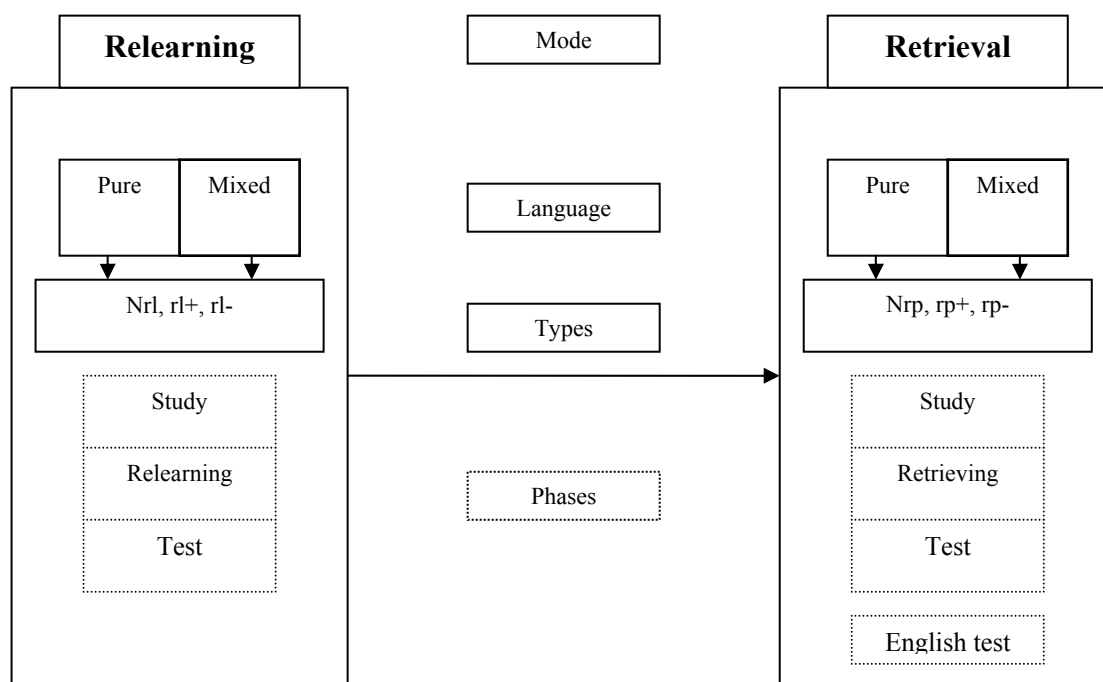


Figure 1. A graphical layout of the 2*2*3 design used consisting of, in the same order, mode (relearning/retrieving), language (pure/mixed) and item types (nrl/nrp, rp/rl+, rp/rl-). This figure also reflects how the experiment was conducted, showing the two main blocks and within these the language condition, item types and phases.

Item selection and item types

All items used were selected from an updated version of the Battig and Montague norms (Van Overschelde, Rawson & Dunlosky, 2003) which lists categories of items and their within-category typicality. The choice of materials to be used in the experiment was affected by the fact that the experiment was based on a cross-language design. This resulted in quite severe limitations on which items and categories that could be chosen. Since the category norms used here were derived in the United States and no Swedish comparable counterpart existed, considerations were taken so that differences such as geographical, environmental and culturally dependant items and categories were classified as not acceptable (for example, a sport such as baseball should not be expected to be classified as a typical item of that category in Sweden). The second restraining factor during item selection was the fact that the material had to be translated into Swedish. Again, with baseball as an example, the translation here would be an exact match with the English word, which would probably render the

differentiation between the two languages severely crippled, if not nullified. Not only had translatable and language specific items to be sorted out, but the material also had to consist of an equal ratio typical and atypical items. A total of 12 categories were selected (see appendix A), each containing ten items where half were atypical and half typical (in accord with the typical retrieval-practice paradigm design). Typicality, again due to the limitations of the material, were defined by choosing the top five and bottom five candidate items in each category that qualified according to the criteria earlier described. All material were translated into Swedish by the author and were also controlled using a Swedish translation database (<http://www-lexikon.nada.kth.se/skolverket/sve-eng.shtml>) and Oxfords advanced learners dictionary (Hornby, 2000), and were finally controlled and approved by a student studying both language disciplines (see Acknowledgements). Summarizing, a total of 12 categories with ten items each had finally been selected and translated. Three item types were created (also in accord with the typical retrieval-practice paradigm design) which were: unrelated unpracticed items, only receiving the initial practice during phase one (nrl), retrieval-practiced items (rp+) and unpracticed items belonging to the same category as retrieval-practiced items (rp-). The same types were also used in block one (described below) but were coded nrl, rl+ and rl-. The assignment of categories and experimental condition was counterbalanced across participants.

