The association between mental imagery and memory accuracy. The moderating role of an affective state

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Abstract: The aim of this present study is to determine the differential influence of mental imagery and affective state on the tendency to report both true and false memories for positive and negative life events. Second, we wanted to assess the interaction between mental imagery and affective state in predicted true and false memories for positive and negative life events. A sample of 128 participants completed the study. In order to study the occurrence of true and false memories, we used a paradigm containing videos. The results showed that mental imagery is positively associated only with false memory for both positive and negative materials, while a negative affective state is positively associated with true memories for positive and negative events. Moreover, the interaction between mental imagery and positive affect is significant in predicting false memories for positive events. Clinical and legal implications of the results are discussed.

***Key words*:** true memories, false memories, mental imagery, positive affect, negative affect

1. Introduction

It is well known that human memory is both reproductive and reconstructive (see Loftus, 2005, for a review). While reproductive memory involves reproducing information in an accurate fashion, the reconstructive character of memory refers to an active process of assuming, inferring or imagine what happened in order to fill in some missing elements. Consequently, memory errors are very likely to occur under certain circumstances, even in healthy persons (Morgan, Southwick, Steffian, Hazlett, & Loftus, 2013). False memories represent an example of these errors. They occur when a person recognizes or remembers events that never happened (Schacter, 1999).

Although accurate memory is a critical part of everyday life, it may be more important in certain situations. In the legal field, for example, memory recollections influence the decision to convict a person. In these cases, memory errors, like faulty testimonies caused by distorted memory, can have serious

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unwanted consequences. Studying false memories may help us understand the personal and situational determinants that make them more likely to occur. Previous studies showed that mental imagery may increase vulnerability to false memory and, secondly, that transient emotional states and the emotional valence of the to-be remembered events affect memory accuracy (Toffalini, Mirandola, Coli, & Cornoldi, 2015; Zhu et al., 2010). However, previous results are not always consistent. In order to fill a gap in the literature, this current study explored the links among the individual differences in mental imagery, affective state and memory accuracy for positive and negative events.

Mental imagery and memory

Across different sensory modalities, images are most influencing when people try to recollect recent events (Holmes & Mathews, 2010; Weßlau & Stei, 2014). For this reason, one of the key functions of mental imagery is reconstructing past experiences (Laeng, Bloem, D'Ascenzo, & Tommasi, 2014). However, previous studies that have examined the relation between mental imagery and memory accuracy reported mixed findings. On the one hand, studies showed that mental imagery facilitates remembering (Meeks & Marsh, 2010). On the other hand, mental imagery increase the probability of creating false memory of the past events (Mazzoni & Memon, 2003; Pezdek et al., 2006). According to the second line of research, people condense into memory events that took place recently. When they try to remember these events, many details are added non-consciously through imagination (Conway & Loveday, 2015; Borst, Ganis, Thompson, & Kosslyn, 2012). There are also studies that did not sustain the significant association between mental imagery and false memories (Bays, Foley, & Zabrucky, 2013). These inconsistent findings require further research in order to assess if mental imagery is differently associated with true and with false memories for past events. Moreover, they suggest that some other variables may moderate these relations. Consequently, the first aim of this present study is to assess the relation between mental imagery and memory accuracy. In addition, affective state was considered in this study, giving the fact that it has the potential to influence human memory (Forgas, 2013).

Much of the previous studies assessed the relation between false memory and guided imagery (Zaragoza, Mitchell, Payment, & Drivdahl, 2011). Relatively few studies analyzed the relation between individual differences in mental imagery and the memory errors. While guided imagery can be used with caution, individual differences are more difficult to control. Beyond specific techniques based on imagery, personal traits that make a person less reliable when he/she report past witnessed or experienced events, under some circumstances, like legal or clinical fields, are also important. In this study individual differences in mental imagery, and not the manipulation of imagery, were analyzed in relation to memory accuracy.

The role of affective state

Affect represents a subjective experience occurring at a given moment in time, varying along two dimensions of positive and negative emotional activation (Tellegen, Walson, & Clark, 1999; Wyer, Clore, & Isbell, 1999). There is evidence that affect can influence memory, especially when an event is first witnessed (Forgas, 2011), though previous results did not converge in only one direction.

