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Elaborato finale

Individual differences in psychopathic personality traits and their relation with false memories for emotional events

Differenze individuali nei tratti di personalità psicopatica e la loro relazione con i falsi ricordi per eventi emozionali

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Introduction

Giving that false memories have always been a reason for misunderstandings in the most diverse fields of application, in the first chapter I will discuss the main theories regarding this construct, especially for emotional contents, followed by a series of factors that could favor or interfere with this phenomenon. Besides, evidence exists that individuals with high psychopathic personality traits process emotionally charged stimuli differently from those with low psychopathic traits, thus, in the second chapter, an introduction of psychopathy and its components will be provided, together with the resulting implications with false memories. Considering that in previous studies high psychopathic individuals turned out to be less susceptible to produce false memories (especially for negative events), the current study aims to further investigate this relation and the underlying mechanisms. Lastly, in the third chapter, I will present the hypotheses, the sample, the materials used to measure the constructs of interest, the procedure and the data analysis, followed by the results and a general discussion about the main findings emerged. Assuming that a perfect degree of certainty will never be achieved due to the reconstructive process involved and the infinite number of factors that could influence a memory, the reason moving this study is the possibility to guarantee an assessment of the validity of the testimonies as fair as possible, in order to prevent false judicial sentences.

1. FALSE MEMORIES

Human memory is not a simple screenshot of the surrounding world, and the last 50 years of research have shown that it is more subject to distortions than what is typically considered from lay people's naïve point of view. Due to the reconstructive process involved in remembering an event, and the fact that a number of variables - including, but not limited to, vision, imagination, semantic memory, and beliefs - have an impact on this (Brained & Reyna, 2005; Howe & Knott, 2015), a single detail can easily lead to misunderstandings; furthermore, a completely different narration of an event can result from reconstructive memory processes. This is why our goal should be to gain further knowledge on which factors could interfere with a correct remembrance and how to evaluate them.

Over the last decades, several researchers, therapists, and criminal justice professionals have focused on how true and false memories are formed when individuals are asked to remember emotionally laden events. Nonetheless, divergent findings emerged in different studies. There is evidence suggesting that emotionally charged information may be remembered more accurately (Kensinger & Schacter, 2005; Pesta et al, 2001), due to the fact that emotionally stimulating contents, especially those with a negative valence, make the material more distinctive while lowering the inclination to endorse unpresented lures (Kensinger & Schacter, 2006a, 2006b). However, observations in the opposite direction have also been made with emotional content boosting false recollections in comparison to neutral ones (Brainerd et al. 2008; Gallo et al. 2009). In the same line the Paradoxical Negative Emotion hypothesis (PNE; Porter et al. 2008) states that false memories are made easier to produce by negative emotions, despite the fact that they typically favor future remembering. This perspective's fundamental premise is that unpleasant emotional experiences have an adaptive purpose by enabling the assimilation of as much information as possible, even if it is inaccurate, in order to prevent potential risks in the future.

It has been discovered that a number of variables interact with emotional valence to influence the creation of false memories, such as mood (Storbeck & Clore, 2005) and anxious/depressive symptoms (Howe & Malone, 2011; Toffalini et al. 2015). Furthermore due to the fact that WM resources are critical for source monitoring to determine whether the memory trace is real or not, higher WM capacity has been found to be associated with a general reduced occurrence of false memories (Bixter & Daniel, 2013; Peters et al, 2007). In particular, if crossed with valence, high WM abilities are connected with a lower

amount of negative false memories compared to neutral ones, instead individuals with low WM produced more negative false memories than average, compared to positive (Mirandola et al, 2017).

One of the most used paradigms to study spontaneous false memories in the Lab is the DRM paradigm (Roediger & McDermott, 1995), which consists of an oral or written presentation of a list of related words (e.g., *bed, rest, awake, tired, dream, wake, snooze, blanket, doze, slumber, snore, nap, peace, yawn, drowsy*) and a request to remember as many words as possible from that list. Typical results show that subjects recall a related but unpresented word (e.g., *sleep*), known as a 'critical lure', with the same frequency as other presented words.

