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Ph.D. THESIS ABSTRACT

Explicit and Implicit False Memories in Deese-Roediger-McDermott Paradigm and Misinformation Paradigm

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I.CHAPTER I. THEORETICAL BACKGROUND

1.1 Introduction and Research Question

1.1.1 Memory

"Memory is ... neither perception or conception, but a state or affection of one of these, conditioned by lapse of time. As already observed, there is no such thing as memory of the present while present, for the present is object only of perception and the future of expectation, but the object of memory is the past."

ARISTOTLE, 350 BC (as cited in Alberini, Milekic & Tronel, 2006)

Memory is one of the cognitive processes that has fascinated scientific knowledge since ancient times. One aspect that has aroused interest among those who have studied memory has been the identification and assumption of a definition. Analyzing the scientifical literature, we have noticed a large number of definitions to describe this complex process. In this paper we will operate with the definition proposed by Atkinson & Shiffrin (1968), used in most scientific studies. Memory is therefore the cognitive process through which information is encoded, stored and retrieved (Atkinson, Atkinson, Smith & Bern, 2002).

1.1.2 Memory Distortions

Human memory is not perfect. It can produce errors and complicate the cognitive process in various ways. Memory errors or memory illusions are called memory distortions, and can be categorized in different types. In the scientific literature, Daniel Schacter (1999) makes a synthesis of 7 distinct categories of memory distortions that he metaphorically compares to the 7 deadly sins, thus referring strictly to the imperfection of human memory. The 7 memory distortions proposed by Schacter (1999) make up 3 distinct categories, as follows:

• forgetting or **omission**, which includes 3 types of memory distortions – ephemerality, inattention, and blockage or lacuna;

• **commission**, which includes misattribution, suggestibility, and interference;

• **persistence**

(Schacter, 1999, 2021).

All of these errors have important implications for the self and self-image (Schacter, 2003).

Ephemerality is the type of memory distortion that refers to the effect of time on memory, more precisely the forgetting over time of certain details or events.

Distraction is also a form of omission memory distortion, which results in forgetting information due to a *lack of attention* to a stimulus at the time of its encoding or re-actualization (Reason & Mycielska, 1982, as cited in Schacter, 1999).

Blockage is another type of memory sin, and refers to the inaccessibility of information, although stored and deeply encoded, with attention focused directly on it.

Misattribution is another type of memory distortion, belonging to the category of commission errors. This can occur through the misattribution of the source of information (for example, we may remember a correct piece of information, but we mistakenly believe that we heard it on television when in fact we read it on social networks). It can also occur through the absence of a subjective memory (for example, we read information and we mistakenly believe that we perceived that information in sensory reality), or through the emergence of false memories, scientifically investigated through the DRM paradigm (Deese, 1959, Roediger & McDermott, 1995), in which words not presented in the acquisition phase are activated, and which are strongly semantically associated with the presented word lists.

Suggestibility is another form of memory distortion that refers to the memory error produced when the individual tries to remember a situation, receives a suggestions, afterwards incorporating those suggestions into his answer. Thus the answer to the memory test will be wrong or erroneous. The individual is not aware of the error, he believes that the suggestion is part of the answer (Loftus, Miller & Burns, 1978, as cited in Schacter, 1999).

The last type of memory error of commission, *interference (or bias),* refers to the error of encoding and re-actualization of past experiences, distorted due to current knowledge, expectations, beliefs, emotional states (Bartlett, 1932; Alba & Hasher, 1983; Bower, 1992; Ochsner & Schacter, 1999, as cited in Schacter, 1999).

The last, or the seventh sin of memory, noted by Daniel Schacter (1999), is *persistence*, which refers to the intrusive recall of unwanted images, emotions, and events. Opposite to the error of omission, when information is trying to be remembered, persistence occurs in post-traumatic or non-clinical stress, when one wants to forget or block memories but fails, so their constant and unwanted appearance is considered intrusive (Koutstaal & Schacter, 1997, as cited in Schacter, 1999).

1.1.3 False Memories

False memories are memory distortions that incorporate misremembered details of a certain event or even erroneously remember certain events that never happened (Roediger & McDermott, 1995). They are formed either by misremembering the source (Schacter, 1999), by suggestibility (Loftus, 1975), or by activating the unpresented word (Deese, 1959, Roediger & McDermott, 1995).

According to the categories proposed by Daniel Schacter (1999), they fall under the errors of commission, for example bias, misattribution or suggestibility, sometimes even persistence, which can explain Posttraumatic Stress Syndrome (PTSD).

False memory is considered in the specialized literature an illusion. Like any illusion, it is formed from a true memory, which eventually comes to incorporate erroneous details from internal or external sources, ultimately distorting the originally encoded true memory. The memory illusion can form at any of the three basic memory stages – encoding, storage, retrieval – and is measured as false memory.

In scientific context, false memories have been explored using two research paradigms, Deese-Roediger-McDermott or DRM (Deese, 1959; Roediger & McDermott, 1995) and Misinformation (Loftus et al., 1978). There are several scientific explanatory theories that underlie this concept. In this paper we will present the Activation and Monitoring Theory, the Implicit Associative Response Theory, or the Fuzzy-Trace Theory (General Idea Source Theory).

False memories can be explicit, that is, measured by explicit memory tests, or implicit, measured by implicit memory tests. They are based on the same investigative research paradigms, DRM and Misinformation, and the same scientific explanatory theories, the difference between them being strictly related to how the testing is incorporated in the design of the study.

1.1.3.1 Deese-Roediger-McDermott Paradigm (DRM) (Deese, 1959; Roediger & McDermott, 1995)

False memories have been studied and reported since the beginning of psychology as a science. Thus, Freud reports the false memories of a patient suffering from hysteria. She presented her repressed memories as true, but they were in fact the result of imagination and fabrication, as Freud claimed (Breuer, Freud, & Brill, 1990, as cited in Mendez & Fras, 2010). Frederic Bartlett (1932, as cited in Roediger & McDermott, 1995) is the one who brings important considerations on the mechanism of memory reconstruction. Their investigation method, that of reading and recalling the story "The War of the Ghosts" several times, resulted in false recall of the details of the story in his studies. However, his results could not be replicated in other scientific studies (Gauld & Stephenson, 1967; Roediger, Wheeler, & Rajaram, 1993, as cited in Roediger & McDermott, 1995), but they distinguished in the literature between reproductive memory and reconstructive memory. Reproductive memory refers to the reproduction of accurate information from memory, and is present in the case of specific and simple material (words, nonsense syllables), and reconstructive memory refers to the reconstruction of memorized information by filling in the existing gaps of information with imagined, therefore erroneous, details, and is found in the case of stories or material rich in meaning (Roediger & McDermott, 1999).

False memories have then been studied using sentences (Bransford & Franks, 1971, as cited in McDermott & Roediger, 1995), prose passages (Sulin & Dooling, 1974, as cited in McDermott & Roediger, 1995), slide sequences (Loftus, Miller & Burns, 1978, as cited in McDermott &

Roediger, 1995), film sequences (Loftus & Palmer, 1974, as cited in Roediger & McDermott), or word lists (Underwood, 1965, Deese, 1959, as cited in Roediger & McDermott, 1995). Finally, false memories were scientifically measured using word lists, which were originally lists of associated words (Underwood, 1965; Anisfeld & Knapp, 1968; Hintzman, 1988; as cited in Roediger & McDermott, 1995), or synonyms (Paul, 1979, as cited in Roediger & McDermott, 1995). The testing method was an explicit one, through the explicit recognition memory test.

Psychologist James Deese (1959) attempted to test false memories by free recall, using lists of words that were strongly associated with an unpresented target word. He observed that the unpresented words still appeared in participants' free recall results after only one presentation of the lists in a single session. This scientific study was received rather superficially by the scientific community at the time, until Henry Roediger & Kathleen McDermott (1995) resumed the procedure used by James Deese (1959), using free recall as well as recognition as a testing method. They obtained false memories of the unpresented target word with a frequency of 40% and 55% in two subsequent studies (Roediger & McDermott, 1995). Thus, a new paradigm for investigating the phenomenon of false memories is created, entitled, after the authors, DRM (Deese, 1959; Roediger & McDermott, 1995). This new DRM paradigm involves presenting lists of words that are strongly associated with each other and associated with an unpresented prototype word (also called target word, challenge word or critical word) in a single session, and then testing the memory of the presented and unpresented words. Testing can be explicit through free recall and/or recognition, or implicit through implicit memory tests, such as word root completion. The lists are made up of words that are strongly associated with each other and associated with a prototype word that designates the category of the list, but which is not usually presented in the encoding phase. However, its appearance in the participants' responses is observed in the testing phase, hence the appearance of false memory. This memory illusion is quite difficult to avoid, the effect being observed in hundreds of scientific studies, which attests to the robustness of false memories, but also of the DRM paradigm and its effect (Gallo, 2010).

The DRM paradigm, although criticized for lacking transfer to ecological validity, for example in the case of autobiographical memories (Gallo, 2010), helps to broadly understand the mechanism of human memory, just as visual illusion contributes to the knowledge of the phenomenon of perception (Roediger, 2006, as cited in Gallo, 2010). Its impact on the scientific literature has been enormous, with an average of one article published every two weeks after the appearance of Roediger and McDermott's article in 1995 (Gallo, 2006, as cited in Gallo, 2010). After 2006, its citation doubled, reaching over 5000 citations of the reference article for the DRM scientific paradigm (Deese, 1959; Roediger & McDermott, 1995). The importance and robustness of the paradigm is therefore verified and reinforced by solid scientific evidence. What does the DRM paradigm bring new and valuable to scientific research or why does it have such an impact? The answer is that the paradigm procedure is simple, easy to use, and brings concrete, quick, and easy evidence in the awareness of the existence of the phenomenon of false memories, every time it is replicated or used. It also strengthens the awareness of the particular function of memory to reconstruct, which is quite unusual for a test that includes word lists. In such a test, the expectation would be to observe the function of raw memory, that is, reproductive, and not constructive. But the DRM task shows that even the simplest and most basic tasks or assignments can bring to the surface the reconstructive function of memory (McDermott, 1995; Bernstein & Loftus, 2009; Johnsoon, 2006; as cited in Gallo, 2010). Thus, it has been used and taken up in studies of neuroimaging, neuropsychology, development, aging and individual differences, precisely because of the simplicity of use and the high degree of replicability of the effect of memory illusion (Schacter, Norman & Koutstaal, 1998; as cited in Gallo, 2010). The DRM false memory test therefore becomes a classic task for demonstrating false memories, just as the STROOP test is a classic form of demonstrating interference (Gallo, 2010).

The DRM paradigm (Deese, 1959; Roediger & Mcdermott, 1995) makes important contributions to the theoretical and applied development of false memories. From a theoretical point of view, it creates an understanding of the phenomenon of false memories at the cognitive and neuronal level, and from an applied point of view, it investigates the connection between the DRM illusion and autobiographical memories. Returning to the theoretical level, the DRM illusion has shown its robustness throughout many scientific studies, in which manipulations were made at the level of encoding, retention interval (delay), and types of memory testing. Despite these manipulations, the memory illusion appears in the participants' responses, thus demonstrating the power of automatic memory association processes. In addition, false memories are activated at all levels of development, and in all categories of the population, including those with neurological deficits. The DRM paradigm therefore underlines the very definition of false memory, that is, it shows that you can falsely remember something that you have not seen or something that did not actually happen. However, there have been challenges to the DRM illusion. One of them refers to the fact that the results could show a simple distortion or strategy of guessing the associated words (Miller & Wolford, 1999; as cited in Gallo, 2010). This criticism has been challenged, however, as scientific evidence shows clear indications that subjects do indeed remember the unpresented word through ‘remember’ judgments (Roediger & McDermott, 1995; Geraci & Mccabe, 2006; cited in Gallo, 2010). Clear evidence is reflected in participants' detailed responses to the Memory Characteristics Questionnaire (Mather, Henkel, &

Johnson, 1997; as cited in Gallo, 2010), which attributes false memory to a specific voice heard or a specific modality used by the experimenter (Payne, Elie, Blackwell, & Neuschatz, 1996; as cited in Gallo, 2010). Also, further evidence would be that the memory illusion persists even when its inhibition or elimination is desired, that is, when explicit warnings are given during encoding with the aim of eliminating the illusion (Gallo, Roediger, & McDermott, 2001; Neuschatz, Payne, Lampinen, & Toglia, 2001; as cited in Gallo, 2010). Moreover, in forced-choice tests, subjects have difficulty choosing between the studied and the unstudied prototype, or critical word. In addition, many studies have shown the existence of priming for prototype words in implicit memory tests, which occurs by association, and is very unlikely to occur through guessing strategies. Priming indicates that there is a mental representation of the prototype word, which is an important component of false memory theory (McDermott, 1997; cited in Gallo, 2010).

Also, in adults, who are more susceptible to developing false memories than emerging adults or children, their false memories being more pronounced, the robustness of their false memories is recorded even under experimental conditions of five repetitions of the DRM task (Kensinger & Schacter, 1999). Moreover, preventing participants from false memories after studying lists of associative words does not eliminate false memories, at most reduces them to the level of true memories (Gallo, Roberts & Seamon, 1997). In the DRM paradigm, the stimuli used can also be emotional. Thus, the associated words presented can be neutral, positive and/or negative. Moreover, states of sadness induced before the acquisition phase diminish false memories, because they lead to specific processing of the item, which reduces false memory in the same way as using the strategy of explicitly guided cognitive control (Storbeck & Clore, 2011).

Recent Research in DRM Paradigm (Deese, 1959; Roediger & McDermott, 1995)

In recent years, investigative studies using the scientific DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) have focused on different mechanisms that include conceptual and semantic similarity (Coane et al., 2021), the persistence of false memories and collective memory (Maswood et al., 2022), the correlation between theory of mind and false memories (Gatti et al., 2022), false memories in the case of scenarios (Děchtěrenko et al., 2021), or the effect of visual imagery on false memories (Robin et al, 2022). Moreover, in the same DRM paradigm (Deese, 1959; Roediger & McDermott, 1995), other recent scientific studies have investigated the relationship between insomnia and false memories (Malloggi et al., 2022), the relationship between sleep and false memories (Mak et al., 2023; Mak, 2024), built software programs generating DRM lists (Petilli et al, 2024), investigated the effects of working memory and emotion on false memories (Yuvruk & Kapucu, 2022), the mnemonic effects of insight on false memories (Du et al., 2021), or even the effects of true and false memories on decisions (Wang & Gutchess, 2024). In a 2021 study, Coane and collaborators compile a review of the concepts of association and similarity and their effects in the DRM paradigm. Similarity between items, defined as similar features of the items in terms of semantic properties, lexical associative properties, or structural properties (orthographic or phonological), contributes to the activation of the prototype word. Association between items, on the other hand, also activates the prototype word. The research question was which of the two can significantly activate the prototype word more strongly. Thus, in the experiments carried out, it was found that adding phonological items to semantic DRM lists, and vice versa, adding semantically associated words to phonological DRM lists, results in a clearly significant increase in false memories, even in the short term if we refer to the addition of phonological words to semantic DRM lists (Coane et al, 2021).