According to the extensive literature that highlighted the benefits of positive affective states, some studies showed that positive emotions facilitate cognitive performance because they allow people to shift attention to novel stimuli in the environment (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Tamir & Robinson, 2007). Moreover, false memories are more likely to occur in situations generating negative emotions (e.g., Dehon, Laroi, & Van der Linden, 2011). On the contrary, some recent findings highlight the benefits of negative affective states, suggesting that these states facilitate a more systematic processing style that improve attention, encoding and memory (Forgas, 2013; Forgas, Goldenberg, & Unkelbach, 2009; Gruber, Mauss, & Tamir, 2011; Storbeck, 2013). Some theoretical frameworks, like affect-as-information hypothesis and the socioemotional selectivity theory, also sustain the positive association between negative affect and memory accuracy. This association can be explained by the fact that the details of negative experiences have higher informational content than the details of positive experiences and, consequently, they attract more attention (for overviews, see Corson & Verrier, 2007). Other studies confirmed the fact that negative affective states reduce the probability of reporting false memory, whereas a positive affective state reduces memory accuracy and increases the probability of incorporating false details into memory (Forgas, Laham, & Vargas, 2005; Hoscheidt, LaBar, Ryan, Jacobs, & Nadel, 2014; Storbeck & Clore, 2011). A paradoxical point of view concerning the relation between affective state and memory is provided by the Paradoxical Negative Emotion (PNE) hypothesis (Porter, Taylor, & ten Brinke, 2008). According to this paradigm, negative emotions have both positive and negative effects on memory, enhancing its accuracy and increasing the susceptibility to misinformation.

Although a large amount of literature confirmed the relation between affect and memory, previous results did not offer a consistent picture about this relation. Accordingly, the second aim of this present study is to assess the relation between affective state and memory accuracy. Third, the interaction between mental imagery and affective states in evoking both true and false memories was also studied. Although we find evidence for the relation among mental imagery, affective states, and memory accuracy, we find no study that assessed how these variables work together in predicting true and false memories. However, there is empirical support for the assumption that there is

a tight interconnection between internal imagery and emotions (Garland, Fredrickson, Kring, Johnson, Meyer, & Penn, 2010), but this interconnection was not studied in rapport to memory accuracy.

Previous experimental studies have shown that both emotional state and emotional content of the to-be-remembered material affect memory accuracy (Nielson & Powless, 2007). Findings concerning whether emotional materials enhance or impede memory are also mixed (Dehon et al., 2011; Gallo, Foster, & Johnson, 2009). For example, some studies showed that memory for negative events are more susceptible when it comes to incorporating false details (Porter et al., 2008), but a debate exists regarding whether negative events make false memories more likely to occur (e.g., Gallo, Foster, & Johnson, 2009). Moreover, a mood congruence effect was also reported, the participants being more likely to report false memories for materials congruent with their mood (Ruci, Tomes, & Zelenski, 2009). Giving previous evidence for the fact that not only affective state, but also the valence of the materials that need to be remembered influence the memory accuracy, memories for both a positive and a negative event were considered in the present study.

2. Method

2.1 Participants

A sample of 133 undergraduate students were invited to take part in the study. Five participants were excluded from the dataset because they failed to complete the tasks required by the study. The final sample of the 128 participants consisted of 84.9% women. The age range between 18 and 34 (mean age of 21.14 years, SD = 2.29). All the participants received credits for their involvement.

2.2 Materials and measures

Video False Memory Paradigm

In this study, we used a video false memory paradigm built around the principles of the Deese-Roediger-McDermott paradigm (Roediger & McDermott, 1996). In this paradigm, participants receive word lists consisting of semantically related words (e.g., temper, rage) that are related to a critical, non-presented lure word (i.e., anger). Recall and recognition tests show that a minority of the participants falsely remember the critical lure. Recent studies showed that false memory paradigms based on visual scenes are effective in evoking false memories (Otgaar, Howe, Peters, Sauerland, & Raymaekers, 2013; Otgaar, Howe, Peters, Smeets, & Moritz 2014; Peters, Engel, Hauschildt, Moritz, Jelinek, & Otgaar, 2012). Specifically, two videos different in terms of emotional valence were used to assess both false and true memories. Each video lasted for about 2 minutes (the negative event – 2 minutes and 19 seconds, positive event – 2 minutes and 10 seconds). We also wanted to select a neutral film, to use for a control group. Based on the results from

the pilot study, we observed that all the events were evaluated as either positive, or negative. Therefore, to choose a neutral film was not possible.

