TRUE, FALSE OR JUST SUGGESTED? COMPARISON OF REMEMBERING EXPERIENCE OF TRUE AND FALSE MEMORY TRACES IN DRM STUDIES

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ABSTRACT
However research focused on human memory – as expected to bring further insight into the entire mind architecture - captured scientists attention many years ago, still very few is known about mechanisms underlying some of crucial memory phenomena, such as e.g. false memories creation (FM). The main aim of presented study is to shed some light onto this issue by establishing which factors enhance FM creation, what are their general characteristics and whether we are able to avoid them by providing correct distinguish between true and false
To achieve these goals 2 experiments were conducted, with use of procedure enabling to evoke false memories under the laboratory condition (Deese-Roediger-McDermott paradigm). First study allows to describe false memories as a long-lasting, sustainable memory traces, which are comparable to true ones, as accompanied by a similar level of confidence and subjective sense of remembering declared by participants (43% and 33% , respectively, compared to 4% for random mistakes). Second study was designed to verify whether subjects show significant difference among tendency to generate FM under influence of suggestion-content differing conditions (positive, negative or neutral).
Obtained results demonstrated vast impact of suggestion on a tendency to generate false memories: both – positively (63%) and negatively (58%) suggested groups notably extended false memories production compared to neutral (50%) and control conditions(50% and 38%, respectively). Interestingly, level of memory-accuracy confidence estimated by participants was stable across all the conditions (79%) and remained significantly higher compared to the actual memory accuracy (mean: 68%).
Additionally, analysis revealed interesting findings among "sense of remembering" under the negative-suggestion condition, which induced rate of remembering achieving 100% false recollection!
Recent findings, interpreted in terms of source monitoring biases (Johansson & Stenberg, 2002) and general discrimination ability (Zhu et. al., 2013) SUGGEST we should pay more attention to what we memorize. It is not impossible at least some of our memories were entirely made up by our own minds or created under the influence of extensive factors, such as outward suggestion (Loftus, 2005).

Key-words: *memory, false memories, suggestion, suggestibility, DRM, mind*

'*Sometimes I feel guilty but I cannot remember what has happened. (...) Detective came and implied many things and thinks I'm in a bad position in the case. He even wants me to get used to the thought of being a murderer. (...) For two years I have had the belief that I did not know anything about this case but now I am supposed to have been very much involved*'

INTRODUCTION
The extract quoted above, derived from 'GS''s diary, refers to ostentatious case of unjustified double-murder accusation (also known as "The Reykjavik Confessions") (Gudjonsson, 2016, s17-21). Such an example provides quite well illustration of how tricky could human memory be, especially under certain circumstances, including suggestive direction. Finally, GS yielded to the pressure, confessed and even pointed particular area where corps should be found (for obvious, nor bodies neither any remains were detected). What's more, his false testimony, as it came out many year later, was supported by a lie-detector, which could point at the fact he

truly believed of what was persuaded to him. Taken together, it seems probable, GS truly developed false memory (FM) of committing the crime he was never involved into.
In attempting to throw some light on the psychological mechanisms underlying memory distortion and its contribution to suggestion, two experimental studies were conducted, both under strictly controlled, laboratory conditions. Leading question, whether FM occurrence could be enhanced by presenting direct suggestion communicate seems important, as well as the aim to establish the extent to which people willingly succumb external influence. Last but not least, participants' personal experience of remembering events that never took place was investigated. Despite decades of research many issues on this field still remain unclear and FM studies are believed to bring possible insight into the function of memory: expand our conception of how memory works and what's it influences on cognitive functioning in general (Bartlett, 1932; Binet, 1900; Baudoin, 1924; McDougall, 1908; Schacter, 2016).

Overview of The Presented Study

However, the variety to be found in procedures used to measure FM in attempt to investigate this phenomenon remains impressive, different research pursuit on memory distortions are linked by a shared principle to predict FM occurrence, and describe factors related to this phenomenon (Pohl, 2004). Most of the research contribute to increase knowledge of individual differences among subjects, such as personal traits (e.g. extraversion, anxiety, need for closure, coping strategies, locus of control, imagination vividness; Bays, Foley & Zabrucky, 2013; Crawford, 1989; Oliver, Bays & Zabrucky, 2016; Sanford & Fisk, 2009), cognitive efficiency (mostly within working memory and attention capacities, ability to control, cognitive flexibility; Atkins & Reuter-Lorenz, 2008; Crawford, 1989; Gudjonsson, 2003, 2004, 2007; Maciaszek, 2016a; Roediger, Watson, McDermott & Gallo, 2001; Schwanenberg, 1989; Watson, Bunting, Poole & Conway, 2005; Watson, McDermott, & Balota, 2004) social-influence vulnerability (e.g. Gudjonsson, 1989, 1990; Loftus, 1997, 2005; Loftus, Miller, & Burns, 1978; McCloskey & Zaragoza, 1985; McGuire, 1968, 1972) or even personal beliefs (Kelly 1955, Jahoda, 1898). Beginning with the early literature, many variations have been elaborated concerning the contents, forms and modes of FM (Bartlett, 1932; Loftus, 1975). There is no lack of studies put forth to account for phenomena related to suggestion, nor is there any lack of discussion of basic mechanisms underlying FM creation. Although several studies has even demonstrated the impacts of suggestion on memory, relatively few have explored the extent to which content of suggestion impacts the robust FM creation (e.g. Storbeck, 2013). As the best of our knowledge, there was no research focused precisely on suggestion content, that would highlight its role on FM creation. For example, Plancher, Nicolas & Piolino (2008) testing the effect of various suggestions showed a profound effect of, feedback (including suggestive communicate) on FM: the stronger influence was, the more FM participants generated. Despite, this research were focused rather on investigating presence (or absence, with additional measure of 'strength') of suggestive directions rather than the impact of its content on the amount of false recognitions. In general, literature investigating this topic remains very poor, although in enables to claim the act of suggesting itself increases a tendency to generate false memories, in any case typical for human mind (Schacter, 1999, 2016).
Study presented beyond contains 2 experiments, both dedicated to examine whether extensive influence (in this case: suggestive communicate) affects the change among participants recognition of false memories. Both studies were conducted with use of Deese-Roediger-McDermott (DRM-*list of words related*) paradigm, which is generally based on the notion that memory, organized as a network, is created by nodes and links between them (Quillan, 1969; Underwood, 1965). Applied to practice, procedure consisted presenting to participants 8 lists of 15 semantically associated words each, linked to one critical lure (CL) that is not presented itself. In this study every list enables to evoke only one CL intrusion. Thus, after presentation all of 8 lists, participants following the memory test (which contains 48 words: 24 studied items, 8 critical lures, and 16 unrelated words), are expected to recognize the presented words and the CL at similar level, as a function of free activation spread over the memory network (Collins & Loftus, 1975; Roediger, Balota & Watson, 2001). During the subsequent recognition test subjects are also asked to declare whether they "remember" precisely presentation of every particular word, or if they experience a sensation that word has already been presented, but they have only a fuzzy feeling of "knowing", in absence of precise memory trace (Tulving, 1972, 1985). Such procedure requires participants to differentiate between highly activated but nonpresented critical lures and studied words. Commonly observed high level of confidence, as well as 'sense of remembering' reported by participants with regard to presented words and critical lures, opposed to non-presented, unrelated items,

