Thesis

Stressing True and False Memories in People with Recovered and Continuous Memories of Childhood Sexual Abuse

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Abstract

The memory processes and qualities of people who have been sexually abused during childhood have for long been subject of a heated debate between clinicians and researchers. This thesis wants to contribute to this discussion by choosing a strictly experimental approach. The influence of stress on true memory performance and false recognition was examined in three different groups: people with recovered memories of Childhood Sexual Abuse (CSA), people with continuous memories of CSA and controls. As CSA generally is a very stressful life event, it was tested how people remember information when learned during a stressful state elicited by Cold Pressure Stress. Because of the emotional nature of CSA, the remembrance of both neutral and emotional information was tested, applying the Deese-Roediger-McDermott paradigm. Assuming that a possible explanation for the existence of in therapy recovered memories is that at least part of those memories might be false memories created during therapy, it was tested whether people with recovered memories would falsely recall more critical lures than the other groups. The results however suggest that people with recovered memories of CSA falsely recalled less critical lures than the other two groups. In addition, neutral information was remembered better than emotional information and stress during learning impaired instead of improved true memory performance. These findings largely contradict what was expected based on prior research. Future studies should point out if the current results are due to the chosen design or indicate that some theories should be revised.
Introduction

Memory Wars

One of the most hot-tempered debates in the history of psychology and law undoubtedly has been the debate on the veracity of so-called ‘recovered memories’, also known as ‘the memory wars’. At a certain time, this debate looked more like a religious conflict than a scientific debate and its participants were more seen as believers than as the objective truth-seekers they should be (Ost, 2003). The conflict came into existence because practicing clinicians claimed that traumatic experiences could be repressed and later recovered in therapy (Clancy, Schacter, McNally & Pitman, 2000). They put this idea into practice by using several techniques to recover memories of victims of criminal acts, in particular childhood sexual abuse (CSA), and sometimes even murder (Loftus & Davis, 2006; Crombag & Merckelbach, 1996). The skeptical scientific community responded by taking the opposite stance, analyzing how false memories could develop in therapeutic settings. In this view, recovered memories might well be the result of an iatrogenic process, i.e. caused by the clinicians who claimed to cure them. This led to a very emotional response from both the practicing clinicians, and from the alleged survivors of sexual abuse and their supporters (Loftus & Davis, 2006). In addition, the growing concern in society about sexual abuse of children may have fueled the debate about recovered memories (Ost, 2003).

It is important to realize that the memory wars were not only being fought by the alleged victims and alleged perpetrators, but most of all by the clinical and scientific world. As more of these cases were brought to court, also more and more ‘memory-experts’ (both academic and clinical) were asked to testify (Ost, 2003). The outcome of recovered memory cases depends heavily on the expert testimony, because those cases rest on many controversial assumptions. Experts may rely on reasonable hypotheses that are not necessarily correct (Merckelbach, 2003) and this does not benefit truth finding. This is why the conflict between clinicians and researchers must be solved, especially when keeping in mind the very serious and sensitive nature of the claims that are made and the huge influence on the lives of many people (Ost, 2003). Fortunately, the scientific world is on track, because a growing number of studies on recovered memories and related issues led to a decrease in intensity and divergence in the recovered memories debate (Geraerts, Raymaekers & Merckelbach, 2008), but there is still some work to do. Thereby it is important to keep in mind why clinicians and researchers contend each other’s expertise. That is mainly because they use different sources of knowledge.

Case Studies versus Experiments

Various types of research have been conducted to study recovered memories, but due to methodological flaws, both parties keep rejecting the outcomes from each other’s studies. Clinicians, in general, use case studies to prove the existence of recovered memories, which means that a therapist writes an account of a case history along with an interpretation that the patient has repressed and later reliably recovered the memory (Loftus & Davis, 2006). The main problem with case histories is that the therapist is the only person who has access to the “data,” which are often subjective and not convincingly subjected to objective external verification (Loftus & Davis, 2006).

While clinicians want to prove the existence of recovered memories, researchers, on the other hand, usually conduct empirical studies in a lab in order to prove that skepticism is important when looking
at cases of recovered memories. Researchers have attempted to simulate certain therapeutic techniques (such as repeated questioning over a number of weeks), usually within a laboratory context, in order to understand the contribution that such techniques may have in the development of claims of early abuse in therapy (Ost, 2003). However, clinicians challenge the validity of such an approach, calling it artificial, and not resembling real life (Loftus & Davis, 2006).

An interesting result from several studies, which seems to refute the viewpoint of the clinicians, is that traumatic experiences other than CSA are seldom, if ever, forgotten (McNally, 2005). Memory researchers have studied this question for many years now and they found that no other experienced traumas, like a child seeing a parent being killed (Crombag & Merckelbach, 1996), being a war veteran or survivors from concentration camps, have ever completely forgotten the traumatic event (McNally, 2005). So this means that seemingly only concerning CSA it is possible to have recovered memories. Or is there another explanation?

*Characteristics of Recovered Memories*

In this study, some underexposed aspects of recovered memories are empirically tested and in order to fully understand why this study is so important, some knowledge about recovered memories is helpful. Recovered memories have been classified as cases in which adults initially believe they were not sexually victimized as children and later come to believe that they were, rather than cases in which people who always knew they survived such abuse as children remember additional details or instances (Lindsay & Read, 1995). But in practice, such clear-cut criteria for a recovered memory are rare (Alison, Kebbell & Lewis, 2006). CSA is the primary field where recovered memories are believed to exist (Loftus & Davis, 2006). To demonstrate that memories can be repressed and later on recovered, at least three aspects must be verified (Loftus & Davis, 2006):

- The abuse took place
- The abuse was forgotten and inaccessible for some period of time
- The abuse was later on remembered

A distinction has been made between two types of recovered memories (Geraerts, 2006; Geraerts, Merckelbach & Jelicic, 2007), both types containing these three aspects. The first type consists of people with *spontaneously* recovered memories. Those memories usually come about spontaneously by a cue in a non-therapeutic situation and are often accompanied by an “aha-feeling”. The other type consists of people who in *therapy* recovered memories. Those memories usually surface gradually during the course of therapeutic treatments that often involve techniques such as hypnosis, guided imagery, dream interpretation and other suggestive procedures (Loftus & Davis, 2006).