The videos were chosen based on the following criteria: (1) themes are easy to identify; (2) themes are universally familiar from human daily-life experience or other sources (e.g., media news, movies); (3) present detailed dynamic setting; and (4) are suitable for the emotional content. For selecting the two videos, a pilot study was conducted, where participants (33 students, 82.7 % females, Mage = 20.15, SD = 1.03) were required to view a series of three negative and three positive film clips. The participants from the pilot study reported their mood after each video using ten items from the Positive Affect Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) on an 11-point scale ranging from 0 (sad mood) to 10 (happy mood), where the middle point (5) represent the neutral position. We selected the films that best enhanced the participants' positive, respectively negative mood (M = 9.27, SD = 1.50 for positive condition, M = 2.70, SD = 1.79 for negative condition). For positive condition, the video presents a party from a child's birthday, with many people, both children and adults, having fun. For negative condition, the video represents a reportage about the consequences of a flood that followed an earthquake.

The recognition task was composed of 40 items: 10 presented items for each video (20 in total) with a corresponding contextual cue from the specific video and 10 non-presented items for each video (20 in total). Of the latter items, five were unrelated to the videos' content (e.g., a present from the child' grandparents in the *anniversary video*) and five were critical, related items with some details that were presented in the video (e.g., police car in the *flood video*). The participants were asked to evaluate if the items (affirmations) were true or false, by choosing one answer from the following: *True/ False/ I am not sure or I do not remember*. These items were presented in random order. Each item had a code consisting of a letter (representing the initial of the videos' names) and a number (the number of the item). The participants were informed that the letter represents the video they should report to when responding to the item. For example, the first item was *A1. The child's name is Matthew: True/ False/ I am not sure or I do not remember*.

The Spontaneous Use of Imagery Scale (SUIS; Reisberg, Pearson, & Kosslyn, 2003) was administered to measure to what extent participants spontaneously use imagery in daily life. This questionnaire consists of 12 items (e.g. *When I first hear a friend's voice, a visual image of him or her almost always comes to mind.*), rated on a 5-point scale (1 = never appropriate, 5 = always completely appropriate). The SUIS has high internal consistency and convergent validity (Reisberg et al., 2003; Nelis, Holmes, Griffith, & Raes, 2014). A total score was computed because it is recommended given the

unidimensional underlying structure (Nelis et al., 2014). The Cronbach Alpha in our sample is .79.

Positive Affect Negative Affect Schedule (PANAS; Watson et al., 1988) was used to measure positive (e.g., "happy") and negative affective states (e.g., "afraid"). The instrument consists of 10 items for positive affect (PA) and 10 items for negative affect (NA). The participants rated all the items on a 5-point scale (1 - *slightly or not at all*, and 5 - *very much*) with that momentary time frame. The average scores were computed separately for each dimension; higher scores indicated a higher level of positive (PA) and negative (NA) affectivity, respectively. The internal Cronbach alphas were .82 for PA and .88 for NA, respectively.

The items of the two scales were translated into Romanian, using the back-translation method. After translating the items into Romanian, a certified professional translated them back into English. There were no major dissimilarities as compared to the original scales.

2.3 Procedure

The participants were informed that they would participate in a memory study that involves completing two scales, and watching two short videos. They were also instructed to pay close attention to the videos because they would be asked to recall the details later. The participants were also informed that their participation was voluntary and that they could finish the experiment at any point they want. After signing an informed consent, they filled in the SUIS and then the films were shown. The participants were tested in six groups of about 20-23 participants for each group, and the order of the videos' presentation was counterbalanced. After watching the videos, the participants were asked to complete PANAS and the recognition task. Finally, the participants were debriefed and the experimenter thanked them for their involvement.

