Memory distortion and false memory creation – a review on recent research*

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Abstract: In this article we review recent research on the field of memory study, particularly regarding memory distortion and false memory creation. Parting from the models that considerate memories in a static Aristotelian way, passing through connectionist and reconstructive models and finally anchoring our paper in the so called Deese-Roediger-McDermott (DRM) paradigm we trace some considerations about research data that support the idea that a memory of a given event (the mental representation about something previously processed, encoded, stored and recalled to mind) could not always directly represent an originally encoded event. More than that, there is strong evidence that suggest that the way that information is provided (visual, aural, internal, external, etc.) or questions are made (in several settings — *e.g.*: school, testimony, therapeutic anamnesis, etc.) could happen a bias in the accuracy of recall and degree of certainty of a given occurrence, whether it is real, invented or even impossible.
Even though the implications of the studies from the Deese-Roediger-McDermott paradigm to applied fields (such as false memory creation in therapy) are difficult to determine, the results are very important for the study and understanding of the false memory and distortion phenomenon.
The relevance for memory research field, learning processes, therapeutic interventions, and judicial matters as testimony and witnesses' inquiry are also discussed.
Key words: memory distortion, false memories, memory creation

Resumo: Neste artigo apresentamos uma revisão acerca de pesquisas recentes no campo do estudo da memória, particularmente relativo à distorção de memórias e criação de memórias falsas. Partindo de modelos que consideram a memória de um modo Aristotélico estático, passando por modelos conexionistas, bem como sendo fruto de um processo reconstructivo com base em informação previamente codificada, e reflectindo finalmente acerca do denominado *"Deese-Roediger-McDermott (DRM) paradigm*" tecemos considerações acerca de dados de investigações que suportam a ideia que a memória de um determinado evento (a representação mental de algo previamente processado, codificado, armazenado e evocado) nem sempre pode ser conceptualizada como a representação directa de um evento originalmente codificado. Mais ainda, há evidências fortes que sugerem que, dependendo do modo como seja

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apresentada a informação (visual, auricular, fonte interna, fonte externa, etc.) ou como sejam feitas as perguntas (em várias situações — *e.g.*: escola, testemunho, anamnese terapêutica, etc.) isso pode introduzir um viés na precisão de evocação e grau de certeza de uma determinada ocorrência, seja esta real, inventada ou até mesmo impossível de todo.

Embora as implicações dos estudos do paradigma de Deese-Roediger-McDermott para campos aplicados (como criação de memórias falsas em terapia) seja difícil de determinar, os resultados são muito importantes para o estudo e compreensão do fenómeno de criação de memória falsas e / ou distorcidas.

A relevância para o campo da investigação em memória, processos de aprendizagem, intervenções terapêuticas, e aspectos judiciais como testemunhos e interrogatórios são também discutidas.

Palavras-chave: distorção de memórias, memórias falsas, criação de memórias

1. Introduction

Many people believe that human memory is a passive and literal recording of reality (Fernández & Díez, 2001). From this point of view, the only problem to recover previously encoded memories would be that the trace faded and, thus, the memory is not anymore available (Diges, 1997). However, since the beginning of the century many authors, such as Binet (1900, in Diges, 1997) or Musternberg (1908) have suggested a more active nature of memory. In 1932, Bartlett studied memory recollections in a more systematic manner and concluded that memories were imaginative reconstructions of past events heavily influenced by previous knowledge (Schacter, 1995). He also described how, with the passage of time, memories become more schematic: the general form is kept the same, but some details are omitted and others are changed for more stereotypical or familiar ones (Cabaco & Crespo, 2001). Later, other models have emphasized the idea of memories as 'complex reconstructions' (Schacter, 1995). For instance, connectionist models emphasized how the output of memory always contains some influence from previously stored material. They argued that it is impossible to have a memory that corresponds exactly to a réplica of the original encoded event (McClelland, 1995). The enhancement of memory when new learning material is associated to previous knowledge is explained by this connectionist view. As well, these models provide a very useful explanation to account for the distortion that all memories are subject to due to preexisting material. The possibilities of distinguishing veridical and distorted memories are remote, according to these models. The constructive nature of memory, described by Bartlett and later models, makes it clear that there is another memory phenomenon to worry about, besides forgetfulness, and that is memory distortion. When distortion occurs, memories do not correspond exactly to the originally encoded event, either because some details are inaccurate or because the whole event is new (Diges, 1997; Fernández & Díez, 2001).

However, as Schacter (1995) proposed, "the key issue is not whether memory is 'mostly accurate' or 'mostly inaccurate'; rather, the challenge is to specify the conditions under which accuracy and distortion are most likely to be observed" (p.25). In order to fulfill this goal, we are going to describe first some studies to show

how memory is less accurate than what people usually think it is. Memory biases are a good example of how the retrieval situation and our expectations may distort our memories in a significant manner. In other cases, we experience emotionally arousing events that seem to stick in our memory and remain unchangeable. The vividness and richness of details of these memories give an impression of accuracy that often does not correspond with reality. At the end of this first section, studies on some controversial therapeutical techniques are reviewed. In this case, the source of the distortion would be external instead of internal to the person.

The second section introduces the experimental creation of false memories. After a brief description of the predecessors of this area of study, the pioneer studies on 'misleading information effect' are reviewed, as well as the hypotheses proposed to explain it. These first studies consisted on changing some details in the memories of events that the participants actually saw by means of suggestion (misleading information). In later studies, the goal was not anymore to change details of experienced events, but to implant the memory of an event that never happened to the participant. The implanted events were either childhood events that never happened to the participants (such as getting lost in a shopping mall) or events that could not happen at all (such as shaking hands with Bugs Bunny in Disneyland). Finally, the possibility of creating new memories without any external suggestion is explored. The Deese-Roediger-McDermott (DRM) paradigm is introduced and some results obtained with it are presented.

2. Memory distortion

When a person is very confident about a memory and this memory is very vivid in details, most of the people do not doubt that the person's recollection is accurate (Schacter, 1996). However, it has been shown that confidence and vividness of details are not good predictors of accuracy (Diges, 1997; Schacter, 1995).

