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Implicit and Explicit False Memories conditioned by lapse of time

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ABSTRACT. False memories represent distorted memories which are remembered incorrectly or didn't happen at all in reality. In the present study, the period of time between encoding and testing has been manipulated, in order to explore the effects of delay on implicit and explicit false memories. Two groups of subjects were tested, using the DRM paradigm, for false implicit and explicit memories. One group had no delay period between encoding and test phases, the other group was tested at one week delay after the encoding phase. Results showed no significant differences between implicit and explicit false memories. The delay had significant effect only for true memories, which were significantly lower after one-week delay. Conclusions and future directions of research are discussed.

Keywords: False memories, implicit false memories, explicit false memories, true memories, delay.

ABSTRAKT. Falsche Erinnerungen sind verzerrte Erinnerungen, an die man sich falsch erinnert oder die in der Realität überhaupt nicht stattgefunden haben. In der vorliegenden Studie wurde der Zeitraum zwischen Kodierung und Test manipuliert, um die Auswirkungen der Verzögerung auf implizite und explizite falsche Erinnerungen zu untersuchen. Zwei Gruppen von Probanden wurden mithilfe des DRM-Paradigmas auf falsche implizite und explizite Erinnerungen getestet. Eine Gruppe hatte keine Verzögerungszeit zwischen der Kodierungs- und der Testphase, die andere Gruppe wurde mit einer Woche Verzögerung nach

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der Kodierungsphase getestet. Die Ergebnisse zeigten keine signifikanten Unterschiede zwischen impliziten und expliziten falschen Erinnerungen. Die Verzögerung hatte nur bei echten Erinnerungen signifikante Auswirkungen, die nach einer einwöchigen Verzögerung deutlich geringer waren. Schlussfolgerungen und zukünftige Forschungsrichtungen werden diskutiert.

Schlüsselwörter: Falsche Erinnerungen, implizite falsche Erinnerungen, explizite falsche Erinnerungen, wahre Erinnerungen, Verzögerung.

INTRODUCTION

False memories refers to certain events that are misremembered or are remembered, but never happened (Roediger & McDermott, 1995). During the last 20 years, researchers investigated both explicit and implicit false memories. Attention grew for implicit false memories when both perceptual and conceptual implicit tests revealed false memories in participants answers (McKone & Murphy, 2000). The difference between explicit and implicit false memories resides in the testing phase, where if an explicit test is used, then it has been measured as an explicit false memory, and if an implicit test is used, it has been measured as an implicit false memory. Either it's explicit or implicit, false memories appear to be robust, as they appear in participants answers throughout all scientifical studies.

Explicit memory refers to the post-event stimulation that is remembered consciously and at the demand of the experimenter. Implicit memory, on the other hand, refers to post-event stimulations that are remembered unconsciously, where the participant is asked by the experimenter to say the first thing that comes to mind (Graf & Schacter, 1985; as cited in Opre, 2012).

False memories have been studied in laboratory settings using the misinformation paradigm (Loftus, 1979) or the Deese-Roediger-McDermott paradigm (DRM) (Deese, 1965; Roediger & McDermott, 1995). The present study will use the former investigation paradigm, DRM. In this paradigm, the participants are presented with lists of words semantically associated between them and strongly associated with a word that is not presented, called the Critical Lure. After a certain amount of delay, participants memory is submitted to the test and participants are asked to recall or recognise the words presented earlier. About half of them usually will remember the Critical Lure also (Roediger & McDermott, 1995), which was never presented, and is called in the scientifical literature *false memory*. The memory tests used for this paradigm are usually explicit memory tests and are part of the concept of *remembering*.

In the last years, false memories have been also investigated, using the DRM paradigm, at the implicit level, and research shows that both perceptual and conceptual implicit memory tests reveal false memories (McKone & Murphy, 2000; Garfinkel, Dienes & Duka, 2006; Van Damme & d'Ydewalle, 2009; McBride, Coane & Raulerson III, 2006; Schacter, Gallo & Kensinger, 2007; Cabeza & Lennartson, 2005; Marini, Agosta, Mazzoni, Barba & Sartori, 2012; McKone, 2004; Kawasaki & Yama, 2006; Tajika & Neumann, Hamajima & Iwahara; 2005; Van Damme & d'Ydewalle, 2010; Lovden & Johansson, 2003; Hicks & Starns, 2005; McDermott, 1997).

