# Inducing False Memories by Manipulating Memory Self-Efficacy

Vittorio M. Iacullo*, Francesco S. Marucci* & Giuliana Mazzoni**

*Department of Psychology – Sapienza University of Rome (Italy)
**Department of Psychology – University of Hull (United Kingdom)

Corresponding author:
Name Vittorio M.Iacullo
Add/ Affiliation Department of Psychology
Sapienza University of Rome
Via dei Marsi 78
00185 Rome, Italy
vittoriomaria.iacullo@uniroma1.it

## *Abstract*

The aim of this paper is to investigate the relationship between self-efficacy and false memories using the Deese/Roediger–McDermott (DRM) paradigm, whereby people falsely remember words not presented in lists. In two studies participants were presented with DRM lists and asked to recall and recognize presented items. In the first study, we found a significant relationship between memory self-efficacy (MSE) and susceptibility to associative memory illusions, both in recall and recognition. They also received the Memory Self-Efficacy Questionnaire (MSEQ), the Big Five Questionnaire (BFQ) and the backward digit span (BDS) test.

In the second study, MSE was manipulated in order to assess whether changes influenced the sensitivity parameter in DRM tasks. Results showed that the manipulation was effective in decreasing self-efficacy, which in turn affected the probability of reporting critical lures as well as sensitivity. Possible explanations for the effect are discussed.

**Keywords:** false memories, self-efficacy, memory, working memory, performance

***Introduction***

Understanding individual differences in memory has become a crucial topic in modern psychological research. Moreover to understand the factors that influence memory illusions could help to improve the applications in several fields, like psychology of testimony, learning psychology and psychotherapy. In particular, our interest is in understanding the relationship between individual difference, as measured by state and trait factors, and false memory as measured using the Deese/Roediger–McDermott (DRM) paradigm.

In DRM paradigm, people study lists of associated words and then take a recall or recognition memory test. Each presented list is semantically associated to at least one specific non-presented words (known as critical lures; Roediger & McDermott, 1995) and are listed in backward associative strength (BAS), such that the most strongly associated word is presented first, then the second, and so forth. For example, one list includes *sour*, *candy*, *sugar*, *bitter*, *good*, *taste*, etc., which should elicit the false recall of the critical lure *sweet*.

There are several theories that can explain from different point of view the DRM illusion (see Gallo, 2010 for a review). Here we shortly report the Activation-Monitoring Theory (hereafter AMT) and the Fuzzy Trace Theory (hereafter FTT). This theory concern the interaction between two processes. The firs process is the spread activation, which describes a higher probability for critical lure being falsely remembered, due to the repeated activation of characteristics that the critical lure shares with the other words in the list. This leads to remember the critical word as a list word. Nevertheless, the theory accounts a monitoring process that reduces false memories trying to determine the origins of this activated information and that a false memory occur when this process fail (e.g., Roediger& McDermott, 2000; Roediger, Watson, McDermott, & Gallo, 2001). (Benjamin, 2001; McDermott & Watson, 2001).

Also the FTT (Reyna & Brainerd, 1995; Brainerd & Reyna, 2002) assumes the intervention of a monitoring process during the memory task. However, differently from the AMT, this theory focuses on the storage of meaning relations; indeed the main assumption is the separate encoding of two type of memory trace: verbatim trace and gist trace. A verbatim trace contains the surface form of presented words and, by definition, it disappears earlier than the gist trace that is the representation of the list meaning. According to FTT, a false memory occurs with an illusory recollection of the gist trace.

In the present paper, we describe two distinct studies. In the first study we investigate the relationship between individual differences and false memories. In the second one, we manipulated the self-efficacy variable that we found to be related to false memories in the first study.

Presently, not many researches are conducted on the relationship between false memories and individual differences; most of them have focused on the manipulation of the DRM paradigm (Watson, Bunting, Poole, & Conway, 2005). In respect to this, (Sanford & Fisk, 2009) these studies showed a significant relationship between the associative networks of semantic and episodic memory and extroversion/introversion dimensions of personality as measured by the Big Five Questionnaire (BFQ) In the first study we retested the relationship between extraversion and false memories. Furthermore, because no studies investigated the relationship between MSE and Big Five of personality we are interesting in investigate it.

Even less research has been conducted regarding the focus of the present study, namely on memory self-efficacy (hereafter MSE), it has been conceptualized in two principal ways (Berry, 1999). In one approach, derived from Bandura’s self-efficacy theory, MSE refers to the belief of holding efficient memory skills evaluated in the context of specific memory tasks (Berry, 1996; Beaudoin & Desrichard, 2011). Another approach, derived from the meta-memory framework, conceptualizes MSE as “one’s sense of mastery or capability to use memory effectively in memory-demanding situations” (Hertzog, Hultsch, & Dixon, 1990). In this approach, MSE is a generalized judgment that is abstracted from specific tasks and situation characteristics.

Furthermore, in the present study we used MSE taking in to account the Bandura’s suggestions (1997), therefore as based on various sources of information, including the appraisal of the relevant features of a task and situation, as well as task-specific, domain-specific, and global beliefs about one’s memory abilities. One’s concurrent MSE is based on the perceived characteristics of the memory task to be performed, on personal-state variables (e.g., concurrent physiological state and mood), and, whether no previous experience with the task is available, on more generalized beliefs about one’s memory abilities (Hertzog et al., 1990b).

Self-efficacy affects the ability to cope, which indirectly supports the hypothesis that the level of MSE affects cognitive performance (Heitzmann et al., 2011; Coffee & Rees, 2011). According to Bandura’s self-efficacy theory (1989, 1997), higher confidence in one’s memory leads to higher memory performance due to greater effort expenditure, greater persistence in the face of difficulties, higher performance goals, and lower state anxiety. Some studies have shown a significant positive correlation between MSE and working memory (hereafter WM) (Caldeira de Carvalho, Marcourakis, Artes, & Gorenstein, 2002; Potter & Hartman, 2006), others reported that WM is predictive of false recognition (Johnson, Hashtroudi, & Lindsay, 1993; Peters et al., 2007). Since WM could mediate the relation between MSE and DRM performance, we decided to include it in our analysis.