In order to explain the nature of these effects and their relation with some personality traits (in particular, in this study we considered psychopathy), two frameworks are considered: AAT (Howe et al. 2009) and FTT (Brainerd et al. 2019). According to the associative-activation theory the encoding of one word automatically spreads to the activation of non-presented but related concepts in our own lexicon and this is especially true with negative contents (Howe et al. 2010), so the result is the formation of false memories. Based on that we could predict a fewer amount of emotionally negative errors in people scoring high on psychopathic traits due to the difficulty in processing negative information, resulting in a reduction of activation of related negative words. On the other hand the fuzzy-trace theory states that the experiences' representations of each individual's event can be stored either as verbatim traces (details and item-specific information) or gist traces (bottom-line meaning, semantic and thematic properties). Following the theory the processing of gist traces may facilitate false memories by incorporating conceptually similar but non-presented events, and this effect can increase with emotional materials due to the related increased activation of gist traces. Indeed, the conclusion is similar: a reduced elaboration of negative contents (supposed for psychopathic individuals) should lead to a more difficult retrieval of the gist, resulting in lower amount of negative false memories. These aspects have been studied also in children with callous-unemotional traits – which are considered precursors of psychopathic personality - using the DRM paradigm (Thijssen, Otgaar et al. 2013). Results were consistent with those two theories, showing that children with high CU traits had fewer false memories on the negative word lists compared to the neutrals, suggesting an impaired emotional processing.

Moreover, further elaborating scripted material through free recall before a recognition task leads to an increased false memory production for the emotional stimuli compared to the recognition-only group (Mirandola et al, 2014); these results are consistent with findings emerged in the DRM paradigm when participants were asked to recall an event prior to a recognition task (i.e., adding a layer of additional processing).

Considering all these factors, one of the most useful application field of this knowledge concerns the validity of the testimonies in the courtroom, when a single error could lead to false accusations resulting in false sentences. According to a Kopelman's study (2013) there may be repercussions for memory and neuropsychiatric issues at every stage of the judicial procedure: fitness to plead, the insanity defence, cases of automatism, diminished responsibility, and at sentencing. Assuming that a perfect objectivity will never be achievable, a more specific understanding of these mechanisms could certainly lead to a less amount of wrongly accused people.

In the following chapter, I am going to revise the major results concerning the role of personality traits, in particular psychopathic personality, on the proneness to incur false memories for emotional events.

2. PSICHOPATHY AND FALSE MEMORIES

Unlike the well established antisocial personality disorder, psychopathy is not included in the DSM-5, but they both have some common characteristics. In particular, the term psychopathy refers to a large range of interpersonal and affective facets, personality traits and behavioural patterns; it can be defined as weakened emotional experience (resulting in lack of empathy), heartlessness, narcissism, manipulativeness, interpersonal appeal, recklessness and impulsiveness (Hare & Neumann, 2008). For this study we considered the following three scores of the Psychopathy Personality Inventory as representative of the most relevant aspects: firstly Fearless Dominance which refers to immunity to stress, hindered threat sensitivity, low levels of anxiety and in general a shallow affective states; secondly Coldheartedness that is characterized by a tendency to be shallow and insensitive to deep emotions; lastly Self-centered Impulsivity which can be explained as carefree nonplanfulness, impulsive nonconformity, Machiavellian egocentricity, and blame externalization subscales. In a comparison between psychopathic and non-psychopathic offenders (Christianson, Forth et al.1996) an important effect emerged: psychopaths, unlike the other group, recalled equally well the central and the peripheral details of both neutral and emotional materials, suggesting that the affective intensity that ordinarily serves to differentiate emotional from neutral events apparently does not exist to the same degree in psychopaths as it does in the other group, suggesting a tendency to consider most events neutral. Nevertheless, psychopathic personality traits are also associated with some useful aspects, such as the ability to get to the top of the career ladder managing the related pressure (Lilienfeld et al. 2015).

Criminal behaviour is not considered a core feature of the construct, but rather a correlate (Skeem & Cooke, 2010). This is consistent with the thoughts of Hervey Cleckley, the pioneer in the field of psychopathy, who theorized that people with psychopathic traits may exist within the population outside of legal systems and have the ability to thrive due to their charming and manipulative styles of interacting. As a matter of fact if we take into consideration, for instance, that the prevalence of clinical psychopathy in the general Spanish population is around 0.55%, and that of subclinical psychopathy is around 1.65% (Sanz-Garcìa, Fernàndez et al. 2022), it is clear how many individuals are able to suit society's needs even living together with those traits.