supports equating CL intrusions with FM creation (Brainerd & Reyna, 2005; Gallo, 2010, 2013; Monds et al., 2013; Meade, Gallo & Olson, 2014; Watson, McDermott & Balota, 2004).
This paper report results obtained from 2 experimental studies, previously adapted to polish language, replicated and adjusted for computer use with INQUISIT software package by Millisecond (for details – see: Maciaszek, 2013; 2016a; Olszewska, & Ulatowska, 2013). Both took place in the laboratories of the Institute of Psychology, Jagiellonian University. The obtained data were analyzed using IBM IMAGO v23 and StatSoft STATISTICA v12 software.

Experiment 1
Participants. Seventy two undergraduate students at the age of 19-25 (M=21.10; SD=1.83) (19 male and 53 female) participated.
Procedure. The first aim of Experiment 1 was to assess the probability of FM occurrence as an effect of DRM procedure to evoke FM (which is in details described above), followed by "remember-know" judgment (DeSoto & Roediger, 2014; Roediger & McDermott, 1995, 1998; Tulving, 1972, 1985). The second purpose was to verify the extent to which the subjects are willing to believe that have perceived something in lack of such experience. Participants were informed they would partake in a memory study and were instructed to follow the stimuli shown on-screen, memorizing as many as possible, and then to comply with the displayed instructions. Detailed scheme of Experiment 1 presents figure 1.

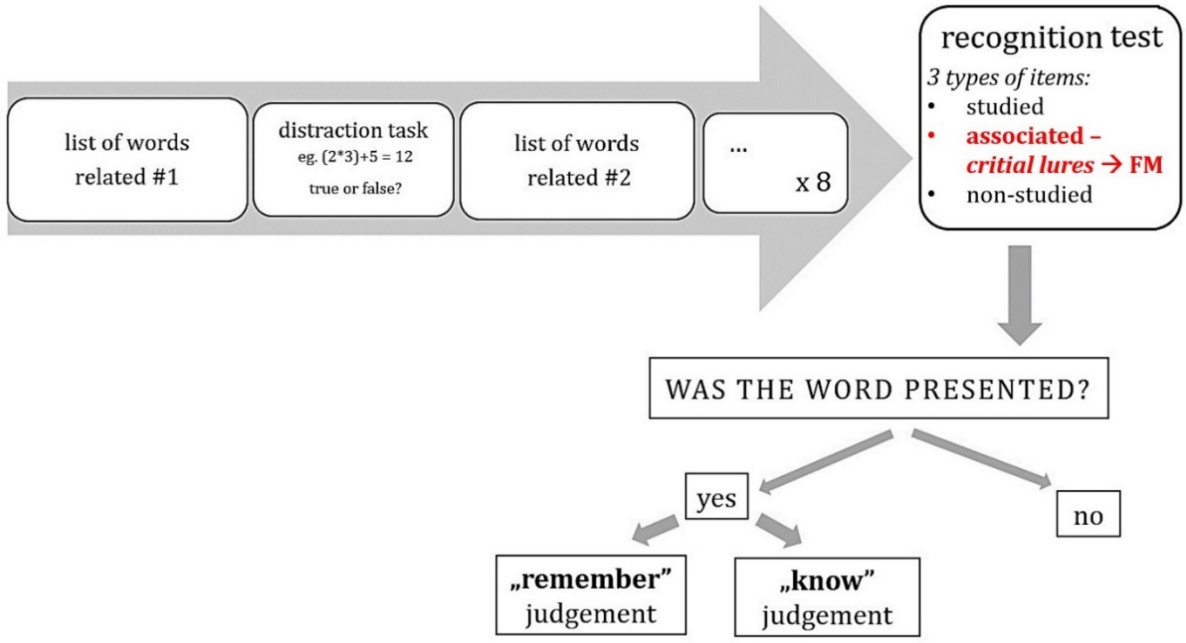

Fig. 1: Design of experiment 1

RESULTS
The mean veridical and false recognition, as well as random errors probabilities are presented in Table 1. In general, correct recognition rates (studied items) and critical lures achieved exactly the same a level of 63%, and mistake rate (unrelated items) reached 25%.
Tab. 1. *Recognition results for 3 types of items (critical lures, studied and non-related words) in Experiment 1. Probability of recall and mean rates (M) as follows.*

Proportion of responses			
	overall	remember	know
studied items	.63 (2.96)	.61 (1.74)	.39 (2.28)
critical lures	.63 (1.37)	.67 (1.11)	.34 (1.88)
non-related	.25 (1.61)	.57 (1.83)	.43 (1.39)

Note: Standard deviations in parentheses.