*Spontaneously Recovered Memories: How Spontaneous is Spontaneous?*

One alternative explanation for the existence of *spontaneously* recovered memories where memory researchers have come up with is the thought that maybe those people never really forgot the abuse. Because it turned out that after closer examination of people who claimed to have *spontaneously* recovered memories, and after gather -
time when they were allegedly amnesic for the event (Schooler, 2001). This indicates that people appear to have a poor understanding of the way in which they remember events (Alison et al., 2006). These authors found that individuals claimed to forget recollecting a childhood event that they thought about, only minutes earlier. This is called the “forgot it all along” (FIA) phenomenon, in which remembering an event in a new way (more vividly and emotionally) leads the individual to fail to recall prior occasions of recollecting that event (Arnold & Lindsay, 2002, 2005). The extent to which people are prone to err in their estimations of prior remembering was empirically tested by Parks (1999) and by Merckelbach and co-workers (2006). Merckelbach et al, for example showed that people with recovered memories underestimated their prior remembering, compared to people with continuous memories of CSA. And more specific: Geraerts et al. (2009) found that people with spontaneously recovered memories of CSA were significantly more prone to forget prior incidences of remembering than people with in therapy recovered memories of CSA.

In Therapy Recovered Memories: the Issue of Susceptibility

Memory is well known to be susceptible to distortion (Geraerts et al., 2008), and it is supposed that false memories can be created by suggestive therapeutic techniques like hypnosis, dream interpretation and guided imagery (Loftus & Davis, 2006). It is therefore not too farfetched to assume that at least part of those in therapy recovered CSA memories might be false memories created during therapy. If this is true, this is an undesirable situation with sometimes huge consequences, and therefore the possibility to create false memories during therapy should be minimized. A better insight in the underlying cognitive procedures and the emergence of false memories is needed. This can be provided by experimental studies using techniques aimed at suggestibility and the elicitation of false memories.

The Use of the Deese-Roediger-McDermott (DRM) Paradigm

The Deese-Roediger-McDermott (DRM) paradigm is memory performance test aimed at eliciting false memories (Roediger & McDermott, 1995) and demonstrates the fallibility of memory (Bernstein and Loftus, 2009). A DRM paradigm always consists of different phases: the encoding phase in which word lists are presented and should be learned, and one or more recall and/or recognition phases. The DRM can be used to study true memory performance (how many words are correctly recalled after a period of time) and it can be used to look at the elicitation of false memories because of the typical structure of the DRM paradigm. The lists of words consist of semantic associates (e.g., butter, knife, old, wheat) that are semantically related to a non-presented theme word (called the “critical lure”, in this case “bread”; Smeets et al., 2008). Participants encode the word lists after which recall and/or recognition performance is assessed. Typically, people falsely recall and/or recognize the critical lures. Because different word lists can be used in the DRM paradigm, it is possible to look at the influence of using lists with different emotional content on memory performance (like negative, positive and neutral words). Smeets, Jelicic and Merckelbach (2006) found that memory effects of exposure to acute stress depend on the valence of the memory material. For this study this is important because CSA by definition involves highly emotional experiences. Schwabe et al. (2008) found that overall, emotional (positive and negative) words were better recalled than neutral words, a finding which is consistent with other research showing that emotional events are better remembered than neutral ones (LaBar & Cabeza, 2006). Pesta, Murphy and Sanders (2001) used the DRM task to test the influence of emotional content on memory
performance and they found that emotional critical lures were more often falsely recognized than neutral critical lures. This effect became even larger when emotional words were added to the, to be learned, word list.

Some researchers already used the DRM paradigm to look at memory performance of people with CSA. This is interesting because an early traumatic experience and the possibly subsequent emergence of a Post Traumatic Stress Disorder (PTSD) have been associated with a wide range of memory disturbances (Bremner, Krause Shobe & Kihlstrom, 2000). In their study, Bremner and colleagues (2000) made a distinction between people with a history of CSA and PTSD, people with a history of CSA without PTSD and a control group without a history of CSA and PTSD. They found that people with a history of CSA and PTSD falsely recognized more critical lures than the other groups and these people even recognized more critical lures than they correctly recognized the studied words. This group also had lower rates of correct recall of previously studied words than the other groups, but the authors could not conclude if this increase in false memory is specific to PTSD diagnosis or a history of abuse. This makes it interesting to also look at the true memory performance and false recall of the continuous memory group.

Not only the memory performances of people with continuous memories of CSA have been studied, there has also been looked at true memory performance and false recognition of people with recovered memories, using the DRM. This is particularly interesting because an alternative explanation for the existence of in therapy recovered memories claims that those people might be more prone to create false memories. Clancy et al. (2000) conducted a study with 4 groups: women with continuous memories of CSA, women with recovered memories, women with repressed memories of CSA and a control group with no history of CSA. The repressed group contained people who believe that they were sexually abused as a child, but who cannot recall this abuse. They found that women with recovered memories were more prone to false recognition than the other groups.

Geraerts et al. (2009) went even further; in their study they made a distinction between the in therapy recovered memories and the spontaneously recovered memories, because for both groups there are alternative explanations for their existence, relying on different cognitive mechanisms. They used the DRM paradigm to test memory performance of people with spontaneously recovered memories of CSA, in therapy recovered memories of CSA, people with continuous memories of CSA and a control group consisting of people without a history of CSA. They found that people with in therapy recovered memories had a significantly higher rate of false recall than the spontaneously recovered memory group. This means that studies which provide a better insight in the elicitation of false memories might especially give a better insight in the emergence of in therapy recovered memories.

The Influence of Stress on Memory Performance

Because sexual abuse (obviously) and undergoing therapy can be seen as stressful events, it is interesting to see whether stress has an influence on true memory performance. And when looking at people with in therapy recovered memories, it is also interesting to look at the elicitation of false memories and the influence of stress on this process. The DRM paradigm can be used to test both true memory performance, as well as the elicitation of false memories and is therefore used in this experiment. The combination of the DRM paradigm and Cold Pressor Stress (CPS) is used to test the influence of stress on memory performance. CPS is a widely used, low-risk technique to expose
participants to painful stressors and is known to induce robust and reliable stress responses (Cahill, Gorski & Le, 2003; Smeets et al., 2008). Here, participants in the experimental stress condition were instructed to hold their hand and wrist in very cold water (4.5 degree Celsius), which is sufficient to create a reliable stress response. Cortisol measurements were used to check the stress response per participant, although it should be noted that CPS is not the most potent elicitor of cortisol responses per se (see, e.g., Schwabe et al., 2008).