Association between items has always been considered a powerful form of learning that supports the recall of a second item, associated with the first (Roediger & Gallo, 2022). The fact that there are also processes of similarity between items that contribute to the formation of false memories appears to be reinforced in the literature and by manipulating the retention interval (Roediger & Gallo, 2022). But how is the appearance of false memories explained in perceptual tests? Researchers have developed the Fluency-Based Attribution Theory in this regard (Roediger & Gallo, 2003; as cited in Roediger & Gallo, 2022). This stipulates that, at the time of testing, participants imagine the critical word, probably in an effort to remember whether it was presented or not, which they then mistake as having been presented. The effect may be due to faster and more fluent processing of the critical word, given that it has already appeared imaginary. The process can also occur automatically or unintentionally (Roediger & Gallo, 2022). Another way to explain the occurrence of false memories in perceptual tests is through the concept of borrowed content, which offers as an explanation the fact that the properties of the studied words are found fragmented in the participants' mental representations, so when the formation of the false memory takes place, it is practically created from the activation of some of the properties of the studied items (Lampinen, Neuschatz, & Payne 1999; as cited in Roediger & Gallo, 2022).

What can reduce false memories? Some studies identify using pictures as items rather than words, or presenting lists visually rather than aurally. False memories can also be reduced by presenting DRM lists more than once, presenting them at an increased rate of time, or warning participants about the effect of false memories before testing (Roediger & Gallo, 2022). In conclusion, the DRM false memory research paradigm (Deese, 1959; Roediger & McDermott, 1995) represents a robust and powerful, scientifically validated measure of false memories. Of course, at the level of ecological validity, the question arises as to how impactful is the paradigm for the ecological contexts in which we live in? This question is important for the present work, which also aims to investigate the ecological impact of false memories using the DRM paradigm. Without direct evidence yet, we can still infer or assume that the DRM paradigm brings awareness to the fact that our memory system is imperfect, subjected to errors, and not all memories can be considered true evidence on their own (Roediger & McDermott, 1995). The paradigm for researching false memories that has strong ecological validity is that of Misinformation (Loftus, 1975; Loftus et al., 1978). A level of correlation was found between the DRM and Misinformation paradigms. Although small ($r= .12$, $p= .02$), it shows that the global discrimination ability is common to the two paradigms, which nevertheless involve different mechanisms (Zhu, Chen, Loftus, Lin & Dong, 2013).

1.1.3.2. Misinformation Paradigm (Loftus et al., 1978)

The misinformation effect refers to the emergence of false memories about a past event after the individual has been exposed to misinformation or erroneous suggestions (Loftus et al, 1978). The paradigm began to be explored with the studies of Elisabeth Loftus, who investigated the effect of words, more specifically verbs and prepositions, in questions on the subject's memory and perception (Loftus & Palmer, 1974). In the first experiment, the researchers showed participants a video of a car accident (the initial event), then asked them at what speed the first car *touched*, respectively *hit*, the second car. The change of verb had a significant effect on the subjects' perception, as the group with the verb "hit" responded with a higher approximate speed (40.8 km/h) than the group exposed to the verb "touched" (31.8 km/h). Moreover, participants who approximated the higher speed were more likely to answer "YES" to the question "Did you see any broken glass?" (Loftus & Palmer, 1974), even though no broken glass was present in the original video. The experiment was successfully replicated and cited in many other subsequent scientific studies. For example, in numerous experiments, the results showed that the way the question is phrased can distort the initial memory of the event, which indicates the function of reconstructing or altering the initial memory representation. When the question contains true or false presuppositions about the existence of an object in the original scene of the event, the possibility of incorporating that object into the account of the event increases (Loftus, 1975). The implications of these initial experimental studies are obvious and significant, both the practical implications for the legal system, for example, witness testimony, and the theoretical implications for the function of reconstructing memory (Loftus, 1975).

Researchers have gone further in exploring the phenomenon of false memories produced as an effect of misinformation, thus forming the *Misinformation paradigm*, which includes *three stages: presentation of the initial event, then presentation of incorrect information through questions, fake pictures, suggestions or false description, then testing the memory of the initial event.* Most participants respond with the erroneous information incorporated, thus creating false memories (Loftus, 2005). More recent studies show the effect of misinformation to be still present. Okado and Stark (2005, as cited in Loftus, 2005) show in countless scientific experiments the presence of the misinformation effect of up to 47%. Moreover, these researchers have also investigated the neural pathways of the misinformation effect and found that false memory can be predicted depending on the activation of these neural pathways. Predicting the effect of misinformation by investigating neural activity is further evidence of the existence of this phenomenon. The effect of misinformation can be contradictory, meaning it contradicts details from the initial memory of the event (the color of the car, the sign at the intersection) or additive, meaning it adds extra, false information to the information initially presented, for example what type of weapon the attacker had on him, when in fact he did not have a weapon (Stoll, 2021). The modality used as misinformation has an impact on the acceptance of false information, with research highlighting the role of the additive modality in faster and easier acceptance of erroneous information (Frost, 2000; Huff & Umanath, 2018; Moore & Lampinen, 2016;as cited in Stoll, 2021).

Knowing the existence of the effect of misinformation on memory for over 40 years, some obvious questions arise (Loftus, 2005). In the following, we will explore some of these questions.

a) When are people more susceptible or vulnerable to the effect of misinformation?

A first answer would be *when time is considered a factor* . Specifically, the time lapse between the initial event and the encoding of the erroneous information. If the length of time between the initial event and the receipt of the erroneous information is quite long, then the susceptibility of the individual to incorporate the erroneous information into the memory of the initial event increases, thus distorting the original true memory (Loftus & Hoffman, 1989, cited after Loftus, 2005). The time lapse can also be that between the receipt of the erroneous information and testing. The shorter the time between receiving the erroneous information and testing, the smaller the effect of misinformation can be (Higham, 1998, as cited in Loftus, 2005). Susceptibility to the effect of misinformation increases especially if a certain state is induced, for example when participants are sleep deprived (Frenda, Patihis, Loftus, Lewis & Fenn, 2014; as cited in Berkowitz & Loftus, 2018), when they are under the influence of hypnosis (Scoboria et al, 2002, as cited in Loftus, 2005) or when they have drunk alcohol (Assefi & Gary, 2002, as cited in

Loftus, 2005). Of course, internal factors can also contribute to the susceptibility of the effect of misinformation, such as the level of intelligence. *The lower the level of intelligence, the greater the vulnerability to the effect of disinformation* (Zhu, 2010; as cited in Berkowitz & Loftus, 2018).

Individual differences in susceptibility to the effect of disinformation also exist in terms of personality factors. *Openness and agreeableness* are two of the personality traits that correlate positively with susceptibility to the effect of disinformation (Liebman et al, 20002; cited in Nichols & Loftus, 2019). Susceptibility to the effect of disinformation is negatively correlated with some personality traits, such as *empathy and self-monitoring*. It seems that *if the level of self-evaluation is higher, then susceptibility to the effect of disinformation is lower* (Davis & Loftus, 2005, cited in Loftus, 2005). Also, the integration of the effect of misinformation is more prevalent in people who have a *higher capacity for imagination* (Cann & Katz, 2005; Eisen, Gomes, Lorber, Perez, & Uchishiba, 2013; Tomes & Katz, 1997; as cited in Nichols & Loftus, 2019) and in those with higher scores on the dimension of imagination ability in general (Tomes & Katz, 2000, cited after Nichols & Loftus, 2019). The degree of individual dissociation is also a predictor of the incorporation of the effect of misinformation into memory, as this dysfunction is associated with cognitive problems, including that of correctly establishing and monitoring the source (Eisen & Carlson, 1998; Eisen, Morgan, & Mickes, 2002; Hekkanen & McEvoy, 2002, Putnam; as cited in Nichols & Loftus, 2019). In terms of individual cognitive differences, *working memory correlates negatively with false memories* related to the effect of misinformation (Calvillo, 2014; Jaschinski & Wentura, 2002, cited in Nichols & Loftus, 2019). Our memory itself can modify our memories, that is, already stored information can influence the encoding or updating of new information, and vice versa (Loftus, 2003, as cited in Stoll, 2021).

The effect of misinformation is more prevalent in younger and older children than in adolescents and young adults or adults over 30 years of age. This emphasizes the role of cognitive processes, such as *attention*, in the emergence and maintenance of misinformation, since the attention of young children tends to be more easily distracted than the attention of adolescents and adults, who are already accustomed to cognitive tasks (Karpel et al. 2001; Davis and Loftus, 2005; as cited in Loftus, 2005). The effect of misinformation also appears in newborns (Rovee-Collier et al, 1993; as cited in Loftus, 2005), and even in animals, such as mice, pigeons (Harper & Gary, 2000; as cited in Loftus, 2005), or gorillas (Schwartz et al, 2004; as cited in Loftus et al, 2005). This is evidence of the nature of memory itself, which is by definition malleable and can be easily distorted due to this function of reconstruction and flexibility.

b) What are the factors that lead to false memories in the case of the disinformation effect?

The literature indicates *cognitive and socio-emotional factors*, in principle the same ones that lead to the formation of true memories (Ecker et al., 2022). The *familiarity factor, the group cohesion factor, the processing level factor,* are just a few of them. For example, in the case of conspiracies related to the SARS COV-II virus, approximately 31% of the US population believed them to be true, although they had not seen any real evidence of them (Uscinski et al, 2020; cited after Ecker et al, 2022). It seems that information, even if is false, if repeated several times, tends to acquire the aspect of familiarity, fluency of processing (a sign that the information is already encoded and processing is easier, without effort), and cohesion (a sign that the information has an internal equivalent, that is, it is already stored in memory), therefore to be considered as true (Fazio et al, 2019; Brown & Nix, 1996; De Keersmaecker et al, 2020; as cited in Ecker et al, 2022). Also, an informative title is believed more if it matches the way the reader perceives the world (Pennycook & Rand, 2021; as cited in Ecker et al, 2022). Intuitive thinking increases the likelihood that false information will be believed as true – for example, there was a correlation between intuitive thinking and the false belief that the Covid-19 virus does not exist, which explains the low adherence to public health measures (Stanley et al, 2020; as cited in Ecker, 2022). At the same time, when the reader is invited to judge the information they receive, based on prior knowledge, they can more easily decide whether the information is false, than when they quickly read the title and decide on the spot whether it is real or false (Brashier et al, 2020; as cited in Ecker, 2022). Another important factor is the source of the information, which if perceived as credible, then the information received will automatically be perceived as credible (Nadarevic et al, 2020, as cited in Ecker, 2022). People also believe information that comes from more attractive, powerful, and similar sources (Mackie et al, 1990; Graeupner & Coman, 2017; as cited in Eckert, 2022). The conveyed emotion or emotional content of information is another factor in making incorrect information credible and contributes to the emergence of the disinformation effect. What has been studied and scientifically proven as persuasive emotion includes *the fear of harm* (Tannenbaum et, 2015, as cited in Ecker, 2022), which leads to harm prevention behaviors, or *thoughts about happiness*, which are more credible than neutral thoughts (Altay & Mercier, 2020, as cited in Ecker, 2022). Emotion distracts the reader from the credibility of the source, and here we refer to both the emotion given by the content of the information and the emotion of the reader, such as *happiness or anger*. These lead to an increase in the effect of disinformation, *or the negative emotion induced by isolation, which leads to increased belief in conspiracies* (Forgas, 2019; Martel, Pennycook & Rand, 2020; Poon, Chen & Wong, 2020; as cited in Ecker, 2022).

c) What helps prevent the misinformation effect?

Warning participants that false information is coming may help, but warning them that false information has already been presented does not. Thus, if the misinformation warning occurs before the misinformation appears, the misinformation effect is considerably reduced, but not if this warning is given before testing, that is, after the misinformation has already occurred (Greene et al, 1982; as cited in Loftus, 2005). The explanation may be based on the same Discrepancy Detection Principle, which can occur before a stable memory trace of the false information is formed. If the trace is already formed, the mind has a harder time perceiving discrepancies, its only solution being to suppress the false information received, but which can be suppressed along with the trace of the true information, since the differences are not clear because both memories, true and false, have been formed (Eakin et al, 2003, as cited in Loftus, 2005).

d) What happens to the memory of the original event?

Over time, researchers have disputed this topic, and although some believed that the memory of the original event is rewritten with the encoding of the misinformation, it seems that the evidence leans towards the side that claims that *the original encoded trace remains intact, and the misinformation creates a new memory trace* (McCloskey & Zaragossa, 1985, as cited in Loftus, 2005). Subjects choose the altered response because they are misled or for other reasons, not because the original memory trace is affected by the misinformation. To demonstrate their theory, McCloskey & Zaragossa (1985) created a modified test in which, after the original event and the misinformation were presented, participants chose between the memory of the original event and an unpresented alternative response. Their responses included both the memory of the original event and the misinformation, thus activating both memory traces. The effect of misinformation was considerably reduced under such testing conditions, but small significant effects of misinformation were still recorded in other studies that replicated the modified test (Ayers & Reder, 1998, cited in Loftus, 2005).

A false memory in this paradigm looks and is expressed very differently from a true memory. Thus, participants use more words in describing the false memory, more explanatory words (I think I saw), with a protective role, and fewer sensory details. However, it may happen that such explanatory words also exist for some true memories, so that differentiating them from the true ones is quite difficult (Loftus, 2005). Some participants even come to believe that the false memory is a true one (even though they never saw the event), which led to the emergence of the explanatory effect in the scientific literature of misattribution of the source (Loftus, 2005). Of course, the size of this effect varies from individual to individual.