In order to analyse this construct and its implications, in this study we administered a paradigm able to elicit false memories: Emotional False Memory paradigm (see Appendix for an example). Particularly relevant is to distinguish between these two types of errors: causal errors refer to wrongly claiming to remember the causal antecedent of the viewed action ending, conversely gap-filling errors occur when a non-presented but related event is erroneously remembered. Besides, through the Remember-Know paradigm (Tulving, 1985), we were also interested in investigating the qualitative phenomenological experiences connected to false memories, this because in past studies Remember responses were correlated to a lower production of both negative and positive memory errors compared to neutral ones (Mirandola et al, 2020).

As far as PPI-R scores are concerned, results achieved in a recent study (Mirandola et al. 2022) are consistent with the hypothesis suggesting a reduction in semantically based negative false memories caused by a tendency for people with high psychopathic traits to handle negative content differently than other individuals. In particular, increasing Fearless Dominance scores were associated with a decrease in false memories for negative experiences, specifically for gap-filling errors. This may be attributed to their decreased capacity to discern how emotionally intense the viewed episodes are, especially the fearful ones. Furthermore, considering causal errors for negative materials, high FD individuals selected less frequently the Remember judgment, such that when false memory occur in people scoring high on this trait, these are not as vivid and memorable as they are for other individuals. Considering Coldheartedness a tendency to have a poorer episodic memory was found only for negative and neutral events, suggesting a similar perception of these two materials due to their difficulty at feeling strong emotions. Following this view, higher scores in Coldheartedness were associated to an equal amount of negative and neutral errors, if compared to positive ones.

Another detectable effect in individuals with psychopathic traits is measurable by a psychophysiological index: the startle reflex (typically measured as the blink response to an acoustic noise). If on the one hand, for non-psychopaths individuals, this reflex is potentiated during viewing of threatening stimuli, for individuals scoring high on psychopathy traits it is attenuated or even absent (Patrick et al. 1993), reflecting an hindered defensive motivational system which leads to a low-fear disposition.

Based on neuroimaging studies with individuals with high levels of psychopathic traits results show lower activity in a number of brain areas, including the amygdala and anterior

insula, when processing emotional/empathy inducing/salient stimuli. Research also implicates an aberrant neural response in regions typically associated with reward processing, cognitive control and emotional regulation, including the orbitofrontal cortex and striatum, when individuals with high levels of psychopathic traits perform tasks involving decision-making and reward (Viding et al. 2014). Moreover the slow cortical potentials in the frontal regions of the brain associated with anticipation of an aversive stimulus were smaller in psychopaths than in non-psychopaths.

In the third chapter, the current study (which is a follow-up study of Mirandola and colleagues' work, 2022) will be described in all its phases.

3. THE CURRENT STUDY

3.1 Hypotheses

Given the fact that several studies have underlined a reduced emotional processing in individuals with high psychopathic traits (Vaidyanathan et al., 2009 ; Buchanan, 2007; Christianson et al., 1996; Patrick et al., 1993; Sadeh & Verona, 2008), and given their lower propensity to produce negative false memories (Mirandola et al, 2022), in the current study we tried to further explore the relationship between psychopathic personality and tendency to process and later retrieve emotional events. In particular, we expected a lower production of gap-filling errors, especially for negative episodes. In order to study in deep this pattern, after the retrieval phase we asked participants to provide a summary of the episodes seen in the encoding phase, conjecturing a worse elaboration and understanding of the negative scenes for those participants with high psychopathic traits. We also considered the role of working memory due to the evidence that an increase in causal errors (especially for negative emotional contents) occurs with decreasing WM (e.g., Mirandola et al., 2017; Mirandola & Pazzaglia, 2021).

3.2 Participants

A group of 25 individuals participated in this study, all of them were Italian citizens. The sample consisted of 7 females and 18 males, from 19 to 55 years old, mean age was 32.04 with a standard deviation of 13,72. All participants were recruited on a voluntary basis and for all of them a written informed consent was obtained before and after the experiment.

3.3 Materials

Emotional False Memory Paradigm

Encoding phase: 9 scripts/episodes were presented on a screen, each of these consisted of 13 pictures representing a normal everyday event. The episodes were the following: waking up, rock climbing, returning home after a long trip, going on a bike trip, track competition, going shopping, playing at the slot machine, dating and birthday (see

Appendix for an example). One among these 13 photos represented the emotional connotation which could be positive, neutral or negative. For example in the waking up episode a girl gets out of bed, opens the window, brushes her teeth, gets dressed and walk to the kitchen to have breakfast, now 3 different pictures could appear: in the positive scenario she finds a bouquet of red roses in the pantry, in the neutral one she normally takes cereals from that pantry, finally in the negative scenario the girl finds a black insect that scares her. The emotional valence was balanced among the 9 episodes, such as every participant saw 3 negative, 3 neutral and 3 positive scenes. The emotional valence was also balanced among the participants, so every episode was administered with a positive, negative and neutral outcome in an equal number of times. Item type was also balanced, one differing from the other for the value of each picture (such as a target in the first condition could be a distractor in the second and viceversa). Finally, 5 photographs that were inconsistent with any of the episodes were shown at the beginning and 5 at the end of the presentation in order to avoid primacy and recency effects on the relevant material.