Earlier stress studies show that stress can affect memory in different ways, depending on the memory phase in which the stress occurs. It has been found that stress during retrieval leads to a decrease in memory performance, while stress right after learning (also called the consolidation phase) enhances memory performance (Smeets et al., 2008; Cahill et al., 2003). CSA and other traumatic experiences are by most of the people thought to be very stressful events and therefore, in this study, the influence of stress during the learning (encoding) of information is simulated. Although the results that stress can improve true memory performance are based at the consolidation phase instead of the encoding phase, still similar results are expected because of the small time difference between the two phases. The effect that stress has on memory performance also depends on the emotional content of information. Cahill and colleagues (2003) found that post-learning stress only enhanced memory performance for emotionally arousing slides. Smeets et al. (2008) found evidence to confirm this statement, because in their study it turned out that the consolidation stress group displayed superior true recall of emotional, but not for neutral words.

Payne et al. (2002) used the DRM in combination with a stress test to look at the influence of pre-learning stress on the elicitation of false memories. They found that stressful conditions lead to an increase of false recognition, which is a type of false memory. Smeets et al. (2008) also looked at the elicitation of false memories, but in combination with stressful conditions on different moments. They did find false recall rates similar to those of other studies, but remarkably they did not find an influence of emotional content.

**Focus of the study**

The aim of the present study is to provide a scientific contribution to ‘the memory wars’ by getting more empirical evidence on memory processes in subjects with continuous and recovered memories on CSA. Because of the emotional nature of CSA, we are particularly interested whether true memory performance in subjects with both continuous memories of CSA and recovered memories of CSA is different for emotional stimuli versus neutral stimuli and to which extent this is influenced by stress. This is important because there are some indications that traumatic stress associated with CSA may result in chronic alterations of the hippocampus or stress-sensitive neurochemical systems, like the hypothalamic-pituitary-adrenal (HPA) axis (Vythilingam, Heim, Newport, Miller, Anderson, Bronen, 2002). Moreover, posttraumatic stress disorder (PTSD) has been associated with a wide range of memory disturbances Bremner et al., (2000). It is important to pay specific attention to the impact of stress on these memory processes, because both experiencing CSA and going into therapy can be seen as stressful events.

Besides looking at true memory performance, it is also very interesting to look at the influence of stress on false recall within the recovered memory group and especially in the in therapy recovered memory group. False recall can be seen as an indication for a heightened proneness for the
elicitation of in therapy recovered memories. Therefore, the focus of this study is: the influence of stress on the encoding and subsequent remembering of (neutral and emotional) information in people with continuous and recovered memories of CSA. This will be tested in an experimental design. In order to be certain that detected differences indeed can be attributed to the phenomenon under study (‘continuous and recovered memories of CSA’), it is important to choose valid control groups. When looking at true memory performance, one control group is used: a group of healthy controls. But when looking at false recall in the recovered memory group, two control groups are being used: (a) a group of healthy controls (b) a group subjects with continuous memories on CSA. The group with continuous memories on CSA shares the traumatic childhood experiences with the group with the recovered memories, but differs in that they have always been aware of these unpleasant childhood experiences. The latter group is needed in order to learn whether detected differences are to be attributed to the process of recovered memories as such or to the underlying unpleasant or even traumatic childhood events. Furthermore, it is expected from the literature, that subjects who recovered their CSA memories during therapy sessions (as compared to spontaneously recovered memories, people with continuous memories of CSA and controls) are especially prone to the false-memory effects elicited by the DRM manipulation (Geraerts et al., 2009). Therefore, the group ‘recovered memories’ will be split for some of the analyses in two sub-groups: spontaneously recovered memories and in therapy recovered memories of CSA.

**Summarizing the focus of the study**, In an experimental design, we will test memory performance on neutral and emotional stimuli under non-stress and stress conditions in three different groups: (a) subjects with recovered memories of CSA (subdivided in subjects with spontaneously recovered memories and subjects with in therapy recovered memories), (b) subjects with continuous memories of CSA and (c) controls without a history of CSA.

**Research questions and hypotheses**

The overall research question is: What are the differences in memory performance between individuals with recovered memories of CSA, those with continuous memories of CSA and controls? This general research question is specified in several sub questions:

**Research questions:**

1) What are the differences in true memory performance on neutral versus emotional stimuli between individuals with recovered memories of CSA, those with continuous memories of CSA and controls, under non-stress as well as under stress conditions?

2) What is the influence of experimental stress on the encoding and subsequent remembering of neutral and emotional information, among individuals with continuous memories of CSA, those with recovered memories of CSA and controls?

3) What is the influence of stress on the development of false memories in individuals with continuous memories of CSA, individuals with recovered memories of CSA and controls?

**Hypotheses:**

1) Participants in all groups will remember more emotional words than neutral words, both in the non-stress and stress condition
2) Participants in all groups will remember more words in a stressful condition than in the non-stress condition.

3) Participants in all groups will falsely recognize more emotional critical lures than neutral critical lures, both in the non-stress and stress condition.

4) Participants in all groups will falsely recognize more critical lures in a stressful condition than in the non-stress condition.

5) People with recovered memories are more susceptible for creating false memories in a stress than in a non-stress condition.

6) Participants with recovered memories are more susceptible to creating false memories than people with continuous memories and the control group, especially in the stressful condition.

**Methodology**

In order to test the hypotheses from the previous section, an experimental study is conducted which consists of a mixed 3x2x2 design, with group (controls vs. continuous memories of CSA vs. recovered memories of CSA) and stress (stress vs. no stress) as independent between-subject variables and wordlists (neutral vs. emotional) as a repeated measure.

This study is part of a larger project consisting of 3 groups (control group, continuous memories of CSA group and recovered memories of CSA group), 6 cortisol measurements, 5 memory tasks, 8 questionnaires and a structured interview about the abuse. For this thesis only 1 memory task (DRM), 1 questionnaire (BDI), 6 cortisol measurements and the structured interview are used and therefore only these components are described in this thesis. From now on, the remaining tasks and questionnaires are described as filler tasks. These filler tasks are considered not to be relevant for this thesis.