In the following, we will present the technique of measuring false memories called ″Lost in the Mall″, in the Misinformation paradigm, and the implications of the misinformation effect, for a more precise clarification of this mnesic phenomenon.

e)The Lost in the Mall Technique and the Disinformation Effect (Loftus, 1975)

False memories, created by suggestibility or the presentation of erroneous information about an original event witnessed by participants, *can also be implanted, created in the minds of participants.* The "Lost in the Mall" technique (Loftus, 1993, Loftus & Pickrell, 1995; as cited in Loftus, 2005) assumes precisely this idea. Participants receive the suggestion that at the age of 6 they got lost in a mall, and then were saved by an elderly person. The technique gives a completely different meaning to the disinformation effect, since not only the original memory of an event is altered, but a completely new false memory is created, which participants can completely believe it has happened. The name of the paradigm in this case is *the paradigm of rich false memories* (Loftus, 2004; as cited in Berkowitz & Loftus, 2018). Methods used to create new, completely false memories include repeated interviews (Loftus & Pickrell, 1995; Shaw & Porter, 2015; as cited in Berkowitz & Loftus, 2018), guided imagery (Goff & Roediger, 1998; Mazzoni & Memon, 2003; as cited in Berkowitz & Loftus, 2018), fake videos and photos (Nash & Wade, 2009; as cited in Berkowitz & Loftus, 2018), fake advertisements (Braun, Ellis & Loftus, 2002; as cited in Berkowitz & Loftus, 2018), fake newspaper articles (Otgaar, Candel, Merkelbach & Wade, 2009; as cited in Berkowitz & Loftus, 2018), or fake feedback (Bernstein, Laney, Morris, Gary & Loftus, 2008; as cited in Berkowitz & Loftus, 2018). The misinformation, coupled with suggestion, led participants to falsely believe that rather bizarre events had happened to them as children. These implanted false memories then influenced the participants' thoughts, decisions, and behaviors (Bernstein & Loftus, 2009; as cited in Berkowitz & Loftus, 2018).

f) The impact of misinformation in online cntext

Recent research on the effect of disinformation reveals its presence in online context as well. For example, during the Covid-19 pandemic, the abundance of false information online was overwhelming, which led to the creation of an infodemic, in which both correct and incorrect information is present. The effect of the infodemic on memory is widely discussed in the meta-analysis by authors Rachel Greenspan & Elisabeth Loftus (2020). The meta-analysis clearly stipulates that the effect of misinformation can have serious negative consequences, even in the online environment, including confusion related to basic health knowledge. Also as an effect of misinformation online, Greenspan & Loftus (2020) recall the perception of US residents about misinformation. They consider them to be more dangerous than illegal immigration, as there have also been cases of destruction of properties, such as 5G phone towers in Europe, after incorrect information circulated that they would contribute to the spread of the Covid-19 virus (Greenspan & Loftus, 2020). Moreover, new research also studies the effect of misinformation in the case of traumatic videos watched online, and the results show that the group of participants who received misinformation about the video, after watching it online, tend to confuse the initial information with the false one, even a few days after watching the video online (Sievwright et al, 2021). The effect of misinformation in the online environment also appears on social networks, and the concern of specialists is notable at a high level. They were trying to understand the cause of such a wide and rapid spread of incorrect information. The effect of disinformation appeared especially when false headlines were spread, but experts point out that sharing does not necessarily mean believing in the incorrect information found in headlines in online social media. Thus, people do not share incorrect information online because they are attentive to its accuracy, but out of a desire for communication or partisanship. On the contrary, if attention is directed to the accuracy of the information read in online social media, the effect of misinformation decreases (Pennycook et al, 2021).

g) Implications of the misinformation effect

The practical implications of research on the effect of misinformation are found in the forensic field (witness testimonies), public health (Covid-19 pandemic crisis), public policy (incorrect information about known political members that impacts social perception, and thus the direction of voting), science and the environment (Walter & Murphy, 2018). Attempting to correct the effect of misinformation has an average efficiency (r=.35), and it is more difficult to correct the effect of misinformation in a political context (r=.15), and marketing (r=.18), but easier in the health field (r=.27) (Walter & Murphy, 2018). The practical implications have drawn attention to this phenomenon, which, taking on such a large scale, has required the intervention of public institutions. These interventions included changes within the US legal system itself (Loftus, 2003; cited in Stoll, 2021), as false eyewitness memories led to wrongful convictions in approximately 70% of cases (The Innocence Project, 2021; cited in Stoll, 2021). As a solution to this problem, researcher Gary Wells (1978) proposed that scientific research clarify what specific factors are within the control of the legal justice system in the case of witness testimony, in order to make the procedure as fair and less distorted as possible. In 2014, this happened, a team of researchers and legal professionals was formed to clarify exactly what factors are within the control of the US legal system and that could distort eyewitness answers, such as questions from lawyers or the line-up procedure. *The team's recommendations included training law enforcement officers in the science of eyewitness memory, line-up repetition, double-blind* *identification procedures to prevent witnesses from receiving cues from law enforcement officers, and recording all witness statements (Berkowitz & Loftus, 2018).*

The theoretical and practical implications, both clinical and legal, also imply that the consumer, the individual consuming the information, plays an important role in correcting the effect of misinformation (Ecker et al, 2022). However, recent studies have shown that it is difficult to correct misinformation, as its effect persists even after the incorrect information has been corrected, a phenomenon called the persistence of the misinformation effect, which still has the same consequences, even at a reduced level, as the initial effect of the initial misinformation. So the confusion remains, and the obvious question is why. Recent studies offer as a possible explanation *the existence of an implicit message in the incorrect information, which does not disappear with its correction.* More specifically, the implicit message leads to additional cognitive processing, which has the effect of deeper activation of the incorrect information, therefore of the misinformation effect (Reynolds, 2020). Thus, we believe that an important future research direction would be the implicit aspect of false memories, not sufficiently widely explored scientifically.

1.1.3.3 Theoretical models of false memories

How do false memories develop? There are several theories that attempt to explain the genesis and mechanisms of false memories. The most well-known are: the **Implicit Associative Response View** (McDermott, 1996,1997; Roediger & McDermott, 1995; Roediger et al 1998; Underwood, 1965; as cited in Cabeza & Lennartson, 2005), the **Fuzzy-Trace Theory** (Brainerd & Reyna, 1990; Payne, Elie, Blackwell & Neuschatz, 1996; Schacter, Verfaellie & Pradere, 1996; as cited in Cabeza & Lennartson, 2005), and the **Activation Monitoring Framing Theory** (Gallo & Roediger, 2002; Roediger et al, 2001; as cited in Garfinkel, Dienes & Duka, 2006).

According to the **Implicit Associative Response Theory (IAR),** unpresented prototype words are generated explicitly or implicitly during the encoding of presented word lists, during the acquisition phase (Cabeza & Lennartson, 2005). Mental associations, which have explained psychological phenomena and mechanisms since ancient times, represent links between basic mental representations (Whitlow, 1992; as cited in Roediger et al, 1998). Starting from Aristotle's hypothesis that "the act of remembering is due to the fact that a movement has, in its nature, another movement that succeeds it in a regular form", until the emergence of connectionism (Rumelhart & McClelland, 1986; as cited in Roediger et al., 1998) which makes major contributions to the analysis of the power of associations between concepts, the scientific literature has been presenting associations as a basic form of memory formation and of the learning process.

New research shows a disadvantage of associative links between mental representations, concepts and cognitive schemas, which lead to the creation of false memories (Roediger et al, 1998). The conceptualization of the implicit associative response began to take shape in 1965, when Benton Underwood studied the strength of natural language associations between words. According to Benton Underwood (1965), the perception of a word can result not only from the activation of its meaning, its semantic representation, but also from the unintentional activation of a word that is associated and related to that presented word, therefore from the activation of its associated implicit response (Roediger et al., 1998). For example, when the word *Needle* is presented, not only its meaning is activated, but also words that are semantically associated or related in meaning to it. This implicit associative response leads to the formation of false memories and predicts their rate of occurrence (Underwood, 1965; as cited in Roediger et al., 1998).

In recent scientific literature, the key question arises whether those words related or semantically associated with that unpresented word (false memory) appear explicitly or implicitly in the acquisition phase in the participant's mind. Is the activation conscious or unconscious? The participant has the unpresented word consciously in mind and the error occurs when monitoring reality, or does the unpresented activated word appear unconsciously and unintentionally in the participant's mind? The results of scientific research provide evidence for both possibilities, both for the activation of the implicit associative response in an explicit way (Norman & Schacter, 1997; Read, 1996; Payne, Elie, Black-well, & Neuschatz, 1996; Schacter, Verfaellie & Pradere, 1996; Roediger & McDermott, 1995; as cited in McDermott & Roediger, 1998), but also implicitly (McDermott, 1997; as cited in McDermott & Roediger, 1998). The authors conclude that in the IAR theory false memories occur through the activation of the implicitly associated response, which participants are then aware of or not. During the testing phase, a breakdown in the reality monitoring process occurs, in which participants confuse perceived events with imagined or internally activated events in the absence of perception (Johnson & Raye; as cited in McDermott & Roediger, 1998).

Another explanatory theory of false memories is the **Fuzzy Trace Theory** (Braynerd & Reyna, 1990). The theory stipulates that during encoding two types of mental representations are created - the surface (gist), which incorporates a general understanding of the encoded stimulus, but is devoid of perceptual information, and the specific (verbatim), which incorporates perceptual details of the encoded stimulus. In the case of this theory, false memories are the result of surface processing, of the general semantic idea that is formed during the study of word lists, the logical deduction of the theory being that those critical words not presented contain only semantic, therefore conceptual, information, and not perceptual (which would be specific, and not surface). Studies of implicit false memories contradict this latter theory, since implicit false memories have been activated in several perceptual experiments (McKone, 2004).

For a better understanding of the Fuzzy-Trace theory, we will briefly describe the 7 basic assumptions from which it was formed. The *first assumption* refers to the fact that the mind extracts the general idea of the learned or encoded material, and assumes that the information is encoded sensorially, in the form of a general surface idea. This general idea represents the extraction of the essence from the encoded information, which can have several levels, depending on the specific information presented. Working memory can therefore contain both general surface information and specific information, and for each participant or subject different levels of the stored information are activated. *The second assumption* is that there is a continuum of accuracy and specificity of the stored information, from vague or general, in which the less relevant aspects of the encoded information also appear, to a specific and clear level, in which the specificity of the information, usually perceptual, is memorized. Working memory prefers specific information. *The third assumption* is that the mind prefers to process the fuzzy or general parts of the continuum, due to accessibility, availability, lack of effort, flexibility, processing complexity and easy parallel processing. *The fourth assumption* is that both short-term memory and long-term memory exhibit the reconstructive character of memory. What leads to the level of information reconstruction depends on considerations of the task (how pervasive it can be in reconstruction) and on endogenous factors of the specific and general encoded information. *The fifth assumption* stipulates that the response will always be accompanied by the interference of background information, irrelevant to the task, with the specific or relevant information, which in working memory needs to be sorted and then extracted as a response. *The sixth assumption* develops the idea of resource independence, so the fuzzy-trace theory does not explain the encoding and response of information based on the resources necessary for the mnesic process, but on the basis of the processes mentioned above. More specifically, the encoding-storage-retrieval process does not take into account, within this theory, the resources necessary for the mnesic process. *The last assumption, the seventh*, confirms that participants will differ in terms of the aspects discussed in assumptions 1-5, therefore the level of encoding and retrieval of the general or specific idea will vary from one individual to another (Braynerd & Reyna, 1990).

The last explanatory theory of false memories discussed in the present paper is the **Activation and Monitoring Theory** (Gallo & Roediger, 2002; Roediger et al., 2001). According to it, there are two processes that contribute to the formation of false memories, activation and monitoring. Processing of word lists in the acquisition phase activates the associated prototype word that was not presented, and the failure to correctly identify whether that word was or was not presented in the acquisition phase is due to the monitoring process. Activation of the critical word that was not presented can be automatic, unconscious (Seamon, Luo, & Gallo, 1998; cf. Collins & Loftus, 1975; as cited in Gallo & Roediger, 2002) or conscious (McDermott, 1997; Underwood, 1965; as cited in Gallo & Roediger, 2002). The disruption of the reality monitoring process or the error in monitoring this activation leads to the formation of false memories (Johnson & Raye, 1981; Johnson, Hashtroudi, & Lindsay, 1993; as cited in Gallo & Roediger, 2002). The important factor in this theoretical framework is the level of association between words ('backward and forward associative strength'), which becomes a predictor of the formation of false memories. Lists with low associative strength between words will activate fewer false memories than word lists with high associative strength (Gallo & Roediger, 2002). Thus, false memory may be due to the associative network of word list items, which then activates at test the unpresented critical word, strongly associated with the word list items initially presented in the acquisition phase (Roediger & McDermott, 1995).

1.1.3.4. Implicit false memories

Implicit false memories refer to memory distortions that do not require the intentional recall of false memory, but rather an automatic reflection of it (Graf and Schacter, 1985, cited in McKone & Murphy, 2000). There are clearly established differences in the scientific literature between explicit and implicit memory. For example, implicit memory remains intact in the case of amnesia, while explicit memory does not (Scovile & Milner, 1957). Extrapolating, those differences also exist between explicit false memory and implicit false memory. The most prominent difference is given by the type of memory test used. Explicit tests require conscious re-actualization of information from the acquisition phase, while implicit tests require unconscious or unintentional, automatic expression of the same information (Opre, 2012).

In the case of false memories, that is, information activated during encoding but not presented to participants, the types of testing have mostly been explicit, i.e. free recall or retrieval. Explicit tests require the intentional recall of words or information from the acquisition phase, and result in the intentional but false recall of the unpresented word or information, activated by word lists in the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) or suggested in the Misinformation paradigm. Metamnesic measures have also been used, in which participants are asked to make reflective judgments about the nature of their explicit memories, for example by rating their confidence in their responses, using the 'remember/know' procedure, or by exploring the source of the judgment (McKone & Murphy, 2000).

However, the literature also indicates scientific studies in which implicit memory tests were used to measure false memories. These tests verified the automatic, unintentional priming or activation of information from the acquisition stage, whether not presented or suggested. Most of the experimental data were obtained in the case of DRM paradigm (Deese, 1959; Roediger & McDermott, 1995). Kathleen McDermott used the implicit perceptual tests of word stem completion and word fragment completion to assess implicit false memories (McDermott, 1997). The results showed the presence of implicit false memories, the author suggesting that the priming of false memories occurs by presenting lists of associated words, even if their activation occurs less than in the case of presented words (McDermott, 1997).

The implicit tests used to test or measure implicit DRM false memories have mostly been perceptual, such as lexical decision (involving deciding whether or not what the participant sees is a word in itself), identification of degraded stimuli, or word stem/fragment completion (Kirsner & Smith, 1974; Warrington & Weiskrantz, 1968; as cited in McKone & Murphy, 2000). Priming is determined, for example, in an implicit test of word stem completion with the first word that comes to mind by the tendency of participants to unintentionally complete words seen or activated during the acquisition phase. These responses are compared with the baseline completion rate, that is, with those identified words that were not studied during the encoding phase and that are not associated with the presented word lists (McKone & Murphy, 2000).