A good example of this lack of correlation is the case of John Dean, a worker of the White House during Nixon's presidency. His memories about the cover-up of Watergate were so rich in details, and he was so confident about them, that he started to be called the'"human tape recorder", referring to his extraordinary ability to remember accurately every single detail from those conversations with the president. However, when actual tapes of the conversations described by John Dean were found and compared to his testimonies, it was made clear that his memories were not as accurate as people initially thought. This case showed how people generally keep a very good memory for the gist of the events compared to the details and, also, how confidence and richness of details of the memory are not good predictors of its accuracy (Diges, 1997; Fernandez and Diez, 2001; Schacter, 1995, 1996).

2.1. Memory biases

When trying to recall how we used to think years ago, we systematically remember our past attitudes as closer to our current ones than what they really were. For instance, in a study described by Schacter (1996), participants were asked to rate their attitudes toward some social issues. These ratings were collected twice for the same sample, with a 9 years interval between them. The second time,

in addition, the participants were asked to indicate what their attitudes were the first time they were asked. The results showed how estimations of their past attitudes were closer to their current attitudes than to their actual past ones. In other words, "memories of past impressions and feelings were filtered through, and made consistent with, current impressions and feelings" (Schacter, 2001, p. 141). However, this retrospective bias does not always act to preserve consistency. In other cases, we bias the information to match our expectations of change. For instance, after completing a self-help program, people expect a change to happen. Even when the program is not effective, participants may rate their previous skill level as lower than what it really was, perceiving a skill improvement due to the program.

In general, people have a tendency to distort reality in a healthy and optimistic way in order to enhance their self-worth (Schacter, 1996). The 'self-enhancing memory bias' is a tendency to remember better positive than negative things about one's past. The lack of this bias in depression and anxiety disorders makes these patients attend to and remember more negative information (for depression) or threatening stimuli (for anxiety), and this leads to and maintains the respective disorders. This can also be explained by a more general memory bias, the 'mood-congruent bias', which makes individuals show attentional and memory biases for information that is consistent with their emotional state (Mineka & Nugent, 1995). Other memory biases described by Schacter (2001) are: hindsight and stereotypical biases. The former refers to the pervasive influence of current knowledge in the recollections of past events. Basically, it states that "once we learn the outcome of an event, we feel as though we always knew what would happen" (Schacter, 2001, p.146). This bias is very typical of contexts such as sports or political elections, where we always 'knew' who was going to win or be elected (but after we already know the outcome). The stereotypical bias refers to the way we distort our memories in order to make them fit with our previous beliefs. It is specially interesting to learn that this occurs even in people that are not aware of holding certain stereotypes (Schacter, 2001).

2.2. Flashbulb memories

In 1977, Brown and Kulick (in Brewer, 1992) asked their subjects to recall events that occurred in the last 13 years. They found that 99% of the participants remembered the circumstances in which they heard about John F. Kennedy assassination. These authors coined the term 'flashbulb memories' to refer to the "memories for the circumstances of hearing about a highly surprising and consequential event" (p. 274). In their original article, Brown and Kulick described these recollections as being like a photograph, very resistant to forgetting and produced by a special biological mechanism that 'print' that image on one's memory. However, they never tested the accuracy of those memories by objective means, relying only on subjective impressions of the participants.

In order to investigate the accuracy of those 'flashbulb memories', Neisser and Harsch (1992) used the''Challenger explosion' as the material to remember. The reason why they selected this event was because, due to its characteristics, it was a potential source of flashbulb memories. The authors collected the versions of a group of students the morning after the explosion and they compared them to their recollections of the event 32 to 34 months later. Neisser and

Harsch concluded that flashbulb memories are not as accurate as Brown and Kulick proposed, even if they are vivid, detailed, and subjects show a lot of confidence about them. They also observed that, once participants included an error in their stories at the time of recall, those errors were integrated and remained in their memories. The unusual degree of retention over time of this kind of memories can be explained by known memory mechanisms, such as distinctiveness of the stimuli or a strong representation provoked by an intense emotion (Brewer, 1992). This explanation does not consider necessary a qualitatively different mechanism to explain this phenomenon.

2.3. Therapeutical techniques

There are some therapeutical approaches that consider the patients' current symptomology as caused by traumatic events occurred in their past. However, the memories of these events are often repressed by the patients and, thus, they may not be aware of them. Since these approaches consider the recovery of these memories as a necessary step in resolving the trauma that is provoking the symptoms, therapists make use of certain techniques to help their patients to recover them (Spanos, Burgess, Burgess, Samuels & Bois, 1999).

In addition, the therapists from these approaches usually believe in the accuracy of these recovered memories and do not consider that they are influencing them in any relevant manner (Lein, 1999). Nevertheless, there is no empirical evidence that support the accuracy of these recovered memories and, in many cases, the experimental data strongly suggest that the therapeutical techniques may promote suggestibility and, as a consequence, memory distortion (Diges, 1997; Schacter, 1996). Some of these techniques are hypnosis, guided imagery, or dream interpretation.

2.3.1. Hypnosis

If we were to think about hypnosis the way it is pictured in the movies, we would probably see it as a kind of 'truth serum'. We would believe that it provokes on people an uncontrollable urge to answer with veridical and accurate information to the questions of the interviewer.

However, empirical studies do not support this point of view. Otherwise, evidence demonstrates that hypnosis increases the amount of information recalled and the confidence of the subject in those memories, but it does not increase the accuracy of the recollections (Brown, Goldstein & Bjorklund, 2000; Diges, 1997; Roediger, 1996; Stocks, 1998). Actually, hypnosis creates a state in which the person is especially suggestible and more willing to label any mental experience as a memory (Schacter, 1995). These two characteristics make hypnosis especially prone to distort the memories of hypnotized subjects and it can help them to create whole new memories.

2.3.2. Guided imagery

Stocks (1998) defines 'guided imagery' as "a form of psychodrama in which the client achieves a relaxed state and then pictures scenarios suggested by the therapist" (p. 428). Some of the therapeutical approaches we alluded to at the beginning of this section use this technique as an aid in searching for presumably lost memories (Garry, Manning, Loftus & Sherman, 1996). In order to do so, patients are encouraged to imagine, for example, a sexual abuse situation that will supposedly help them to recover their own childhood memory of abuse.