For each participant, three scores were computed: a score representing true memories (the total number of *True* answers for true statements and *False* answers for false statements, which represent a good memory for the videos' content) and two scores that reflect false memories (a score for unrelated items and a score for critical related items). When it came to measuring false memories, we computed the number of *True* answers for false statements.

3. Results

To ensure that the participants rated the valence of the events presented in the videos according to our expectations, we asked them to provide valence ratings on a three-point Likert scale (1 = negative, 2 = neutral, 3 = positive) after watching the two videos. As we expected, all the participants rated the positive event with a 3 and the negative event with a 1.

Correlations analysis

Means, standard deviations, and correlation coefficients for all scales are reported in Table 1. Mental imagery positively correlated with critical false memories for a positive event (r = .22; p = .013) and a negative event (r = .16; p = .042). Negative affect positively correlated with true memories for positive event (r = .13; p = .047) and negative event (r = .10; p = .032). Moreover, the negative affective state negatively correlated with false memories for both events (r = -.15; p = .022, for positive event; r = -.11; p = .017, for negative event). All the above presented correlations are weak to medium (Cohen, 2013), and there are no problems with multicoliniarity (Tabachnick & Fidell, 2007).

Table 1. Means, standard deviations, and bivariate correlations for all study variables

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. TMP	1								
2. TMN	.24**	1							
3. FMPc	.15	.04	1						
4. FMNc	.08	-.11	.30***	1					
5. FMPun	-.01	.04	.49***	.32***	1				
6. FMNun	.25**	.06	.22*	.24***	.35***	1			
7. MI	.06	.11	.22*	.16*	.13	.09	1		
8. PA	.18	.09	.16	.09	.13	.11	.20*	1	
9.NA	.13*	.10*	.01	-.11	-.10	.04	.06	-.15	1
M	36.53	78.89	22.26	23.61	25.20	34.12	48.33	7.34	33.31
SD	11.90	15.57	5.56	3.51	3.92	4.33	6.26	7.91	8.90

Note. TMP – true memories for positive event; TMN - true memories for negative event; FMPc – critical false memories for positive event; FMNc - critical false memories for negative event; FMPun – unrelated false memories for positive event; FMNun - unrelated false memories for negative event; N = 128; *p < .05; **p < .01; ***p < .001.

Testing for moderation

We conducted hierarchical regression analysis for true and false memory outcomes, with mental imagery in step one, positive and negative affect in step two and interactions between mental imagery and affective states in the final step. The main and interaction effects were centered to minimize multicollinearity.

For true memories, the results showed that mental imagery did not interact with positive and negative affect in predicting the number of true memories (Table 2).

Table 2. Hierarchical regression models of mental imagery, positive and negative affect on true memories for positive and negative life events

True memories								
	Positive event				Negative event			
	β	t	ΔR^2	ΔF	β	t	ΔR^2	ΔF
Step 1			0.01	0.50			0.01	1.48
MI	0.06	0.71			0.11	1.22		
Step 2			0.05*	2.55*			0.01	0.89
PA	0.15	1.64			0.06	0.63		
NA	0.11*	-1.25			0.10*	-1.05		
Step 3			0.02	0.84			0.01	0.48
MIxPA	-0.24	-0.42			0.50	0.86		
MIxNA	0.65	1.05			-0.13	-0.20		

Note. MI – mental imagery; PA – positive affect; NA – negative affect; N = 128; *$p < .05$.

For critical false memories, the results showed that mental imagery interacted with positive affects in predicting only false events for a positive event (Table 3). The participants with a high level of mental imagery and a high level of positive affect reported the highest number of false memories. For participants with a low level of mental imagery, the number of false memories does not depend on the level of positive affect (Figure 1).

Table 3. Hierarchical regression models of mental imagery, positive and negative affect on critical false memories for positive and negative life events

False memories (critical)								
	Positive event				Negative event			
	β	t	ΔR^2	ΔF	β	t	ΔR^2	ΔF
Step 1			0.05*	6.38*			0.02*	3.48*
MI	0.22*	2.52			0.17*	1.87		
Step 2			0.04	0.86			0.02	1.07
PA	0.12	1.30			0.04	0.46		
NA	-0.13*	0.14			-0.11*	-1.29		
Step 3			0.06*	2.06*			0.03	1.50
MIxPA	1.09*	1.96			0.84	1.50		
MIxNA	0.64	1.06			0.79	1.28		

Note. MI – mental imagery; PA – positive affect; NA – negative affect; N = 128; $^*p < .05$.