The literature indicates that priming also exists for prototype words, or non-presented words, activated by lists of associated words (Bennett, 1996; McDermott, 1997; as cited in McKone & Murphy, 2000). Priming is defined as "the phenomenon of facilitation in the processing of a stimulus as a result of recent encounter with it, which may occur after the perception of physical stimuli similar to those in the test phase, semantically related, or conceptually similar" (Coffer, 1967; as cited in Opre, 2012). The implicit memory tests used to measure false stimulus priming in the DRM paradigm were perceptual tests. Perceptual tests measure stimuli that are physically or semantically similar to the stimuli presented in the acquisition phase, and conceptual tests measure stimuli that are similar in content or meaning to those presented in the acquisition phase. Perceptual tests activate the memory system by presenting information in a degraded form, and conceptual tests involve the re-actualization of a word based on another semantically related word (Opre, 2012). However, research has shown that tests are not exclusively perceptual or conceptual, but express different degrees of activation of perceptual and conceptual processing (Hirshman et al, 1990; Srinivas, Roediger, 1990; Roediger, 2003; as cited in Opre, 2012). This may be the explanation for why perceptual tests still identified the priming of words not presented in the word lists in the study phase, which, although semantically activated, did not show physical similarities with the previous stimuli, so there was no overlap between the stimuli in the acquisition phase and the stimuli in the test phase (McDermott, 1997; cited in McKone & Murphy, 2000).

In the case of implicit perceptual tests, the important stages are the duration between study and test and the duration of recording the participants' response. The first measures the duration of the effects of semantic priming on perceptual tasks, and the second records the first word that comes to the participants' minds (McKone & Murphy, 2000). The duration between study and test ('delay') has been used in scientific studies of 5 minutes, one week or even two weeks. The duration of recording responses in the same scientific studies has approximated between 2 seconds and 20 seconds. At 2 seconds, no priming was obtained (Smith et al, 1998; as cited in McKone & Murphy, 2000), and at 20 seconds, although priming was present, some researchers have contradicted the results due to possible explicit contamination. Therefore, it is considered that 20 seconds for each response would be too long to effectively record the first word that comes to the participants' minds, as they could intentionally and explicitly use memory during that 20-second interval, as was the case in the first scientific study evaluating implicit false memories through perceptual tests (McDermott, 1997; as cited in McKone & Murphy, 2000).

In the years that followed, a number of other scientific studies investigated the emergence of implicit false memories, using the DRM paradigm and perceptual tests of implicit memory. Their results both confirm and deny the results of the author Kathleen McDermott. We will therefore present in the following both the scientific studies that confirm the emergence of implicit false memories using perceptual tests, and those that deny this hypothesis, but also those that showed implicit false memories in the DRM paradigm using other implicit memory tests, both perceptual and conceptual.

Kathleen McDermott (1997) undertook 3 scientific experiments through which she explored whether the unpresented critical word or prototype word appears through priming, although unstudied, in the implicit perceptual and conceptual testing phase. The author listed three possible predictions. The first stipulates that priming occurs, given that these unpresented critical words behave as if they were present in the encoding phase. The second prediction was that priming occurs in part if these unpresented critical words are consciously activated in the mind during the acquisition phase (Underwood, 1965; Jacoby, 1983; Masson & MacLeod, 1992;

Rajaram & Roediger, 1993; cited in McDermott, 1997). The last possibility was that priming does not occur if the unpresented critical words are consciously activated during the encoding phase (Colins & Loftus, 1975; Weldon, 1991; as cited in McDermott, 1997). The experiments used as testing methods: in the first experiment free recall, conceptual implicit memory test, in experiment 2 free associations and in experiment 3 perceptual implicit memory test, word root completion test. All experiments were conducted both in the experimental condition in which the critical word is presented in the acquisition phase and in the experimental condition in which it is not presented (the classic false memory paradigm). The results showed that free recall of critical words occurred more frequently when they were studied, in the conceptual test, priming of critical words was present regardless of whether they were presented in the encoding phase, and in the perceptual implicit test, the results showed priming, especially for critical words presented in the encoding phase. Of course, such results lead to a confusion of the answer to the question of whether or not there is priming for unpresented critical words, so the author undertook a 4th experiment, in which the testing method was a perceptual implicit one, through the word fragment completion test. The results, this time, indicated priming of critical words, and no significant difference between presented and unpresented critical words. Of course, such results contradict the implicit memory theory, which states that an unpresented stimulus cannot be primed in a perceptual implicit test. However, priming of unpresented stimuli is possible in the case of implicit false memories, perhaps due to the high degree of association between items. The author concludes, however, that a single experiment cannot contradict the entire literature, so she summed the results of experiment 3 with those of experiment 4, and there, indeed, a statistical difference in priming between presented and unpresented critical words is confirmed (McDermott, 1997).

Hicks & Starns (2005) set up three experiments to test the effect of presentation and testing modalities of implicit false stimuli. Their results confirm that priming of unpresented critical words is greater when the presentation modality of the initial stimuli (words from the DRM lists) matches the presentation modality of the stimuli at test, with the visual modality activating a higher level of priming. The authors also test the perceptual characteristics of the priming that occurred in perceptual tests of implicit false memory. They compare two implicit tests, word root completion and perceptual identification. In the case of the first implicit test, word root completion, priming of unpresented critical words was significantly present, but in the case of the second test, it was not. Perceptual identification is a more perceptually restrictive type of test than the word stem completion test (Burgund & Marsolek, 1997; Jacoby & Dallas, 1981; Marsolek & Andresen, 2005; as cited in Hicks & Starns, 2005). In the case of the perceptual identification test, participants are asked to identify highly perceptually degraded stimuli, or with many perceptual gaps, that is, stimuli that do not show the complete form of the presented object (Hicks & Starns, 2005). The authors explain the lack of priming of the unpresented critical words in the case of the perceptual identification test by the existence of conceptual features of the unpresented but primed critical words. In fact, many scientific studies indicate that the word stem completion test is more open to conceptual processes than to perceptual ones (Thapar & Greene, 1994; Weldon, 1991; as cited in Hicks & Starns, 2005). The perceptual identification test is more sensitive to perceptual factors than to conceptual ones (Marsolek & Andresen, 2005; Postle & Corkin, 1998, Weldon, 1991; as cited in Hicks & Starns, 2005). False memories also differ from true memories in terms of perceptual details, a fact confirmed by neuroscientific studies, which have found such differences in the sensori-perceptual area of the brain, the parahippocampal gyrus (Cabeza, Rao, Wagner, Mayer & Schacter, 2001; as cited in Hicks & Starns, 2005). In fact, any implicit memory task is susceptible to both perceptual and conceptual factors, because there are no pure implicit perceptual or conceptual tests (Opre, 2012). In the case of implicit false memories, the scientific literature has shown the presence of priming of unpresented critical words through perceptual tasks such as word root completion (McDermott, 1997; McKone & Murphy, 2000; Smith, Gerkens, Pierce & choi, 2002; as cited in Hicks & Starns, 2005), word fragment completion (McDermott, 1997), anagram solving (Lovden & Johansson, 2003), and lexical decision (Hancook, Hicks, Marsh & Ritschel, 2003; Whittlesea, 2002; as cited in Hicks & Starns, 2005). In other scientific studies, the lexical decision test did not shown priming of unpresented critical words (McKone, 2004; Zeelenberg & Pecher, 2002). Likewise, the word naming task did not show the priming of implicit false memories (Whittlesea, 2002; as cited in Hicks & Starns, 2005).

In conclusion, implicit false memories have been demonstrated in numerous scientific studies, and perceptual tests have changed the view that implicit false memories are purely conceptual. Implicit false memories differ from real ones by conceptual, but also perceptual factors.

1.1.4 Implications of False Memories

What is the importance of false memories for our cognitive system? Why is there susceptibility of our cognitive system integrated as part of our adaptation to the reality in which we operate? Researchers have offered several explanations for such questions.

A first important function of false memories that is worth mentioning is that of *revisiting the past and imagining the future*. Such operations allow us to function and adapt as humans in a social system that is constantly moving and changing. Our cognitive system therefore adapts to a unique reality, and offers as a solution the ability to revisit the past and imagine the future, for future plans or objectives (Byrne, 2002; as cited in Newman & Lindsay, 2009). For such operations, the mind uses episodic memory (Johnson & Sherman, 1990; Neisser, 1988; Schacter & Addis, 2007; Tulving, 1983, 2002; as cited in Newman & Lindsay, 2009), and there is neurobiological evidence for this claim (Addis, Wong & Schacter, 2007; as cited in Newman & Lindsay, 2009). Memory flexibility even allows us to recombine elements of semantic memory with that of episodic memory, otherwise our ability to imagine new events and reevaluate the past would be limited and inflexible (Schacter & Addis, 2007; as cited in Newman & Lindsay, 2009). Autobiographical memory serves the role of integrating us into present episodes and projecting ourselves imaginatively into future scenarios, for example when we relate to school successes to preview a successful career, or when we avoid dangerous situations due to a past experience (Bluck, 2003; Bluck, Alea, Habermas, & Rubin, 2005; Pillemer, 2001, 2003; as cited in Newman & Lindsay, 2009).

Another function of false memories is directly related to our identity as people (Conway & Pleydell-Pearce, 2000; James, 1890/1950; Neisser, 1988; Wilson & Ross, 2003; as cited in Newman & Lindsay, 2009). *When memory is lost, identity is affected* (Addis & Tippett, 2004; Schacter, 1996; see Stuss, Rosenbaum, Malcom, Christiana, & Keenan, 2005; as cited in Newman & Lindsay, 2009), and *when emotional or identity states are affected, memory is affected* (Bradley, Mogg, & Williams, 1995; Eich, Macaulay, & Lam, 1997; Ridout, Astell, Reid, Glen, & O'Caroll, 2003; as cited in Newman & Lindsay, 2009). For example, people suffering from depression have more negative false memories, their tendency being to orient themselves negatively (Howe & Malone, 2011; Bradley, Mogg, & Williams, 1995; Eich, Macaulay, & Lam, 1997; Ridout, Astell, Reid, Glen, & O'Caroll, 2003; Mineka & Nugent 1995; as cited in Newman & Lindsay, 2009).

False memories can impact the social function of collective memory, for example they can contribute to the 'flashbulb' phenomenon, which states that *an event will have a different impact on memory depending on the influence of the social group* (Berntsen, 2008; Brown & Kulik, 1977; as cited in Newman & Lindsay, 2009). It seems that the social functions of communication, empathy, intimidation, have a more impactful role in the group memory of individuals than the accuracy of the phenomenon discussed or shared (Cuc, Koppel & Hirst, 2007; cited after Newman & Lindsay, 2009), and *the cultural context plays a fundamental role* (Mone, Benga & Opre, 2016).

False memories are, therefore, the result of the flexibility of our cognitive system. Their relevance lies in the adequate functioning of this cognitive system, for a good adaptation to the social environment, external, but also to the internal one (resuming the past to change or influence the present of the self-identity). Of course, the implications of false memories do not only appear in the field of cognitive psychology or social psychology, they also exist in the field of **forensic psychology**. For example, false memories have been intensively studied for the accuracy or correctness of witness testimonies (Loftus, 1975). More recent studies show that false memories can also appear in the case of children's testimonies, their testimonies being influenced by parental opinions, especially mothers, who in turn may have memory distortions from other sources (Principe, Kirkpatrick & Langley, 2022). **In everyday life**, the impact of false memories has proven to be of increased importance. In the context of the pandemic, for example, exposure to erroneous information about the Covid-19 virus has led to the creation of false memories, especially among less analytical individuals (Greene & Murphy, 2020). In the context of problem solving, false memories present an advantage and facilitate this process (Garner & Howe, 2014).

The clinical and practical implications of false memory research have made major contributions to changing the accuracy and perspective on mental disorders, the legal system, and the understanding of the cognitive system. Regarding the theoretical implications of the relevance of scientific research on false memories in the laboratory, they have had a major impact, with the number of citations reaching impressive levels, with the number of published experiments estimated at an interval of 2 weeks (Gallo, 2010). The major theoretical contribution made is the proven awareness of the constructive nature of memory (Gallo, 2010).

In psychology, memory plays a fundamental role. To date, the literature shows as important factors in the assessment and development of memory: age (Visu-Petra, Miclea, Cheie & Benga, 2009), emotions, which have a direct link to memory, for example anxiety as a trait (Miu, Heilman, Opre & Miclea, 2005), and emotional regulation, which is a key variable in the decision-making process when there is risk and uncertainty (Heilman, Crișan, Houser, Miclea & Miu, 2010).

In clinical psychology, false memories have been studied in relation to depression (Howe & Malone, 2011), schizophrenia (Robin et al, 2022) and anxiety disorders (Toffalini et al, 2015). As a treatment, virtual reality exposure can help reduce the intensity of anxiety symptoms (Opriș, Pintea, Garcia-Palacios, Botella, Szamoskozi & David, 2012), REBT cognitive restructuring techniques are used in a wide range of pathological diagnoses (David, Szentagotai, Eva & Macavei, 2005), so future research may include investigations related to the impact of treatment on false memories in psychopathology.

Future research directions may also take place by investigating *the impact of false memories in education* (Miclea, 2004; Opre & Opre, 2005), in the search for professional calling (Dumulescu, Opre & Buzgar, 2015), in the search for meaning, spirituality (Matei, Dumulescu, Siladi & Opre, 2022), on the topic of identity and the search for goals (Timar-Anton, Negru-Subțirică & Opre, 2022), or motivation (Mărincaș, Dumulescu, Pintea & Opre, 2021).

1.2 Research Relevance

The present paper aims to contribute to the theoretical and empirical development of the scientifical study of false memories, relevant in the fields mentioned above. The importance of DRM word lists, the main investigation tool of false memories, validated in Romanian language, and of a DRM tool with emotional valences, which will allow the investigation of new research directions using the DRM paradigm in Romanian language and culture, is highlighted in the first study of this paper.

The present paper also highlights the importance of recent research investigating the phenomenon of false memories in the online environment through the Misinformation Paradigm, given the frequent use of technology in recent years and the impact created by it.

Finally, we also want to investigate the implicit mechanisms that form false memories, since their importance may lie precisely in finding new ways to reduce the phenomenon of false memories.

1.3. Current State of Research in the Field

Currently, scientific research on false memories brings theoretical and practical contributions, enriching knowledge on this specific mnesic phenomenon, and on the mnesic and cognitive system in general.

Scientific studies in recent years show an increased interest in the role of semantic activation in the case of DRM paradigm. The importance is given by the effect of misinformation on the development of false memories, or on the development of methods for controlling and preventing false memories. Some of such methods could be: improving the quality or quantity of sleep, raising awareness of the phenomenon, etc.

The effect of misinformation has recently been studied in a social context, so it seems that it appears socially and before or without exposure to misinformation, by simply listening to the misinterpretation of a secondary person. The experiment used the joint encoding procedure, meaning that participants encoded information in pairs, and the results showed that participants reported more false memories semantically related to those of their partner, not to the control lists (Wagner, Schlechter & Echterhoff, 2022).

False memories studied through DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) have also been studied in relation to mental scenarios regarding the future. The results show that word lists that were evaluated as future scenarios presented more false memories than word lists evaluated as past scenarios or those evaluated by the degree of pleasure. Therefore, false memories arise as a result of adaptive cognitive processes, the authors conclude (Dewhurst, Anderson, Grace & Esch, 2016).