In the Deese-Roediger-McDermott paradigm (Deese, 1959: Roediger & McDermott, 1995), researchers have found that the delay between the encoding and testing phases have an effect on the memory tests. There have been found effects of 2 days delay on recall test (McDermott, 1996), which increased false recall over veridical recall. Those results where in line with previous prose literature (Sulin & Dooling, 1974; Bartlett, 1932; Spiro, 1980; as cited in McDermott, 1996). The delay between encoding and testing phase has had an effect on an EMDR task also, where false recall and false recognition were higher than veridical recall and recognition after 2 days delay, even though EMDR has proven to reduce false memories when there is no delay involved (Houben et al., 2020). Moreover, new research show that delay doesn't make fade the differences between true and false memories (Neuschatz et al., 2010), contrary to theories as source monitoring framework or fuzzy-trace theory. In the source monitoring theory, it has been interpreted that true and false memories distinguish less as the time period between study and test increases (Belli & Loftus, 1994; as cited in Neuschatz et al, 2010). In the fuzzy-trace theory it has been stipulated that verbatim traces disintegrate into parts that may adhere to gist traces, which will make seem the gist traces very similar to verbatim traces (Reyna & Titcomb, 1996). However, new research indicate that although characteristics of both true and false memories decrease over time, they still remain present after 2 days delay (Neuschatz et al., 2010).

It has been well known in the scientifical literature that the longer the delay is, the harder the accurate recall is, the more the false memories increase (Brainerd & Reyna, 1996). The longest delay between the encoding and the test phases was 2 weeks (Brainerd & Reyna, 1996). In the short and immediate memory testing, researchers have used math exercises to distract the subjects from the encoding phase, in order to accurately test what participants truly remembered after the word lists exposure. For the longer delays, participants will lead their daily activities, so there is no need to distract them from the encoding phase. Given that memory resides on the concept of time, the objective of the present study is to investigate the effects of one week delay on implicit and explicit false memories.

MATERIALS AND METHODS

Participants

A total of 113 university students in their first academic year participated in this study. They were divided into two groups, the *Delay group* and the *No Delay group*. Their participation was voluntary and they were randomly assigned in the two groups. At the end of the study, each 30st participant received a self-help book as a reward.

The two groups, Delay and No Delay, were created according to the assignment of the academic class. In the end we had two groups of students for each group of participants. We couldn't control for their second participation in the delay group, and we have excluded participants based on their answers at a specific questionnaire: Awareness Questionnaire. Therefore the groups don't have an equal number of participants. Out of the 113 participants, 78 were assigned to the No Delay group (42 females, 4 men, 1 nonbinary, 3 undeclared, 27 with no gender and age specification; M_{age}= 19.4, SD_{age}=1.20) and 35 to the Delay group (6 females, 2 males, 27 with no gender and age specification, M_{age}=19.5), according to the class assignment. After the exclusion criteria based on the Awareness Questionnaire, the No Delay group had 56 participants for Implicit False Memory test and 75 participants for Explicit False Memory test. The Delay group had 24 participants for Implicit false memory test and 34 participants for Explicit False Memory test.

Instruments

A total of 12 lists of DRM words were used. Each list had 1 critical lures and 15 associated words. The DRM lists of words were created according to McKone (2000), Van Damme & d'Ydewalle (2009), and Stadler et al (1999). Both created in Romanian language and translated from English to Romanian lists of words were used for this study, as there are no statistical differences between them (Horoiță & Opre, 2020).