Language design within blocks and block design

Ascending from item level to language level design we still find ourselves within the main block design. Each of the two blocks consisted of three single language lists (which were solely in Swedish) and three mixed language lists (where English was the second language). These three lists per language represented the rp/rl+, rp/rl- and nrl/nrl (depending on block) item types also part of the original retrieval practice paradigm. One list consisted solely of nrl/nrl items whereas the other two consisted of five rp/rl+ and five rp/rl- items each, keeping the material balanced in terms of item count/type. As mentioned, categories consisted of five atypical and five typical items. In the mixed lists, all atypical (rp/rl+) items were also in English since the experiment's aim was to investigate if retrieval-induced forgetting could be obtained even if retrieval-practice was performed in another language. The purpose of the single language condition was that of control, replicating the original retrieval paradigm conducted by Anderson and thus making it possible to ensure that the setting had enough sensitivity to induce the effect as such.

As described earlier, the experiment was also designed in two main blocks, where the first block in all runs always was the relearning block whereas the second was that of retrieval. As also mentioned earlier, the order in which items are reported in can affect an item's chance of being reported in a linear fashion, even when they are equally available (output-interference). Since this experiment used free recall as the test of memory, a control for output-interference was needed. Thus, the relearning block was designed, constructed exactly as block two with one exception evident in the second phase. In block one, the written retrieval-practice (described later in the section of procedure) was replaced with a written relearning task, where rl+ items received the same amount of additional practice but without performing any retrieval. RI- items should thus be remembered to the same extent as nrl items; if not, a greater forgetting of rl- items should be attributable to output interference. The reason for using free recall was that, due to the earlier presented limitations created by demands on the material, it was impossible to use word stems to balance item recall order during testing without causing too much between-items related interference. The relearning condition was always conducted first to avoid retrieval-induced effects on the second block and also because relearning was thought to have a minimal impact on later test phases. Concluding, the relearning types were created to be used for comparison with retrieval-type items; thus supplying the design with a tool to be used during analysis for investigating possible effects related to output interference.

Item presentation design

Categories were rotated across groups for counterbalancing purposes and item presentation orders were randomized in each group. Each item was presented on a separate slide together with the related category in both Swedish and English. Categories were centred at the top in bold Times New Roman, size 32 and items were centred below in the same font, size 28. As in the booklet, the first slide consisted of basic instructions. The phases (learning, relearning/retrieving and memory test) were separated by two timed mathematical distractor tasks (described below). The two blocks were separated by a screen stating that part 1 had ended and that part 2 soon would begin.

Procedure

The experiment consisted, as already stated, of a total of two blocks, each divided into three phases separated by two distractor tasks in each block. The first block was the relearning condition and the second was the retrieval condition. Participants were positioned in an outspread manner at separate desks in a darkened room with no outside view, and a presentation of the overall design was given. The first learning phase started with verbal and written instructions to memorize and relate all words to their category respectively, also stressing the importance to memorize the material in the language presented. Participants were informed of the total amount of words, which in the learning condition consisted of 60 items. A heads up was once more given that some words would be in English, again, stressing the importance to memorize items in the language presented on the screen. Participants were motivated by the experimenter to learn the material as well as possible since this would give them a better chance to perform well on a memory test later. Each item presented during the learning phase was shown with duration of 5 seconds. When the learning phase was finished participants were given instructions for the distractor task, which were, counting backwards, to deduct three from a given number for each symbol presented on screen with a 3 second interval (with a total span of 90 seconds). When this task was completed participants were asked to write down the final number reached and instructions concerning the relearning phase were given. Instructions for the relearning phase were in general identical to those given before the first run except that there were a total of 20 items and that the participants were instructed to write down the answers and cover these, thus preventing rehearsal. This task was also motivated as an extra chance to learn the material and perform as well as possible on the upcoming tests. Again, the importance to learn the material in the language presented was stressed. After the relearning phase came an identical distractor task with a new given number and finally the memory tests were administered. These were conducted by presenting each category on screen for a duration of 30 seconds (which participants were informed of) and during this timeframe participants were asked to write down as many of the words earlier presented, related to the category shown, as possible. Again, participants were told to write down the items in the language they had memorized during the earlier phases. When all memory tests were finished, block two, the retrieval block, began. Participants were informed that this would consist of new material and that the previously presented items would not be part of the upcoming procedures. The first phase of this block was identical to that of block one and was also followed by the same distractor task. The second phase,

however, differed in terms of how the additional learning practice was conducted. This time, participants were again presented with 20 items, but in a word stem form (see appendix A) which had to be completed by writing the words down. Instructions given here again stressed the importance of language and that participants actively tried to retrieve the words cued by the presented word stems. All participants were made aware that all stems presented were words that had been part of the first learning phase in this block. A chance to perform better on upcoming tests was again given as a motivation to make an active effort. After the retrieval phase of block two another distractor task followed and finally memory tests were administered in the same way as during block one. The experiment was finished with an English test where participants were instructed to translate all, in total 30, English words in the test to Swedish. All participants were given the earlier mentioned reward, were debriefed on the experiment and thanked for their participation.