Recognition phase: Participants received a surprise test. Stimuli for the recognition phase consisted of a unique sequence of 90 photographs (45 targets and 45 distractors) presented in a randomized order. For each episode, four targets and four distractors were included, one of the four distractors was the causal antecedent whose outcome was the picture that gave the emotional valence presented during the encoding phase (considering the previous example, a photo depicting the girl about to open the pantry is presented). Furthermore, 18 photographs inconsistent with any of the episodes were included (9 targets and 9 distractors).

Forward and backward digit span tasks (Wechsler Adult Intelligence Scale; Wechsler, 2008).

Considering the fact that in previous studies working memory had a protecting role against the false memories' production (e.g., Mirandola et al., 2017), we included a WM task in the experiment. Both the forward and the backward digit span tasks require the participants to recall strings of digits, the first in the correct presentation order and the latter in the reverse. Sequences of numbers were read aloud by the experimenter with a delay of 1 second between one and the other, every time the sequence is retrieved correctly the

number of digits increased by 1, the test stopped when the participant failed two consecutive trials of the same length.

Psychopathy Personality Inventory.

The Italian version of the Psychopathic Personality Inventory-Revised, PPI-R (La-Marca, Berto, & Rovetto, 2008) was administered. The instrument is a self-report questionnaire made up of one hundred and fifty-four items, each of them with 4 answer possibilities (1 = false; 2 = mostly false; 3 = mostly true; 4 = true). This test provides a large range of scores but in order to accomplish the needs of our experiment we considered only 3 scales: Self-Centered Impulsivity (SCI; Cronbach's alpha = .91. Example of item: "If i really want i can persuade many people to do almost anything I want"); Fearless Dominance (FD; Cronbach's alpha = .85. Example of item: "When I meet people, a smile is often enough for me to make them interested in me"); Coldheartedness (C; Cronbach's alpha = .65. Example of item: "I often feel guilty about small things"). The correlations among the three scales of the PPI-R are the following: FD and C: $r = .36$, $p = .11$; FD and SCI: $r = .65$, $p = .002$; C and SCI: $r = -.07$, $p = .74$. Raw scores were then converted into T-scores, based upon the Italian normative sample.

Summary of the episodes

Participants were asked to tell the experimenter about the main actions remembered for each script, giving the title of the episode as stimulus. Data were then evaluated in terms of completeness and number of details retrieved in order to reveal if high scores in the PPI-R questionnaire can predict a poor understanding and retrieval.

3.4 Procedure

The study was mainly conducted face-to-face, apart from 4 people who were tested online, via Zoom. They were first welcomed by the experimenter and asked to provide the pre-informed consent while their general personal information was marked (name, gender and age). Whereupon the experimenter showed the computer (or shared his screen, for those who took the online experiment) to the participants and administrated the Encoding phase of the Emotional False Memory paradigm. Participants were instructed that they would

watch a series of images depicting people during normal everyday activities and they would have to pay attention and try to understand what those pictures represented. This phase consisted of a series of 126 pictures, each one separated from the following one by a black screen, with a delay of 2 seconds between each transition. As soon as that phase was finished, the forward and the backward digit span tasks were administered. Subsequently, making sure that a 15 minutes interval from the end of the encoding phase was passed, the recognition phase was administered: for each photograph, participants had to utter "yes" or "no" whether they could, respectively, remember having seen that picture during the encoding phase or not. In case of "no" response we moved on to the next one, conversely participants were asked to specify between 2 options: "Remember" if they could clearly recall that image (so they could remember a detail or the moment they saw it) or "Familiar" if they only had the feeling of having seen it. Answers were marked on a paper scheme by the experimenter. As soon as the 90 pictures were concluded, the PPI-R questionnaire was administered and lastly the summary of the 9 scripts was asked. Eventually participants were informed about the main goals of the experiment and then asked to fill the post-informed consent. Unless the last task (whose evaluation was qualitative) all data were then transcribed in an Excel file.