It was necessary to respect the standards for word stem completion test (Graf & Schacter, 1985; as cited in Opre, 2012; as cited in Van Damme & d'Ydewalle, 2009). Therefore all words had a minimum of 4 letters long, their 3-letter stem had a minimum of 7 different word completion, and all lures and presented items had 3 different letters in their stem. In addition, it was necessary to ensure that their baseline completion rate is not too high, in order to avoid ceiling effects on priming scores. In order to accomplish all criteria for DRM lists of words that were about to be used in a word stem completion task, two pilot studies were conducted before the present study.

The first pilot study took place in order to ensure the baseline completion rate of lures, as to avoid ceiling effects. A total of 47 first year students completed 30 lures words stem with the first word that come to mind. The lures were chosen from the validated DRM lists in Romanian language (Horoiță & Opre, 2020), in keeping the standard of maximum 45 % completion rate in the first pilot study. At the end of Pilot I study, a total of 12 critical lures were chosen to form the 12 DRM lists of words matching the word stem completion test. 15 associate item target words, with the highest to lowest association frequency, were then chosen to form the 12 DRM lists (Horoiță & Opre, 2020). In the encoding phase, we have chosen to use only 10 associates per list, in order to avoid memory loading.

A second pilot study was taken to match the list targets to critical lures on word frequency and baseline completion rate, as this is known to influence repetition priming (Scarborough, Cortese, & Scarborough, 1977; as cited in McKone, 2000). Therefore, 35 first year students completed 36 stem words with the first word that came to mind. Target words were chosen from position 3,4 and 5 from each list, therefore we had 36 list items matching the critical lures on word frequency and baseline completion rate. Out of the three target words, one was chosen to best fit the closest baseline completion rate of each lure for each DRM list. Therefore, critical lures were matched to list targets on word frequency (M= 37 and 27 occurrences per million, ranges 2 to 221 and 1 to 117, with frequency counting based on the Romanian lexical database of Brysbaert & New, 2009) and baseline completion rate (M=12% and 8 %, ranges 4 to 37 and 1 to 62).

The 12 DRM lists were then divided into two sets of 6 DRM lists, to allow counterbalancing of studied vs nonstudied words. The sets were matched as closely as possible on word frequency and baseline completion rate, as in previous implicit false memories studies (McKone, 2000; Van Damme & d'Ydewalle, 2009). The target words which were to be tested were not allowed to appear in the first two or last two positions in the DRM lists.

The list of words to be tested was constructed from 6 list targets from each DRM studied list, 6 critical lures from each DRM studied list, 12 distraction words created from 6 list targets and 6 critical lures from the unstudied DRM lists, giving us a total of 24 words to be used in the testing phase. The distractor words will provide as baseline scores, in order to reduce explicit contamination of implicit false memories results (McKone & Murphy, 2000).

Procedure

University students in their first academic year were tested in students groups in two rounds, for each group assignment, Delay and No Delay. Each

group received the Informed Consent and the study instructions. They were not told that this a study that investigates memory, they were told that the study investigates words, their participation is voluntary and there is a reward for each 30st participant. Participants read the Informed Consent and signed it. Each group received afterwards the encoding phase, where the 6 studied DRM lists were presented in the same word order to them. The instruction for the encoding phase was „Please read carefully the next words which will be presented to you". Participants view 60 words on a PowerPoint display, at a 2s interval between them. The critical lures were not displayed, and each DRM list was separated from the next one by *, at a 4s duration.

The next step was the test phase, which for the No Delay group was done immediately, and for the Delay group was one week after the encoding phase. In the test phase, all participants received instructions for an implicit task and an explicit task, in this particular order because if the explicit test were to be used before the implicit test, the explicit contamination could have been higher (McKone, 2004). For the implicit task, a word stem completion test was used. Subjects received the instruction to write down the first word that come to mind which complete the stems they will view on the slides. The experimenter used an example for better understanding of the task. The 24 word stems were presented on a PowerPoint display, at a 4s interval, which had the same writing font. Participants wrote down the first word that came to mind which completed the stems from the slides on a paper sheet, that contained only the instruction, given by the experimenter. They were instructed to leave blank the stem for which they can't find a word. After the implicit test, all participants received an Awareness Questionnaire, in order to avoid explicit contamination. Following McKone & Murphy (2000), they were asked: (1) "What was your general strategy when completing the word stems?"; (2) "Did you deliberately try to complete stems with words you remembered from the study lists?"; and (3) "Did you complete stems with whatever word popped into your head first?". Not all participants responded *no* to question number 2 and *yes* to question number 3, therefore they were excluded from the study.