However conducting between-subject ANOVA revealed significant differences for mean probabilities of occurrence to all tested item: $F(2,70)= 99,10$; $p<.001$, post-hoc analysis detected saliencies between "critical lures" and "unrelated words". Also, significant difference emerged for probability of recollection "unrelated words" compared to "studied items". To determine whether presented words and critical lures were in any distinguishable, the proportion of "remember" and "know" judgments made by participants to studied words and critical lures was examined. Interestingly it came out that the number of CL identified by participants as "remembered" (67%) exceeded veridical recognition of presented words, declared as "remembered" (61%)!

Such results stood in line with prior work, as well as other researchers findings. In example, Roediger et al. (2001) through multiple regression analysis demonstrated, that the strength of association is the best predictor of the FM-occurrence (Arndt, 2012). Therefore, conducting DRM procedure that involves only carefully selected lists of 15 strongly associated words was expected to elicit similar number of false and "true" memories (in presented study mentioned rates were actually the same – 63% probability of occurrence). On the other hand, it is not impossible to show this effect for six or even five words on "list", although, FM rates remain remarkably lower at this condition (46% and 26%, respectively) (Robinson & Roediger, 1997; Robson, 2009). In general, characteristics of the lists could affect individuals tendency to elicit FM, creating more or less favorable environment for distortions to appear, but they could not determine whether the effect occurs (Stadler, Roediger & McDermott, 1999; 2004; Roediger, 2016).

Such result seems to provide supportive evidence for general framework of associative-memory network theory, highlighting the role of contextual remembering and automatic activation spread in recollection (Collins & Loftus, 1975; Quillan, 1969; Underwood, 1965). The more words associated with the CL are presented, the higher the probability of "spoiling" activation to particular CL, and – as a result – probability of false recollection in subsequent memory test, as the cognitive system is unable to distinguish which part of the semantic network was actually stimulated during encoding. It is also probable, participation in an experimental procedure, designed this way constitutes memory representation of an episode for the events, such as e.g. entering to psychology laboratory, taking part in a research, responding to stimuli appearing on a screen etc., which define unique episode by the context in which they occur. This, taken together with high rate of "remembering" judgments, allow researchers to claim that false memory of presenting word that was never shown, occurred at participant's memory (Monds et al., 2013; Olszewska & Ulatowska, 2013).

One further view which should be discussed in more detail here concerns the reference to some specific features of FM. Previously conducted studies disclosed that participants willing to declare "remembering" critical items (in opposite to making report of "knowing" them) present greater tendency to create false memories (average FM rate: 75%), compared to those making more "know" judgments (average FM rate: 38%) (for details - see: Maciaszek, 2013, 2015, 2016b). Such findings, supported by current research results, indicate that the "feeling of remembering", considered as a specific episode (participants in fact declared remembering the moment of presentation critical words, that never happened) often attends creating false memories. Going further, one may assume, the tendency to make a "remember" declaration, which expresses subjects' general belief of storing accurate memory traces, is in fact a risk-factor of FM vulnerability. In other words, the higher remembering confidence people show, the more likely they are to develop vast number of robust FM. Compellingly, results presented in Table 1, show that probability of recollecting veridical words and critical items were at the same level (63%), however the "remember" judgments for CL achieved greater probability compared to studied words. Therefore, it is more likely to remember false memories, compare to events that actually took place! (Atkins & Reuter-Lorenz, 2008; Brainerd & Reyna, 2005; Brewer, Sampaio & Barlow, 2005; Gallo, 2010, 2013; Johansson & Stenberg, 2002; Kawasaki & Yama, 2006; Miyaji & Yama, 2002; Kelley & Alban, 2014; Roediger, Craik & Rose, 2014; Yonelinas, 2002; Sampaio & Brewer, 2009; Roediger & Desoto, 2012, 2014; Roediger & McDermott, 2000).

To sum up, worth emphasizing is that participants clearly believed what they recollect was truly perceived, (as they experienced sense of remembering of CL at higher level that studied items). In other words, people developed a vivid "memory" of event that never took place! These evidence demonstrate how easily is to creating false memory traces might be accomplished. Once appeared, such trace became a part of memory, a long-lasting, persistent and undistinguishable from real. To provide further investigation for this phenomenon, Experiment 2 was conducted.

Experiment 2.

With respect to multifaceted nature of suggestion, for a need of current study definition proposed by Gheorghiu (1989b, p.102) was acknowledged: 'Suggestions are primarily considered to be mere statements which are applied directly to the purpose of influencing a person'. This implies no social factors, such as i.e. prearranged experimenter assistants' behavior need to be present to examine the impact of suggestive communicate on memory. Speaking strictly, from this perspective suggestion remains a kind of specific mode of influencing, that affects behavior of the individuals, as well as groups. It could be measured as the observable change among the pattern of behavior, appearing as an effect of experimental manipulation (Gheorghiu, 1989a)

Participants. Eighty six undergraduate students at the age 18-25 (M=20.81; SD=1.89) (22 male and 62 female) participated.