Again, empirical evidence do not support the usefulness of this technique to recover accurate information. For example, Hyman and Pentland (1996) found that imagery increased true as well as false recall of childhood memories. These authors collected some real events from questionnaires completed by the parents of the subjects, and added a fictitious one for all the participants. This false event was: spilling the punch bowl on the parents of the bride during a wedding reception at the age of 5. In order to obtain the subjects' recollections about the events, they were interviewed 3 times in a single week, with a day interval between interviews. It is interesting to note about the results that the condition (imagery versus control) did not make a difference in the percentage of true events recalled. However, the experimental condition (imagery) produced a higher rate of false memories than the control did. The effect of imagining false events on memory has been called *imagination inflation* (Paddock, Noel, Terranova, Eber, Manning & Loftus, 1999; Garry *et al*., 1996).

Even though it is always difficult to extrapolate empirical results to the clinical field due to the differences between the two settings, the conservative criterion that most of the studies used for evaluating the effect of imagery on memory distortion does not restrain them from obtaining an important effect (Paddock et al, 1999; Paddock & Terranova, 2001; Hyman & Pentland, 1996)

Other results that suggest the power of this technique to create memory distortion are the greater effects found when working with childhood events compared to recent past ones (Johnson et al, 1988, cited in Garry *et al*., 1996) as well as the important effect of the perceived authority of the person that guides the visualization (Paddock & Terranova, 2001). When used in therapy, the guided imagery is usually used to recover childhood events, and the therapist is an important authority figure to the patient.

Imagining a false event repeatedly may make it difficult to be distinguished from a real memory. This reality monitoring difficulty is specially true for people with very good mental imagery abilities, since they are able to form more vivid images of the event (Hyman & Pentland, 1996; Paddock *et al*, 1999). Individuals with dissociative tendencies are also specially susceptible to these imagery techniques (Hyman & Billings, 1998). It seems that individuals who experience dissociations are "*more accustomed to integrating external information to their self-concept*" (p. 16) and, therefore, are more susceptible to commit source monitoring errors involving an experienced and a suggested event.

Another factor that influences reality monitoring is the plausibility of the event occurring in one's life. However, the important factor is not the objective plausibility of an event, but how plausible the person perceives it. This subjective plausibility can also be increased with imagination (Garry *et al*., 1996).

2.3.3. Dream interpretation

Some therapeutical approaches view dreams as a privileged way to access to unconscious information of the patient that is not accessible in a normal state. This view is based on the hypothesis that the symbolism of dreams has personal meaning and it can be representing, for example, repressed memories of unpleasant events that the patient does not permit to reach consciousness. Empirical evidence, on the other hand, suggests that the content of

dreams is normally incorporated from the immediately preceding day (Nielsen & Powell, 1992; cited in Stocks, 1998).

Our concern, however, is not whether dreams are representing the unconscious of a person or what happened the day before. What really interests us is whether the interpretation of a dream by the therapist can lead a patient to develop false beliefs about her past. Mazzoni, Lombardo, Malvagia & Loftus (1999) asked themselves the same question and designed a very intelligent experiment to test this possibility. In their study, participants filled out the Life Events Inventory (LEI), in which they rated the likelihood that certain events had happened to them during their childhood. The experimenters selected 3 items as critical, and 50 subjects that obtained low scores (less likelihood) on these critical items constituted the sample. The 25 participants assigned to the experimental condition were asked by another experimenter to participate in a supposedly unrelated dream and sleep study. Ten to fifteen days after completing the LEI, they participated in a 30 minutes mini-therapy simulation where a well-known clinical psychologist asked them to bring one or more dreams to be interpreted. All the dreams, independently of their content, were interpreted as meaning the occurrence of one of the critical events that the participants rated as unlikely. They were also said that, even if they could not remember them at the moment, it was probably due to the ability of our mind to bury unpleasant experiences and keep them away from conscious awareness. Ten to fifteen days after this dream session, the participants were administered the LEI again, and the ratings for the critical items were compared to the original one. The results showed a significant difference for 2 out of 3 items, suggesting that dream interpretation may lead to false beliefs about the past of the subjects.

These results strongly suggest that people are suggestible to the influence of the therapist in a setting similar to the clinical one. As Mazzoni *et al*. (1999) proposed, the differences between this situation and a real therapy would enhance even more this effect. Some of these differences are: greater need to find an explanation for distress in therapy, more sessions (repeated suggestion), and other elements with which the therapist also work in therapy, such as thoughts, feelings, or behaviors.

2.3.4. Other techniques: group therapy, journaling and drug therapy

Another therapeutical technique that can promote distortion and creation of new memories is group therapy. In these sessions, participants share their experiences with other members of the group. The support and understanding of other people in the same situation may be comforting. However, some therapists use it as a means to help patients recovering repressed memories of abuse (Schacter, 1996; Stocks, 1998). In these groups, a patient that has no recollection of any abuse in her past participates in group sessions where all the members are incest survivors and describe their experience. This situation may increase the confidence that they have had such an experience, which they initially denied. An increase in the plausibility of that event in their environment (Mazzoni, Loftus & Kirsch, 2001) and the social pressure of the group (Asch, 1951, cited in Pastor, 2000) seem to be important factors in provoking this phenomenon.

Journaling and the administration of certain drugs are also techniques used sometimes as a means to recover supposedly repressed memories. The former consists in "*having*

the client start with a central detail such as a feeling or an idea, and record in words the sensations and thoughts that arise" (Stocks, 1998). There is no evidence that supports the effectiveness of this technique recovering accurate memories, and some evidence suggests that it can create false memories (Stocks, 1998). Drug therapy (for example, with amytal) causes in the patients to relax and creates a desire to talk. However, its effects are very similar to hypnosis in that the subjects under the influence of these drugs are more suggestible than the control group.

3. False-memory creation

3.1. Brief history

One of the first psychologists to study how questions affect the memories of children was Binet (1900; in Diges, 1997 and Schacter, 1995). He presented children to different objects, testing later their memories for them in the presence or absence of misleading questions. He found an important effect of questions on the testimony of children. These data already suggested what is now well known: free recall promotes less complete, shorter, but more accurate testimonies, whereas questions promote more complete, longer, but less accurate ones (Diges, 1997). Stern (1910; in Schacter, 1995) was also interested in the effect of questions on the memories of subjects. In his studies, the experimenter staged an event in front of a class or a group and the observers were later asked about the event. He also obtained an important effect of questions on witnesses' testimonies.