After the implicit task, the explicit task followed, in which we have used the same type test, word stem recall. Subjects were asked on a A4 paper to write down all the words they can remember from the previous word presentation, that could complete the letters on their paper. The specific instruction was "Please write down a word that you can remember from the previous lists of words that you saw in the previous presentation, which complete the following sets of letters. If you don't remember the word, please leave the space uncompleted and move to the next word.". The 24 stems were already printed on the paper they received, along with the instruction. *59 Participants received*

the Awareness Questionnaire for this explicit task also, and 54 did not, therefore the authors decided to include all 54 answers, as the instruction for explicit task is clearly explicit, therefore all participants deliberately tried to remember the words seen before in the word presentation.

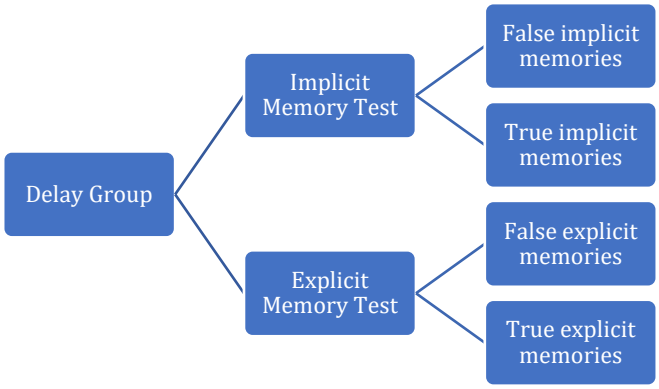
No time constraints were used for this explicit task.

At the end of the experimenter, four reward books were handed out to the participants.

RESULTS

The design of the present study is Delay Interval(Absent x Present) x Type of Memory Test (Explicit Memory x Implicit Memory) x Item Type(Targets x Lures). The independent variable is the Delay interval, the between factor, which randomly formed the groups No Delay and Delay. The dependent variables are type of memory test (explicit vs implicit), and type of memory items (true-targets vs false-lures). For a more accurate view of the design, Fig.1 shows all variables used in the present study.

We have first analysed, using a dependent T test, the differences between studied and unstudied words, for each of the groups. Significant differences were found for the (No Delay) Explicit Targets, $t(74)=13.73$, $p<.001$, Cohen's $d= 1.58$, (No Delay) Implicit Targets, $t(55)= 5.98$, $p<.001$, Cohen's $d= 0.79$, and for the (Delay) Explicit Targets, $t(33)= 6.30$, $p<.001$, Cohen's $d= 1.41$.



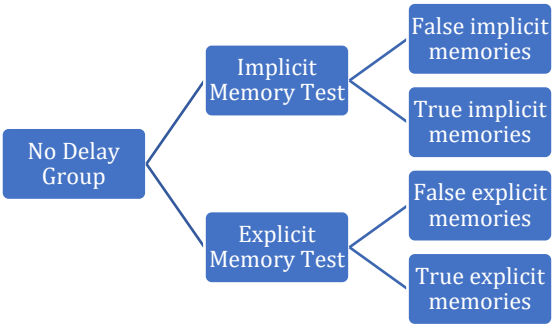


Fig. 1. The design of the study

Table 1 shows the proportions for implicit and explicit memory, both lures (false memory) and targets (veridical memory), for No Delay group and Delay group, and Fig. 2 a visual representations of the mean proportions for true and false memories, implicit and explicit, at No Delay and Delay conditions.