Procedure. Procedure - in main points similar to Experiment 1 - was enriched by implementing additional measure of confidence (see: figure 2). Also, instead of previous study, two equivalent sets of DRM list were applied, separated by suggestive communicate, both followed by separated recognition tests (Maciaszek, 2016a). During both memory tests (after presentation first set of 15 words related, consisting of 8 lists and – similarly – after second), participants were asked not only to state whether they "remember" or "know" recognized word but also to declare how confident they feel about this decision (on a slider-scale, form 0 to 100%; see: figure 2) (Brainerd & Reyna, 2005; DeSoto & Roediger, 2014; Roediger & DeSoto, 2014).

Experiment 2 was aimed at defining the strength and the direction of the relationship between suggestion content (positive: N=31, negative: N=30 or neutral: N=25), and a tendency to change answering patter in a following task as an effect of undergoing suggesting influence. Observing significant change among participants' recollections during a memory test, with particular attention paid to the FM rate would support hypothesis of noticeable impact of suggesting communicate on memory.

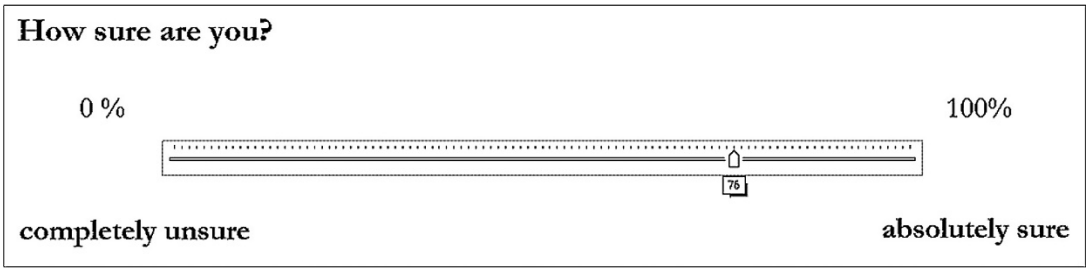

Fig. 2. Percentage measure of confidence for recognitions in Experiment 2, declared by participants – slider.

In experiment 2 suggestion presented to participants contained: (1) ostentatious feedback (information about the level of participants' accuracy was randomly generated by computer program), (2) comparison of participant's result to "average" performance, and (3) instruction how to perform during the next part of the procedure. Figure 3 present scheme of Experiment 2 in a detailed way and table 2 provides further knowledge of details procedure used. Importantly, despite the communicate was presented to participants directly, it was crucial to conceal the actual intention of suggestion (in this case: make participants believe they receive true feedback).

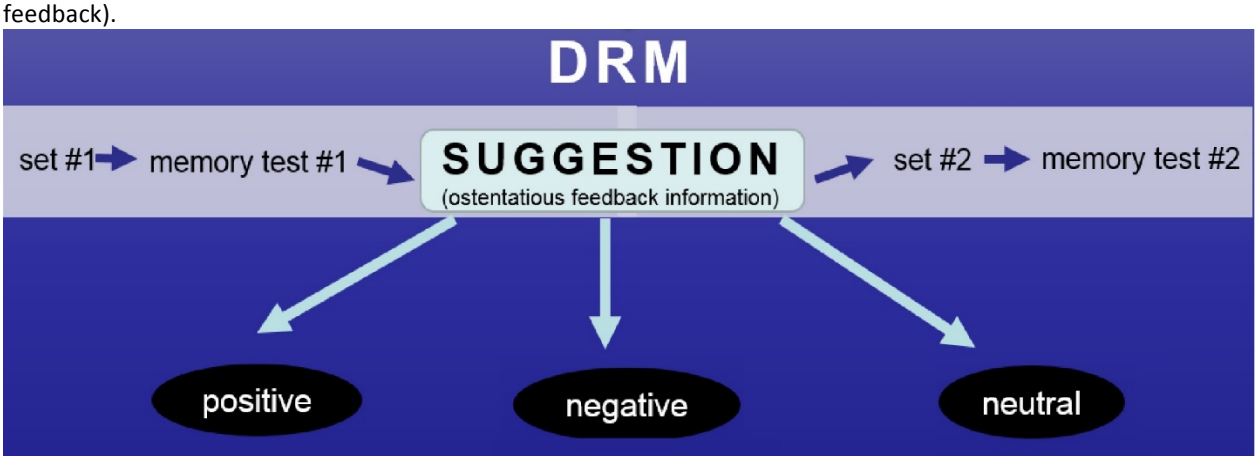

Fig. 3: Design of experiment 2

Tab. 2. *Differences in experimental conditions due to the content of suggestive communicate*

Suggestion content / Experimental condition	Condition 1 (–)	Condition 2 (+)	Condition 3 (0)
Feedback	negative	positive	neutral (conrol)
Accuracy	0–30%	70–100%	–
Comparison to 'standard' task performance	above average	below average	average
Instruction	memorize better	memorize as well as previously	memorize material as precisely as possible

Note. The DRM-list equivalence was previously examined revealing no significant differences among its FM-evoking potential (Olszewska & Ulatowska, 2013a).

Experiment 2 consists of 2 DRM-lists sets, which should be considered separately. Results obtained from first set (8 list of 15 words related) demonstrated that participants recognized 50% of critical lures as actually presented words, compared with 53% of words from lists and 18% of unrelated items (see: table 3). One-way ANOVA with Bonferroni correction demonstrated significant differences: $F(2,252)=109.33$; $eta^2=.46$, revealing significance at the level of $p<.001$ for studied words, critical lures, unrelated items. Notably, no significant difference between critical lures and studied words was disclosed.