**Classification**

One of the main problems with the subject of recovered memories is the lack of objectivity concerning the classification of the memories of the abuse. Different authors use different groups and criteria, which makes it difficult to compare the outcomes of different articles. This should not be the case and therefore, we opted for a more strict classification for this study. This new classification is mainly based on the question whether the person really has forgotten the abuse. To find out to which extent a person really has forgotten the abuse for a certain period of time, the researcher focused on 2 different aspects. The first aspect concerns the fact that CSA sometimes occurs when a child (the victim) is too young to know what CSA is. When a person becomes older she will learn more about sexuality and this can lead to the realization that she was sexually abused as a child. This is called a reinterpretation and in the past researchers often classified people with this experience as belonging to the spontaneously recovered memory group. However, here we decided that these people are part of the continuous memory group, because they never truly forgot what happened, it only took them some time to name it. The second focus of the researcher is to find out if the person really ever forgot that the abuse took place. This happened by targeted questions during the screening by telephone and during the structured interview. An example is the
question whether the person would have known about the abuse if a person had asked it. During the structured interview attention was also paid to strategies people can use to not think about the abuse. Because not knowing about the abuse is very different from not thinking about it. If it turned out a subject actually knew about the abuse during the amnesic period, but did not want to think about it, we also classified him as a person with continuous memory of CSA.

The new criteria led to a large decrease in number of people in the recovered memory group, because it turned out that people often think of themselves as having recovered memories but after some questions it then turned out they reinterpret the abuse or they never really forgot the abuse at all. These people were now categorized in the group with continuous memories of CSA. One person was excluded from the sample because she did not have actual memories of the abuse. There were also 5 participants who had continuous memories in combination with recovered memories of CSA (i.e., “mixed profile” cases) and were excluded from the analyses.

Because of the new, stricter criteria, we found only a handful of people with recovered memories, thus after an active and extended search for people with recovered memories, it unfortunately had to be concluded that this study probably would have too little power to detect differences between the subjects with recovered memories and the two control groups.

**Participants**

*Recruitment*

In total, 12 adults with recovered memories of CSA, 35 adults with continuous memories of CSA and 27 non-abused control subjects participated. People with continuous memories of CSA, who were only abused when they were younger than 2 years were excluded from this study, due to the childhood amnesia claim made by several authors in the past (Crombag & Merckelbach, 1996). The minimum age to participate was 18 years (with a maximum age of 65 years) and both men and women were able to participate. All subjects participated on a voluntary basis, signed the informed consent and were financially compensated for their time (75 euro). The ethics committee of the Faculty of Psychology and Neuroscience of Maastricht University approved the test protocol.

The participants with continuous memories and recovered memories of CSA were recruited via advertisements in local newspapers and on the Internet, saying that Maastricht University was “looking for adult volunteers with a history of CSA who always have remembered the abuse or adult volunteers with a history of CSA who not always have remembered the abuse to participate in a study about the relationship between CSA and their memory performance”. Some recovered memory subjects were recruited from among those who had participated in other studies of the Faculty of Psychology and Neuroscience of Maastricht University. The control group was recruited via an advertisement on the Internet and flyers spread through the city centre of Maastricht. People who were interested in participating contacted the researcher by e-mail or telephone for more information. During this contact an initial screening took place. People with a high blood pressure or heart and vascular diseases were excluded or put in the no-stress condition, depending on the type of disease and medication. People with diseases that can cause memory deficits were excluded from this study. With the respondents who fitted the requirements, appointments were made.

*Background Characteristics*
The 3 groups do not differ significantly on gender and most participants were women (see table 1 for more information). The 3 groups do differ on education, with controls being higher educated than both groups with a history of CSA. The control group is also younger than the other 2 groups. These differences can be explained by the fact that this study has been carried out at an university and therefore some students are used in the control group, while participants in the other 2 groups are older and are meanly lower educated. The Beck Depression Inventory (BDI) was also part of the testing procedure. The BDI is a questionnaire to measure depression and in this study it is used to check if there is a difference in the degree of depression between the 3 groups (see materials for more information about the BDI). It turned out that the groups differed significantly on their degree of depression, with people with continuous memories of CSA and people with recovered memories of CSA being more depressed than people without a history of CSA.

<table>
<thead>
<tr>
<th></th>
<th>Recovered memory group (n=12)</th>
<th>Continuous memory group (n=33)</th>
<th>Control group (n=27)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>83.33% women 16.67% men</td>
<td>85.71% women 14.29% men</td>
<td>66.67% women 33.33% men</td>
</tr>
<tr>
<td>Education</td>
<td>41.66% Lower 58.33% Middle</td>
<td>17.14% Lowest 40.00% Lower 37.14% Middle 5.71% Higher</td>
<td>3.70% Lowest 25.93% Lower 40.74% Middle 29.63% Higher</td>
</tr>
<tr>
<td>Age</td>
<td>Mean &amp; SD 45.92 (14.08)</td>
<td>Mean &amp; SD 44.14 (9.15)</td>
<td>Mean &amp; SD 36.15 (12.41)</td>
</tr>
<tr>
<td>BDI score</td>
<td>Mean &amp; SD 16.08 (10.86)</td>
<td>Mean &amp; SD 15.06 (13.54)</td>
<td>Mean &amp; SD 6.64 (7.73)</td>
</tr>
</tbody>
</table>

*Table 1. Demographic and psychometric data*

**Materials**

*Beck Depression Inventory (BDI)*

The BDI is a 21-item questionnaire addressing current depressive symptoms (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Per item, a choice can be made between 4 statements, increasing in severity, with a score ranging from 0-3. The total BDI score is the sum of all items and can range between 0-63. The cut-off score is 13. Participants were instructed to choose the statements that described best how they felt the previous week.

*Cold Pressor Stress (CPS) and Memory Encoding Task (DRM)*

Ethical considerations prevent the use of extreme stressors. In the laboratory simple but effective stress tests are used like the Cold Pressor Stress (CPS). The CPS consists of a bucket with water on a specific and constant temperature. In this study, water of 4.5 degree Celsius is used for the stress
condition and water of 25 degree Celsius is used for the no-stress condition. This part of the study took place in a specific CPS lab.