Because no previous study has assessed whether MSE affects the extent to which people develop false memories, we investigated this hypothesis using two different experiments. The focus of the first study was to examine the relationship between false memories and individual difference traits mentioned above. In the second experiment, we tested whether experimentally induced changes in MSE (considered as a state variable) produce changes in memory performance.

Experimental studies which try to manipulate personal variables such as MSE are rare, and in most cases do not include any measure of memory performance (e.g. Sanbonmatsu, Harpster, Akimoto, & Moulin, 1994). Among studies in which memory performance is assessed, one did not report any MSE manipulation effect on memory performance (Gardiner, Luszcz, & Bryan, 1997), while another reported an effect of manipulation on both MSE and memory performance but did not test whether the impact of manipulation on memory performance was mediated by MSE changes (Nicoson, Dick, Lineweaver, & Hertzog, 2008).

# Study 1

The purpose of the first study was to investigate individual differences in false memory. Particularly we wanted to examine whether MSE can determine memory performance, using the DRM paradigm. In the DRM paradigm people study lists of associated words and then take a free recall and recognition memory test. The typical result is that people often falsely remember a non-studied critical word associated with the words in the list. According to self-efficacy theory (Bandura, 1989), individuals with low MSE should be less willing than individuals with higher levels of MSE to expend mental effort during the DRM tasks. We hypothesize that individuals with higher MSE are better able to initiate intentional monitoring activities and screen out potential memory errors, including critical false memories, compared to individuals with low levels of self-efficacy. Moreover, we expect that only MSE for words is predictive of performance in the DRM paradigm, because this scale is closer to DRM conditions than the MSE scales for groceries and errands.

Furthermore, we tested the hypothesis that the confidence intervals of the recognition task could be related to MSE as a meta-memory task. As regards to BFQ, coherently with previous researches (e.g., Paddock et al., 2000; Sanford & Fisk, 2009) we aspect that extroverts produce a significantly greater number of false memories than introverts. In this study, we also assessed the role of WM in predicting performance of a DRM task.

### *Method*

### *Participants*

Forty-one native English speakers students from the University of Hull (UK), 10 were male, 31 were female (mean age = 20.6; *SD* = 4.35). Forty-one native Italian speakers students from the Sapienza University of Rome, 11 were male, 30 were female (mean age = 24.8; *SD* = 6.04).[1]

### *Materials*

*DRM lists* – Study items were 14 of the lists rated by Stadler, Roediger, and McDermott (1999) as producing medium levels of false recognition. Each list consisted of 15 associations of a non-presented critical lure (see Appendix). The recognition test included a printed sheet containing 28 studied words (two from each list), 14 critical lures of the studied lists, plus 28 non-presented words semantically

[1] There were exclusion criteria that included psychiatric and learning disorders estimated asking participants if they had experienced in the past psychiatric disorders or learning disabilities and if they were used to assume drugs.

related with critical lures and 28 words unrelated to critical lures or any other word in this list. As the Italian language does not possess as many extensive association norms as the English language (Buchanan et al., 2012), we translated the original English stimuli, matching use frequency, into Italian. For this purpose we referred to Corpus of Contemporary American English (Davies, 2008) and *Corpus e Lessico di Frequenza dell'Italiano Scritto* (Corpus and Frequency Lexicon of Written Italian) (Bertinetto, et al., 2005).

*Backward Digit Span (BDS)* – This test is used to measure WM, attention, concentration, and mental control (Ostrosky-Solís & Lozano, 2006). In a typical test of memory span, a list of random numbers is read out loud at a rate of one item per second. At the conclusion of the list, participants are asked to recall all digits in reverse order. The test begins with three digits, increasing one digit after each two sequences of digits until people fail to report two sequences of the same length.

*Memory Self-Efficacy Questionnaire (MSEQ)* – This questionnaire includes the description of several memory exercises (classic laboratory tasks and more everyday tasks) which must be carried out at different levels (Berry, West & Dennehey, 1989). Subjects are required to decide whether or not they are capable of attaining each level of performance for each task and to state their level of confidence. For this study we selected three MSE scales: chores, groceries and words.

*Big Five Questionnaire (BFQ)* – This is a personality test (Caprara, Barbaranelli, Borgogni, & Perugini, 1993; Costa & McCrae, 1985) based on five major dimensions: openness, conscientiousness, extraversion, agreeableness and neuroticism. In this study, we used the 50 item short version of BFQ.

### *Procedure*

Subjects were tested individually in a room set up to avoid distractions and interference. DRM lists were administered in random order through headphones connected to a computer. The words were presented with a frequency of one every 1.5 seconds. Subjects were instructed to recall each list after listening to it. The request to recall the words in the list followed the presentation of each list. Recall of all 14 lists was followed by the backward digit span task administration. The DRM recognition task was then presented. For the recognition task, subjects were asked to recognize the words presented in the lists from a recognition list containing new and old words by indicating a level of confidence for each item (4 = certainly old; 3 = probably old; 2 = probably new; 1 = certainly new). After this step, the MSEQ and BFQ questionnaires were presented and filled out.

## *Results*

***Preliminary analysis***

As previously explained, in this study we used two language groups; in order to compare DRM results we conducted some preliminary analyses that showed some differences between the Italian and English groups in correct recall and in correct recognition. For this reason, we decided to analyze the two language groups separately. Nevertheless, no significant differences were found between these two groups in the MSEQ or false memory production.