Table 1. *Mean proportions and Standard Deviations for Explicit and Implicit Lures and Targets in the No Delay and Delay Groups*

		Explicit Test			Implicit Test		
		Studied	Unstudied	Memory Scores	Studied	Unstudied	Memory Scores
No Delay Group	Target List (N=75; N=56)						
	M	3.63	1.31	2.32	2.86	1.75	1.11
	SD	1.35	0.822	1.46	1.14	0.83	1.38
No Delay Group	Lures (N=75; N=56)						
	M	2.31	1.83	0.493	2.00	2.34	-0.339
	SD	1.36	1.16	1.55	1.10	0.793	1.40
Delay Group	Target List (N=34; N=24)						
	M	2.71	1.29	1.41	2.08	1.50	0.583
	SD	1.24	0.719	1.31	0.776	0.834	1.14
Delay Group	Lures (N=34, N=24)						
	M	2.24	2.21	0.05	1.71	2.17	-0.458
	SD	1.18	0.845	1.15	1.30	0.868	1.18

Note. Proportions of Means and Standard Deviations for Implicit and Explicit True (Targets) and False Memories (Lures) in No Delay and Delay Groups, for each participant. *M=mean, SD= Standard Deviation.*

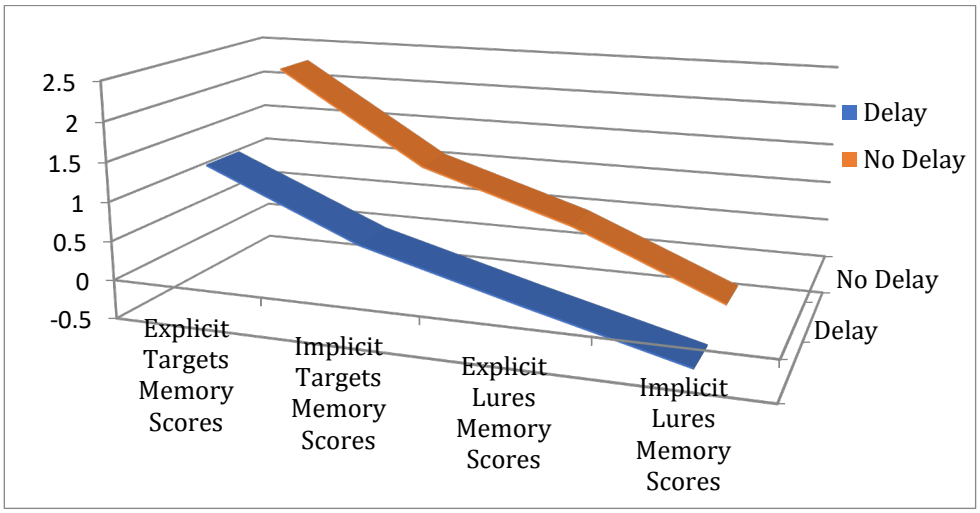


Fig 2. Proportion of memory scores (Studied-Unstudied) for each condition and each group.

We can read from the table that most studied words have greater means than the unstudied one, except in the case of implicit lures, in both groups. Comparison with baseline (the unstudied words) allows us to notice memory scores higher than 0, therefore priming was obtained for true memory scores in the implicit and explicit tests, but false implicit memory scores were not greater than 0, therefore priming for lures was not obtained, therefore priming for false implicit memories were not obtained. However, for both groups, explicit true and false memory was obtained, and implicit true memory.

Given that participants were tested first for the implicit memory, and then for the explicit memory, we have also run a Paired Samples T Test to investigate if there are significant differences between implicit memory scores and explicit ones, in the same group of participants. Results indicated significant differences in No Delay group between implicit and explicit targets memory scores ($t(52)= -5.93$, $p<.001$), and between implicit and explicit lures memory scores ($t(52)= -3.52$, $p<.001$). For the Delay group, there were also significant differences between implicit and explicit targets memory scores ($t(22)= -2.56$, $p=.018$, where p is significant at $p\leq.05$) and between implicit and explicit lures memory scores ($t(22)= -2.51$, $p=.020$, where p is significant at $p\leq.05$). All t scores are negative, given that implicit memory scores were lower overall than explicit memory scores.