The CPS is used in this study in combination with the encoding phase of the DRM. The encoding phase of the DRM exists of the presentation of the words and the free recall phase. During the encoding phase, participants were instructed to first read the instructions at the computer screen. The instruction explained the procedure and told that as the procedure could be painful, the participant could remove his arm from the cold water whenever she wanted without any consequences. Participants were warned during contact by email or telephone that a physical task was part of the program. During the procedure, participants were not informed beforehand to which condition (stress vs. no stress) they were assigned, so condition was single blind. To which condition the participant had been assigned, was told during the debriefing.

After reading the instructions, the CPS in combination with the encoding phase of the DRM started. The computer program started and asked the participant to hold his hand in the bucket with water next to him. The temperature of this water is 4,5 (stress condition) or 25 (no-stress condition) degree Celsius. After 1 minute, the participant pulled his hand out of the water, dried his hand with a towel and looked at the computer screen because the first neutral word list, consisting of 10 neutral words which were presented one by one, appeared on the screen for 20 seconds. After the words were shown, there was a 1 minute free recall test during which the participant had to recall every word she could remember and the researcher wrote down these words. After this free recall period of 1 minute, the second list of words was presented for 20 seconds. The second list consisted of 10 emotional words, which was followed by a second free recall period for the list of emotional words. After the presentation and free recall of 2 word lists (first 1 neutral list, followed by an emotional word list), the computer asked the participant to hold his hand in the bucket with water again. This procedure was repeated 5 times, thus totaling 5 lists with neutral words and 5 lists with emotional words. During the CPS, the researcher always remained in the room to write down the free recall words mentioned by the participant, to answer questions and to monitor participants’ compliance with the test instructions.

The complete DRM encoding phase, consisting of the presentation of the words and the free recall phase, existed of:
- introduction
- hand in water for 1 minute, presentation of word list 1 (neutral), free recall word list 1, presentation of word list 2 (emotional), free recall word list 2
- hand in water for 1 minute, presentation of word list 3 (neutral), free recall word list 3, hand in water for 1 minute, presentation of word list 4 (emotional), free recall word list 4,
- hand in water for 1 minute, presentation of word list 5 (neutral), free recall word list 5, presentation of word list 6 (emotional), free recall word list 6
- hand in water for 1 minute, presentation of word list 7 (neutral), free recall word list 7, presentation of word list 8 (emotional), free recall word list 8
- hand in water for 1 minute, presentation of word list 9 (neutral), free recall word list 9, presentation of word list 10 (emotional), free recall word list 10.

*Deese-Roediger-McDermott Paradigm*
This study used a Dutch version of the DRM paradigm (Roediger & McDermott, 1995; Smeets et al., 2008). The DRM paradigm used in this study exists of 2 different phases: the encoding phase (consists of the presentation of the word lists and the free recall test) and the recall phase (consisting of the stem-cued recall test; see figure 1 for a timeline of the testing procedure). The encoding phase took place in combination with the CPS and therefore took place in the specific CPS lab. The rest of the testing took place in another research lab.

**Figure 1**

In total, the DRM test consisted of 10 word lists (5 neutral and 5 emotional lists) and each of the lists consisted of 10 words (see appendix 1). The mean word frequency of neutral and emotional critical lures did not differ \( t(8) = 0.22; \text{ns} \). Furthermore, mean associative strength between the neutral list words and their critical lures and the mean associative strength between the emotional list words and their critical lures did not differ \( t(8) = 1.69; \text{ns} \) (Smeets et al., 2008). The lists of words are highly associated with a primary associate (critical lure) that is not part of the list of studied words (Roediger & McDermott, 1995). To explain this more clearly, an example from this study will be used. The first list used in this study consists of the following words: Baker (bakker), butter (boter), spreads (beleg), brown (bruin), dough (deeg), rye (graan), flour (meel), knife (mes), wheat (tarwe) and old (oud). All these words have to do with bread (brood), which is the critical lure and therefore not presented in the list. One of the aims of the DRM is to see whether people create pseudo memories. A pseudo memory in this example is when a participant falsely recalls a critical lure during the stem-cued recall test.

*Stem-cued Recall Test (retrieval DRM)*

The stem-cued recall is constructed in the same way as the presentation of the DRM word lists. This means that the words presented during the encoding phase of the DRM were presented in the same order as the words on the stem-cued recall forms. The stem-cued recall test took place 140 minutes after the encoding phase and in order to avoid a possible floor effect, a stem-cued recall test was used instead of a free recall test. For the same reason, 3 of the 10 previously presented words of each list were included to cue the words pertaining to that particular list (Smeets et al., 2008). These words are always presented at the first, fourth and tenth position of the list. From the other 7 words, the stem, consisting of the first 2 characters, was given (see appendix 2). The stems were not words in themselves and they could be completed in many different ways. Only 9 of the 10 words per list were earlier presented during the encoding phase. The other word, always presented at the
fifth place of the list, is the critical lure (see appendix 2). This word was not presented during the encoding phase, and therefore, a participant should not complete this word. The more critical lures a participant complements, the more prone a person is to creating false memories. Besides testing a persons’ suggestibility, the DRM is also used to test a person’s memory for neutral and emotional words. In total, 4 dependent measures were derived from the stem-cued recall: the proportion recall of presented neutral words (proportion neutral true recall), the proportion recall of presented emotional words (proportion emotional true recall), the proportion falsely recalled neutral critical lures (proportion neutral false recall) and the proportion falsely recalled emotional critical lures (proportion emotional false recall; Smeets et al., 2008).

Measuring Cortisol

In order to measure to which extent the CPS has lead to activity of the HPA-axis and therefore has created a physical stress response, the cortisol level is measured by a synthetic cortisol sampling device, called salivettes (Sarstedt®, Etten-Leur, the Netherlands). To measure the amount of cortisol present in a participant on a given moment, the participant is asked to gently chew on a salivette for 1 minute. The first measurement takes place just before the CPS to get a baseline for each subject. The next cortisol measure takes place right after the CPS. Three cortisol measures are taken during the filler tasks. And the sixth cortisol measure was obtained after the filler tasks and directly before the stem-cued recall test and the recognition test. When a participant finished the testing procedure, the salivettes were collected, organized and put in a freezer (-20 degree Celsius) for preservation. When all participants were tested, the salivettes were sent to a lab for examination.