Results

Before presenting the results I wish to clarify by what criteria the material was scored. When scoring the nrp/nrl, rp/rl+ and rp/rl- items, only items that were answered in a lexical common base were accepted; since the design used free recall as testing method it was essential to establish a firm scoring criteria due to the many variations possible in participants answers. An example of this would be that the word sunny would not be accepted when the originally learned item was sunshine. Changes in terms of plural form instead of singular were accepted as well as misspelling since this experiment was conducted in a cross-language setting with time limits during testing, creating a somewhat pressing situation for participants. Scoring the English-test was conducted in the same way, although some leeway was given concerning translation into synonyms. The reason for this was that the test was only used for control purposes and was not related to the scoring of type items when testing the hypothesis. It was also expected that individuals would in some cases translate differently since variations between languages and amount of words known differ between participants. The factors in the experimental design were named mode (relearning/retrieving), language (language) and type (nrp/nrl, rp/rl+ and rp/rl-) and will at times be referred to when presenting the results. Analyses were conducted using paired-samples *t*-test.

The scores from the English test gave acceptable results, thus validating the participants for the experiment ($M=25,56$, $Min=21/30$, $Max=30/30$). Tests for normality were not conducted since the size of the sample and the resolution of the material used were too small to be used in any generalizing perspectives and thus skewness was to be expected.

Table 1. Proportion of correct answers as a function of mode, language and item type

	Mean	N	Std. Error Mean
Pure nrl	,3967	30	,03234
Pure rl+	,5533	30	,04004
Pure rl-	,3933	30	,02834
Pure nrp	,4900	30	,03008
Pure rp+	,5800	30	,02853
Pure rp-	,4300	30	,03528
Mixed nrl	,4133	30	,02826
Mixed rl+	,5967	30	,03234
Mixed rl-	,3500	30	,03243
Mixed nrp	,4600	30	,03166
Mixed rp+	,5833	30	,02997
Mixed rp-	,3633	30	,03407

Pure language condition

In the pure language condition (Swedish) the additional practice received during the relearning/retrieving phase (rl/rp+ items) significantly facilitated memory performance in both modes [relearning: $t(29)=3.53$, $p=0.001$, retrieval: $t(29)=2.65$, $p=0.013$] in accord with earlier findings (Anderson et. al, 1994). The unretrieved (rp-) items did not show a significant amount of forgetting, however, a trend replicating retrieval-induced forgetting could be observed [$t(29)=1.73$, $p=0.095$]. As expected, the unrelearned (rl-) items reached a close-to-baseline amount of forgetting [$t(29)=0.97$, $p=0.923$] thus suggesting that output-interference did not cause the forgetting observed for the unretrieved (rp-) items.

Mixed language condition

The additional practice received during the relearning/retrieving phase (rl/rp+ items) in the mixed language condition (Swedish/English) also facilitated memory performance significantly [relearning: $t(29)=5.76$, $p<0.001$, retrieval: $t(29)=2.81$, $p=0.009$]. While the

unrelearned items did not reach significant amounts of forgetting (however, note the trend, $t(29)=1.52$, $p=0.139$), the unretrieved (rp-) items were associated with a significant retrieval-induced forgetting effect [$t(29)=2.44$, $p=0.021$], which is in accordance with our hypothesis. However, caution should be taken since, although not significant, some amount of forgetting seems also to have occurred in unrelearned items (rl-), allowing effects to be attributable to output-interference.