Given that we have an independent variable with two modalities (delay, no delay) and 3 dependent variables with two modalities each (studied and unstudied, explicit and implicit memory, true and false memory), a Manova test was used to test the effect of delay on memory. However, a Shapiro-Wilk test indicated that our sample size didn't fit the normality assumption, p<.001. Therefore, we employed a non-parametrical test, One-Way Anova KrusKal-Wallis, and the results showed statistical significance at H(1)= 10.75, P=.001 for explicit studied targets and H(1)=7.85, P=.005 for the implicit studied targets. In the case of memory scores (studied-unstudied), statistical significance was found only for the explicit targets, H(1)= 8.25, P=.004. The effect of delay between encoding and testing phase has significant implication for the true explicit and implicit memory, but not for false memory.

DISCUSSIONS

Our present study had the objective to identify if the delay is an important factor in increasing or decreasing false explicit and implicit memories. Our results indicated that one week delay, used as a between factor variables, has no effect on false memories, explicit or implicit. It had however, an effect on the veridical memory, for both explicit and implicit memory, therefore subjects remembered less studied true explicit and implicit memories after one-week delay. Our results are in accordance with other scientifical results

Our results didn't replicate the false memory priming found in previous studies (McKone, 2000; McKone & Murphy, 2004; etc). One possible explanation for this occurrence is the small number of participants. Another possible explanation could be the procedure, given that participants were tested first for the implicit memory and afterwards for the explicit memory. The residual information may have created confusion in participants mind, which were told first to complete the stems with the first word that came to mind and then with the words seen in the previous presentation. Future studies could focus on different groups of participants for the implicit condition and different participants for the explicit condition, as was also the case in previous studies where implicit false memory priming was found (McKone, 2000; McKone & Murphy, 2004; VanDamme, 2009, 2010; etc).

Our results are in accordance to the literature on false memory, which shows that explicit false memories, in particular false recall, remain more robust over time than true memories (Jou & Flores, 2012). It is however unclear what happens to implicit false memories, if the robustness of implicit memory and that of the explicit false memories will lead to a higher robustness over time on implicit false memories, therefore future directions of research could investigate more this question of research.

A direction of our hypothesis, which stated that implicit false memory performances will decrease over time, could be seen in both explicit and implicit memory scores, which were lower in the Delay group. Nevertheless, time had a statistical effect on explicit and implicit veridical memory, therefore true memory decreases over time. These results are in line with previous findings, for example in Kathleen McDermott's study (1996), explicit false memories were not affected by a two-days delay, but true explicit memory (free recall test) was.

Limits of the present study are represented by the big difference in the number of participants between the two groups, the different number of participants in explicit and implicit condition, and also the small number of participants overall. The procedure may have a limit in that it tested implicit memory and then explicit memory on the same participants. The previous implicit test, along with the Awareness Questions which immediately followed the implicit test, could have influenced the explicit test. Latest research suggest that implicit priming leads to increased explicit recollection, given that implicit memory increase the processing fluency, which leads to increased familiarity of the "old words", therefore to increased explicit recollection (Park & Donaldson, 2016).

Future directions of research could maybe try to investigate the effect of time on implicit and explicit memory with 4 groups of participants, one for implicit memory and one for explicit memory, therefore 2 groups tested in no delay condition and 2 groups in delay condition. An interesting approach would be to test the delay condition after two or three weeks, therefore, to increase time and investigate the possible effect on true and false explicit and implicit memory. Future lines of research could also investigate if the specific perceptual characteristics of false memories fade after one week delay or longer, considering that this hypothesis initially offered by Loftus (1994; as cited in Neuschatz et al, 2001) was not confirmed at a 48-hours delay (Neuschatz et al, 2001).

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Declaration of interest statement

The authors report no conflict of interest.

Disclosure statement

The authors report there are no competing interests to declare.

Data availability statement

The data that support the findings of this study are available from the corresponding author, AO, upon reasonable request.

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