Procedure

During the first telephone call or the contact by email, besides personal information, also information about the abuse was asked to make it possible to classify the person to one of the three groups (the control group, the continuous group or the recovered memory group). A structured interview about the abuse was also part of the testing procedure and this information was used for the final classification. In case of ambiguity, a panel of 3 independent persons was consulted to draw a final conclusion about the group a certain participant should be classified in. The participants were semi-randomly assigned to the stress or no-stress condition, depending on medical conditions. And all participants were tested with both the emotional as with the neutral word lists as a repeated measure.

The testing occurred in two different labs. The first lab is the testing lab where most of the testing took place, like the stem-cued recall DRM test. The second lab is the stress lab, where the CPS was located. This is where the CPS in combination with the encoding phase of the DRM took place.

When the participant entered the test lab, she was first asked to read and sign the informed consent. After signing the informed consent, the participant had to fill in 2 screening forms. These screening forms asked about personal information like age, height and weight, but also medical information and some questions about the use of drugs, alcohol and cigarettes. The latter information is important because of their possible influence on the cortisol levels of the participants.

After completing the screening forms, the participant was asked to chew on a salivette for 1 minute. After the first cortisol measurement, the researcher and the participant went to the second lab, the
stress lab. In the stress lab, the CPS in combination with the encoding phase takes place. During this part of the DRM test, which takes about 20 minutes, participants were asked to hold their hand in the bucket with water, which stands beside them (CPS). Half of the participants had to hold their hand during the encoding phase in cold water (4,5 degree Celsius). This leads to a physical stress response. The other half of the participants held their hand in warm water (25 degree Celsius). The warm condition will not lead to a physical stress response and therefore this is called the control condition.

After completing the DRM encoding phase, the researcher and the participant returned to the normal test lab, where the participant was asked to do the second cortisol measurement. After the second cortisol measurement, the participant had to do filler tasks for 136 minutes. The filler tasks consisted of some other memory tasks, a break, some questionnaires, 3 cortisol measurements and the structured interview about the abuse. After the filler tasks, the sixth cortisol measurement was obtained, followed by the DRM stem-cued recall test. After reading the instruction, the participant had to fill in every word she remembered from the words presented during the encoding phase. Three words per list were already shown and of the other words; the first 2 characters were already given (see materials and appendix 2 for more explanation). When the stem cued recall test was completed, the participant engaged in some more filler tasks. To conclude the procedure, the participant read the debriefing, had the opportunity to ask questions and completed the payment form.

**Statistical analysis**

As Shapiro Wilk tests of normality showed skewness of CORT data, the data were log-transformed before use in subsequent analyses. CORT responses were evaluated using a 3 (Group: recovered memory vs. continuous memory vs. controls) x 2 (Stress: stress vs. no-stress) x 6 (Time, t-2, t+20, t+32, t+54, t+66, t+158) repeated measures ANOVA, with ‘Time’ being a repeated measure. For each participant individually, we also computed a CORT response (called cortisol reactivity; i.e., delta increase in CORT) defined as CORT measurement with the highest concentration minus pre-stress CORT concentration. Delta responses were analyzed using univariate ANOVAs (Smeets et al., 2008).

For analysing the results of the stem-cued recall test of the DRM, ANOVAs are used. True recall performance for presented words and false recall of critical lures was separately evaluated using 3(Groups: continuous vs. recovered vs. control) x 2 (Stress vs. no-stress) x 2 (Valence: neutral vs. emotional) repeated measures ANOVAs, with Valence being a repeated measure. And when necessary, univariate ANOVAs and Least Significant Difference (LSD) corrected post hoc tests were performed in order to take a closer look at findings.

Spearman’s Rho correlations were computed between true and false recall and delta CORT increases. When sphericity assumptions were violated, Greenhouse—Geisser corrected $p$ -values are reported (Smeets et al., 2008).

Alpha was set at 0.05 and adjusted for multiple comparisons if necessary.
Results

Pre-stress Cortisol Analyses

None of the participants reported to have violated the prohibition on eating, drinking and heavy exercise one hour before testing. An independent samples t-test showed that the stress group (10.10 ± 3.22) and the no-stress group (12.84 ± 7.56) differed on the pre-stress CORT level at T-2 [t (53.11) = -2.06; p = 0.04].

Cortisol Stress Responses

Figure 2 shows the CORT concentrations during the testing procedure. Repeated Measures ANOVA showed a main effect of time \[ F(5, 330) = 40.00, p < .001 \] and a time X stress interaction \[ F(5, 330) = 7.36, p < .001 \]. No main effect of group was found, nor an interaction effect of time X group or time X group X stress. As is apparent from inspecting figure 2, the CORT response pattern for the no-stress group decreased continuously, while the CORT response pattern for the stress group first increased because of the CPS and then decreased continuously. Moreover, delta increase, here called “cortisol reactivity” has been measured by subtracting the first measurement (baseline) from the highest cortisol measurement per participant. Cortisol reactivity differed significantly between the stress and no-stress condition \[ F(39.48) = 5.57, p < .001 \], with means of 6.45 ± 8.38 and -2.13 ± 3.12 for the stress and no-stress conditions, respectively.

---

1 There is a statistical difference between some demographic characteristics of the controls, the continuous memory group and the recovered memory group (see table 1). This should be taken into account when interpreting the results.
Figure 2. Mean salivary cortisol levels (nmol/l) for the stress and no-stress groups are shown. Data points indicate cortisol levels throughout the session.

True Memory Performance and False Recall

Mean percentages and standard deviations of true and false recall as a function of group for both neutral and emotional words are shown in table 2. Two repeated measures ANOVAs were used (separately for true recall and false recall), with valence being the repeated measure. Stress vs. no stress and group (people with continuous memories of CSA, people with recovered memories of CSA and controls) were used as independent variables. For true recall, a main effect of valence was found [F(1, 66) = 67.85, p < 0.001], with neutral words (0.55 ± 0.14) more often being truly recalled than emotional words (0.42 ± 0.15). For true recall, also a borderline main effect for group was found [F(2, 66) = 2.35, p = 0.10. Further exploring this trend towards a main effect of group using LSD post hoc tests showed that controls correctly recalled somewhat more words (both neutral and emotional) than people with continuous (p = 0.07) and people with recovered memories of CSA (p = 0.09).