***Recall***

An overall two (languages: English and Italian) by three (type of recall: correct, critical and non-critical errors) ANOVA was computed on recall scores. The results showed a main effect for type of recall, $F$ (1, 80) = 419.59, $\eta_p{}^2$= .84, $p$ < .001 ($M_{hits}$= .58, $SD_{hits}$ = .08, $M_{\mathrm{cl}}$= .39, $SD_{cl}$= .18, $M_{\mathrm{n\text{-}cl}}$= .07, $SD_{n\text{-}cl}$=05). While the performance in the two language groups differed significantly in the proportion of correct recall, $F$(1,80) = 6.67, $\eta_p{}^2$=.07, $p$ = .012 ($M_{\mathrm{eng}}$= .61, $SD_{eng}$ = .08, $M_{\mathrm{ita}}$= .56, $SD_{ita}$= .08), no difference was observed in false memory production, either for critical recall, $F$(1,80) = 0.77, $\eta p2$ =.01, $p$ = .382 ($M_{eng}$= .41, $SD_{eng}$= .21, $M_{ita}$= 37, $SD_{ita}$= .16), or non-critical recall, $F$(1,80) = 0.946, $\eta p2$ =.01, p = .334 ($M_{eng}$= .03, $SD_{eng}$= .02, $M_{ita}$= .04, $SD_{ita}$= .03).

In spite of the significant differences in correct recall, the curves of the serial position in the recall task of English and Italian words had the same trend. Figure 1 shows the typical effect of the DRM paradigm, i.e. a percentage of critical lures comparable to those of the words positioned in the middle of the list (this overlap is around 40% for both groups).

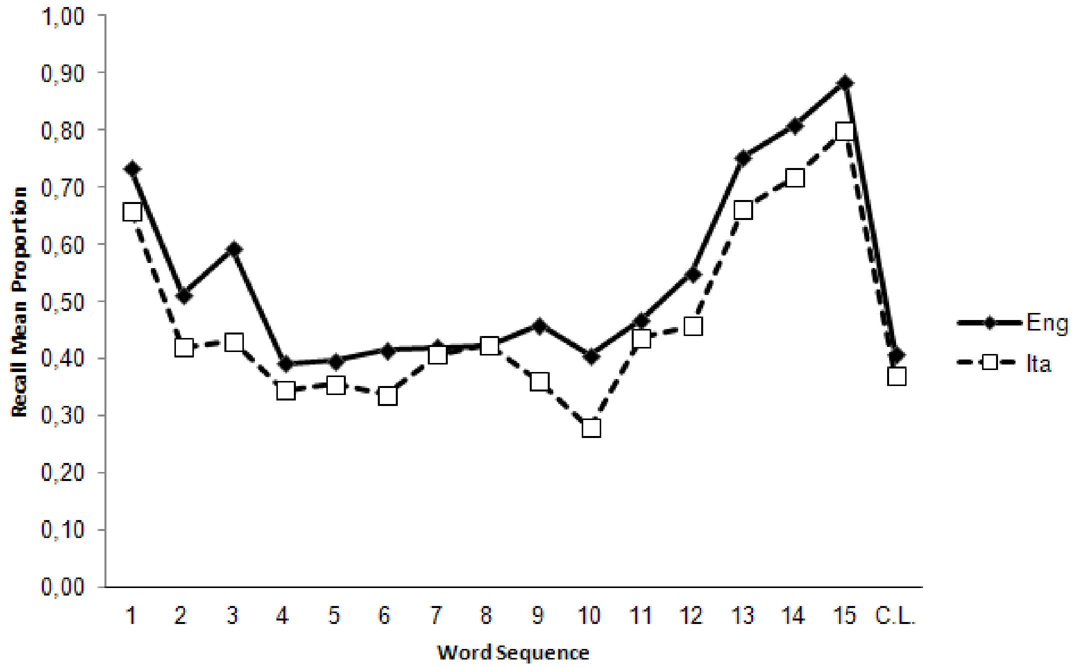


**Figure 1.** *First experiment*: *mean proportion of words correctly recalled by serial position and mean proportion of critical lures falsely recalled averaged over all lists*

### *Recognition*

A similar ANOVA was computed for the recognition scores. Similar to the results in recall, there was a main effect of languages, $F$ (1, 80) = 546.66, $\eta_p{}^2$ = .87, $p$ < .001 ($M_{hits}$= .71, $SD_{hits}$ = .11, $M_{cl}$= .76, $SD_{cl}$= .22, $M_{rel}$= .24, $SD_{rel}$=12, $M_{nrel}$= .11, $SD_{nrel}$=07). Moreover, results showed a significant interaction between Italian group and English group for hits, $F$ (1, 80) = 5.78, $MSE$ = 0.34, $p$ = .018; the English group reported a mean percentage of hits significantly higher than the Italian group (respectively $M_{eng}$= .74, $SD_{eng}$ = .12, $M_{ita}$= .68, $SD_{ita}$= .10). Instead, no significant difference between the two languages in critical lure production was found, $F$ (1, 80) = 1.67, $MSE$ = 0.01, $p$ = .20. Furthermore, a significant difference for unrelated errors, $F$ (1, 80) = 4.04, $MSE$ = 0.21, $p$ = .048 (see, Table 1) was obtained but not for related errors, $F$(1,80) = 0.69, $MSE$ = 0.40, $p$ = .409.

With respect to confidence scores, in both languages critical lures were recognized as occurring with the same frequency as presented words. Critical lures, when judged as old, were reported with more ‘not sure’ responses than studied words. Vice versa, when a word was judged as new, more certain responses for critical lures were reported. Moreover, related errors were recognized as presented words more frequently than unrelated errors; certain/probably judgments reflect this result (see, Table 1).

Results of both recall and recognition showed that the translation of the DRM lists into the Italian language did not change probability of the list inducing false memory; the English group and Italian group were comparable in this crucial dimension.