3.5 Data analyses

Data were of a binomial type ("yes": 1, or "no": 0), so we decided to use a logistic mixed-effects model (Baayen, 2008; Jaeger, 2008), through R software (R Core Team, 2017). Causal and gap-filling errors were the dependent variables and were calculated as the "yes" responses to causal and script-consistent distractors, respectively. Hits were the "yes" responses to target photographs. Each dependent measure was included in separate models. Participants were treated as random effects. Valence was treated as the fixed effect of interest. The three factors of the PPI-R (Coldheartedness, Fearless dominance and Self-centered impulsivity) were the predictors in the respective model, we decided to use these three scores separately (rather than the total score of the questionnaire) because not all of them significantly correlated with each other. The significance of both fixed and random effects was tested through a series of likelihood ratio tests for nested models based on the chi-square distribution (Pinheiro & Bates, 2000). The Akaike Information Criterion (AIC; Akaike, 1974) was also reported; lower AIC indicates a better model. Moreover given the available evidence of the influence of WM (Mirandola et

al., 2017) on emotional false memories, we included WM (in particular the score at the backward digit span task) as control variables. Qualitative answers collected in the summaries did not fit into this model as they were appointed to find if a meager elaboration of the episodes could emerge with high PPI scores.

3.6 Results

Control variables – Working memory

Following the results of past research suggesting a protective role of working memory in the creation of false memories (e.g., Mirandola & Toffalini, 2018; Mirandola & Pazzaglia, 2021) we introduced it in our analysis, considering both the Backward and the Forward span scores. Concerning causal errors no main effect of the Backward score was found, $\chi2(1)= 0.24$, $p= 0.62$, same for the interactive effect with Valence, $\chi2(2)= 3.30$, $p= 0.19$. Similarly no statistical significance was reached for the main effect of the Forward score, $\chi2(1)= 0.13$, $p= 0.72$, but this analysis yielded a significant interactive effect with Valence, $\chi2(2)= 5.81$, $p= 0.05$ (model with interaction: AIC= 311.01; model without interaction: AIC= 312.83) consequently we can strengthen the idea that working memory has a protecting role in reducing false memories, especially for positive and neutral contents (see Figure 1). On the other hand, considering gap-filling errors, this analysis did not reveal any main, $\chi2(1)= 0.93$, $p= 0.33$ nor interactive, $\chi2(2)= 2.18$, $p= 0.34$, effect of the Backward score with Valence. Finally, for gap-filling errors, no main effect of the Forward score was found, $\chi2(1)= 0.01$, $p= 0.93$, and the same for the interactive effect with Valence, $\chi2(2)= 1.20$, $p= 0.55$.

Causal errors

Concerning causal errors, considering only valence, a significant main effect was not found, $\chi2(2)= 1.08$, $p=0.58$. Coldheartedness did not have a main effect, $\chi2(1)= 0.84$, $p= 0.36$, even considering the interaction with Valence, $\chi2(2)= 0.42$, $p= 0.81$. Referring to Self-centered Impulsivity, neither a main effect, $\chi2(1)= 0.79$, $p= 0.37$, nor an interactive effect, $\chi2(2)= 0.52$, $p= 0.77$, was found. As far as the Fearless Dominance is concerned a significant main effect did not reach statistical significance, $\chi2(1)= 0.39$, $p= 0.53$, but it did if considered in interaction with Valence, $\chi2(1)= 6.25$, $p= 0.04$ (model with interaction: AIC= 310.32; model without interaction: AIC= 312.57) suggesting that at increasing scores in Fearless Dominance subscale, the probability of committing causal errors decreases for

positive events and increases for neutral ones (see Figure 2). Due to the fact that during the preliminary analysis no statistical significance was found using the working memory , we decided not to include it in this analysis.

Gap-filling errors

Considering gap-filling errors, the fixed effect of valence did not have a main effect, $\chi2(2)=$ 1.35, *p*= 0.51 (model with Valence: AIC= 897.26; model without Valence: AIC= 894.62). Regarding Coldheartedness this analysis did not reveal any main $\chi2(1)=$ 3.47, *p*= 0.062 or interactive effect with Valence $\chi2(2)=$ 0.77, *p*= 0.68. Secondly, the single main effect of Self-centered Impulsivity did not reach statistical significance, $\chi2(1)=$ 0.79, *p*= 0.37, nor any interactive effect with Valence, $\chi2(2)=$ 3.40, *p*= 0.18. Finally a main effect of Fearless Dominance was not found, $\chi2(1)=$ 2.51, *p*= 0.11, as well as an interactive effect with Valence $\chi2(2)=$ 1.72, *p*= 0.42. Due to the fact that during the preliminary analysis no statistical significance was found using the working memory as predictor, we decided not to include it in this analysis.