<table>
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<tr>
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<td></td>
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<td>Continuous memories (n=15)</td>
<td>Controls (n=16)</td>
<td>Recovered memories (n=9)</td>
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<td>Hits</td>
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<td>Hits</td>
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<td>Critical lures</td>
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<td>0.79 ± 0.17</td>
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<tr>
<td>Neutral</td>
<td>0.53 ± 0.50</td>
<td>0.75 ± 0.21</td>
<td>0.76 ± 0.20</td>
<td>0.64 ± 0.19</td>
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</table>
When looking at false recall, a main effect of valence was found \([F(1, 66) = 17.11, p < 0.001]\), with neutral critical lures (0.86 ± 0.15) more often being falsely recalled than emotional critical lures (0.73 ± 0.21). The analysis also showed a borderline main effect of stress \([F(1, 66) = 2.78, p = 0.10]\), with people in the no-stress condition (0.81 ± 0.02) falsely recognizing more critical lures (both neutral and emotional) than people in the stress condition (0.75 ± 0.03), but also a borderline interaction effect of valence X group \([F(2, 66) = 2.61, p = 0.08]\). Univariate ANOVAs with stress (stress vs. no-stress) and group (recovered memories of CSA, continuous memories of CSA and controls) being used as independent variables, and proportion critical lures neutral and proportion critical lures emotional were used separately as dependent variables. For false recall of neutral critical lures, the ANOVA yielded a borderline main effect of stress \([F(1, 66) = 2.87, p = 0.10]\), with people in the no-stress condition (0.89 ± 0.14) falsely recognizing more neutral critical lures than people in the stress condition (0.83 ± 0.16). For false recall of emotional critical lures, the ANOVA yielded a borderline main effect of group \([F(2, 66) = 2.87, p = 0.06]\), with the recovered memory group (0.62 ± 0.28) falsely recognizing less emotional critical lures than the continuous memory group (0.74 ± 0.20; \(p = 0.06\)) and controls (0.78 ± 0.18; \(p = 0.02\)). These results were found using LSD corrected post-hoc tests.

**Table 2.** DRM stem cued recall performance of participants in 3 groups: people with recovered memories of CSA, people with continuous memories of CSA and controls. A distinction was made between stress (CPS induced) and no-stress

The Influence of Stress on True Memory Performance and False Recognition

Spearman’s Rho correlational analyses have been calculated between cortisol reactivity and the four DRM recall variables (neutral true, neutral emotional, false neutral and false emotional; see table 3 for the results of the stress condition). These correlations were used to evaluate the role of cortisol on true and false memory performance over the three groups. Both true and false recall correlated negatively with cortisol increases in the stress condition, but none of these correlations reached statistical significance.

<table>
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<th>P</th>
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<tr>
<td>Proportion Hits Emotional</td>
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<tr>
<td>Proportion Critical Lures Neutral</td>
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<tr>
<td>Proportion Critical Lures Emotional</td>
<td>-0.08</td>
<td>0.67</td>
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</table>

**Table 3.** Correlations between cortisol reactivity and the four recall variables: Proportion Hits Neutral, Proportion Hits Emotional, Proportion Critical Lures Neutral & Proportion Critical Lures Emotional, subdivided into stress vs. no-stress

Discussion

Focus of the study
The memory processes and qualities of people who have been sexually abused during childhood have for long been subject of a heated debate between clinicians and researchers. This thesis wants to contribute to this discussion by experimentally testing some existing memory assumptions about both true memory performance and false recall. In total, three groups were examined: people with recovered memories of CSA, people with continuous memories of CSA and controls. As CSA can be a very stressful life event, it was tested how people remember information when learned during a stressful condition (in this study induced by applying CPS). Because of the emotional nature of CSA, the remembrance of both neutral and emotional information was tested, applying the DRM paradigm.

Expectations

Based on prior research, it was expected that emotional information would be remembered better than neutral information (Schwabe et al., 2008; LaBar & Cabeza, 2006; Cahill et al., 2003) and that the a CPS induced stress response during the consolidation phase would lead to an increase in remembering words correctly (Smeets et al., 2008; Cahill et al., 2003). Concerning false recall, it was expected that a stressful condition would lead to falsely recalling more critical lures (Payne et al., 2002; Smeets et al., 2008), especially emotional ones (Pesta et al., 2001). A possible alternative explanation for the existence of in therapy recovered memories is that at least part of those memories might be false memories created during therapy, and therefore it was tested whether people with recovered memories would falsely recall more critical lures than the other groups, especially emotional critical lures and in a stressful condition.

One recovered memory group

After looking post hoc separately at the in therapy recovered memory group and the spontaneously recovered memory group, no differences between the groups on DRM performance, both true memory performance and false recall, were found. This result is in contrast to what were expected based on studies like Geraerts et al. (2008) and Geraerts et al. (2009). According to Geraerts and colleagues, a distinction should be made between two types of recovered memories, spontaneously recovered memories and in therapy recovered memories, based on their assumption that both types rely on different underlying cognitive mechanisms. Because in this study the sample size of the recovered memories group was too small to draw any conclusions, no differences between the in therapy recovered memory group and the spontaneously recovered memory group were made. From now on there will be spoken about the recovered memory group, which includes both groups. This however implies that no real conclusions can be drawn from the results of this study concerning the recovered memory group.