Recent research also investigates the role or effect of sleep on false memories. Investigations within the DRM paradigm have shown that lack or decreased sleep duration leads to more false memories, even affecting performance on true memories. The exception is performance on the visual false memory task, which does not seem to be affected by sleep loss (Chatburn, Kohler, Payne & Drummond, 2016).

Research within the Misinformation Paradigm shows that lack of sleep leads to increased suggestibility and increased incorrect responses to non-suggestive questions. The same scientific study also measured the effects of substance use on false memories through the false memory implantation technique, and the results reinforce previous findings that substance use can reinforce or create a convenient environment for the formation of false memories. Consumption also led to an increase in incorrect answers to non-suggestive questions, but not to an effect of implanting a total false scenario, although a small percentage of participants incorporated it. The study used the virtual reality of a music festival (Kloft et al, 2022).

False memories in witness statements have been intensively studied in the scientific literature, having as a sample and objective the population and legal system of the United States. In recent years, however, the model has been followed by other states, which propose preventive measures to combat false memories in the forensic system by using cognitive interviewing, warnings given to witnesses and blind line-ups. The importance of the practical implications of the scientific study of false memories in the Misinformation paradigm is therefore observed (Wang et al, 2022).

The study of fake videos (deepfake videos) investigated whether they can lead to the activation of more false memories than fake texts or fake texts with photos. The results showed that the level of false memories is the same as in the case of texts with wrong information (Murphy & Flynn, 2022).

Recent theoretical explanations of the phenomenon of false memory propose their connection in the cognitive system with semantic memory. Studies of distributional semantic models place this theoretical idea at the center of researchers' attention, since these models exist in the human cognitive system to extract the meaning of words from the natural context, whose structure is copied from the structure of the surrounding physical world (Louwerse, 2018; Rinaldi & Marelli, 2020; as cited in Gatti et al., 2022). The semantic relationship between words can therefore predict false memories, in the DRM paradigm. Lists of words, seen as clusters, activate distributional semantic models of words semantically related to them, which in turn activate the following words present in the semantic field close to the initially activated cluster. All of these are activated from the initial semantic memory of each individual (Gatti et al, 2022).

Also, recent scientific literature has brought to the forefront **the importance of false memories in learning** or educational context. It seems that after retrieving information, even if it is wrong or false, memory is more flexible, which produces a good context for error correction and learning or re-learning the studied material. Scientific studies have shown that *errors improved considerably if correction feedback was administered immediately after recall rather than after the passive recognition or encoding phase*. The malleability of memory is therefore greater after testing it, which produces an opportunity for learning (Maraver et al., 2022), given that the learning process includes implicit structures, acquired through direct experience (Jurchis, Costea & Opre, 2022).

What is missing in the scientific literature on false memories, and what we have tried to investigate in the present thesis, would be the validation of DRM word lists in Romanian language, the investigation of false memories in an online context, and the investigation of implicit false memories or the implicit mechanisms that could underlie the formation of false memories. The instrument by which false memories are measured in the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) is represented by lists of words semantically associated with each other and strongly associated with a target word not displayed to the participants, but which appears in their responses (which is considered a false memory). Over time, researchers have created and validated DRM word lists in the participants' native languages, such as Italian, Spanish, German, Polish, etc. (Anastasi et al., 2005, Iacullo & Marucci, 2016, Stadler et al., 1999; Ulatowska and Olszewska, 2013). Thus, in order to investigate the phenomenon of false memory, it is necessary to validate DRM word lists in Romanian language as well.

Also, the scientific literature shows an exponential increase in false information in an online context, for example during the Covid-19 Pandemic, which led to information confusion (Greenspan & Loftus, 2020; Siewright, 2022). Thus, we considered it important to investigate their impact on memory, asking ourselves whether false memories can also occur in an online context, not just physically or in the laboratory, using techniques specific to the Misinformation Paradigm. And last but not least, the mechanism of false memory formation, whether we are talking about the association between words or the suggestion of erroneous information, could also include automatic or unconscious processes, according to existing scientific literature, which led to another research direction of this thesis, that of investigating implicit false memories, in a physical context.

II. CHAPTER II. RESEARCH OBJECTIVES AND METHODOLOGY

General Objective

1. To investigate the phenomenon of implicit and explicit false memories, using the Deese-Roediger-McDermott (DRM) (Deese, 1959; Roediger & McDermott, 1995) and Misinformation (Loftus, 1975) research paradigms.

Specific Objectives

1. **Objective 1**: To create and validate word lists, according to the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995), in Romanian language.

Hypothesis 1: DRM word lists created in Romanian will produce a significantly higher number of explicit false memories than DRM word lists translated from English into Romanian. (Study 1a)

2. **Objective 2**: Creation and validation of DRM word lists in Romanian, with neutral, negative and positive emotional valence

Hypothesis 2: Ad hoc DRM word lists created in Romanian language with neutral, negative and positive emotional valence will produce a significantly higher number of explicit false memories compared to DRM lists translated from English into Romanian, with neutral, negative and positive emotional valence. (Study 1b)

3. **Objective 3**: Investigation of explicit false memories in an online context, using specific techniques from the Misinformation Paradigm.

Hypothesis 3: The misleading question technique and the suggestibility technique, from the Misinformation Paradigm, will produce a significant number of explicit false memories, in an online context. (Study 2)

4. **Objective 4**: To investigate the differences that occur in implicit and explicit false memory performance when the time interval between acquisition and testing is increased to one week in the DRM paradigm.

Hypothesis 4: Increasing the time interval between acquisition and testing to one week negatively and significantly affects the emergence of implicit and explicit false memories. (Study 3)

5. **Objective 5**: To investigate the effect of stimuli with neutral, positive and negative emotional valence on implicit and explicit false memories when the retention interval between acquisition and testing is increased to one week in the DRM paradigm.

Hypothesis 5: Negative emotional valence of stimuli will positively and significantly affect the emergence of implicit and explicit false memories when the retention interval is one week between the encoding and testing phases. (Study 4)

III.CHAPTER III. ORIGINAL RESEARCH CONTRIBUTION

In the first scientific research study, we will focus on the specific objectives 1 and 2, in which we validated the DRM word lists in Romanian language, with and without negative, neutral, and positive emotional valence, so that they can be used in future investigative studies of false memories, in the DRM Paradigm.

3.1 Study 1. False Memories: Lists of Deese-Roediger-McDermott words în Romanian Language

3.1.1 Introduction

False memory, or memory illusion, is defined as the memory of an event that never occurred or the memory of an event that incorporates details that are incorrect about what actually happened (Roediger & McDermott, 1995). Experimental investigation that has provided simplified materials for exploring this fascinating phenomenon of false memory began with James Deese (1959). He reported a study in which lists of semantically related words were presented to participants, who were then asked to indicate which words they remembered. The words were associated with a critical lure, that was never presented to the participants. During the test phase, subjects tended to falsely recall words that were not presented in the word lists, up to 44% of the time, which Deese (1959) called "memory intrusions."

The DRM procedure consists of an encoding phase and a recall/recognition phase. In the encoding phase, participants are presented with lists of words that are inter-associated with each other and strongly associated with a specific word, called the 'critical lure' (Stadler, Roediger, & McDermott, 1999). The critical lure is never presented to participants. In the memory testing phase, through explicit tests such as free recall or recognition, participants often falsely recall the critical lure, due to the semantic associative strength with the list of words presented in the encoding phase. For example, we present the list 'bed, sheet, rest', and participants falsely recall the unpresented critical lure – the word 'sleep'. As first observed by James Deese, if the association between words at encoding is high, the chances of false memory (the critical lure not presented) appearing in free recall or recognition tests are also high. Roediger and McDermott

(1995) initiated a series of experimental investigations based on this observation by using multiple lists of inter-associated words to observe exactly how a false memory is formed. False memory is precisely the memory of the critical lure that is not presented. Their results showed false memories in rates of up to 40% in free recall tests and 55% in recognition tests. Furthermore, the Critical Lure systematically appeared in free recall or recognition test as 'remembered'. Based on these findings, researchers created lists of word associations and specific norms for creating DRM word lists (Stadler, Roediger & McDermott, 1999).

The lists of associated words are formed through a specific standard procedure, in which participants respond with the first word that comes to mind to a word indicated by the experimenter. The first word is a strong associate of the indicated word because our mind creates neural circuits when learning (Hebb, 1949; Hebb, 1952) and many of the associations stored in our memory that we use daily are implicit in terms of economy of our own resources. In the process of recall or free memory, these implicit associations become explicit (Opre, 2012). The scientific literature also states that "the trace of false memories becomes an additive trace that integrates into episodic memory, with the same features of true memories" (Sergi, Senese, Pisani, & Nigro, 2014).

3.1.2. The Present Studies

DRM word lists in English language provide a unique research framework for investigating false memories. But what about the lists in other languages and cultures? Typical scientific research is usually conducted in the language of the target population, but within the same native language there are specific factors that can lead to variations in the given stimuli, such as frequency of use, word variants or spellings, or pragmatic questions (Martinez & Trejo, 2014). Therefore, there is a need to have specific tools for different conversational languages. To date, to our knowledge, adaptations of DRM word lists are available in Polish (Ulatowska & Plszewska, 2013), Spanish (Anastasi, De Leon, & Rhodes, 2005), or Italian (Iacullo & Marucci, 2016).

The DRM paradigm has been criticized for lacking sufficient ecological validity. However, the most recent scientific studies indicate that emotional valence can be implicitly conditioned by the association of an emotional stimulus with an initially neutral stimulus (Jurchis, Costea, Dienes, Miclea & Opre, 2020). In real life, false memories depend on the specific context and often the context is emotional (Howe et al., 2010 as cited in Freyd & Gleaves, 1996). Thus, in response to this limitation, researchers have developed DRM lists with emotional valences, starting with the negative-emotional DRM word lists and continuing with the neutral and positive-emotional ones (Howe et al., 2010). This research aimed to investigate the real context more accurately, therefore increasing the ecological validity of DRM. Thus, Andrew Budson and colleagues (2006) developed a procedure in which the unpresented critical items are emotional, negative, or neutral words, and the words in the presented list are semantically associated with those unpresented critical items with emotional valence (e.g., “danger”). This procedure has been used in other studies (Brainerd et al., 2008; 2010; Brueckner & Moritz, 2009; Dehon et al., 2010; Howe, 2007; Howe et al., 2010) and was developed from the initial attempt to introduce emotional valence (negative, neutral, positive) for target stimuli associated with orthographic items (Pesta et al., 2001).

The procedures in the present studies are consistent with the standard validation of DRM word lists, used in other studies with a similar objective, namely their validation for subsequent use in other scientific studies measuring false memories (Anastasi et al., 2005, Iacullo & Marucci, 2016, Stadler et al., 1999; Ulatowska and Olszewska, 2013). Therefore, a first objective of the present studies was to investigate whether there are significant differences between Set A and Set B in terms of activation of the unpresented critical item. Our hypothesis is that DRM word lists in Romanian will produce a significantly higher number of explicit false memories than DRM word lists translated from English into Romanian.

Using the same principle as Andrew Budson et al. (2006) – according to which the critical item could have an emotional valence per se, and the activation may be different – the results were also analyzed according to the neutral, negative and positive critical items. Therefore, a second specific objective focuses on the validation of the Romanian DRM word lists with emotional valence – neutral, negative and positive. A final specific objective is to measure the differences in the activation of the unpresented critical items, with different emotional valences, of the two sets of lists. The hypothesis is that the DRM word lists created in Romanian, with neutral, negative and positive emotional valence, will produce a significantly higher number of explicit false memories than the DRM lists translated from English into Romanian, with neutral, negative and positive emotional valence.

3.1.2.1 Study 1a. Creating and validating Romanian DRM lists

The first objective of the current study was to create and validate 24 Romanian word lists to further use in the DRM experimental paradigm (Deese, 1959; Roediger & McDermott, 1995). The 24 lists are composed of 12 lists created in Romanian language, set A, and 12 lists translated from English into Romanian, set B. Our hypothesis is that set A will produce a significantly higher number of false memories than set B.

Method

Participants

The sample of the current study consisted of 197 participants, first-year students, majoring in Psychology. The participants were of Romanian nationality and native Romanian speakers. The participants were randomly divided into two groups, one group for the lists in Set A and one group for the lists in Set B. The first group (which was tested for the lists in Set A) included a total of 99 participants (15 men and 84 women). Their mean age was M_{age} = 19.23 (SD = 1.14). The second group (tested with lists in Set B) consisted of 98 participants (20 men and 73 women). Their mean age was M_{age} = 19.53 (SD = 1.43). Their participation was voluntary and they all signed the informed consent, according to the international ethical standards and procedures imposed by the Declaration of Helsinky.

For the first set of semantically associated word lists (set A), an online pilot study was conducted, the procedure of which is described below. For the purpose of this study, a sample of 420 participants (M_{age} = 19.00, SD = .61) from different regions of Romania participated online. All participants were Romanian citizens and had Romanian as their native language. The reference sample was composed of emerging adults, aged between 18 and 20 years, because after 20 years language is shaped according to specific career choices.

Instruments

In the present study, two sets of semantically related word lists were used as instruments. Set A included 12 word lists created in Romanian language, while Set B included 12 word lists translated from English into Romanian language. Both sets included the same 12 critical items, chosen from the DRM word lists from the English normative study (Stadler et al.,1999). Each list included 15 inter-associated words, following the procedural norms of Stadler et al. (1999).

Procedure

To create the first set A of DRM word lists, we used a pilot study. As a procedure, we shared a link to a Google form on social networks. At that link, participants opened the Google form, through which they were informed about the scientific study in which they were participating. After reading and voluntarily signing the informed consent, they were asked to write down the first 15 words that came to mind when they saw each critical item. Based on the statistical analysis, we selected the 15 most frequent words associated with each of the 12 critical items in order of associative frequency, from the highest frequency to the lowest frequency associated with the critical item. This procedure led to the creation of 12 DRM word lists in Romanian with 15 words associated for each prototype item (set A).

The procedure of the present study included testing the participants, randomly selected and organized into groups of 30-40 participants for each set of lists. A PowerPoint presentation was used to present the lists in the encoding phase. All 12 word lists, with 15 words per list, were displayed in the same order as presented in Appendix 1. The order of the lists for each set was randomly determined using the website random.org. The words were presented at 2-second interval. For the testing phase, we used explicit memory recall and recognition tests, the pencil-and-paper method. Participants wrote the response on a sheet of paper (the recall or free recall test), then circled Yes/No for each word, whether it was present or not (the recognition test). Each group of participants received a different set of lists, A or B.