Another important work in the history of memory distortion is the book written by Hugo Musternberg (1908): *On the Witness Stand: Essays on Psychology and Crime*, where he reviews some studies about eyewitness testimony. He demonstrated how different people show important inconsistencies in their testimonies when witnessing the same situation. He considered it very relevant for the legal field because of the important influence that eyewitness testimonies have on the final verdicts in court.

From a different perspective, Sigmund Freud is also an important reference in the study of memory distortion. When he postulated his first theory about repression (Seduction Theory), he described it as a mechanism that takes certain (traumatic) memories out of our consciousness without voluntary control. One of the characteristics of this first theorization was the assumption that repressed memories were kept intact in the unconscious and, in the event of undergoing certain type of therapy, were susceptible to be recovered in their original format (without being subject to any kind of distortion). However, Freud faced later many cases that made him doubt about the validity of his first hypothesis. In the second formulation of his theory, he proposed that the recovered memories by the adult do not correspond to real past events, but to childhood fantasies or confabulations. He also states that it is almost impossible to distinguish these fantasies from veridical memories (in Schacter, 1995; Roediger, 1996). For example, in 1910, he wrote about how, in the process of recalling childhood memories, "*they are altered and falsify, and are put in the service of later trends, so that generally speaking they cannot be distinguished from fantasies*" (quoted in Roediger, 1996).

The next group of important studies about memory distortion came from the Gestalt school (in Schacter, 1995; Roediger, 1996). Gestalt authors proposed that memories

were modified over time following the Gestalt laws of organization, such as the tendency of remember symmetrical forms. However, they obtained many inconsistencies in their studies and this trend was abandoned (Roediger, 1996).

A very relevant book for the field was Bartlett's *Remembering: a study in experimental and social psychology* (1932), often considered the first experimental study of memory distortion and false memory creation. It showed how people distort stories when they are instructed to remember them. Bartlett observed how subjects' previous knowledge affected their memories. Over time, subjects tended to recall shorter versions of the story in which some details were omitted and, what it is more important for us, others were added to make more sense of the story (rationalization). Even though these studies have not been replicated following the same procedure, and his methodology is susceptible to a lot of criticisms, the conclusions drawn from those experimental observations are widely accepted and Bartlett's work is now highly valued (Roediger, 1996). The main conclusion is that memory as well as perception, is a constructive process and as a consequence, memories can never be replicas of the external world (McClelland, 1995). However, Bartlett's work was not considered as relevant until the late 1960s and early 1970s with the raise of Cognitive Psychology, for which it is an important predecessor (Cabaco & Crespo, 2001; Roediger, 1996; Schacter, 1995).

Before the beginning of the systematic study of memory distortion, there were two more authors that provided important contributions to the field, working with lists of words. First, Deese (1959) created some lists of words semantically associated to a critical unpresented word. Shortly after the presentation of the lists, the participants were asked to recall the lists. The unpresented item was recalled with a high probability for some of the lists. Deese's study was ignored during the years following its publication until, in 1995, Roediger III and McDermott revived that methodology and added some extra features to it, originating a new paradigm *called Deese-Roediger-McDermott (DRM) paradigm*. In this case, the study gave rise to abundant research that will be covered later in the paper.

The second relevant author working with lists of words was Underwood (1965). He tested the recognition of words presented in the lists compared to words related to previously presented ones and to words with no association at all. He found that words that were associated to the originally presented ones were more likely to provoke false alarms than unrelated words. Furthermore, larger number of related words increased the probability of false alarms (Roediger, 1996; Schacter, 1995).

3.2. Post-event misinformation effect

3.2.1. Memory impairment hypothesis

Almost 30 years ago Loftus and Palmer (1974; cited in Diges, 1997) studied how the information a person receives after witnessing an event may affect or alter the original memory of the event. The fact that we commit a lot of errors in estimating amounts of time, distance or speed has been demonstrated since the beginning of the century (Musternberg, 1908). Loftus and Palmer investigated how different formulations of questions affected those estimations. They presented movies of traffic accidents to the participants and, after each one of them, they asked them to explain the accident and answer to some specific questions about it. The

manipulation consisted in changing the verbs used in the questions to refer to the collision; they supposed that the different verbs implied different gravity of the accident (for example, 'smashed into' implied a harder collision than''hit'). The results of this experiment showed that, even though the real speed of the cars (between 32 and 60 km/h) did not influence the estimations of the participants, the verb used in the questions had important and systematic effects. Furthermore, when one week later the subjects were asked whether they saw any broken glasses, the subjects that were asked with verbs that implied a more violent collision remembered more often the glasses than the ones that were asked with lighter verbs. It is important to note that the original scene did not contain any broken glass.

Loftus and Palmer's study already showed how "*leading questions can systematically alter memory reports*" (Schacter, 1995; p.13). However, it was not until 1978 that Loftus, Miller and Burns proposed a paradigm to study the effect of post-event information on the memory for the original event. These authors presented to the subjects a sequence of slides depicting a car accident. Among them, there was a critical one that was different for half of the subjects: for the first half, the car stopped in front of a stop sign and, for the rest, in front of a yield sign. The second part of the experiment consisted in a 20 item questionnaire that the subjects had to complete about the accident. This questionnaire contained a critical item that referred to the traffic sign in the car accident. In this case, half of the participants were asked with information consistent with what they saw in the slides, and the rest with misleading information (a stop sign instead of a yield, or vice versa). For the experiments 2 and 3, Loftus *et al*. (1978) included a third condition where no signal was mentioned in the questionnaire. The final part of the experiment consisted on a forced-choice recognition test. The participants were presented to a sequence of pairs of slides and they were asked to choose the one that did appear in the original presentation. The critical pair included both the original slide and a new one that contained the object suggested to each subject in the questionnaire.

The results obtained by Loftus *et al*. (1978) showed a poorer performance for participants in the misled condition compared to the rest of conditions. The explanation proposed by the authors is that, when new information is presented, this information is introduced in the representation of the accident, modifying it. An alternative hypothesis that the authors considered is that the participants accepted the misleading information, even though they still remembered what they saw in the first place. Later studies (Loftus, 1979; in McCloskey & Zaragoza, 1985) investigated this alternative by offering three options to the subjects in the forced-choice recognition test and asking them to report what their second choice would be, in the case the first one was wrong. The participants that chose the misleading information as their first option did not perform better than chance in their second guess. These results supported Loftus' hypothesis.