**Table 1.** *First experiment recognition results: the proportion of items classified as certainly old (a rating of 4), probably old (3), probably new (2), or certainly new (1) and the mean proportion of words recognized as presented in DRM lists.*

| | Old | | | | New | | | | Mean | |
|---|---|---|---|---|---|---|---|---|---|---|
| Study status | 4 | | 3 | | 2 | | 1 | | Rating | |
| | ENG | ITA | ENG | ITA | ENG | ITA | ENG | ITA | ENG | ITA |
| Studied | .61 | .56 | .13 | .15 | .16 | .15 | .10 | .14 | .74 | .71 |
| Nonstudied | | | | | | | | | | |
| Critical lure | .55 | .58 | .20 | .23 | .10 | .09 | .15 | .13 | .74 | .81 |
| Weaklyrealatedlure | .08 | .08 | .15 | .17 | .37 | .26 | .40 | .42 | .23 | .25 |
| Unrelatedlure | .05 | .05 | .05 | .07 | .41 | .27 | .49 | .53 | .10 | .13 |

### *Individual differences*

ANOVA conducted on data of the backward digit span test and the MSEQ showed no differences between language groups. Significantly, differences in three of the five BFQ scales were found: openness, $F$ (1, 80) = 21.92, $MSE$=0.62, $p$<.001; conscientiousness, $F$(1,80)= 16.98, $MSE$=0.52, $p$<.001; and extraversion, $F$(1,80)= 8.01, $MSE$=0.62, $p$=.006 (see Table 2). No significant difference was found in backward digit span scores between the English and Italian groups.

**Table2.** *First experiment ANOVA and mean of individual difference tasks.*

| Test | Factor | English (n = 41) | | Italian (n = 41) | | |
|---|---|---|---|---|---|---|
| | | M | DS | M | DS | F (1,80) |
| BDS | | | | | | |
| | Working Memory | 7.54 | 1.87 | 7.24 | 1.59 | 0.58 |
| MSEQ | | | | | | |
| | MSE Grocery | 27.59 | 7.4 | 30.78 | 7.73 | 3.66 |
| | MSE Words | 27.32 | 5.95 | 29.29 | 6.32 | 2.12 |
| | MSE Errands | 27.73 | 6.82 | 31.02 | 8.41 | 3.79 |
| BFQ | | | | | | |
| | Extraversion | 38.85 | 6.16 | 38.44 | 4.32 | 0.12 |
| | Neuroticism | 35.02 | 6.65 | 36.51 | 4.11 | 1.48 |
| | Openness | 42.61 | 6.43 | 36.83 | 4.6 | 21.92*** |
| | Consciousness | 42.17 | 5.65 | 37.90 | 3.48 | 16.98*** |
| | Agreeableness | 41.80 | 6.18 | 38.32 | 4.91 | 8.01** |

Note – ** $p < .01$; *** $p < .001$

Following analyses were computed combining English and Italian scores. For this, we only considered variables that didn't show significant differences between the two languages groups.

### ***Multiple regression analysis***

In order to define predictors of false memories, two stepwise multiple regressions were conducted on critical lures for recall and recognition respectively. We considered as independent variables scores of tests that didn't show significant differences between languages (i.e., backward digit span, all MSEQ scales used in the study, extraversion and neuroticism from the BFQ).

As expected, the variance in false memories during recall was explained by scores in the MSE word subscale, $t$ (80) = -3.36, $p$<.01, $R^2$ = .21, which predicted false memories produced during recall, $\beta$ = -.60, (see Table 4). None of the predictors explained the variance of critical lures produced during recognition.

**Table 3.** *First experiment: multiple regression, using enter method.*

| | Recall of Critical Lure | | | |
|---|---|---|---|---|
| Predictor | $\beta$ | Semipartial r | t(80) | $R^2$ |
| IncludedVariable | | | | |
| MSE Words | -0.60** | -.41*** | -3.36** | .21** |
| ExcludedVariable | | | | |
| MSE Grocery | .13 | | 0.87 | |
| MSE Errands | .12 | | 0.84 | |
| Extraversion | .11 | | 1.05 | |
| Neuroticism | .08 | | 0.77 | |
| Working Memory | .02 | | 0.17 | |

Note –$F$(1,81) = 3.09~~16.641~~, $p$=.009~~<.001~~
**$p$<.01; ***$p$< .001

***Memory self-efficacy and false memories***

Scores in the MSEQ for word subscale of the MSE dimension were divided using the median score in order to create two groups of high and low MSE words. Multiple ANOVA results (see Table 5) showed no significant differences between the high MSE group and the low MSE group for correct recall. As predicted, participants with high self-efficacy showed lower levels for critical lures, $F$ (1,80)=10.17, $MSE$=0.29, $p$=.002, $\eta_p^2$=.113. No significant difference between high and low MSE groups was found in correct recognition. Otherwise, participants with high self-efficacy produced significantly lower numbers of critical lures than participants of the group with low MSE, $F$(1,80)=8.74, $MSE$=0.35, $p$=.004, $\eta_p^2$=.098. Interesting, this result reflect the significant differences in confidence ratings. In particular subjects with low MSE, when a critical false memory occurs, report being more confident than the high MSE group, $F$ (1, 80) = 7.91, $\eta_p^2$ = .09, $p$ = .006 ($M_{low}$= .63, $SD_{low}$ = .04, $M_{high}$= .46, $SD_{high}$=. 04). On the other side, high MSE group report a higher mean proportion in confident response in correct rejections, $F$ (1, 80) = 8.29, $\eta_p^2$ = .09, $p$ = .005 ($M_{low}$= .08, $SD_{low}$ = .03, $M_{high}$= .21, $SD_{high}$= .03). No significant difference was obtained for related errors, $F$ (1, 80) =2.58, $MSE$=0.40, $p$=.11; conversely, a significant difference for unrelated errors was found, $F$ (1, 80) =4.98, $MSE$=0.22, $p$=.028, $\eta_p^2$=.059. As noted above, the unrelated errors score was significantly different between English and Italian group so we computed two separate ANOVA tests for the language groups using as independent variable MSE for words and unrelated error score as the dependent variable. Results showed that there was a significant difference in the number of unrelated errors between high and low MSE participants, $F$ (1, 80) =9.22, $MSE$=1.80, $p$=.004 in the English group.

Finally, a significant difference between high and low MSE was obtained in BDS score, $F$ (1, 80) =15.41, $MSE$=0.19, $p$<.000, $\eta_p^2$=.162.