Subjective remembering: causal errors

We first analysed the fixed effect of valence on the Remember responses associated to causal errors, and it was significant, $\chi2(2)=$ 6.18, *p*= 0.04 (model with Valence: AIC= 148.34; model without Valence: AIC= 150.52), suggesting a bigger amount of Remember responses for neutral events (see Figure 3). Following that, we checked if the WM (we included the Backward digit span score because it is considered an active task, tapping the central executive, Baddeley, 1996) had a main effect on the Remember responses but no statistical significance was found, $\chi2(1)=$ 2.93, *p*= 0.08. Furthermore we analysed if the 3 scores of the PPI-R had an impact on subjective remembering, for causal errors. Coldheartedness did not reach statistical significance on the Remember responses, $\chi2(1)=$ 0.60, *p*= 0.44, nor the interactive effect with Valence, $\chi2(2)=$ 3.54, *p*= 0.17; in the same way no main or interactive effect was found with Familiar responses (*p*>0.1). Concerning Self-centered impulsivity a significant main effect did not reach statistical significance, $\chi2(1)=$ 0.15, *p*= 0.69, nor the interaction with Valence, $\chi2(2)=$ 3.04, *p*= 0.22; similarly no effects were found with Familiar responses (*p*>0.2). No main effect of Fearless Dominance was found $\chi2(1)=$ 0.60, *p*= 0.44, nor any interactive effect with Valence, $\chi2(2)=$ 0.48, *p*= 0.79, same for Familiar responses (*p*>0.4).

Subjective remembering: gap-filling errors

Considering gap-filling errors, we first analysed the impact of the fixed effect of valence on the Remember and Familiar responses, and no significant effect was found (all *p*>0.3). Secondly we considered the effect of WM on the Remember responses and an effect emerged, $\chi 2(1)$= 3.67, *p*= 0.05, such as high performance in WM was related to a reduced amount of Remember responses associated to gap-filling errors (see Figure 4). In addition to that, we checked if the 3 scores of the PPI-R questionnaire had an impact on the subjective judgments associated to gap-filling errors. An effect of Coldheartedness on the Remember responses did not emerge, $\chi 2(1)$= 0.73, *p*= 0.39, nor the interactive effect with Valence, $\chi 2(2)$= 0.45, *p*= 0.8; same if considering Familiar responses (both main and interactive effect with Valence: *p*>0.3). As far as Fearless Dominance is concerned, this study did not reveal any main, $\chi 2(1)$= 1.44, *p*= 0.23, nor interactive, $\chi 2(2)$= 0.04, *p*= 0.98, effect on the Remember responses; same results emerged if considering Familiar responses (*p*>0.2). Finally, considering Self-centered impulsivity on the Remember responses, no main effect emerged, $\chi 2(1)$= 1.60, *p*= 0.21, even considering the interactive effect with Valence, $\chi 2(2)$= 0.77, *p*= 0.68; similarly the analysis did not yield a statistical significance for the Familiar responses (*p*>0.2).

Hits

Analysing the performance in true recognition, neither the fixed effect of valence, $\chi 2(2)$= 1.54, *p*= 0.46, nor the single effect of working memory, $\chi 2(1)$= 0.02, *p*= 0.88, or the interactive effect between those 2 factors, $\chi 2(2)$= 1.11, *p*= 0.57, were significant. Concerning the influence of psychopathic traits, none of the 3 scores (not even the interactive effects with Valence) reached statistical valence (all *p*> 0.1).