3.2.2. Coexistence hypothesis

The interpretations of the studies described above as indicative of impairment of the original memory due to the presentation of post event misleading information has been controversial. The first alternative interpretation proposed to account for the misinformation effect is the *coexistence*

hypothesis (Bekerian & Bowers, 1983, cited in Diges, 1997; Christiaansen & Ochaleck, 1983, cited in McCloskey & Zaragoza, 1985), which proposes that the original memory is not modified by the misleading information, but it merely renders it inaccessible.

Christiaansen and Ochalek (1983, cited in Diges, 1997) introduced a modification in the original paradigm used by Loftus *et al*. (1978) in order to evaluate this alternative hypothesis. This modification was introduced between the presentation of the misleading information and the recognition test and consisted in warning some of the participants about the existence of inaccurate details in the post-event information. The warning intended to help the participants regain access to the original information that, according to their hypothesis, was still available. Therefore, they expected the subjects in the misled/warned condition to perform better than the subjects that never received the warning but did receive the misleading information. Their results were consistent with their hypothesis.

Bekerian and Bowers (1983, cited in McCloskey & Zaragoza, 1985) also defended the coexistence hypothesis. They proposed that the recognition test used in previous studies (e.g. Loftus *et al*., 1978) made it difficult to access to the original memory, but failed to demonstrate that the representation was not there. They argued that the presentation of test items in a random order impeded the use of some cues that otherwise would help the participants to access to these memories. Instead, they proposed the use of a test that reinstated the original encoding environment more fully, presenting the items in the same order as they were originally encoded. They obtained that the order of the items in the recognition test had an effect on the performance of their subjects. Thus, the use of a *random order* test provoked a better performance of the consistent post-event information group compared to the misleading information group. In contrast, when using a *sequential order* test, the results showed no difference between both groups. Altogether with the study of Christiaansen and Ochaleck, these two studies constitute the main support for the coexistence hypothesis.

3.2.3. No effect hypothesis

McCloskey and Zaragoza (1985a, 1985b) proposed that misleading information had no effect on the original memory for the event. Thus, they disagreed with both the impairment and the coexistence hypotheses. They argued that previous studies did not use the appropriate procedures to test their hypotheses and, therefore, their conclusions could not be valid. In their alternative interpretation of previous results, they proposed two main reasons why participants performed poorer in the misled condition than in the control condition. First, the response bias of those participants that forgot the original memory but received misleading information. Assuming a similar amount of forgetting in both conditions, control subjects are expected to perform better (at chance) than misled participants. The misleading information would make them perform below chance, since their responses would be biased toward this erroneous information. The second reason was the tendency of some participants that remembered both to trust more the post-event information than their own recollections. According to the authors, these two reasons would explain previous results without the need of a memory impairment or inaccessibility hypothesis. McCloskey and Zaragoza (1985a, 1985b)

proposed a 'modified test procedure' to test their hypothesis. The difference with the original one was that the alternatives of the forced-choice test did not include the item introduced in the misleading information. Otherwise, the alternative to the original item was a new (never presented) item belonging to the same category as the original and misleading items. The results showed that the performance was always poorer for the misled group compared to the control when using the original test, but no difference was found with the modified test procedure. These results supported the hypothesis that the post-event information had no effect on the original memory.

The answers to McCloskey and Zaragoza arrived soon (Loftus, Schooler & Wagenaar, 1985; Belli, 1989; Tversky & Tuchin, 1989). For example, Loftus *et al*. (1985) criticized the absence of a misleading item as an alternative in the recognition test, arguing that it could lead to correct responses by guessing. If this was true, the sensitivity of the 'modified test' to detect the state of the original memory may be compromised. Furthermore, Loftus *et al*. (1985) criticized that the 'modified test' was not able to detect memory blends (where features from both the original and the suggested memories are blended into a single one). They also argued that the confidence of the participants on their memories for the misleading information observed in their experiments is hardly compatible with an interpretation of the misinformation effect as being provoked by the demand characteristics.

Nevertheless, the importance of McCloskey and Zaragoza studies for later research on misinformation effect cannot be denied. For instance, studies started to worry more about finding procedures to control the effect of the demand characteristics and response biases (Diges, 1997) that had been demonstrated to influence subjects' performance.

3.2.4. Source monitoring error hypothesis

Lindsay and Johnson (1989, cited in Diges, 1997) proposed an alternative hypothesis in order to explain why the subjects said that they actually saw the suggested details. They explained the post-event information effect by a source monitoring error in which 'people misattribute memories of suggested information to the wrong source, namely the original event' (Higham, 1998, p.267). This kind of error is more likely to happen if the sources of two memories are similar. For example, in most of the misinformation effect studies, the original and suggested details referred to the same semantic category, were presented relatively close in time, in a similar experimental environment, and often, by the same experimenter (Diges, 1997). The source monitoring error hypothesis would explain why misled subjects perform poorer than control subjects, independently of what the fate of the original memory is.

Lindsay and Johnson (1989, cited in Diges, 1997) evaluated the effect of including a source monitoring test in the procedure. This test required the subject to specify the source of each memory and decide whether the detail was (a) seen only in the visual scene, (b) read only in the narrative, (c) both seen in the visual scene and read in the narrative, or (d) neither read nor seen (Higham, 1998). Their results showed how misled subjects that were encouraged to monitor the source of the information performed at the same level as the control group, and better than misled subjects that were not encouraged to monitor the source. These results were

consistent with their hypothesis and suggested that source monitoring errors played an important role in the misinformation effect.

In another experiment by Lindsay and Johnson, described by Abeles and Morton (1999), the temporal sequence was modified. Thus, the verbal suggestions were given before witnessing the visual scene. The memory test was a written checklist with items from the visual scene and some distracters. The fact that this procedure also produced misinformation effect revealed that an impairment of the original memory is not necessary to explain it. Lindsay and Johnson, however, considered the possibility of integration of information from different sources (Abeles & Morton, 1999).