Moreover, similar to Experiment 1, subjects tended to make judgments based on "remembering" rather than "knowing", and the highest level for such declarations was noticed for CL recognitions.

Tab. 3. *Recognition results for 3 types of items (critical lures, studied and non-studied words) in Experiment 2, set 1, regarding mean level of certainty expressed by participants.*

Proportion of responses

item type	overall	R	K	confidence (%)
studied	.53 (2.10)	.60 (1.78)	.40 (2.29)	94
critical lures	.50 (1.58)	.64 (1.14)	.36 (1.78)	93
non-related	.18 (1.76)	.67 (1.23)	.33 (1.89)	61

Note: R = remember judgment; K = know judgment. Standard deviations in parentheses.

The presented and related (CL) words were recollected with a similar level of confidence (94% and 93%, respectively), while unrelated words – achieved only a score of 61% (see: fig. 4). Obtained result remain unlike other studies, which mostly common show higher level of confidence for presented (studied) words than critical lures despite approximately the same recognition rates, for example participants taking part in studies provided by Benmergui, Stuart, McKelvie and Standin (2015) declared significantly higher confidence for correct recognition than for false recognition. Also Benmergui, McKelvie & Standing (2015) report obtaining lower confidence to false responses, compared to correct ones (73% and 80%, respectively; see also: McKelvie, 2003, 2004). Here we observed participants showing actually the same confidence-level to studied words and critical lures – upcoming false memories (no significant differences detected).

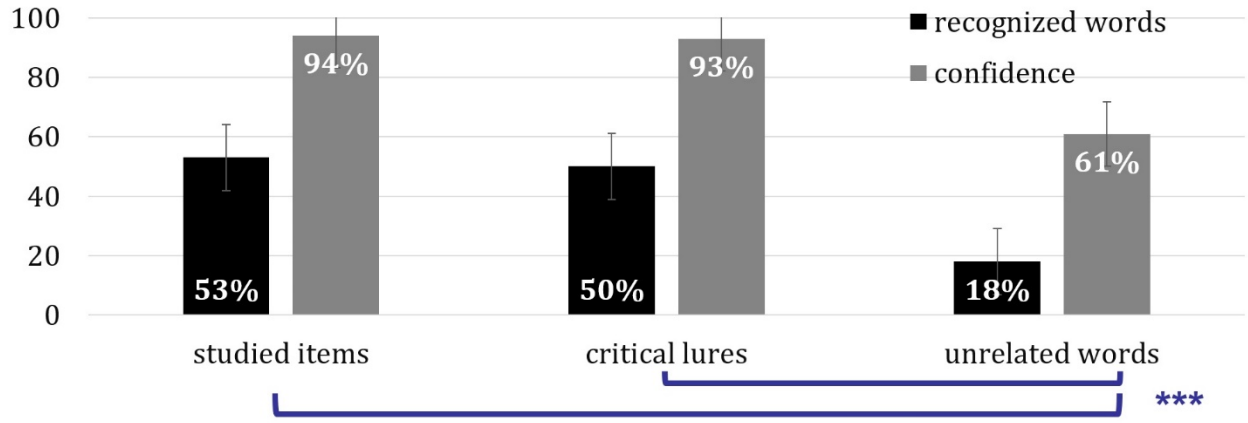

Fig. 4. Mean rates of recognitions and confidence for studied items, critical lures and unrelated words in Experiment 2, set 1.

Results obtained from second DRM-lists-set provided some additional findings to this picture. Firstly, it could be easily noticed, the general level of confidence was decreased, compared to the first set. The possibility of disrupting participants' attention, which focused on processing suggestive communicate could not be excluded, however objective measures of memory did not revealed significant differences between both sets (Oberauer 2001, 2016) (see: table 4).

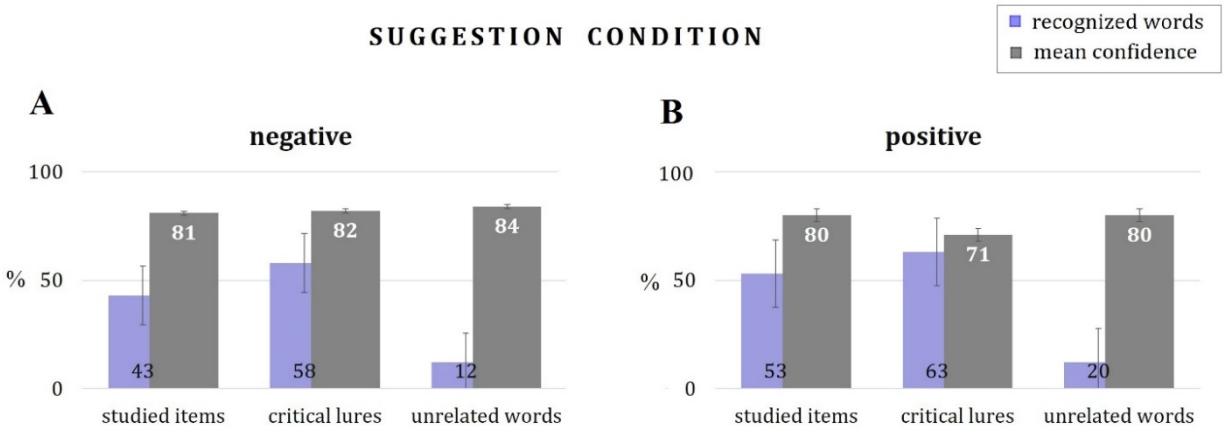

Fig. 5. Mean rates of recognitions and confidence for studied items, critical lures and unrelated words in Experiment 2, set 2 as a function of suggestion: negative (A) or positive (B).