Summary of the episodes

Concerning the total sample, the majority of the participants remembered at least the general sense of each episode. Only in two cases participants failed to remember the episode "Going on a bike trip" that, compared with the other 8 scripts, obtained the poorest summaries. Considering the 3 participants scoring high in the PPI-R questionnaire (Subject 2: C=77; Subject 13: C=80 & FDT=86; Subject 21: C=74 & FDT=79), some contrasting effects emerged. Subject 13, regardless of the valence, provided a general weak performance and failed to remember some emotional outputs. For instance, in the waking-up script (with negative valence), he wrote "Girl wakes up, gets out of bed, gets

ready and leaves the house" without quoting the black insect found in the pantry. In the slot script (with neutral valence), a poor summary was obtained, adding a negative value that wasn't actually there ("A man receives money from someone (€100), then loses it on the slot"). Lastly, this participant failed to remember two positive outcomes in the scripts "Rock climbing" and "Shop", giving a neutral emotional connotation. Results of this participant are consistent with our hypothesis of a hindered emotional elaboration for individuals with high psychopathic traits. On the contrary subject 2 produced really complete summaries, full of details and without missing any emotional valence, obtaining one of the best performances of the whole sample. To give an example, in the "Slot" episode (with positive valence), this participant wrote "A boy heading to a bar. Here the barman receives a 100 euro note from the boy who then goes near a slot machine. He wins by aligning the same figures and happily shows the money won to the barman". Analyzing this report it becomes clear that personality traits can interfere with the production of false memories but also other cognitive skills can heavily influence the performance (such as, in this participant, a high educational level and a high commitment in the task). Finally, referring to subject 21, all emotional valences were correctly retrieved but really poor summaries emerged, for example "Mom and son go downstairs and go shopping" was the summary obtained for the "Shop" episode.