Findings

The DRM paradigm was used to test both true memory performance and false recall. Concerning the true recall data, there are two findings. A main effect of valence was found. People in all groups remembered neutral words better than emotional words. Second, compared to controls, people with recovered memories of CSA and people with continuous memories of CSA displayed a bit inferior true recall. So controls were slightly better in remembering information than were the people with recovered and continuous memories of CSA. Concerning the false recall data, there are 3 findings. First, a main effect of valence was found, with neutral critical lures more often being
falsely recalled than emotional critical lures. Second, a borderline main effect of stress was found with people in the no-stress condition falsely recognizing more critical lures than people in the stress condition. And third, a borderline interaction effect of valence X group was found. ANOVAs and LSD corrected post hoc tests were used to make a distinction between false memory performance on neutral and emotional critical lures, in order to further explore the nature of this interaction. These statistical analyses showed a borderline main effect of stress, with people in the no-stress condition falsely recognizing more neutral critical lures than people in the stress condition. It was expected that both stress and emotional content would lead to an increase in false memory performance, but it turned out to be the other way around. Also a borderline main effect of group was found, with the continuous memory group and the controls falsely recognizing more emotional critical lures than the recovered memory group. It was expected that people especially with in therapy recovered memories would falsely recall more critical lures than the other two groups, as an indication for the idea that some in therapy recovered memories are elicited during suggestive therapy sessions. But here, it turned out that the people with recovered memories falsely recognized even less emotional critical lures than people with recovered memories. This might be explained by the fact that the recovered memory group not only exists of in therapy recovered memories, but also of spontaneously recovered memories. Another explanation may be found in the small sample size of the recovered memory group, a thought that is strengthened by the high standard deviation in the stressed recovered memory group (n=3).

Rejecting hypotheses

The results of this study led to the conclusion that none of the hypotheses could be confirmed. For some hypotheses no supportive results were found, for some even contradictory results were found and the hypotheses about the in therapy recovered memory group could not be answered because no distinction could be made between the two types of recovered memories, which was due to the small sample size of the recovered memory group. So this study unfortunately cannot contribute to validating the alternative hypothesis that some in therapy recovered memories might be false memories elicited during suggestive therapy.

Both hypotheses about true memory performance were not confirmed in this study. Different studies have shown that emotional information is remembered better than neutral information (Schwabe et al., 2008; LaBar & Cabeza, 2006; Cahill et al., 2003), but we did not find this effect. Even the contrary was found: Overall, neutral words were more often truly recalled than emotional words. And while Smeets et al. (2008) and Cahill et al. (2003) found that stress during consolidation enhances memory performance, here no effect of stress on true memory performance was shown.

Concerning false recall, it was expected that stress would lead to an increase in false recall (Payne et al., 2002; Smeets et al., 2008). Here stress did not lead to an increase of false recognition, because apparently people in the no-stress condition falsely recalled somewhat more critical lures than did the people in the stress condition. So a stressful condition led to a decrease in false recognitions instead of an increase. An explaining for this remarkable finding is that this study combined the word presentation with the stress task, so this study actually tested the influence of stress during learning instead of stress right after learning, as was done in the studies of Payne and colleagues and Smeets and colleagues. Schwabe and Wolf (2009) found that memory is negatively effected when people learn while they are stressed, just like was found in this study. Their and our findings show a memory
impairing effect of learning under stress and challenge some stress related assumptions. When looking at valence it was expected that emotional critical lures would be falsely recognized more often than neutral critical lures (Pesta et al., 2001), but it turned out that in this study, the opposite was found. Overall, neutral critical lures were falsely recalled more than emotional critical lures, which is a very unexpected and interesting finding.

**Limitations of this study**

Several limitations of the current study need to be addressed. First and most important it should be noted that the power of this study is very low. The group sizes differed a lot; especially the recovered memory group \( n=12 \) is quite small compared to the continuous memory group \( n=33 \) and the controls \( n=27 \), which made it impossible to make a valid distinction between in therapy recovered memories and spontaneously recovered memories. The main reason the recovered memory group is that small is because of the more restricted new classification criteria that were used here. Because past studies have lacked objectivity concerning the classification of the memories of the abuse, stricter criteria were designed and used in this study. These new criteria focus on the question whether the person has really ever forgotten the abuse. After interviewing many people it turned out that a big part of the originally classified people with recovered memories, have never really forgotten their abuse memories. They merely reinterpreted memories that were there all along. Though several authors may claim that this “illusion of forgetting” entails a recovered memory experience, we believe this is not the case. We have therefore decided to not include people reporting these experiences in our recovered memory group. After an extended search for more people with recovered memories, we had to conclude that this group of people it a lot smaller than previously assumed and it appeared not to be possible to find more of them to enlarge the power of this study. Future studies should point out if these new criteria really lead to a decrease in recovered memory group size.

The differences on memory performance between the groups can also be explained by the demographic differences between the 3 groups. As can be seen in table 1, the control group is higher educated than the continuous memory group and the recovered memory group. The control group is also younger than the other 2 groups. Both education and age can have an influence on memory performance. This might explain why the controls correctly recalled somewhat more words (both neutral and emotional) than people with continuous and people with recovered memories of CSA. It is important for future research to create a control group that does not differ on demographic characteristics compared to the experimental groups, to see if demographic differences and other methodological flaws caused the differences on memory performance found in this study.

**Conclusion**

In summary: None of the hypotheses were confirmed and while some of these findings can be explained by a low amount of people in the recovered memory group or the fact that the controls were younger and higher educated than the other two groups, not all of them can. The finding that neutral words are remembered better than emotional words more is quite a robust finding, just like the discovery that neutral critical lures were falsely recalled somewhat more than emotional critical lures. These findings are contrary to what was expected based on prior research. Future studies
should point out if the found results are due to the chosen design and methodological flaws or that they indicate that some theories should be revisited.

In conclusion, this study contributed to the recovered memories debate in many ways. The new and stricter classification criteria led to questioning the size of the recovered memories problem. Future studies should be conducted using these new criteria to validate this idea. Also further studying the influence of stress on the elicitation of false memories is very interesting, especially in people with recovered memories of CSA, because of the high practical and real life relevance of this subject. Replicating this study with a higher power and a matched control group might lead to a better insight in the underlying cognitive mechanisms of recovered memories. Using suggestibility questionnaires and personality tests, which could ultimately lead to a standard diagnostic procedure that clinicians might use when meeting with a new patient, can extend future studies.

**Conflict of interest**
No conflicts of interest are declared.

**Acknowledgments**
I thank Tom Smeets and Linsey Raymaekers for their stimulating, dedicated and nice supervision. Their insightful en sometimes even funny comments really helped improve this paper. Tom Smeets’ patient statistical advice was one of those improvements. I also want to thank Christine Bouw for her help in collecting the data.
References


## Appendix 1

### Encoding phase (DRM)

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Appendix 2

Stem-cued recall test (DRM)

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