In conclusion, all four hypotheses presented in this section are supported by data and it is difficult to decide which one is most accurate. Even though the mechanisms underlying the experimental alteration of memories remains unclear, the overall results support the idea of human memory as being very malleable (Diges, 1997).

3.3. Complex childhood events

The misinformation studies attempted to change memory for details of an event that participants actually witnessed (Tsai, Loftus & Polage, 2000). However, those studies "*did not provide evidence that a false memory of a complete event can be created through recurring suggestions*" (Oakes & Hyman, 2000, p.48).

Loftus and Pickrell (as described in Fernández & Díez, 2001) designed the following study to explore this possibility. They told the participants that the purpose of the study was to examine how much detail they could remember about childhood events. The participants were given written descriptions of four different events that supposedly happened to them when they were between the age of four and six. Three of these had been confirmed as true childhood experiences by their relatives, whereas the other event was false (as confirmed by the family). This false event was the same for all the participants and referred to an occasion when the person had got lost in a shopping mall at the age of 5 (the description of the false event was made as realistic as possible). After the descriptions of the events, they were asked to write what they could recall about each one of them. If they could not remember anything, they were instructed to report:

'I do not remember this'. The interview was repeated twice in the following two weeks. By the third interview, the participants remembered 68% of the true events and, in addition, 25% of the participants recalled the false event, at least partially. Among the differences found between memories for true and false events, participants used more words to describe true memories than false ones and rated higher in clarity true events compared to false ones (Loftus, 1997).

Hyman, Husband and Billings (as described in Tsai, Loftus & Polage, 2000) used more bizarre events, such as spilling a punch bowl on the parents of the bride at a wedding reception or releasing the parking brake of a car and hitting something. The participants were interviewed three times (every other day) and were instructed to describe what they remembered about three to five events and, also, about the false event. The true and false events were obtained by the same procedure as in Loftus and Pickrell's study and, in this case, the subjects were said that the purpose of the experiment was to study how people remember shared experiences differently (Loftus, 1997).

In Hyman *et al*. study, the recall of true events increased from 89% to 95% by the third interview. The false event was not remembered by anybody in the first interview, but up to 25% of the participants remembered it by the third. This study showed how repeated suggestion can create false memories of never experienced events. Further study of this issue found that the responses of the participants to the initial interview predicted who was more vulnerable to create false memories. For example, Hyman and Billings (1998) showed the influence of relating the suggested event to self-knowledge on the creation of new memories. The fact that the participants who related the suggested information to self-knowledge were more prone to memory creation suggested that the construction of new memories is made "*by combining the false suggestions with true information from their pasts*" (Oakes & Hyman, 2000, p. 51). This would explain also the finding of Heaps and Nash (2001) that found that subjects rated false memories as more typical of their previous experience than true memories.

Hyman and Pentland (1996) suggested that these results imply that previous knowledge about to-be-created memories is necessary to successfully implant a memory. However, it seems possible that this self-knowledge may be suggested first in order to facilitate the creation of false memories, as would be the case of implanted memories of sexual abuse. In the same line, some studies proposed plausibility of an event as an important factor that influences the implantation of a memory (Pedzek"*et al*., 1997, cited in Mazzoni, Loftus & Kirsch, 2001). However, as Mazzoni *et al*. (2001) showed, the important factor to take in consideration is the perceived plausibility of the event and this subjective plausibility may be changed if the appropriate information is presented to the subject (in their case, they used narratives about the event). Nevertheless, in recent studies, Loftus states that "*one of the cleverest and most powerful techniques for implanting highly implausible false memories involve use of fake photographs*" (Loftus, 2003, p.232). In these cases, the plausibility is increased by showing the subject a photograph made up of a real photograph of himself and a relative, but in a situation that had never occurred (as confirmed by the family). With this technique, she reported that as much as 50% of the subjects recalled the false event, partially or clearly. The increase of the subjective likelihood of the occurrence of an event that often accompanies the increase of its plausibility has important implications in clinical and forensic contexts.

Heaps and Nash (2001) investigated the differences between recollections of true and false autobiographical memories. According to their results, true memories are rated as richer in recollective experience and as more emotionally intense than false ones. However, repeated rehearsal of false memories made them closer to true autobiographical memories, minimizing their differences. When this was the case, rememberers were reluctant to believe that their memories were false. Heaps and Nash's study also found less content related to the consequences of the event in false memories compared to true memories. In addition, the authors found a difference in the perspective of the imagery accompanying these memories. Thus, false memories were more likely to be experienced from the observer perspective, whereas true memories were characterized by a first-person experience.

3.4. Creation of impossible memories

Even though the studies described above already demonstrated the possibility of creating false childhood memories in healthy adults, the following studies reinforce this evidence by implanting impossible memories, either because they belonged to a period of life when it is not possible to have any memory (Spanos, Burgess, Burgess, Samuels & Bois, 1999) or because the event is not feasible in real life (Braun, Ellis & Loftus, 2002).

Spanos *et al*. (1999) were interested in studying how the use of hypnotic versus non-hypnotic procedures affected the creation of false memories. They administered some questionnaires to the participants and, after completing them, they were led to believe that their answers were being computer analyzed. However, all the participants received the same results, independently of their performance in the tests. They were said that they possessed a specific profile characterized by an "*insightful and intuitive cognitive style*" (p.205), which was largely determined by the stimulation received during a critical period: the first days after birth. The participants were suggested that they possessed this style because they were probably born in a hospital that hung "*swinging colored mobiles a few inches over the head of infants*" (p.205). They were said that they were going to be regressed to the first days after birth in order to confirm the hypothesis that they were early stimulated in the hospital. This regression was made either with a hypnotic procedure or with a non-hypnotic one. The responses of the participants were audio taped and analyzed to examine whether they recovered any memory of the day after birth and whether they recalled the suggested mobile. Fifty eight percent (58%) of the subjects reported memories from the day after birth in response to suggestion for age regression. Furthermore, up to 51% of the participants recalled the suggested mobile.

The interest of this study for our discussion lay on the nature of the memories that were implanted. These memories were supposed to belong to the first day after birth, which is a period from which adult recall of episodic memories is impossible according to what we know about infantile amnesia. Thus, these results show how impossible false memories can be created when an authoritative figure makes them plausible, the subjects are given information consistent with the false memory, and they are led to believe that the administered procedure will facilitate its recovery. This study has important clinical implications.