Thus, extremely precise measure of memory-confidence, appeared to be also very prone to distortions coming from participants subjective experience. Unfortunately, such confidence-evaluation bias makes this scale completely useless to investigate whether suggestion affects FM. Also, figure 5 presents no saliences among 3 kinds of words (scored by % confidence) despite existing differences between their 'real' recognition rates made by participants.

DeSoto & Roediger (2014) to meet demands for one of their works, enumerated at least five trustworthy measures of confidence, enable to assess this variable as objective as possible, including rates basing on remember-know distinguish. Therefore, it seemed reasonable to take this issue into the account providing further analysis. Hence, as predicted, noticeable change was observed between suggested and non-suggested participants: $F(2,83) = 3,12$; $p<0,05$ (see: table 4).

Tab. 4. *Recognition results for studied items, critical lures and unrelated words, with mean levels of certainty as a function of condition in in Experiment 2, set 2.*

		Proportion of responses			
suggestion content	item type	overall	R	K	confidence [%]
negative					
	studied	.43	.59	.41	81
	critical lures	.58	**1**	**0**	82
	non-related	.12	.53	.47	74
positive					
	studied	.53	.61	.39	80
	critical lures	.63	.64	.36	71
	non-related	.20	.60	.40	80
neutral					
	studied	.47	.67	.33	83
	critical lures	.50	.62	.38	79
	non-related	.23	.56	.43	77

Note. R = remember judgment; K = know judgment. To investigate an effect of suggestion implementation, only data derived from a second list of words related presentation was analyzed.

What is shown in table 4, the presence of any suggestion, as well as it content affected recognition for false memories (CL) and presented word (studied items). Similar to Experiment 1, FM rates (58%, 63% and 50%, in dependence of condition) exceed the correct recognitions (43%, 53% and 47%, respectively). Interestingly, due to FM these differences achieved saliences only in experimental, suggestion-including conditions (see: table 5). This issue would be discussed wider elsewhere, although, it is worth to mention.

There are few important points to note about these presentation rate results. Firstly, both experimental groups – receiving negative as well as positive suggestion compared to control subjects – indeed generated higher FM-rates, however the positively suggested participants produced the highest level of false recognition (counted by percent). Such results, bizarre at a glance, are easy to explain in terms of different responses strategies, triggered by suggesting feedback.

Gheorghiu (1989b) points initiating a desirable reaction, attributed to automatic response, runs only with some kinds of suggesting communicates. Here what he called “desirable” would be following the suggestive communicate, thus for positive condition – decrease of FM should be observed. What we noticed about this rates was something in contrary. However – following Gheorghiu’s (1989b) explanation – we tentatively hypothesized, processing positive information remains easier, less engaging and demand smaller amount of cognitive resources, compared to negative. Therefore, the entire process remains under weaker control and stays more automatic. Forgoing theoretical explanation (levels of processing and limited cognitive resources; Craik & Lockhart, 1972; Craik & Tulving, 1975; Tversky & Kahneman, 1973; Kahneman, 1973) help to clarify why people tend to create robust FM, accompanied by a sense of remembering (Thapar, & McDermott, 2001). Positive communicate seem to trigger modes of processing, - that in general - are less effort-demanding and occupy resources to a lower degree than negative does. Contrary, when it comes to proceed negative communicate, we assume its content contributes to provoke non-automatic information proceeding strategies strongly affecting participants behavior, as they are memorized better and proceed deeper. As an effect, subjects are willing to strictly undergo suggestion communicate, by providing reaction exactly coherent with its’ content. Namely, participants which received positive communicate didn’t internalize suggestion, as they proceed information automatically, and as an effect, weren’t able to act in line with its’ content. On the contrary, negative feedback, well-known as a factor provoking deeper and more analytical information processing, made subjects to initiate non-automatic strategies, and as a consequence –incorporate the suggestion content. Thus, althought results obtained from both conditions might seem paradoxical, in fact they create a coherent and understandable pattern that shed some light on mechanisms underlying suggestion phenomenon.

Second and even more important issue to consider is the cutting-edge result in negative suggestion condition. Not only between-group differences of “remember” and “know” judgments were revealed, but it also came out participants under negative suggestion show 100% rate of “remembering” critical lures! Such a pattern of results didn’t show up under any other circumstances, concerning prior work with use of DRM paradigm, as

well as other researchers studies, i.e. Plancher at. al. (2008) extended false recognition rates for CL made by participants, as well as increased declared feeling of remembering under the suggestion, however, did not obtain absolute certainty for remembering false memories (what we did)! The act of suggestion itself lead to create robust, long-lasting FM in DRM procedure. Presented results seem to provide evidence that negative communicate, above all the others, favors internalization of suggestion among human mind.

Final analysis comprised answers given by participants to CL after the first set of DRM-lists (no suggestion) compared to similar rate after second set (including suggestion). We believed such that design of experiment 2, providing suggestive communicate between two, separated DRM lists enables to observe specific fluctuations among FM rates as an effect of experimental manipulation, allowing to establish if the suggesting influence elicits a noticeable change among participants' recollections during a memory test, with particular attention paid to the FM rate.

As table 5 shows, suggestion influenced false memories of critical words. Within-subjects analysis revealed significant differences among mean number of critical lures generated by participants after first DRM-lists-set presentation compared to second as a function of suggestion. Participants were mostly willing to supplement their memory by remembering non-presented, related word under the negative suggestion condition: probability of recognition increases from 43% after first set to 58% after second ($t(30)=-3.37$; $p<.05$). Also positively suggested participants tend to increase their false recognition (from 50% to 63% ; $t(29)=2,76$; $p<.05$), and however the effect of 'FM boost' was slightly lower, still remains salient, implying significant change appearance.