**Table 4.** *First experiment: ANOVA results for recall and recognition task; independent variable is memory self-efficacy for words.*

| Variable | High MSE (n=19) *M* | *SD* | Low MSE (n=22) *M* | *SD* | *F*(1,80) | *p* | $\eta_p^2$ | Observed Power |
|---|---|---|---|---|---|---|---|---|
| Recall | | | | | | | | |
| Studied Word | 124.82 | 18.92 | 121 | 15.98 | 0.98 | .325 | .012 | .165 |
| Critical Lure | 4.55 | 2.34 | 6.31 | 2.64 | 10.17 | .002 | .112 | .883 |
| Non Critical Error | 7.3 | 5.14 | 9.88 | 6.96 | 3.61 | .061 | .043 | .468 |
| Recognition | | | | | | | | |
| Studied Word | 19.9 | 3.79 | 20.09 | 2.59 | 0.07 | .785 | .001 | .058 |
| Critical Lure | 9.67 | 3.56 | 11.64 | 2.38 | 8.74 | .004 | .098 | .823 |
| WeaklyRelatedError | 6.15 | 3.31 | 7.43 | 3.85 | 2.59 | .111 | .031 | .356 |
| Non RelatedError | 2.62 | 1.75 | 3.59 | 2.15 | 4.99 | .028 | .059 | .597 |
| Working Memory | | | | | | | | |
| BackwardDigitSpan | 8.1 | 1.76 | 6.71 | 1.42 | 15.41 | <.000 | .162 | .972 |

***Discussion***

We conducted separate preliminary analyses that reported significant differences between the English and Italian groups. However, no differences were found for the crucial variables (critical recall and recognition) and the probability that a word will elicit the critical lure in a free association paradigm was observed, both in English and Italian. The results of ANOVA and regression confirm our first hypothesis: the tendency to produce false memories in recall is predicted by MSE scores. This however occurs only when MSE refers to words. The MSE scales for errands and groceries did not predict the results of the DRM task, because they referred to everyday situations, as Berry, West, and Dennehey (1989) maintained. Furthermore, when a false recognition occurs, subjects reported a higher confidence as old item. On the other side, high MSE group was more confident in correct rejection. This result is in line with the meta-memory framework (Hertzog, Hultsch, & Dixon, 1990) and supports the prediction that higher MSE reflects the capability to use memory effectively in memory-demanding situations. In particular, high MSE seems to be effective in avoiding false memories.

Our results are consistent with some studies reporting a positive correlation between MSE and different forms of semantic memory tasks (Gillström & Rönnberg, 1995; Schmidt, Berg & Deelman, 2001). According to self-efficacy theory (Bandura, 1997), MSE affects the level of performance attained on a memory task through its effect on motivational and affective processes, such as mental effort expenditure (i.e., the amount of processing resources voluntarily allocated to a task).

As found during the current study, low MSE is related to a less efficient WM. Conversely, individuals with high MSE generally have better performance levels in

WM tasks. Nevertheless, our results showed no significant correlation between WM and DRM performance.

Finally, previous studies have indicated that extraversion reliably predicts self-efficacy (Tams, 2008), and that self-efficacy plays a mediating role between personality and social interest or perceived stress (Caprara et al., 2012; Nauta, 2004). In our study, extraversion was not correlated with any variable.

# Study 2

The aim of the second study was to explore the effect of manipulating the level of MSE to produce false memories. As argued above, we refer to MSE as a state variable that can be immediately influenced by the perceived performance to the task. Previous research (West, Bagwell & Dark-Freudeman, 2005; West, Welch & Thorn, 2001; Coffee & Rees, 2011; Le Foll, Rascle & Higgins, 2008) shows that when subjects receive feedback they engage more in a task and display better performance than participants that receive no feedback. Moreover, Desrichard and Köpetz (2005) suggest that the influence of MSE on memory can be manipulated indirectly using suggestive instructions. Furthermore, theories of cognitive consistency assume that the discrepancy between beliefs and perceived behavior creates a discomfort that motivates a person to reduce perceived discrepancies (Abelson et al., 1968). Finally, McConnell and Reed Hunt (2007) have shown that providing participants with feedback on their performance this feedback affected their subsequent performance to the same task.

In this study, we used positive and negative feedback on subjects' DRM recall performance. Both feedback types were introduced to alter the level of self-efficacy of the participants. Coherently with results of the previous study, we expect these three groups reporting different performance in DRM task.

### *Method*

The general method used was the same as that used in the first study.

### *Participants*

Forty-eight young Italian adults (*M* = 23.6, *SD* = 3.48) took part in the study; 23 were male and 25 were female. Each person was tested individually in a room. Subjects were divided into three groups. Two groups were assigned to the experimental condition and one to the control group.

### *Materials*

Twelve Italian DRM lists (used in the first experiment), recorded using a male voice in digital audio format at the rate of one word every two seconds were used. The 12 lists were randomly divided into two sets of three and one set of six. The recognition test consisted, for each DRM list, of one critical lure, two words included in the list (positions two and nine), two non-presented words associated with a critical lure and two words not associated with any other word in this list. Lists were divided into three blocks: two by three lists and a one by six list, with different lists per block across participants.

Regarding MSEQ, in the present study the scale “chores” was replaced with “digits”, because digits is not referred to an everyday domain. Thus in this study we considered an everyday task (i.e. grocery) and two laboratory domains (i.e. words and digits) but we focused MSE manipulation on the words domain, and not on the digits domain.

Furthermore, two parallel versions of the backward digit span were used.

***Procedure***

All participants heard 12 DRM lists through headphones. The subjects were told that this was a word experiment, that they will hear several lists of words, and that at the end of each list (indicated when the experimenter clicked on the pause button), they should write as many of the words down as they could remember (see Figure 2).