In the free recall test phase, participants were told that this was a memory study, and that they would view lists of words. Next, at the end of each list, as indicated on the last PowerPoint slide, specific instructions were given to write down all the words they could remember from the previously presented lists. Participants had 1 minute to write down all the words they remembered on paper. In the recognition test, which immediately followed the free recall test, participants were given the recognition lists on sheets of paper and were told to circle "Yes" for words they remembered from the previous lists and "No" for words they did not remember. At the end of both explicit memory, free recall, and recognition tests, participants were asked to write about what they thought the experiment was about. No participant realized what the experiment was really about.

Results

Analysis of the Explicit Free Recall Test Data

There is a significant difference between the recalled presented items from Set A (M =.65, SD =.04) and Set B (M =.60, SD =.05), t(22) = 2.57, p =.017, Cohen's d = 1.09, indicating a very large effect size. These results suggest that true memories (presented items) were significantly higher using the lists created in Romanian. However, there were no statistically significant differences between the recalled critical items from Set A (M =.16, SD =.10) and Set B (M =.13, SD =.09), t(22) = .66, p =.51. The results suggest that although set A activated true memories more effectively than list set B, it did not activate more false memories (critical lures) than set B. The potential for activation by free recall of false memories was the same for both lists created in Romanian and lists translated from English into Romanian.

Explicit Recognition Test Data Analysis

In general, the pattern of results was maintained as in previous normative scientific studies (Stadler et al., 1999; Ulatowska & Olszewska, 2013; Anastasi et al., 2005; Iacullo & Marucci, 2016). The presented items (set A: $M = .83$, $SD = .05$; set B: $M =.80$, $SD = .05$) had higher means than the critical lures(set A: $M = .54$, $SD = .14$; set B: $M = .55$, $SD = .18$). The differences between the means of the presented items from the lists and the critical lures are statistically significant: for set A $t(11) = 6.65$, $p < .001$, Cohen‘s $d = 1.92$ and for set B $t(11) = 4.46$, $p = .001$, Cohen‘s $d = 1.28$. False memories did not differ significantly for the Romanian DRM list sets, A and B ($p = .89$). The same pattern emerged for true memories in sets A and B ($p = .13$).

Correlation coefficient analysis

Pearson correlation coefficients were calculated to investigate the relationship between critical items and presented, recalled, or recognized items, for each participant and for each Romanian word list. A high and statistically significant correlation coefficient was found in list set A, between recalled and recognized critical items, $r = .96$, $p < .01$. In addition, correlations were calculated between the Romanian DRM lists (sets A and B) and the English lists (Stadler et al., 1999). For the recall test data, high associations were found between recalled critical items from Set B and recalled critical lures from the English lists (Stadler et al., 1999), $r = .68$, $p < .05$, but also for presented items from Set B and the English lists (Stadler et al., 1999), $r = .76$, $p < .01$. A strong association was also found between critical lures from Set B and those from the English lists, from the normative study (Stadlet et al., 1999): $r = .62$, $p < .01$.

Discussion

The main goal of Study 1 was to create and validate DRM word lists in Romanian language, for further use in DRM experiments investigating false memories, for the Romanian language and population.

To answer the question of whether there are significant differences between the created and translated sets of lists, we compared the two sets of DRM lists, and the answer is that there are no significant differences in false memories, but there are significant differences in true memories. Participants correctly recall more words from the lists created in Romanian language (set A). Some lists may produce higher levels of false recall and recognition, while other lists may produce lower or sometimes even no false recall and recognition in both sets of word lists.

3.1.2.2 Study 1b. Romanian DRM lists with emotional valence

Following the scientific procedure of the adapted DRM paradigm (Deese, 1959; Roediger & McDermott, 1995), the objective of Study 1b was to create and validate Romanian DRM lists with neutral, negative, and positive emotional valence. The DRM lists used were those from Study 1a, selected on the basis of emotional valence. Therefore, we had two sets of DRM lists with emotional valence: **Set A**, created ad hoc in Romanian language, and **Set B**, translated from English into Romanian language. Our specific hypothesis was that Set A of lists with neutral, negative, and positive emotional valence would produce a significantly higher number of explicit false memories than Set B of lists with neutral, negative, and positive emotional valence.

Method

Participants

The study included the same sample as Study 1a. One group of participants (N = 99) received the first set of DRM lists in Romanian (set A), and the other group of participants (N = 98) received the second set of lists (set B). The groups were randomly assigned to list sets A and B.

Instruments

The emotional valence of the critical items was determined using the **RoEmoLex dictionary** (Briciu & Lupea, 2017; Lupea & Briciu, 2019), the **WordNet database** (Tufis et al., 2008; Tufis, 2009) and the **SentiWordNet software** (Esuli & Sebastiani, 2006). Of the 12 critical items originally selected from the original English DRM lists (Stadler et al., 1999), 6 were neutral (Window, Chair, High, Spider, Fruit, Sleep), 3 negative (Anger, Black, Thief), and 3 positive (Sweet, Music, King). In order to have an equal number of lists, we randomly selected 3 neutral critical items from the original 6, using the website random.org. The randomly selected neutral critical items were High, Spider, and Sleep. In total, we used *9 semantically related word lists for 9 critical items (out of 12), for each list set, A and B. Each list set, A and B, is comprised of 3 neutral lists (High, Spider, Sleep), 3 negative lists (Anger, Black, Thief), and 3 positive lists (Sweet, Music, King).* Using the One-Way Anova test, no statistical differences in word length were found for Set A ($p = .14$) or Set B ($p = .29$).

Procedure

The present study 1b followed the same procedure as described in Study 1a.

Results

Analysis of free recall test data

In general, both sets of Romanian language lists activated more recalled presented items than critical lures. Neutral presented items (set A: M = .66, SD = .02; set B: M = .57; SD =.04), negative presented items (M = .63, SD =.02; M =. 56, SD = .04), and positive presented items (M = .64, SD = .06; M = .64, SD = .03) have higher means than neutral critical lures, (M = .21, SD = .11; M = .08, SD = .07), negative critical lures (M = .14, SD = .06; M = .15, SD = .02), and positive critical lures (M = .13, SD = .05; M = .15, SD = .16). **We performed a One-Way ANOVA with repeated measures** to compare the differences in means between presented and critical items for all three types of emotional valence lists. The design was: 2 (word type: presented item x critical item) x 3 (emotional valence: neutral x negative x positive). For Set A, there was a significant effect of word type or recalled item, Wilk's Lambda = .021, $F(1,6) = 276.93$, $p < .001$. No statistically significant result was found for emotional valence, so the means of critical and presented items did not differ statistically significantly between the neutral, negative, or positive lists. In Set B, a significant result of word type or item (presented item vs. critical lure) was found, Wilk's Lambda= .045, $F(1,6) = 127.96$, $p < .001$.

Recognition Test Data Analysis

Differences between Set A and B were analyzed using a **mixed ANOVA test**, with a design of 2 (group: set A x set B) x 3 (Emotional valence: neutral x negative x positive) x 2 (word type: critical item x presented item). No statistically significant differences were found. Set A did not differ statistically significantly from Set B in terms of means between emotional valence (neutral, negative, positive) or word type. Univariate ANOVA indicated no statistically significant differences between neutral, negative, and positive recognized false memories ($p = .49$ – set A, $p = .64$ – set B, $p = .47$ – sets A and B).

Analysis of Correlation Coefficients

Pearson correlation coefficients were calculated for the relationship between critical items and presented items, in sets A and B, recall, and recognition. The only statistically significant correlation was found between the recognized critical items in Set A and the recognized critical items in Set B, $r = .67$, $p < .05$.

Pearson correlations were also calculated for each level of emotional valence. For the neutral lists, significant results were found in the relationship between recalled neutral critical items and presented items, $r = -.99$, $p < .05$, Set B. No significant correlations were found for the negative or positive lists.

Analyses were also conducted between the emotionally valenced Romanian DRM word lists and the English lists from the normative study (Stadler et al., 1999). The results indicated significant correlations for recalled neutral critical items in Set B and those in the English lists (Stadleret al., 1999), $r = .99$, $p < .05$. There were also significant results for the recognized presented items from Set B and those from the English lists (Stadler et al., 1999), $r = -1.00$, $p < .01$.

Discussion

Study 1b analyzes the results of explicit memory recall and recognition tests for critical lures (false memories) and presented items (true memories), with neutral, negative, and positive emotional valence, of Set A and B of lists. These 18 DRM lists with emotional valence, 9 for each List Set A and B, demonstrate a strong memory illusion effect, the results being consistent with the results of previous scientific DRM studies (Budson et al., 2006; Brainerd at el., 2008; 2010; Brueckner & Moritz, 2009; Dehon et al., 2010; Howe, 2007; Howe et al., 2010).

3.1.3. General Conclusions

The current studies were conducted with the aim of validating 24 lists of semantically associated DRM words in Romanian language, 18 of which with emotional valence. These will be used as tools in further research on the activation of the memory illusion through the DRM paradigm in the Romanian population. Emotional valence was added to increase ecological validity. Given that people usually integrate information from specific contexts, and this is often emotionally influenced, it is possible that the activation of memory distortions related to such contexts to be emotionally dependent, similar to the way in which this information is initially encoded (Howe et al., 2010). In ecological contexts, events and memory distortions may or may not be emotionally dependent (Howe et al., 2010).

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In the following scientific study, we specifically pursued objective 3, namely the investigation of false memories in an online context, using specific techniques from the Misinformation paradigm.

3.2 Study 2- False Memories in Online Misinformation Experimental Context

3.2.1. Introduction

The implications of scientific research on memory are always significant, as daily functioning depends on its use. Memory, or recollection, is a psychological process and mechanism with important practical implications in a number of fields - psychology, education, law, social sciences, public health, healthcare - to name a few (Ecker et al., 2022). In the legal system, more specifically in the field of eyewitness testimony, which relies entirely on memory, testimony or testimony of the witness, the eyewitness memory has a major impact on the decision of "guilty" or "not guilty" of the accused or defendant, thereby influencing the course of a person's life.

The misinformation effect refers to post-event information that alters the original memory of a particular event (Pickrell, McDonald, Bernstein & Loftus, 2016). In the classic paradigm, participants witness an event, then receive incorrect information about the event they witnessed, through questions, photographs, prompts, etc., and then take a memory test about the event they originally saw. The effect is that the incorrect information is incorporated into the original memory of the event (Loftus, 2005).

In the initial development of the misinformation effect paradigm in a laboratory setting, the influence of question wording was used for post-event questions, which ultimately changed the perception of the event and affected the original memory of it (Berkowitz & Loftus, 2018). After viewing videos or slides of an event, usually a car accident, participants asked in different wordings about the event responded differently to specific questions about the slides or video originally presented (Loftus & Palmer, 1974). This technique is called "leading questions" (Loftus, 1996; Wells & Olson, 2003) and refers to questions asked by investigators, with content consisting of certain verbs, prepositions or specific words, which can lead to a desirable or distorted answer from the main witness being questioned (Loftus, 1996). Experiments on leading questions mainly address the relationship between verbs or prepositions and participants' answers. In the experiment conducted by Loftus & Palmer (1974), participants watch a short film about a car accident. They then answer the question "At what speed did the first car hit the second?" with a higher estimated speed (40.9 km/h) than if the question was asked with the verb "Hit" (30.9 km/h). The effect of verbal labels on memory when presented with visual stimuli has also been experimentally demonstrated in other scientific studies (Daniel, 1972; Santa & Ranken, 1972; Lindauer, 1970; Loftus, Miller & Burns, 1978; Doyle & Lindquist, 2018; Huang & Awg, 2018). Therefore, the wording of the question can influence participants' responses (Loftus, 1975).

The way questions are formulated has major implications for the legal system. For example, the use of prepositions can lead to different answers (Loftus, 1974; Loftus & Zanni, 1975). In research done by Elisabeth Loftus and colleagues (1974, 1975), when participants were asked whether they had seen "the" broken lighthouse versus "a" broken lighthouse, they were 50% more likely to say yes to the first option. Articulation leads to a false assumption that there was a broken lighthouse when, in fact, there was no broken lighthouse present in the video (Loftus, 1975). The replication of how different words in a question can lead to a different specific answer has also been demonstrated by numerous researchers (Harris, 1973; Dodd & Bradshaw, 1980), which has raised awareness among legal and non-legal researchers, challenging them to find solutions to this problem.

Suggestibility is also a technique used in the research on the effect of misinformation. Our memory becomes vulnerable and malleable to the influence of suggestions, and false memories can arise as a result of external suggestions (Nichols & Loftus, 2019). The misinformation paradigm contains three phases, encoding or learning, misinformation by providing a suggestion or wrong information, and memory testing (Nichols & Loftus, 2019). Individual differences in suggestibility state that people who are prone to developing false memories of their past due to imagination or suggestibility are also prone to presenting more false memories in a laboratory setting. Studies of repressed memories support this idea, for example, women who recovered repressed memories scored higher on DRM false memories in a laboratory setting (Clancy et al., 2000; Geraerts et al., 2005; Geraerts et al., 2009; as cited in Nichols & Loftus, 2019). Divided attention is also a factor in the false memories suggested by the misinformation paradigm. For example, participants who used divided attention during the encoding phase (Lane, 2006; as cited in Nichols & Loftus, 2019) and also during the recall test phase (Zaragoza & Lane, 1998; as cited in Nichols & Loftus, 2019) were more likely to incorporate misleading suggestions into their memory (Nichols & Loftus, 2019). Furthermore, suggestion is more difficult to correct than directly stated misinformation (Reynolds, 2020). Recent studies show that suggestibility is stronger for additive false information than for contradictory false information. Older adults incorporate less contradictory false information than younger adults (Huff & Umanath, 2018; Swan, Giulianni & Weber, 1982; Geiselman et al., 1986; Pahre, 1999).

Research on the effect of misinformation in an online context has recently begun to explore its consequences on memory. Sievwright et al. (2021) measured the effect of misinformation in an online context after participants were exposed to a traumatic online video and were subsequently exposed to misinformation about the previously viewed traumatic video. Their results demonstrate that the effect of misinformation also occurs online, in this particular case using virtual exposure to traumatic videos.

False memories have therefore been studied online in a single scientific study. The need to investigate this phenomenon in the online environment from multiple research directions is thus evident, as the post-pandemic situation has completely changed the meaning of using technology, online social networks and the online context in general, which is currently used by the majority of the population globally. Thus, our current study focuses on the same idea of the online context dependency factor. The general objective is to assess false memories in the online environment, using the Misinformation Effect paradigm as a design and theoretical basis, but without an interviewer and without the demand pressure. More specifically, the objective is to assess, in an online setting, the Misinformation Effect using the classic techniques, the Misleading Questioning Technique (Loftus & Palmer, 1974) and the Suggestibility Technique (Loftus, 2005) – in an online format. Therefore, the first specific objective is to assess false memories through misleading questions, in an online context. The second specific objective is to assess false memories through the Suggestibility Technique in an online context. Our hypothesis is that the Misleading Questioning Technique and the Suggestibility Technique, from the Misinformation Paradigm, will produce a significant number of explicit false memories, in an online context.