Tab.5. *Recognition of critical lures as a function of condition in Experiment 2, set 2.*

Condition	N	CL #1	%	CL #2	%	t	df
Negative suggestion	31	3.5 (1.96)	43	5 (1.67)	58	-3.37 (2.03)*	30
Positive suggestion	30	4 (1.23)	50	5 (1.76)	63	-2.76 (1.52)*	29
Neutral (control)	25	4 (1.34)	50	4 (1.88)	50	0.53 (0.38)	24
Total	86	4 (1.58)	50	5 (1.81)	63	-3.16 (1.90)*	85

Note: 'CL #1' refers to a mean number of critical lures (false memories) generated by participants after first DRM-lists-set presentation; 'CL #2' – second ('%' following both columns represent percentage level of CL calculated from dividing number of recognitions to maximum, ~~possible to obtain~~ – here it was 8, as every set includes 8 lists of words related). Standard deviations – given in parentheses.

* – groups differ significantly from control condition (t statistics) at the level of $p<.01$

Significant differences observed among between-subjects analysis supported this observation. Considering only results delivered from the second set DRM lists-of-words-related we are enabled to claim that suggestion – in general – affects FM development among participants memory: subjects receiving neutral communicate created FM at the level of 50%, which makes significant change, compared to participants' results in both condition consisting suggestion (58% and 63%, respectively). What is more, subjects divided into control condition, did not change the amount of FM all over the experiment (see: table 5). In general, one-way analysis of variance (ANOVA) conducted for a number of FM as a dependent variable supports this observations ($F(2,83)=3,12$; $p<.05$).

Such results clearly demonstrate although suggesting communicate affects memory, the details of this impact aren't obvious. Perhaps people have in disposal a kind of the residual ability to distinguish between presented words and non-presented lures, that could be impaired by many factors, including suggestion. Several theories explains such tendency, for example information-source monitoring biases (see: Johansson & Stenberg, 2002; Johnson, Hashtroudi, & Lindsay, 1993; Lindsay, 2014). In this framework cognitive system is supposed to be disturbed by suggestive directions, hence, it is unable to run meta-control processes in an effective way. This explanation also turns into lack of necessary resources, currently occupied by processing another stimuli (in this case: suggestive information), thereby distinguish between actually presented and merely activated critical

lures (by association) becomes extremely difficult, whether not impossible. Several research highlights limitations contributed to individual differences among ability to control and supervise upcoming stimuli, that could be related to participants suggestibility (i.e. Watson, et al., 2005; Johansson & Stenberg, 2002; Loftus, 2005; Schwanenberg, 1989 Jaschinski and Wentura (Ecker, Lewandowsky, Oberauer & Chee, 2010; Smith & Engle, 2011; Smith, Lozito & Bayen, 2005; Smith, Hunt & Dunlap, 2011). Despite, presented studies, as well as prior work, demonstrating the stable effects of suggestion to false memory creation in DRM paradigm (Maciaszek, 2013, 2015, 2016a) .

GENERAL DISCUSSION

The fallibility of memory isn't a surprise not only for researcher – many people are aware of at least some "memory sins" (Schacter, 1999). Although, the variety of possible distortions, just to put as an example imagination inflation, misinformation effect or confabulation, remains impressive. Presented study examined false memory phenomenon in terms of associative memory network (Quillan, 1969; Underwood, 1965) aiming to answer the question whether suggestive communicate influences FM creation. To assess those variables well-valuated and wisely used by cognitive psychologists method was applied. In particular, DRM (lists of words related, Deese, 1959; Roediger & McDermott, 1995) enabling to study the illusion of remembering events that never happened.

There are 3 important points to note about FM & suggestion influence presented in a current studies. Firstly, it was demonstrated how extremely easy false memories could be implemented into ones' memory. This effect has been amply discussed with a countless studies using DRM procedure, frequently involving certain variations, e.g. using pictures instead of words, manipulating instructions, elements of study design or materials, leading to FM occurrence (Benmergui, McKelvie & Standing, 2015; Dewhurst, Rackie & van Esch, 2016; Israel & Schacter, 1997; Mirandola & Toffalini, 2016; Arndt & Reder, 2003; Smith, Hunt & Dunlap, 2015; Seamon et al., 2002; Oliver, Bays & Zabrucky, 2016; Oliver, Bays & Zabrucky, 2016; Maciaszek, 2016a; Nelson et al., 2013). Current study findings stood in line with general claim of mechanisms underlying FM creation, providing some additional knowledge to this picture. Result obtained from experiments 1 and 2 remain coherent, and achieved rates are relatively constant, which supports the main effect of DRM-evoked false memories: they are often recognized by participants at approximately the same level to presented items. In Experiment 1 participants recognized 50% of critical lures and 53% of studied items as presented previously with high rates of "remembering" for both: 64% and 60%, respectively (thus, confidence for false recognition exceeded correct!). Such results might also support the idea of very early origin of false memory trace, believed to appear at the stage of encoding (Olszewska & Ulatowska, 2013). Thus, semantic relatedness bound false memories to true ones and they became encoded in a similarly way, false traces supplementing original record of the event. In this terms, high level of confidence declared by participants to FM could also be explained: whether FM appears during encoding of the regular stimuli (here we used lists of words related), they became a part of mental representation of an event, stored in memory (Dehon, 2012; Gallo, 2013, 2006).