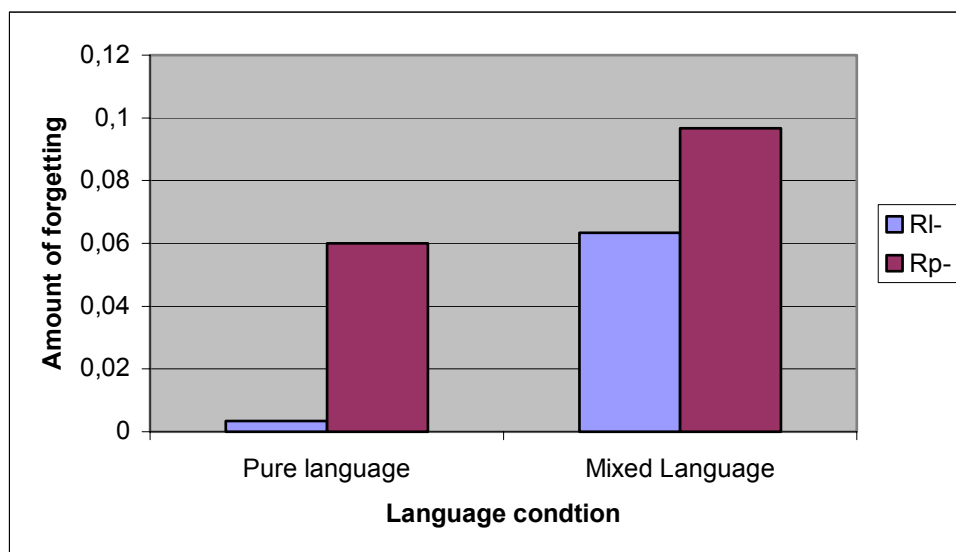


Figure 2. Illustrates the amount of forgetting in rl/rp- items in the two language conditions

Discussion

This article should be seen as an explorative study without claims of having contributed any conclusive evidence. There are several reasons for this. The first is that this variation of the retrieval-paradigm has never been conducted before, resulting, in a way, in grasping in the dark before finding the first of many light switches. There are in all probability many unknown factors that have influenced the results in many different directions. The second reason is the material. As described earlier, quite constraining demands were taking its toll during item and category selection, resulting in low sensitivity due to a limited number of available categories and items. The translation itself should also be expected to have had an impact since no corresponding Swedish material existed, thus making it possible for geographical, demographical and cultural factors to influence the material (the typicality of some items may for example differ between countries). New and more powerful research opportunities could be created by conducting a replication of the Battig and Montague

categories (Battig & Montague, 1969), possibly also adding the task of generating material in the commonly spoken second language. This could generate useful new tools for researchers in both language and memory disciplines. Finally, the small sample size results in large statistical noise and low power, which makes it harder to establish statistically significant results and might affect the generalizability of the findings.

As the results showed, a trend towards retrieval-induced forgetting was observed in the pure language setting with output-interference accounted for in the relearning condition. This could be interpreted as a (although merely borderline significant) replication of the results obtained in Anderson's paradigm (Anderson et al., 1994). This, in turn would indicate that the design used in this study had sensitivity to detect retrieval-induced forgetting in its original retrieval-practice paradigm.

The most interesting finding in this experiment, however, was the results obtained in the mixed language setting. A significant induced forgetting was observed as predicted, but the relearning condition, meant for controlling for output interference, showed a similar pattern of forgetting. While this could be due to output-interference, a more interesting perspective though, is that of context. Since it was the mixed language condition that showed the more robust induced forgetting pattern, it could be argued, similar to conclusions made by Perfect and colleagues in their study (2004), that language could be seen as a context while cue-independence (Anderson & Spellman, 1995) still is maintained at a conceptual item-level.

It could be that Anderson's retrieval-paradigm used in this experiment primarily induces forgetting at a conceptual item level but was not originally meant to induce a context-related forgetting. My reasoning here lies in that when participants access a second language item, this process likely will include activity at a lexical/syntactic level as well as accessing concepts possibly common to both languages. The results obtained here then, could be discussed as causing a conceptual item-level induced forgetting while also, in the mixed (language context) design, causing an unintended context-induced forgetting affecting the relearning-mode (also at a higher level than the concept). This would explain why the relearning-mode in the mixed language setting showed a trend similar to that of the retrieval-mode. It should again be noted, however, that output-interference could still have contributed to the observed pattern of effects.

A second language could be seen as an atypical context, and the quite demanding effort just accessing this knowledge might result in a context-retrieval also inducing forgetting, which in turn would warrant an inhibition of the competing native language context. A question derived from the discussion above could be if a more lexical similar language would

cause a smaller impact on the results obtained. The earlier presented studies in this article could also be, instinctively, seen in a context related view. The article investigating eye-witness memory (MacLeod, 2002) could reflect how contexts can form new relations between items by forming novel categories. Another example is the study by Dunn & Spellman (2003) investigating retrieval-induced forgetting in stereotypes. The fact that the strength of a stereotype seem to mediate the amount of induced forgetting could be that it is difficult to raise atypical stereotypical aspects to the same availability as the already maintained stereotype, thus competition might not as easily occur in firmly believed stereotypes. It could also be that a strong stereotype could be seen as a context whereas a weaker form is more susceptible on an item-conceptual level. Finally, if the present findings were to be replicated with more clear-cut and reliable results, it would be interesting to connect, or even expand this design with neurological and linguistic data (also referred to in the introduction). Investigating language and how it is functionally and anatomically represented as well as the existence of a distinction between item representations and language systems should be of interest. Exploration of common concepts for these systems could benefit from the possibilities created using versions of the retrieval-practice paradigm.