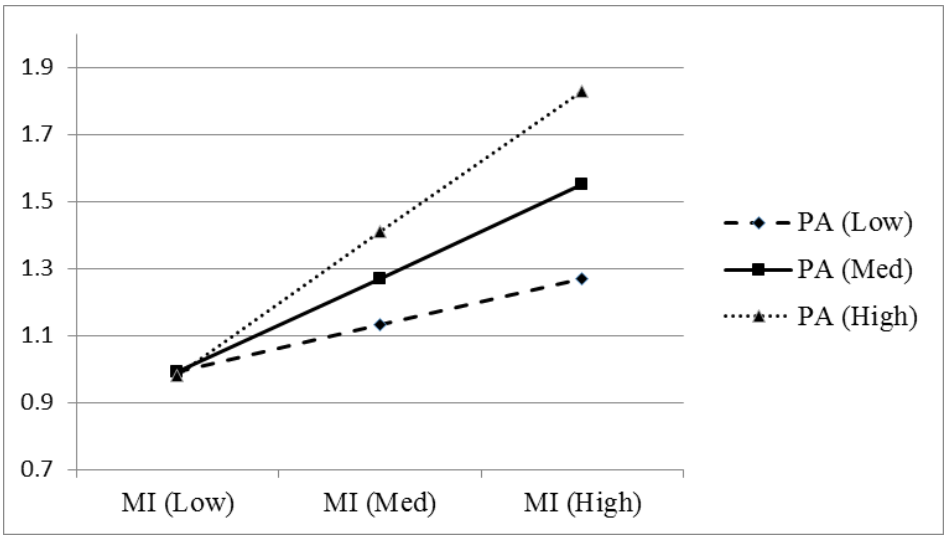

Figure 1. Presence of critical false memories for positive event as a function of mental imagery and positive affect. Notes: MI – mental imagery; PA – positive affect. Simple effects were represented with mental imagery and positive affect defined as at least +1 and -1 standard deviations from the mean, respectively.

For unrelated false memories, the results showed a similar pattern. Specifically, mental imagery interacted with positive affect in predicting false memories for positive event (Table 4). The participants with a high level of mental imagery and a high level of positive affect also recorded the highest number of false memories. The results are presented in Figure 2.

Table 4. Hierarchical regression models of mental imagery, positive and negative affect on unrelated false memories for positive and negative life events

False memories (unrelated)								
	Positive event				Negative event			
	β	t	ΔR^2	ΔF	β	t	ΔR^2	ΔF
Step 1			0.01	2.43			0.01	0.98
MI	0.14	1.56			0.10	.99		
Step 2			0.01	1.20			0.01	0.74
PA	0.09	1.00			0.10	1.17		
NA	-0.09	-0.99			0.05	0.53		
Step 3			0.04*	2.55*			0.01	0.18
MIxPA	1.12*	1.99			0.35	0.60		
MIxNA	0.97	1.58			0.10	0.15		

Note. MI – mental imagery; PA – positive affect; NA – negative affect; N = 128; *$p < .05$.