From a very different field, Braun *et al*. (2002) have recently investigated the effect of certain autobiographical advertisement on the memories of the observers. They hypothesized that if advertisers presented consumers with false information about their pasts, they could make them believe that those events had happened to them. In their experiment, the participants were showed an advertisement of Disney that made autobiographical reference to their past, inviting them to remember when they were in the thematic park and shake hands with Bugs Bunny. This information was absolutely impossible because Bugs Bunny is a Warner Bros. character that would never be in Disneyland. The results showed how 16% of the subjects receiving the false information recalled the event. Even though the effect is quite small, the conditions of the experiment (only one presentation to the advertisement and a character that is not representative of the specific park) suggested that real life advertisement using this strategy might have a larger effect. However, for the purpose of this section

what it is interesting in this study is the possibility of creating memories of impossible events.

d. *Deese-Roediger-McDermott (DRM) paradigm*

To this point, numerous examples of how external suggestion can affect memory have been presented, either by modification details of an event that actually took place (Loftus *et al*., 1978) or by creating a new memory of an event that never happened (Hyman & Billings, 1998). However, it is not always necessary to receive an external influence to distort our memories. The studies on flashbulb memories (e.g. Conway, 1995) and, especially, on memory biases (Schacter, 2001) have already suggested the possibility of memory distortion without any external suggestion. We can consider Bartlett (1932) as the first author that experimentally investigated the phenomenon of false memories (Roediger & McDermott, 1995), and he did not use any external suggestion. He observed how people usually store schematic versions of the stories they listen to and, when recalling, they reconstruct the event based on their previous knowledge. These reconstructions from a limited material often leads to distortions and even inclusions of new details that did not appear in the original event, but that are congruent with the experience of the person.

More recently, Schacter (1996) emphasized the relevance of the encoding process. Information may be added to memory in this stage and be recalled later as part of the original event. For example, the 'verbal overshadowing' shows how one's verbal description of a nonverbal stimulus (such as a face or a color) can impair subsequent recognition of the stimulus originally encoded. In these cases, "*an imprecise verbal description overrides a more precise nonverbal memory*" (Schacter, 1996, p. 102). Our expectations for a certain situation can also be incorporated into our memory. The strategy of associating the new incoming information with preexisting knowledge has been shown helpful in acquiring and retrieving new information. However, this association can sometimes lead to inclusion of false details in our recollections of stories.

As Roediger and McDermott (1995) pinpointed, most of the false-memory creation studies have used "*materials that tell a story*" (p. 803), such as slides or prose passages. This fact could lead us to believe that those complex materials are necessary to create false memories. Only two studies before Roediger and McDermott's used lists of words to study false-memory creation: Deese, in 1959, and Underwood, in 1965. Both studies are briefly described in the historical review, but Deese's study is especially interesting for us because of the conditions of his study. The use of lists of words as material of study and a single-trial, free-recall test did not restrain him from obtaining reliable and predictable intrusions (Roediger & McDermott, 1995).

Roediger and McDermott (1995) reintroduced and modified the paradigm used by Deese. They used in their study lists of 12 semantically related words critically associated to a non presented word (lure). An example of list could be: *bed*, *rest*, *awake*, *tired*, *dream*, *wake*, *snooze*, *blanket*, *doze*, *slumber*, *snore*, and *nap*, being the critical nonpresented word for that list *sleep*. The participants were presented to six lists of words aurally and, immediately after each one of them, they were instructed to write all the items they could remember from the preceding list (free recall test). The instructions specified that they must not write words when they

were not *reasonably* confident that they were in fact presented. After the presentation (and free recall test) of the six lists, they were given a recognition test to rate each item according to the confidence that it had been presented in the lists. For each of the six lists, the test included: two presented words, two words that were weakly related to presented words, two unrelated words, and the lure. The rating scale of the test had four points: 4 for *sure that the item was old*, 3 for *probably old*, 2 for *probably new*, and 1 for *sure that the item was new*.

Their results showed how the high level of free recall in single-trial and immediate testing. In addition, the participants falsely recognized the critical items nearly as often as they correctly recognized presented words. The confidence in these false recognition responses was very high.

This paradigm has given rise to abundant studies that have explored more in depth these first results. For example, Payne, Elie, Blackwell and Neuschatz (1996) confirmed the high confidence the participants have on their false memories. In one of their experiments, two different voices (masculine and feminine) presented the lists and participants were asked to indicate which one of them spoke the item they recognized as old in the test. Participants were willing to give this information to the experimenter and, during debriefing, they frequently refused to believe that the item they remembered was never spoken. Other evidence that shows the similarity between the subjective experience for presented and critical nonpresented items came from experiments that study the areas of the brain activated for each one of them. Schacter, Norman and Koutstaal (2000) described studies using brain imaging techniques in combination with this paradigm. PET and fMRI studies did not find significant blood differences between false and veridical memories. For both of them, the blood flow increased in the areas implicated in episodic retrieval. The only two different trends were: an increased activity in the left superior temporal area for veridical recognition, and an increased right anterior prefrontal blood flow for false recognition. These similarities found in the brain activity underlying correct recognition of a presented word and false recognition of nonpresented item present further evidence for a similar subjective experience of both memories.

Thus, Kellogg (2001) studied the effect of the modality of presentation and observed that false written recall of intrusions was lower when the original presentation was visual rather than aural. They hypothesized that this was due to the use of orthographic features in the visual conditions that were not available in the aural presentation. When orienting the aural presentation to ensure orthographic encoding, they were able to eliminate the differences, corroborating their hypothesis.

Payne *et al*. (1996) were interested on the effect of time on these memories. They showed how false recognition did not decrease over a 24 hours period, whereas correct recognition did. Furthermore, false recall did increase across successive recall tests. In another study, McDermott (1996) showed how false recall for the critical item increases one day after the encoding phase, whereas accurate recall level decreases. After a two day delay, false recall could even exceed veridical recall.