3.2.2. Method

3.2.2.1 Participants

Participants were randomly divided into two groups. The total number of participants was N=201. For the first group, N=102, the mean age was M_{age}=23.19, SD=5.83, and for the second group, N=99, the mean age was M_{age}=22.04, SD=6.56. All participants signed the Informed Consent Form, which was created according to the International Ethical Standards in the field of scientific research.

Participants were told that this was a research study and, if they participated, they had the chance to win 50 euros at the end of the study. When the data collection was completed, one participant was randomly selected, using the website random.org, to collect the promised reward.

3.2.2.2 Instruments

The study was conducted online. The online participation link was distributed via social media, particularly through student Facebook groups. All participants accessed a Google link, where they were presented with a video of a car crash. The video was a reproduction of the original car crash video used by Loftus & Palmer (1974). Then participants saw random images of two damaged cars. All misleading questions and suggested descriptions of the images used were presented in the Google link. Participants' responses were recorded in the same Google link.

3.2.2.3 Procedure

In the first section, participants were briefly informed about the study, without disclosing the purpose of the study, and were asked to read the informed consent form, then, if they wished to participate, to sign the informed consent agreement. After their consent, questions regarding their age and email address followed.

The next section in the Google link asked participants to watch a video clip carefully. The video clip was a replication of the car accident from the main experiment of the original study of false memories as an effect of misinformation (Loftus & Palmer, 1974), with a duration of 14 seconds. The video clip replicated a car crash in which a blue car ignored a “Yield” sign at an intersection and collided with a gray car. Those 14 seconds only show the collision between the blue car and the gray car, with the “Yield” sign at the intersection, on the main road.

After watching the video, in a separate section, participants were asked several questions. Group 1 of participants was asked “What was the approximate speed of the blue car when it *smashed* the gray car?”. Participants in Group 2 were asked “What was the approximate speed of the blue car when it *hit* the gray car?”. Separate sections in a Google Form do not allow the participant to go back and watch the video again. The method of collecting responses to the main questions was a forced choice option. Both groups of participants were given the option to choose between 30 km/h, 40 km/h, and 50 km/h. A second question for each group, in the same Google section, was “Did you see the “Stop” sign in the video?”, even though there was not a “Stop” sign in the video, but a “Yield” sign. Both groups responded using a forced-choice method, with the options of YES or NO to this question.

In the next section, we introduced a false suggestion, to assess the effect of misinformation. Two images of two damaged blue cars, which had no connection to the car accident in the previous video, were presented in a separate section of the Google link. The first image, A, consisted of a slightly damaged blue car, with signs of damage to the front of the car. The second image, B, presented a severely damaged blue car, with visible signs of damage to the same part of the car. The two cars had different brands, but for the second car the brand was not visible due to the damage. Participants were asked to describe the images. A suggestive example was provided.

Group 1 received the following instruction that incorporated the descriptive suggestion: ″Please describe the following images. For example, "Image 1 – smashing the blue car with the gray one" ″, and for Group 2 the same example, but the verb ″smashing″ was replaced by the verb ″hit″. Participants were asked to describe each image with a short text.

We expect to find a slightly different misinformation effect between the two groups and the two images. Thus, we expect that for Group 1 the misinformation effect will be significantly higher for Image B (where the car was more damaged, given that they received the suggestion containing the adverb "crushed"), and for Group 2 the misinformation effect will be significantly higher for Image A (where the car was slightly damaged and they received the suggestion containing the adverb "hit").

3.2.3. Results

Each section was analyzed independently, therefore false memories were analyzed separately for the misleading questions technique and separately for the suggestibility technique, in the online context.

3.2.3.1 False memories of "misleading questions" technique, in online context

The results were analyzed using the statistical analysis of the t-test with independent samples. The independent variable consisted of the verbs used (″Izbit-Smashed″ and ″Lovit-Hit″), and the dependent variable was the speed chosen by the participants. The results showed no statistically significant differences for the perceived speed between the two groups ($p=.517$, significant at $p\leq0.05$).

The ″STOP″ sign was seen by 0.09% of the participants in the ″Izbit (Smashed)″ group and by 0.07% of the participants in the ″Lovit (Hit)″ group. The probability, P (Y), of answering YES to the question “Did you see the STOP Sign when the cars crashed/hit each other?” is 0.09 for the verb “Smashed” and 0.07 for the verb “Hit”. The independent Chi-Square test did not indicate statistically significant results between the two groups, related to the verbs “Smashed” and “Hit”, for participants who answered Yes and No to the question “Did you see the STOP Sign in the car accident video?”.

3.2.3.2 False memories through the ‘suggestion’ technique, in online context

In this part of the experiment, we wanted to evaluate whether an example of a misinformed or false suggestion will lead to a false memory in the description of the photos, in an online context. Participants in each group first described image A, then image B. The design was 2 (image A X image B) X 2 (group 1 X group 2). In order to have a quantitative analysis, responses were scored as 1 for false responses, 2 for neutral responses, and 3 for correct responses.

The Two-Way Anova repeated measures statistical test indicated a statistically insignificant difference between the within variable, Image A and B, and the between factor, Group 1 and 2 (1- ″Smashed″, 2- ″Hit″), as a result of the suggested examples.

However, the **One-Way Anova statistical test** led to a statistically significant effect between the proportions of false, neutral, and correct response means, $F(2,9) = 141.242$, $p=.000$, significant at $p \leq 0.01$. Tukey's Post-Hoc test indicates significant differences in the means between neutral and false responses (M= .13, SD= .01), correct and neutral responses (M= .14, SD= .02), and correct and false responses (M= .27, SD= .02), $p= .000$, significant at $p \leq 0.01$.

The results do not indicate a statistically significant misinformation effect using the misleading questions technique using online tools. However, *false memories appeared in participants' responses using the suggestibility technique, more specifically in the description of images,* which were not actually part of the previously watched video, although the experimental example suggested this. We did not find a statistically significant effect for Image B, Group 1, nor for Image A, Group 2. In conclusion, the results suggest that when a particular suggestive example is provided for a particular description, that suggestion, often false, can be incorporated into the initial memory of that description, distorting it, even in an online context.

3.2.4. Discussions

The results of the present scientific study indicate that, in a virtual or online context, there is no influence of the verb on the perception of speed estimation. Also, there is no influence of the articulation of the word sign (STOP sign), in English using the preposition ″the″ (engl. 'the STOP sign'), on the false memory of the STOP sign at the intersection presented in the video. In conclusion, in an online context, a misleading question might indeed not produce the phenomenon of false memory. A possible explanation for the lack of significant differences could also be the estimated speed options given, 30-40-50 km/h, which were too close in values and highlighted the median value of 40 km/h. Perhaps in the case of other estimated values of the speed distance (e.g. 30-60-80 km/h), or using a free response of the participants to estimate the speed, the results would have been different. In the original study by Loftus & Palmer (1974), which took place in the laboratory, open-ended responses were used, allowing participants to estimate their speed, so the group for the verb "Izbit-Smashed" estimated a higher speed (40.9 km/h) than participants in the groups that used the verbs *Hit, Collied, Bumped, Contacted* (30.9 km/h). Open-ended responses may have allowed for freedom of response that could have been altered by the influence of the verb used.

3.2.5 Conclusions and Future Research Directions

Can we predict that suggestibility provided in an online context can form false memories? According to the results of our study, the answer would be yes. False memories appear as a result of the suggestibility technique in the online setting. Of course, future research is needed to confirm and strengthen these results.

Implicit memory within altered event memory represents a line of future research that would bring more understanding and consistency to the effect of misinformation or memory illusion in general, through online tools. Implicit false memories raise doubts about the unintentional modified effects of human memory. The theoretical framework of source monitoring reflects memory as a source of attribution, which consists of both conscious and unconscious processes (Zaragoza, Belli & Payment, 2007). The cognitive unconscious, defined as a ″failure of introspection″ (Opre, 2012), can lead to confusion of memory sources or the activation of true and false memory sketches.

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In the following scientifical study, we pursued objective 4, namely investigating the effect of the one-week time interval between encoding and testing on implicit and explicit false memories, within the DRM Paradigm.

3.3 Study 3 – Implicit and Explicit False Memories Conditioned by Lapse of Time

3.3.1 Introduction

False memories refer to events that are misremembered or are remembered but never happened (Roediger & McDermott, 1995). Over the past 20 years, researchers have investigated both explicit and implicit false memories. Attention has grown for implicit false memories when both perceptual and implicit conceptual tests have revealed false memories in participants' responses (McKone & Murphy, 2000). The difference between explicit and implicit false memories lies in the testing phase, where if an explicit test is used, explicit false memory is measured, and if an implicit test is used, implicit false memory is measured. Whether explicit or implicit, false memories are shown to be robust, as they appear in participants' responses when reading scientific studies that investigate them.

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

Given that memory relies on the concept of time, the objective of the present study is to investigate the effects of a one-week delay on implicit and explicit false memories. Our hypothesis is that a one-week time interval between encoding and testing will negatively and significantly affect the emergence of implicit and explicit false memories.

3.3.2 Method

Design

The design of the present scientific study is Interval (Delay x No Delay) x Memory Test Type (Explicit Memory x Implicit Memory) x Item Type (Targets x Critical Words). The independent variable is the time interval, the between factor, the factor that randomly formed the No Delay and Delay groups. The dependent variables are the memory test type (explicit vs implicit) and the item type (target vs critical), which is the memory type (true vs false).

3.3.2.1 Participanți

A total of 113 first-year university students participated in this study. They were divided into two groups, the Delay group (with a time interval between learning and testing) and the No Delay group (with no time interval between learning and testing). Their participation was voluntary, and the assignment of subjects to groups was random. At the end of the scientific study, every 30th participant received a book as a reward.

The participant groups, Delay and No Delay, were randomly created according to the academic group assignment, with two groups of students for each assigned group. We could not control for their second participation in the Delay group and excluded participants based on their responses to the Awareness Questionnaire. Therefore, the groups do not have an equal number of participants. Of the 113 participants, 78 were assigned to the No Delay group (42 women, 4 men, 1 non-binary, 3 undeclared, 27 unspecified for gender and age; M_{age}=19.4, SD_{age}=1.20) and 35 to the Delay group (6 women, 2 men, 27 unspecified for gender and age, M_{age}=19.5). After exclusion criteria based on the Awareness Questionnaire, the No Delay group had 56 participants on the implicit false memory test and 75 participants on the explicit false memory test. The

Delay group had 24 participants on the implicit false memory test and 34 participants on the explicit false memory test.

3.3.2.2 Instruments

A total of 12 DRM word lists were used. Each list had 1 critical lure and 15 associated words. The DRM word lists were created according to the criteria of previous implicit false memory studies (McKone,2000; Van Damme & d'Ydewalle, 2009; Stadler et al., 1999). For this study, word lists both created in Romanian and translated from English into Romanian were used, as there are no statistical differences between them (Horoiță & Opre, 2020).

It was necessary to respect the standards for the implicit memory test, the word stem completion test (Graf & Schacter, 1985; cited in Opre, 2012; cited in Van Damme & d'Ydewalle, 2009). Therefore, all words were at least 4 letters long, the 3-letter root had at least 7 different word completions, and all presented and non-presented words had 3 different letters in the word root. In addition, it was necessary to ensure that the baseline completion rate was not too high, to avoid a ceiling effect on priming indicators. To meet all criteria for DRM word lists to be used in an implicit word stem completion task, two pilot studies were conducted prior to the present study.

3.3.2.3 Procedure

First-year Academic participants were tested in seminar groups in two rounds, for each experimental group, Delay and No Delay. Each group received the study instructions and the Informed Consent form. They were not told that this was a study investigating memory, they were told that the study investigated words, their participation was voluntary, and there was a reward for every 30th participant. Participants read the informed consent and signed it. Each group then participated in the encoding phase, where the words from the 6 studied DRM lists were presented to them in the same order. The instruction for the encoding phase was "Please read carefully the following words that will be presented to you". Participants viewed 60 words on PowerPoint slides, at a 2-second interval between them. Critical words were not displayed, and each DRM list was separated from the next by the * sign, at a duration of 4s.

The next step was the test phase, which for the No Delay group was done immediately, and for the Delay group it took place one week after the encoding phase.

In the test phase, all participants received instructions for an implicit task and an explicit task, in that order. If the explicit test occurred before the implicit one, there was a risk of explicit contamination of the implicit test (McKone, 2004). A word stem completion test was used for the implicit task. Subjects were instructed to write down the first word that came to mind that completed the string of letters they would view on the slides. The experimenter used an example for a better understanding of the task. The 24 word roots were presented on a PowerPoint display, at a 4s interval, which had the same writing font. Participants wrote down the first word that came to mind that completed the presented 3-letter strings (the word stem) on a sheet of paper containing only the instructions given by the experimenter. Participants were also told not to complete the string of letters if they could not find a word, and to move on to the next one. After the implicit test, all participants received an Awareness Questionnaire, to avoid explicit contamination, according to McKone & Murphy (2000). The questionnaire contained the following questions: (1) "What was your general strategy when completing the presented string of letters?"; (2) "Did you intentionally try to complete the string of letters with a word that you remembered from the previously presented study lists?"; and (3) "Did you complete the string of letters with the first word that came to mind?". Not all participants answered NO to question number 2 and YES to question number 3, therefore they were excluded from the study.

After the implicit task, the explicit task followed, in which we used the same type of test, word stem completion, but with explicit instruction. The subjects were asked on an A4 paper to write down all the words they could remember from the previous presentation, which could complete the letter strings on the paper. The specific instruction was “Please write a word that you remember from the word lists presented previously and that completes the following letter strings. If you do not remember the word, please leave the space blank and move on to the next word.”. The 24 roots or letter strings were already printed on the paper they received, along with the instruction. 59 participants received the Awareness Questionnaire for this explicit task as well, and 54 did not. The authors decided to include the 54 responses because the instructions for the explicit task were clearly explicit, so all participants intentionally tried to remember the words they had previously seen in the word presentation. There were no time constraints on the explicit task.

At the end of the experiment, four books were given to four randomly selected participants as a reward.

3.3.3 Results

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

Given that we have an independent variable with two levels (Delay, No Delay) and 3 dependent variables with two levels each (studied and unstudied, explicit and implicit memory, true and false memory), we used a **Manova statistical test** to analyze the effect of time on memory. The Shapiro-Wilk test indicated that the assumption of normality is violated, our distribution was not normal, $p<.001$. Therefore, we used a **nonparametric test, One-Way Anova KrusKal-Wallis**, and the results showed statistical significance at $H(1)= 10.75$, $P=.001$ for explicit studied target words (explicit true memories) and $H(1)=7.85$, $P=.005$ for implicit studied target words (implicit true memories). In the case of memory scores (studied-unstudied), statistical significance was found only for explicit target words, $H(1)= 8.25$, $P=.004$. *The effect of time between the encoding and testing phase has significant implications for explicit and implicit true memories, but not for false memories, in the case of the results of our study.*

3.3.4 Discussion

The present study aimed to identify whether time has an effect on the increase or decrease of explicit and implicit false memories. Our results indicated that one-week interval between encoding and testing, used as a statistical factor between, has no statistically significant effect on false explicit or implicit memories. It did, however, have an effect on veridical or true memory, for both explicit and implicit memory, therefore subjects remembered fewer target words, explicitly and implicitly, after a one-week delay.