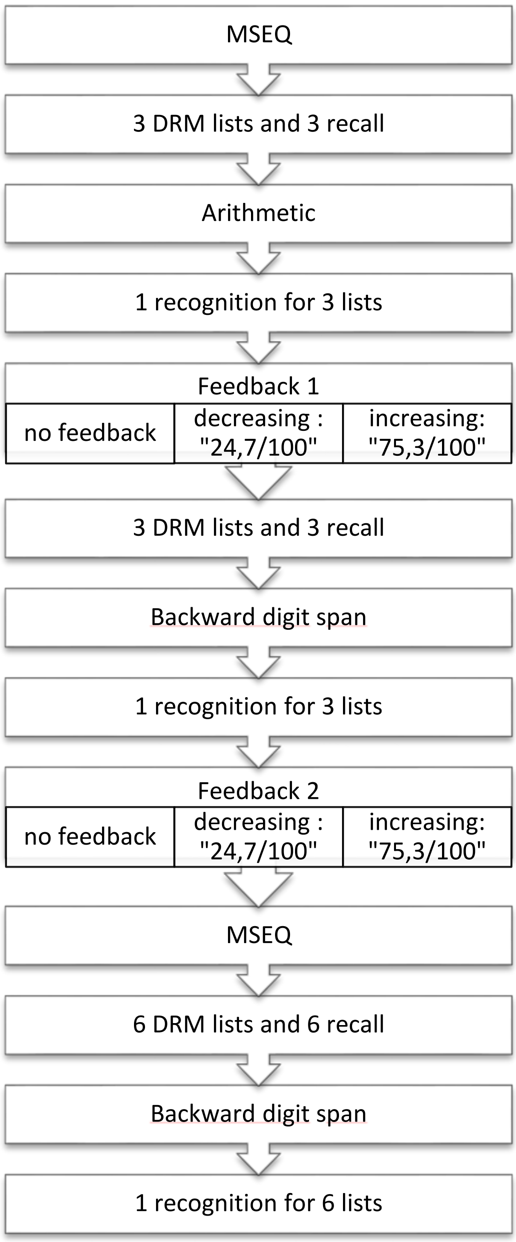

**Figure 2.***Procedure of the second experiment.*

Firstly, participants filled out the MSEQ. Then they started to listen to the DRM lists. The subjects were given two minutes to recall each list after its presentation. After the last recall task of the first block subjects were distracted with an arithmetic calculation task. After three minutes the participants were asked to complete the recognition test. After the recognition task the experimenter gave a different feedback[1] for each group about the memory performance. After the feedback the second block started. This block was the same as the first, but instead of an arithmetic task the backward digit span (BDS) test was conducted.

The third and final block contained six rather than three lists. After the final recognition task, there was a three-minute interval in which the participants performed the BDS test. Finally, participants received the recognition task. During debriefing the researcher informed the subjects that the feedback was independent from their real performance and explained the aim of the experiment.

***Results***

No significant difference for gender was found in pre-feedback condition of self-efficacy and performance. At the end of the experiment all participants judged the credibility of the feedback on a scale of five points (1: not reliable; 5: totally reliable; $M$ = 4.39, $SD$ = .72).

An interaction between group condition (decreasing MSE, increasing MSE and control) and time condition (pre-feedback and post-feedback) was obtained; in particular it was statistically significant in MSE for number, $F(2,45)=13.33$, $MSE= 25.26$, $p<.001$, and MSE for words, $F(2,45)=9.01$, $MSE= 25.26$, $p<.001$. Moreover, we computed multiple comparisons among each of the three levels of group condition in both level of time condition for every possible dependent variable (Table 6); results showed significant differences between increasing and decreasing MSE groups and between control and increasing MSE groups, but not between control and decreasing MSE groups (both in MSE for number and for words).

Regarding DRM performance, the interaction between group and time condition was statistically significant only for critical recall, $F(2, 45) =4.34$, $MSE=0.04$, $p<.05$. Contrast analysis showed a significant difference in critical recall between control and decreasing groups and between decreasing and increasing groups in post-feedback condition, but not in pre-feedback condition. No significant interactions between group and time condition were found in recognition scores and confidence intervals.

**Table 5.***Second experiment: contrast test for MSEQ subscale and DRM performance in time (pre-feedback and post-feedback) between experimental conditions (increasing and decreasing MSE) and control group. F represents interaction effects between group (decreasing MSE, increasing MSE and control) and time (pre/post-feedback) condition.*

| Contrast | Pre-feedback | | | Post-feedback | | | Mixed ANOVA 3x2 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Control * Decreasing | Control * Increasing | Decreasing * Increasing | Control * Decreasing | Control * Increasing | Decreasing * Increasing | $F(2,45)$ | $\eta_p^2$ | Observed Power |
| MSE for digits | | | | | | | 13.33*** | .37 | .99 |
| Value of Contrast | -0.75 | 1.06 | 1.81 | 1.31 | -9 | -10.31 | | | |
| Std. Error | 3.25 | 3.25 | 3.25 | 3.44 | 3.44 | 3.44 | | | |
| *t*(45) | -0.23 | 0.33 | 0.56 | 0.38 | -2.61* | -2.99** | | | |
| MSE for words | | | | | | | 9.01** | .29 | .96 |
| Value of Contrast | -3.18 | -1.62 | 1.56 | -0.31 | -8.68 | -8.37 | | | |
| Std. Error | 2.85 | 2.85 | 2.85 | 3.03 | 3.03 | 3.03 | | | |
| *t*(45) | -1.11 | -0.57 | 0.55 | -0.10 | -2.87** | -2.77** | | | |
| Critical recall | | | | | | | 4.34* | .16 | .72 |
| Value of Contrast | 0.04 | 0.04 | 0.01 | -0.24 | 0 | 0.24 | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Std. Error | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | | | |
| | *t*(45) | 0.46 | 0.47 | 0.01 | -2.47* | 0 | 2.47* | | | |
| *d'* | | | | | | | | 3.19* | .12 | .58 |
| | Value of Contrast | -0.06 | -0.11 | -0.04 | 0.18 | -0.08 | -0.27 | | | |
| | Std. Error | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | | | |
| | *t*(45) | -0.68 | -1.14 | -0.46 | 1.83 | -0.79 | -2.64* | | | |

Note – $*p< .05$; $**p< .01$; $***p<.001$

Furthermore, we computed the system sensitivity (*d'*) and the criterion just for the recall task, because in recognition no interaction effect was found[2]. These measures helped to better understand the actual impact of feedback on the DRM effect.