The attempts of some researchers to avoid the false memories created by the DRM paradigm have led them to conclude that '*this illusion of memory appears to be remarkably robust and little affected by the instructional manipulations*' (McDermott & Roediger, 1998). Multitrial study/test

procedures (McDermott, 1996) have been shown to reduce the effect of these memory illusions. However, even after studying five times the same lists, the intrusions could not be completely eliminated. McDermott and Roediger (1998) found another way to attenuate the effect. This time, the manipulation consisted in warning the subjects about the false recognition phenomenon and instructed to pay especial attention to detect it. Again, this procedure was successful in attenuating the effect. However, it did not permit the participants to perform accurately under these conditions. Hicks and Nash (1999) have tried to use source monitoring to reduce false recall in the DRM paradigm. Although they obtained a relative success when using internal-external source monitoring, the false recall was not reduced when the source monitoring affected either two external or two internal sources in nature.

Overall, the DRM paradigm has been shown to be useful in the study of false-memory creation. The high rate of false recall and recognition provoked by this paradigm facilitates studies exploring the differences between false and veridical recollections. In addition, the simplicity of the material permits more controlled manipulations than when more complex materials are used. Even though the implications of the studies from this paradigm to applied fields (such as false memory creation in therapy) are difficult to determine, the results are very important for the study and understanding of the false memory phenomenon. Furthermore, Roediger and McDermott (1995) suggested that it is relevant to consider that "*despite conditions much more conducive to veridical remembering than those that typically exist outside the lab, we found dramatic evidence of false memories*" (p.812). Thus, the fact that such a high false recall and recognition effects are found with lists of words, under conditions of intentional learning, with short periods of interval, with college students, and without any kind of external suggestions by the experimenter makes these experiments a very interesting referent to defend the existence and pervasiveness of false memories in our lives.

4. Conclusions

Most of the errors we commit are a kind of 'side effect' of an adaptive feature of memory (Schacter, 2001). Thus, for example, we have talked at various moments during the paper about how our ability to associate new incoming information with our previous stored knowledge may help us remembering better in most situations (McClelland, 1995). Furthermore, this ability is a necessary condition for learning. Most of the techniques to improve memory use this associative nature of memory to enhance the ability of people to learn new material and be more resistant to forgetting. Unfortunately, these associations with previous knowledge may also provoke errors in accuracy. Good examples of this effect are the high rate of false recognition that the presentation of associated words provoke in the rememberer (Roediger & McDermott, 1995) or the introduction of what we believe it is going to happen into the memory of what in fact happens (Schacter, 1996).

External suggestions and misleading information have been shown to influence somehow our memory for an event. The magnitude and characteristics of this change has been a controversial issue (Loftus *et al.*, 1985; McCloskey &

Zaragoza, 1985). However, at this point most of the researchers support that there is an effect of post-event information on our ability to remember the event, even if there is no consensus for the explanation (Diges, 1997).

This external influence is not only able to affect our memory for an event without personal significance by changing insignificant details. It has also been demonstrated to be capable of creating whole new memories that we will experience as real events that had occurred to us in our past (Tsai, Loftus & Polage, 2000). However, individual differences play an important role in modulating this vulnerability to external suggestions (Hyman & Billings, 1998).

Is it necessary that an external source influence us in order to distort our memories? Memory biases that most of us possess, and that preserves our self-concept, show that memory distortion does not require the influence of external source (Schacter, 2001). Is it possible to create whole new memories without external influence? The studies of Bartlett in 1932 showed how we reconstruct our memories from limited information that we have stored. This reconstruction is prone to different errors, including the addition of new details. However, the results of Bartlett and other researchers that have investigated the recall of stories (Schacter, 1996) demonstrated the existence of spontaneous distortion. However, it just suggested the possibility of creating spontaneous false memories. The paradigm of Deese, Roediger and McDermott (1995) seems to be more effective in demonstrating that false memories can be created in the absence of any external influence that promotes it. Previous knowledge can be considered as an internal suggestion that leads us to distort our memories.

Up to this point, we know that memory is not always accurate and that, whether due to external or to internal sources, memories are subject to distortion to the extent that it is possible to create a new memory that does not correspond to any real event occurred to the person. And why is this interesting? The research in the area of memory distortion and false memories has two main areas of application: legal context (Diges & Alonso-Quecuty, 1993) and clinical context (Brown *et al*., 2000). In the legal context, the studies in memory distortion provide information that is useful mainly for two different purposes. First, the investigation of the differential characteristics of veridical and false memories can be used to analyze eyewitnesses testimonies and determine how reliable they are. Even though research shows overlapping functions for the characteristics of memories for true and false events and there is no fail-proof test to distinguish between them (Pedzek & Taylor, 2000), the study of this area is useful in orientating the analysis of testimonies. For instance, the Reality monitoring model of Johnson and Raye (1989, cited in Diges & Alonso-Quecuty, 1993) proposes some characteristics that distinguish memories from an external (perceptual) source from those that have an internal source (such as thinking). The study of the conditions that promote false memories, as well as the ones that attenuate them, have also implications to the legal context. The knowledge about the conditions that promote the creation of false memories and distortion has been useful in developing interview techniques to obtain the most accurate information form the subject (Alonso-Quecuty, 1993, 2001). This is especially true when interviewing children that are more suggestible to external influence than adults

(Ceci, Ross & Toglia, 1987). The *cognitive interview* is a technique used for minimizing the influence of the interviewer when interrogating a witness. Basically, this procedure follows four techniques: cognitive reinstallation of the context, emphasis in recovery of all types of details, recall from different perspectives and recall from different starting points (Alonso-Quecuty, 1993).

The other field to which the study of memory distortion is useful is the clinical context. Numerous therapeutical approaches consider the recovery of supposedly repressed memories as a prerequisite for the patient to solve his problems. Furthermore, the recovery of memories of childhood traumas (e.g. sexual abuse) is considered as accurate by both the therapist and the client. Often the patients accuse their relatives based on this recovered memories (Loftus, 1995). Research from this area has shown that techniques used in these kinds of therapies are very suggestive (Garry *et al*., 1996; Mazzoni *et al*., 1999; Paddock *et al*., 1999; Spanos *et al*., 1999). In addition, it has shown that the memories are never free from distortion, even if it is possible to recover memories from a repressed state (Schacter, 1996). Thus, the area basically recommends the therapists to use less suggestive techniques and proceed in an informed manner (Paddock *et al*., 1999). When therapists are accused of malpractice and implantation of false memories in their patients, memory researchers may play a role in assessing the risks of the therapeutical techniques used (Loftus, 1995).

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