Going further, results of Experiment 2 disclosed that participants not only declare "remembering" particular non-presented CL, but also – perhaps more importantly – rate them at the same level of confidence as actually presented words! Confidence, declared by participants on a slider (see: figure 1) achieved 93% for CL and 94% for truly presented word, which makes no significant difference (compared to 61% for non-presented items). Such result disposes to claim both – true and false memories – appear in the memory at approximately the same time, therefore may also mutual origin. Such explanation conforms to semantic network activation theory, which contributes FM appearance to activation spread (Collins & Loftus, 1975; Quillan, 1969; Underwood, 1965).

Secondly, presented results clearly demonstrated that suggestion, regardless its content, affects memory by increasing false recognition of semantically related words that were never presented for study, considered as false memories (Monds et. al., 2013). Hence, as predicted, noticeable change among answering pattern was observed between suggested and non-suggested participants: sole presence of suggestive communicate affects FM recognition from 50% to 63% (while content was positive) and from 43% to 58% (negative), whereas control group stood at the stable level of 50% FM recognition during entire procedure (see: table 5). Why is this so?

According to Schacter (1999), suggestion causes incorporation of information given externally, e.g. provided by others, into one's own memory of an event. This remains coherent with similar answering-pattern change, for confidence rates of recognitions given by participants to critical lures (from 93% to 79%) and studied items

(from 94% to 83%) as an effect of experimental manipulation, that was observed. Therefore, it seems justified to claim suggestive communicate contributes to boost internalization of false memories, emerging as an effect of semantic activation spread.

Present study findings, consistent with what Leding (2012) explored using varied persuasion strategies, point out that FM occur one way or another – with or without suggestion - however the magnitude of this effect itself dramatically grows when suggestive directness are implemented.

Also what must be noticed about Experiment 2 is the increasing rate of FM recognitions noticed for both positive and negative suggestion conditions. One may argue, it is due to cognitive-resources occupation, demanded to proceed (and memorize) information in complex way. Lack of sufficient resources, currently engaged with processing suggestive communicate, creates extremely favorable conditions for undergoing suggestive communicate, as it makes it more difficult for participants to distinguish between presented words and non-presented words. Therefore, reducing available resources results in observable growing number of false memories (Smith & Engle, 2011; Smith, Hunt & Dunlap, 2015).

Corresponding explanation offers source-monitoring framework, which contributes systematic memory errors (such as FM) to meta-control biases (Johansson & Stenberg, 2002; Johnson, Hashtroudi, & Lindsay, 1993; Pohl, 2004). Following this theory, it could be assumed that necessity to process multi-component suggestive communicate leads to temporary cognitive overload and – as an effect – enhances one's tendency to commit bias. The effect of cognitive load on task performance is well-described (Allred, Crawford, Duffy & Smith, 2016; Ricker et. al.,2015; Sporer, 2016; Sweller, 1988, 1994). In this case, not only general impairment was shown, but also easiness to mislead cognitive system resulting in source monitoring errors. As a consequence subjects is unable to distinguish between what was presented and what was only related to presented.

Thirdly, it was established, the content of suggestion does matter. What must be noticed is that probability of false recognition to CL increased from the first set of DRM lists to second among both experimental conditions (contrary to control group receiving neutral communicate), however, only negatively suggested participants developed 100% certainty of remembering FM. It seems possible that negative suggestion probably elicits deeper encoding processes (compared to positive or neutral), therefore it affects memory in more complex way (Flegal & Reuter-Lorenz, 2010, 2014; Rose & Craik, 2012; Thapar & McDermott, 2001). Probably, not only level of information processing plays a role to create robust FM in subject's memory, but also some specific patterns of processing emotional stimuli (Storbeck, 2013). Unlike positive suggestion, negative feedback may demand greater amount of cognitive resources to proceed information and – as a consequence of temporal unavailability - cause breakdown in source monitoring, which fails to discriminate between activation arising from presented words and related item (CL) (Ruffman et. al., 2001). Perhaps, for the future studies it would be interesting to extend this procedure, i.e. by increasing emotional component of suggestive communicate, as existing study findings merely scratched the surface of this fascinating issue (e.g. Storbeck, 2013; Plancher at. al., 2008)

CONCLUSIONS

Although several research demonstrated impact of suggestion on memory, relatively few explored the extend to valence of such communicate to impact FM creation. The main involvement of presented research addressing the creation of FM was centered on a role that suggestive multi-component communicate might play in occurrence of robust, long-lasting false memories among participant's memory. In general subjects receiving suggestion showed greater tendency to distort memories, generating predictable false recognitions. What is worth emphasizing, however all FM were accompanied by an expectably high level of certainty, (which was similar to true ones), only participants receiving negative suggestion changed their behavior in line with communicate content. In other words, both experimental groups demonstrate increasing willingness to yield DRM-list-context (and generate FM), however undergoing suggestion content was revealed only for negative condition.

Taken together, presented study highlights in a pointedly way the issue that goes far beyond psychological dilemma: there is always a blend of truth and fiction among our recollections. Here it is important to mention that many aspects of our everyday experience do not have to be explicitly remembered but might be based on main regularities observed in the environment or be inferred from contextual cues (e.g. Dehon & Laroi, 2011). According to Steyvers and Hemmer (2012) our recall of past events could be impaired by many factors, such as previous knowledge, or expectations, and presented study extends this knowledge by adding influential role of suggestion on our memory of the past. What seems essential is paying attention to construction of our

memory that allows such phenomenon to occur, hence we are dealing with suggesting directives as well as evaluating feedback in our everyday life. What can be claimed for sure – suggestion affects our memory and behavior. Due to described results, one may develop doubts, whether it is even possible to distinguish true from false, as it came out we remember both in similar way. As the best of our knowledge, no golden mean was found yet, but perhaps it mean we should keep on searching.

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