Results show a group by time interaction for *d'*: the decreasing self-efficacy group effectively reduced the system sensitivity compared to the increasing self-efficacy group, $F$ (2, 45) =3.19, *MSE*=0.08, $p$=.05. Multiple comparisons highlighted a significant *d'* difference between decreasing and increasing group performance. On the other hand, no criterion differences between control and experimental group were obtained. No effect for WM task was found.

### *Discussion*

We found two group by time condition interaction effects. The first was on MSE that significantly went in the predicted direction for two different experimental groups. Consistent with results from our first study and that conducted by Berry, West and Dennehey (1989), different MSEQ subscales predicted memory domains they referred to. In fact, we obtained an interaction effect just for laboratory memory task self-efficacy. Nevertheless we couldn't discriminate between MSE for digits and number; it would be interesting to build a MSE scale for false memories, in order to better understand the MSE and false memory relationship.

The second interaction effect was on critical lures recall. In the decreased self-efficacy condition there were significantly more critical lures than in the two other conditions (increase and control). We demonstrated that decreasing/increasing self-efficacy feedback procedures induced a substantial changing of sensitivity (*d'*), while no significant difference was observed in the criteria. As predicted, subjects assigned to decreasing groups exhibited a worse performance in the last block, unlike the increasing group. Decreasing MSE feedback probably induced people to believe that they were not able to improve their memory performance giving rise to a worse DRM performance. On the other hand, increasing feedback induced people to believe in themselves and to maintain their performance. We cannot explain which types of feedback (positive/negative) better influenced memory performance in DRM tasks because no difference between the control group and experimental group was found. However, the significant difference in sensitivity, between decreasing and increasing self-efficacy groups, is congruent with some evidence from previous research, showing that low MSE is associated with low willingness to expend mental effort and with high cognitive anxiety, both of which reduce the amount of processing resources available for performing a task. Our results can be explained when considering that the differences in sensitivity depend on different degrees of cognitive effort in the increasing and decreasing groups. Indeed high MSE consists in greater effort expenditure, greater persistence in the face of difficulties, higher performance goals, and lower state anxiety, which, as we showed, reduce DRM illusion propensity.

Coherently with McDougall and Kang (2003) statement, that memory self-efficacy may or may not predict performance, depending on the congruence between predicted memory tasks and the memory tasks actually performed, in our study the feedback influenced recall performance, but not recognition and WM performance. Future research could consider replicating this experiment using feedback on recognition, also in order to extend the results of the first study that showed a significant effect of MSE on confidence ratings of critical false recognition.

***General discussion and conclusions***

We investigated an uncharted question: can the memory self-efficacy affects the production of false memories?

In study 1, we found that MSE is related to WM and false memory. Moreover, the tendency to produce false memories in recall is predicted by a meta-memory component: the MSE. Indeed, coherently with SE theory (Bandura, 1997), we speculate that people who had a resilient self-efficacy were those who engaged more resources and utilized more effective coping strategies. Berry (1996) demonstrated that enhancement of memory performance depends on enhancing efficacy beliefs, which in turn increases resource allocation and the cognitive effort needed for deeper levels of cognitive processing (i.e., elaborative and associative coding and mental rehearsal). In turn, these beliefs are thought to lead to less effort expenditure, less persistence in the face of difficulties, lower performance goals, and higher anxiety during memory tasks, all factors that may lead to poorer performance on memory tasks (Bandura, 1989; Berry, 1999). Our results support this hypothesis.

We believe that the experimental procedure used in the second study significantly influenced the recall task, because, as the cognitive consistency theory predict, feedbacks motivated subjects to reduce perceived discrepancies between their MSE and their perceived performance (Abelson et al., 1968), which in this case was strongly influenced by the feedback that we provided, in that specific memory domain (Bandura, 1997).

Considering DRM performance, the interpretation of our findings is most consistent with the FTT of false memory. According to this account, more false memories in decreasing MSE group occur because of a more comprehensive gist recollection strategy that the first group assumes in order to improve their disappointing memory performance. Significantly, this strategy had no consequences on the recollection of presented words because it depends on verbatim trace.

On the contrary, we think that the AMT does not explain our findings as well as

FTT. The reason is that in this case a more liberal monitoring decision criterion (Miller, 2011) in decreasing MSE should have produced more false memories but also more correct recall, resulting in a significant difference of the criterion parameter $\beta$ between the two experimental groups. However, that is not what we observed.

The only way to explain our findings, using the AMT, is pointing out that MSE influenced both activation and monitoring processes. Nevertheless, it seems not so plausible to us that a metacognitive process could influence an automatic process, as the spread activation, in so little time and just after two feedbacks.

To conclude our two studies together coherently show that the level of MSE for words is related to memory performance in DRM tasks and that it has a causal effect on memory performance.

In the future, new researches will be required which improve the experimental procedure aimed at assessing other possible feedback effects on the DRM task or other memory tasks; certainly other false memory paradigms based on episodic memory (e.g., the misinformation effect: Loftus, 2005; and imagination inflation: Garry, Manning, Loftus, & Sherman, 1996; Mazzoni & Memon, 2003).

### *Limitations of the present research*

A limit of this study is the lack of a BAS index for recognition distracters and Italian DRM lists, due to lack of a sufficiently wide corpus of associative norms in Italian.