Earlier in this article, an experiment showing a correlation between the CFQ and retrieval-induced forgetting was presented (Groom & Grant, 2005). My thoughts concerning this issue could be that the amount of false/incorrect answers on memory tests also might correlate with the amount of inhibitory control an individual exert; reflecting, in its own way, everyday cognitive failures. This did not seem to be the case in this experiment and was thus not reported. This field of research could still be of interest when researching false memories or research in clinical settings (Nestor et al., 2001; Moulin et al., 2005) related to cognitive failures (lesion studies, neurological diseases affecting prefrontal regions).

I also want to connect to Perfect and colleagues' study of implicit retrieval-induced forgetting (2002). Here, retrieval-induced inhibitory effects were observed on concepts, even without using cues. When the effect was not obtained it was reasoned that it could be due to the use of perceptually or lexically oriented representations. Is there a possibility that these designs would observe a retrieval-induced forgetting in for example a cross-language design where, in accord with results obtained in the present study, an inhibition of contexts could be possible (with processes occurring at lexical/perceptual levels)?

Summarizing, retrieval-induced forgetting was obtained in a cross-language design, supporting its role as an inhibitory control mechanism. The results reflected inhibition of concepts but also showed a similar affect in the relearning mode which could be accounted for

by either output-interference or contextual factors. Inhibitory control could be seen as a dimension-scaled mechanism, possibly operating on basic memory concepts as well as generalizing to contexts. Both reliability and validity of this study can be contested but the present pattern of findings does support this idea; especially if the forgetting observed in the relearning mode was not due to output-interference. Thus language might be considered as a contextual factor, reflecting the rather instinctive notion when traveling abroad described in the beginning of this article. However it is important to point out that future studies are needed to assess the validity of the speculations made here.

As a possible (theorized) real life example of an inhibitory account in a language perspective I want to conclude this article by mentioning an episode I experienced during my travels in Laos. I was sitting at a café while a man, a Norwegian it turned out, asked us in a very primitive Norwegian if we came from Scandinavia. From the few words I understood (Scandinavians normally understand each other quite well), it seemed that the man had lived in Laos for quite a long time and he also, loosely translated, muttered that it (the Norwegian language) was slowly coming back, but that it was hard because it was such a long time ago since he spoke with Scandinavians (although he still quickly recognized the language pattern, which is interesting in itself). Could this be an example of a long term inhibition, rendering a language almost obsolete in favour of a new tongue? Hopefully, future studies will flick more light switches and thus shed additional light on inhibitory mechanisms, interference and maybe even their effects in our very real everyday life.

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Appendix A

Original categories selected and used in this experiment:

A carpenters tool
A four-footed animal
A natural earth formation
A part of a building
A vegetable
An insect
A thing made of wood
A weather phenomenon
A part of the human body
A bird
A thing women wear
An occupation or profession

Example of a selected category's items, original and translated versions:

Four-footed animal/Fyrfota djur	Horse	Häst	Typical
Four-footed animal/Fyrfota djur	Dog	Hund	Typical
Four-footed animal/Fyrfota djur	Bear	Björn	Typical
Four-footed animal/Fyrfota djur	Deer	Hjort	Typical
Four-footed animal/Fyrfota djur	Pig	Gris	Typical
Four-footed animal/Fyrfota djur	Raccoon	Tvättbjörn	Atypical
Four-footed animal/Fyrfota djur	Wolf	Varg	Atypical
Four-footed animal/Fyrfota djur	Fox	Räv	Atypical
Four-footed animal/Fyrfota djur	Lizard	Ödla	Atypical
Four-footed animal/Fyrfota djur	Donkey	Åsna	Atypical

Example of an item in word-stem form:

Four-footed animal/Fyrfota djur - Ho__

Acknowledgements

I sincerely want to thank my supervisor Mikael Johansson for his excellent, inspiring and crucial guiding (and patience) during all phases concerning the production of this article. Without his help, this would have never been possible. I also want to thank Karin Lundqvist for controlling the translated material which gave me some much needed confidence about continuing with the selected items. Finally, my warmest gratitude to all participants agreeing, on such a short notice, to be part of this experiment.