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In the following scientific study, we pursued objective 5, namely investigating the effect of neutral, positive, and negative emotional valence on implicit and explicit false memories, when the retention interval is one week between the encoding and testing phases, within the DRM paradigm.

3.4 Study 4 – Emotional Valence of Implicit and Explicit False Memories- Effect of Retention Time Interval

3.4.1 Introduction

Our memory reconstruction model can lead to false memories, which represent events that never happened or that happened differently from how we remember them (Roediger & McDermott, 1995). From a scientific perspective, false memories can be investigated using the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959 Roediger & McDermott, 1995) or the Misinformation paradigm (Loftus, 1975). In the DRM paradigm, participants are given lists of words that are inter-associated with each other and strongly associated with an unpresented critical word. On subsequent memory tests, participants often recall or recognize the unpresented critical words (e.g. 'doctor'), which are words that are semantically associated with all the words in the list (e.g. 'scalpel, hospital, emergency').

Emotional Valence of False Memories

What is the effect of emotional valence on false memories? The scientific literature shows results in favor of negative valence as having an effect of increasing the level of false memories (Budson et al., 2006, Howe et al., 2010; Sharkawy et al., 2008; Brainerd et al., 2008; Brainerd et al., 2010; Dehon et al., 2010; Monds et al., 2012; Zhang, Gross & Hayne, 2017; Bookbinder & Brainerd, 2016; Bessette-Symons, 2018; Chang et al., 2021). However, there are also results in favor of neutral valence, as it has elicited more false memories in other scientific studies (Pesta et al., 2001; Kensinger & Corkin, 2004; Monds, Paterson & Kemp, 2016). However, for positive valence the results are also mixed. Some studies show that positive valence increased susceptibility to false memories (Piguet et al, 2008; Li et al., 2021; Storbeck & Clore, 2005), and other studies demonstrate that positive valence caused fewer false memories (Porter et al., 2003; Choi, Kensinger & Rajaram, 2013; Brainerd et al, 2010; Dehon et al., 2010).

Implicit False Memories

Emotional valence can lead to either an increase or a decrease in explicit memory distortions. Our research question is what happens in implicit memory distortion research? The question is quite new in the scientific field. There are, however, scientific studies that demonstrate how semantic emotional content can affect conscious and unconscious perception and implicit memory (Opre, 2006, 2012). Emotional stimuli are preceded by prior cognitive processing, which can sometimes be automatic, and influence the response in different subliminal or supraliminal tasks (Opre, 2006). Moreover, implicit emotional stimuli can occur unconsciously when neutral stimuli are associated with emotional ones, especially in the case of positive emotional valence (Jurchis, Costea. Dienes, Miclea & Opre, 2020).

It has been shown that implicit false memories occur in response to implicit perceptual and conceptual tests (McKone & Murphy, 2000; MCKone, 2004; Hicks & Starns, 2005; Marini et al., 2012).

The role of emotional valence for automatic semantic priming has been previously investigated and the results show that positive mood has an effect of increasing the automaticity of priming of semantically associated true and false memories (Corson, 2002). However, when it comes to associative priming, each mood facilitates activation, due to the associative link between words (Corson, 2006). For semantic priming, negative valence has an effect only for negative words with high physiological activation (Corson, 2006).

Retention time period

Another important aspect when conducting experiments on false memories is the retention interval, or the time between the acquisition phase and the response phase, which has been manipulated in a number of studies in the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995). Typically, retention intervals of 5 minutes are used, but, to our knowledge, studies have also shown intervals of one day (Payne et al., 1996), two days (McDermott, 1996), one week (Toglia et al., 2010; Thapar & McDermott, 2001), two weeks (Seamon et al., 2002), three weeks (Toglia et al., 2010), or even two months (Seamon et al., 2002).

In the scientific study that manipulated the two-day retention interval, the level of explicit false memories exceeded the level of truthful memories (MCDermott, 1996). Explicit false recall has been shown to be more robust than truthful recall after different retention intervals in other studies as well (Thapar & McDermott, 2001; Toglia et al., 1999; as cited in Seamon et al., 2002; Smith & Kimball, 2012). Explicit false recognition tends to follow the same pattern, as false memories remain robust over time and decline less than truthful memory (Seamon et al., 2002). However, in some studies, false recognition has declined at retention intervals of 2 days to 2 months, to the same extent as true recognition (Brainerd et al., 2001; Lampinen & Schwartz, 2000; Neuschatz et al., 2001; Seamon et al., 2002a, as cited in Jou & flores, 2013). In general, true memory declines at longer retention intervals, but false memory remains stable over time, although it shows a slight decline at short retention intervals, such as one day (Verma & Kashyap, 2020).

Objective and hypothesis

Therefore, the aim of the present study is to investigate the effect of neutral, positive, and negative emotional valence on implicit and explicit false memories, when the retention interval is immediate or one week between the encoding and testing phases, in the DRM paradigm. Based on previous literature, we hypothesized that negative emotional valence would positively and significantly affect the performance of implicit and explicit negative false memories after a one-week retention interval.

3.4.2 Method

3.4.2.1 Participants

The participants of the present study were first-year students at Babeș-Bolyai University. The total number of participants, N=113, was divided into two groups: the 'No Delay' group, N=78 (42 women, 4 men, 1 non-binary, 3 undeclared, 27 without gender and age specifications; M_{age}=19.4, SDage=1.20) and the 'Delay' group, N=35 (6 women, 2 men, 27 participants without gender specifications, M_{age}=19.5).

3.4.2.2 Instruments

For the encoding phase, we used two pilot studies to create DRM lists in Romanian language with neutral, negative and positive emotional valence, which could be used both for the implicit memory test - word stem completion, and for the explicit memory test – stem free recall ('cued recall'). Therefore, it was necessary to respect the criteria for the implicit memory test, the word stem completion test: a minimum of 4 letters for all words, the 4-letter root to have a minimum of 7 possible different word variants, all critical words and items presented had 4 different letters in the stem, and the completion of the base level to be less than 45%, to avoid the ceiling effect on the priming scores (Graf & Schacter, 1985; cited in Opre, 2012; as cited in Van Damme & d'Ydewalle, 2009).

For the response or testing phase, we constructed a new list composed of 24 words in total. The 24 words were formed by the 12 studied and unstudied target words, and 12 studied and unstudied critical words. For the data analysis of the present study, we considered only responses to 18 words, the 9 studied and unstudied target words, and the 9 studied and unstudied critical lures. The unstudied words were used as baseline scores, in order to reduce explicit contamination of implicit false memory results (McKone & Murphy, 2000). The target words were measured as true or truthful memory, and the critical lures as false memory.

3.4.2.3 Procedure

Participants were not told the objective of the study, only that the study was investigating words. Both groups read and signed the Informed Consent. This was followed by the encoding phase, in which participants viewed the DRM lists. The instruction was "Please read carefully the following words that will be presented to you". The DRM lists were presented in the same order for both groups. The words were presented on a Power Point screen, at a duration of 2 s/word. The lists were separated by the * sign, at a duration of 4 s. The critical words were not presented.

The No Delay group received the test phase immediately, and the Delay group was tested one week after the encoding or acquisition phase. The test was the same for both groups: the implicit memory test, the word stem completion test, the Awareness Questionnaire, the explicit memory test, the stem free recall ('cued recall'), and again the Awareness Questionnaire. The Awareness Questionnaire was used to reduce explicit contamination from implicit responses. It was translated and adapted from McKone & Murphy (2000). Participants were asked: (1) "What was your general strategy when completing the word?"; (2) "Did you deliberately try to complete the letters with words that you remembered from the study lists?"; and (3) "Did you complete the letters with the first word that came to mind?". Not all participants answered NO to question number 2 and YES to question number 3, therefore they were excluded from the study. The test was completed with the pencil-and-paper technique. Participants were given the word stems to complete and the Awareness Questionnaire on A4 paper. For the implicit memory test, the word stems were presented on a Power Point display for 2 s. Participants wrote down the first word that came to mind for each stem before the slide changed. In conclusion, they had 2 s for each word stem. No time constraint was used in the explicit memory test.

At the end of the experiment, 4 students were chosen to receive a reward for participating in our study.

Design

The design of our study was 2 (With Retention Interval X Without Retention Interval) X 2 (True X False) X 2 (Implicit Memory X Explicit Memory) X 3 (Neutral X Positive X Negative). The independent variable was retention period, with two groups, the one-week retention group and the group without retention period between encoding and testing. The dependent variables were: memory type (with two modalities: true, false), test type (with two modalities: implicit, explicit), and emotional valence (with three modalities: neutral, positive, negative).

3.4.3 Results

For this design we used the **One-Way MANCOVA** statistical test. The normality test, Shapiro-Wilk, was significant, meaning that the data are not normally distributed. Therefore, we used a non-parametric statistical test, **Kruskal-Wallis One-Way Anova**. Kruskal-Wallis revealed significant differences for implicit neutral true memories, $\chi2$ (1) = 7.23, p = .007, $\varepsilon2$ = .06, explicit neutral true memories, $\chi2(1)$ = 11.68, p < .001, $\varepsilon2$ = .10, and positive = .361, χ = .10) and explicit positive false memories $\chi2(1)$ = 3.68, p = .05, $\varepsilon2$ = .03. There were no statistically significant differences for implicit false memories with neutral, positive, or negative emotional valence.

3.4.4 Discussion

The hypothesis of our study was that negative emotional valence would positively and significantly affect implicit and explicit false memories after a one-week retention interval between encoding and testing phases in the DRM paradigm. Our results revealed a significant difference for positive explicit false memories, which increased for the one-week retention interval group. Regarding negative valence, we can observe a trend of increasing for explicit false memories and decreasing for implicit false memories. The trend for implicit and explicit false memories to increase in the one-week Delay group can also be observed for neutral valence.

Limitations and future research directions

The limitations of the present study are represented by: the number of participants, the use of implicit and explicit memory tests for the same participants, the use of retention period as a between factor, the number of DRM lists for each emotional valence (we used two studied DRM lists and one unstudied DRM list for both negative and neutral emotional valence, and one studied DRM list with two unstudied DRM lists for positive valence, which could explain the negative results of positive emotional valence). However, all limitations could be potential lines of future research directions in the field of false memories.

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IV.CHAPTER IV. CONCLUSIONS AND GENERAL DISCUSSION

False memories are memory distortions through which we falsely or incorrectly remember certain events, situations or information. They are investigated in the scientific literature through two major research paradigms, DRM (Deese, 1959; Roediger & McDermott, 1995) and misinformation (Loftus, 1975).

The main general objective of this paper was to investigate implicit and explicit false memories using both paradigms. We believe that a psycological phenomenon is known more concretely if it is presented through the different facets that each paradigm shows and emphasizes. *Therefore, using both research paradigms allowed us to explore the concept of false memories from several scientific research perspectives, which further allows us to investigate several implications that the phenomenon of false memories can have.*

The first scientific study conducted used the DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) and aimed at validating stimuli in Romanian language. We created an ad-hoc set of DRM lists in Romanian language and translated the set of DRM lists from the normative study from English into Romanian language. We expected to find significant differences in false memories between these two sets of DRM lists, but the results showed no statistically significant differences in false memories, only in true memories (more for set A of lists, created in Romanian). Therefore, our conclusion was that we can create or translate DRM lists into Romanian and they will activate false memories to the same extent. The same pattern existed when investigating the differences between the two sets of DRM lists with emotional valences.

The second scientific study aimed to investigate false memories in an online context, this time using the Misinformation paradigm, more specifically the techniques of misleading questions and suggestibility. The results showed that both in online context, and not only in the laboratory, false memories appear, in the case of suggestibility technique. In the case of misleading questions technique, the results did not show significant false memories in online context. Possible explanations could be the very close response options in terms of speed, or the use of forced response and not free response. Also, another factor could be the fact that there are specific characteristics of online context (absence of an interviewer, absence of a spoken request to answer the question) that can lead to a lower attentional level than in the case of the physical, real, laboratory context, where a verbal label directs the subjects' attention and can produce changes in memory (Daniel, 1972). In conclusion, the results of this scientific study show the presence of false memories in online context as well. The suggestibility technique shows its efficiency in this new investigative context, while the misleading questions technique does not. Perhaps if we brought the online procedure closer to the physical one, the results would look different. In addition, this study shows us the importance of studying false memories due to the disadvantages they bring in online and misinformation context. Considering that we live in the age of online information, it is essential to know the characteristics of false memories, how they are formed, and the phenomenon of misinformation, precisely to prevent possible distortions in health-related decisions, and not only.

Study 3 used the DRM paradigm and had the hypothesis that one-week time interval between encoding and testing would result in a significantly weaker performance of implicit and explicit false memories. We evaluated implicit false memories following the standards of the implicit word stem completion test. The results showed a trend of decrease in implicit and explicit false memories, but due to the small number of participants we did not obtain the priming of implicit false memories. On the other hand, although we did not aim to measure true memories, the analyzed data showed a significant decrease after one-week interval between encoding and testing.

Study 4 aimed to investigate the effect of neutral, positive, and negative emotional valence on implicit and explicit false memories, when the retention period between encoding and testing is immediate or one week. Our hypothesis was that negative emotional valence will positively and significantly affect performance on implicit and explicit false memories. The results showed that there are no differences between implicit false memories with neutral, positive, and negative emotional valences at a one-week retention interval. The results of studies 3 and 4 are consistent with the results of several scientific studies showing the robustness of implicit and explicit false memories. *They remain stable over time*. In conclusion, the present work achieved the proposed objective, which is to investigate explicit and implicit false memories within the two major research paradigms of DRM (Deese, 1959; Roediger & McDermott, 1995) and Misinformation (Loftus, 1975). In the four scientific studies conducted, we used various data analyses, from the T-test, mixed Anova, to non-parametric tests, One-Way Anova KrusKal-Wallis. False memories were presented in detail, according to existing scientific theories. The relevance of studying them is significant in the legal, political, public health fields, and beyond, as false memories are important in any context in which we use cognitive and decision-making processes. Future research directions could focus on the school environment, exploring the relationship with other important concepts, such as increasing commitment to learning (Opre, Buzgar, Pintea, Opre & Secară, 2021), volunteering (Mateiu-Vescan, Ionescu & Opre, 2021), or emotional regulation (Wild, Macavei & Opre, 2024).

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