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**Notes**

1. Subjects were randomly assigned to one of three groups. Two groups of participants (experimental conditions) received two types of feedback on their performance. The control group did not receive any feedback. The information contained in the feedback was independent from the real performance in the DRM tasks. In the experimental high MSE group, subjects were told that their performance ranked at the 75.3 percentile, while in the low MSE experimental group subjects were told that their performance was low (i.e. 24.7 percentile). Self-efficacy theory suggests that in order for information to be persuasive it needs to come from an authoritative source; for this reason the subjects were told at the beginning of the experiment that the memory performance would be computed using a program. Indeed, during the recognition task, the experimenter acted as if recall data was being entered into data software in order to compute memory performance even though real performances had nothing to do with the feedback that was presented. Feedback needed to be very specific (containing a decimal) because a specific score is more credible, and it seems more plausible than generic information. Furthermore, the

second type of feedback was more coherent than the first. If participants were told that their score was 75.3% during initial feedback, subsequent feedback mentioned that their performance was 79.7% (increasing MSE). Conversely, if the initial feedback reported 24.7%, then it was reduced after the second block to 20.3% (decreasing MSE). Considering previous studies that induced changes in the sense of self-efficacy through feedback (Litt, 1988; Jacobs, Prentice-Dunn, & Rogers, 1984), we assumed that this score oscillation was sufficient to induce a change in self-efficacy and at the same time provided plausible and credible information (only two subjects said they did not believe the information provided by the experimenter; they were eliminated from the data set).

2. The first result was computed subtracting the z mean score of critical (false) recall from the z mean score of hits. The criterion was also calculated as the ratio between the z mean scores of hits and critical lures ($\beta = z_{hits} / z_{criticallures}$) and indicated the choice of recalling a word that could be a false memory (Heit, Brockdorff, & Lamberts, 2004).

# Appendix

**Critical words and 15 words of english DRM lists.**

ANGER: mad, fear, hate, rage, temper, fury, ire, wrath, happy, fight, hatred, mean, calm, emotion, enrage
CHAIR: table, sit, legs, seat, couch, desk, recliner, sofa, wood, cushion, swivel, stool, sitting, rocking, bench
CITY: town, crowded, state, capital, streets, subway, country, New York, village, metropolis, big, Chicago, suburb, county, urban
MOUNTAIN: hill, valley, climb, summit, top, molehill, peak, plain, glacier, goat, bike, climber, range, steep, ski
MUSIC: note, sound, piano, sing, radio, band, melody, horn, concert, instrument, symphony, jazz, orchestra, art, rhythm
NEEDLE: thread, pin, eye, sewing, sharp, point, prick, thimble, haystack, thorn, hurt, injection, syringe, cloth, knitting
RIVER: water, stream, lake, Mississippi, boat, tide, swim, flow, run, barge, creek, brook, fish, bridge, winding
RUBBER: elastic, bounce, gloves, tire, ball, eraser, springy, foam, galoshes, soles, latex, glue, flexible, resilient, stretch
SLEEP: bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy
SLOW: fast, lethargic, stop, listless, snail, cautious, delay, traffic, turtle, hesitant, speed, quick, sluggish, wait, molasses
SMOKE: cigarette, puff, blaze, billows, pollution, ashes, cigar, chimney, fire, tobacco, stink, pipe, lungs, flames, stain
SWEET: sour, candy, sugar, bitter, good, taste, tooth, nice, honey, soda, chocolate, heart, cake, tart, pie
THIEF: steal, robber, crook, burglar, money, cop, bad, rob, jail, gun, villain, crime, bank, bandit, criminal
TRASH: garbage, waste, can, refuse, sewage, bag, junk, rubbish, sweep, scraps, pile, dump, landfill, debris, litter

*(fromStadler, Roediger& McDermott 1999)*

**Critical words and 15 words of italian DRM lists.**

RABBIA*: furioso, paura, odio, sdegno, malumore, furore, ira, collera, felice, lotta, arrabbiato, avversione, meschino, calma, emozione, imbestialire.
SEDIA*: tavolo, sedersi, gambe, sedile, divano, scrivania, pieghevole, sofà, legno, cuscino, girevole, sgabello, seduto, poltrona, panchina.
CITTÀ*: cittadina, affollato, stato, capitale, strade, metropolitana, paese, Roma, villaggio, metropoli, grande, Milano, sobborgo, contea, urbano.
MONTAGNA: collina, valle, salita, cima, colle, picco, pianura, ghiacciaio, capra, bicicletta, scalatore, alta, scosceso, sciare.
MUSICA*: nota, suono, pianoforte, cantare, radio, banda, melodia, corno, concerto, strumento, sinfonia, jazz, orchestra, arte, ritmo.
AGO*: filo, spillo, occhio, cucire, acuto, punto, puntura, ditale, pagliaio, spina, ferita, iniezione, siringa, tessuto, maglia.
FIUME*: aqua, torrente, lago Tevere, barca, marea, nuotare, flusso, corrente, chiatta, affluente, ruscello , pesce, ponte, sinuoso.
GOMMA: elastico, rimbalzo, guanti, pneumatico, palla, cancellare, molla, gommapiuma, galosce, suole, lattice,colle, flessibile, estendere, allungare.
SONNO*: letto, riposo, sveglio, stanco, sogno, svegliare, pisolino, coperta, sonnecchiare, assopito, russare, siesta, pace, sbadiglio, sonnolento.
LENTO*: veloce, inerte, fermo, svogliato, lumaca, prudente, ritardo, traffico, tartaruga, esitante, velocità, rapido, pigro, attendere, piano.
FUMO*: sigaretta, soffio, accendino, nube, inquinamento, cenere, sigaro, camino, fuoco, tabacco, puzza, pipa, polmoni, fiamme, macchia.
DOLCE*: acido, caramella, zucchero, amaro, buono, sapore, dente, goloso, miele, lievito, cioccolato, cuore, pasticcino, crostata, torta.
LADRO*: rubare, rapinatore, truffatore, scassinatore, denaro, poliziotto, cattivo, scippatore, carcere, pistola, furfante, criminalità, banca, bandito, criminale.
SPAZZATURA*: immondizia, rifiuti, bidone, pattume, liquame, busta, rottami, scarti, spazzare, frammenti, cumulo, scaricare, discarica, detriti, sporcizia.

*Used in the second study too.