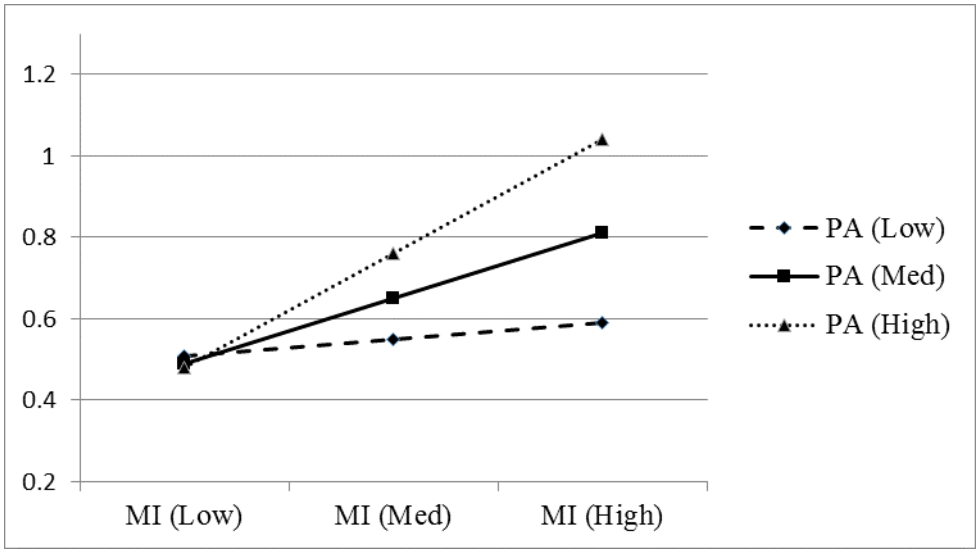

Figure 2. Presence of unrelated false memories for positive event as a function of mental imagery and positive affect. Notes: MI – mental imagery; PA – positive affect. Simple effects were represented with mental imagery and positive affect defined as at least +1 and -1 standard deviations from the mean, respectively.

4. Discussion

The overall aim of this present study was to analyze if mental imagery interacted with a positive and negative affect in predicting true and false memories for positive and negative valence materials.

First, our results showed that a high level of mental imagery is associated with a high level of critical false memories for the positive and negative event. Related effects were also showed by previous studies, which found that mental imagery increases the probability of the occurrence of false memories (Mazzoni & Memon, 2003; Pezdek et al., 2006). Therefore, these results bring further support for the fact that a person with a high level of mental imagery has a higher tendency to add false details when trying to remember a past event (Conway & Loveday, 2015). Another important result showed that a negative affective state is positively associated with a high level of true memories for both a positive and negative event. Moreover, a high level of negative affective state is associated with a lower tendency to report false memories. This result is also in accordance with previous studies that highlight the benefits of a negative

affective state, consisting in encoding and memory improvement (Forgas, 2013; Storbeck, 2013).

Mental imagery interacted with a positive affect in predicting the number of false memories for a positive event (both for related and critical items). Specifically, the participants reported a higher number of false memories when they also reported a high level of mental imagery and a high level of a positive affect. An affect congruency effect may occur for the relation between positive affective state and memories for only a positive event. Previous studies also showed that participants were more likely to report false memories for materials that were congruent with their mood (Ruci et al., 2009). This effect may explain why the positive affective state was associated only with memories for a positive event, not with memories for a negative event. Therefore, a current positive affective state may direct the attention preponderantly to stimuli congruent with that state.

Studying how affective state and mental imagery interact to influence memory for a witnessed event is relevant for understanding the factors that contribute to eyewitness testimony. Moreover, these findings may have some implications in clinical psychology. Psychologists and psychotherapists should be aware of the individual particularities that make a person more likely to report false details when remembering past events. The present findings highlight the benefits of negative mood, according to some previous studies; this brings evidence for the fact that positive affective state may have maladaptive consequences, in combination with a high level of mental imagery.

Several limitations should be noted. First, the study is cross-sectional, and it did not allow us to assume the existence of causal relations. Second, the emotional valence of the positive event may be more intense than the emotional valence of the negative video. Consequently, the positive video was more salient for the participants. Probably a negative life experience caused by humans (e.g., an act of violence, a car accident) may be more disturbing and would be more appropriate for studying false memories, because it would be more similar to real life situations reported in a legal field or clinical practice. Due to ethical concerns, we wanted to avoid exposure to a situation with a high negative emotional impact. Third, in this study, the female participants represent the majority of the sample. Previous studies showed that there are gender differences that moderate the relation between intense negative states (e.g. stress) and memory performance (e.g., Buchanan & Tranel, 2008). Future studies assessing false memories should use samples consisting of an equal number of males and females and should assess the role of gender differences in reporting false memories.

Although the question related to the way mental imagery and affective states may influence the memory accuracy requires further empirical support, this current study facilitates the understanding of how these factors interact to

determine the tendency to report false details for past witnessed events. Because the reports of previous experienced or witnessed events are helpful as long as they are truthful, particular circumstances that affect memory accuracy should be known.

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