3.7 General discussion

Concerning the whole experiment, we did not notice every hypothesized effect. This could probably result due to the low sample size but, nonetheless, some interesting results emerged. High fearless dominance scores did not produce a decrease of negative gap-filling errors, nonetheless this trait correlated with a lower amount of positive causal errors and an increase in both negative and neutral causal errors, suggesting a similar elaboration of those last two materials. However, another interpretation of this result is possible: high FD individuals not only produced a lower amount of negative false memories (Mirandola et al. 2022) but also positive, this could suggest a general impairment of the elaboration of emotionally charged materials. Considering the subjective remembering related to causal errors, less Remember responses were obtained for negative and positive materials, compared to neutral ones. This is consistent with the protective role of emotion in associating vividness and false memories and the idea that emotionally charged information may be remembered more accurately, such that safe
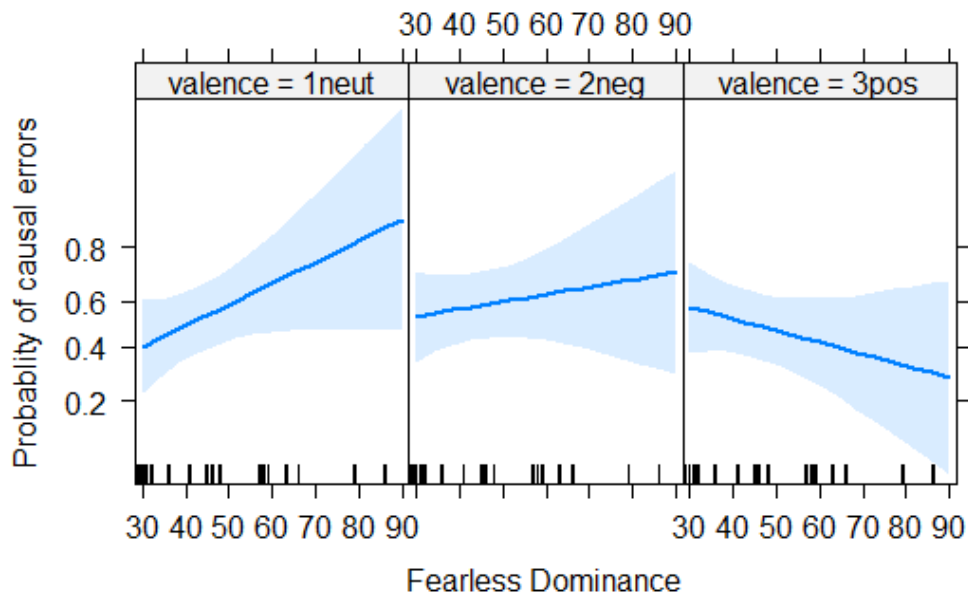
statement causal errors (Remember responses) in emotionally charged materials are less likely to happen. In general, also considering the subjective summaries, the main effect of psychopathy leading to a hindered elaboration of emotionally charged stimuli is confirmed, so this study could be another proof of how several factors could interfere with a correct remembrance and of how human beings could, also in good faith, make a mistake assuming that what they remember corresponds to the pure truth. In a more general sense, this study is a proof of the suggestibility of the human brain, specifically for emotionally charged events. However, a further insight will be necessary to establish if and how this knowledge could be used in criminal processes, considering the potential invalidity of some testimonies in specific circumstances that could lead to false memories. In the next years the creation of new questionnaires and interviews and a more specific sensibility to these themes by the criminal justice should be considered.
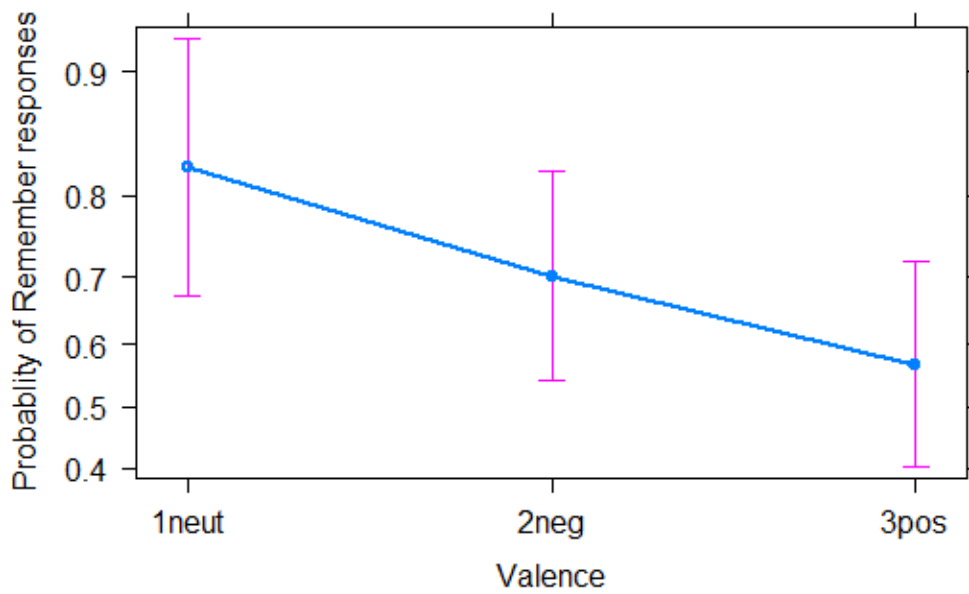
3.8 Figures
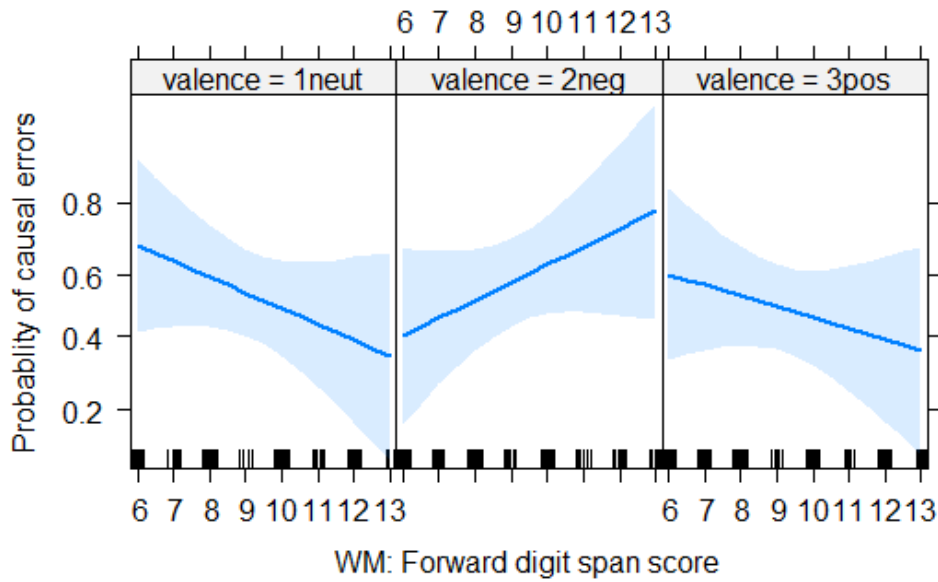
Figure 1: Probability of causal errors as a function of the interaction between valence and the forward digit span task scoring. Shaded blue areas represent 95% CIs.

Figure 2: Probability of causal errors as a function of the interaction between valence and Fearless Dominance. Shaded blue areas represent 95% CIs.

Figure 3: Probability of Remember responses associated to causal errors as a function of valence. Shaded blue areas represent 95% CIs.
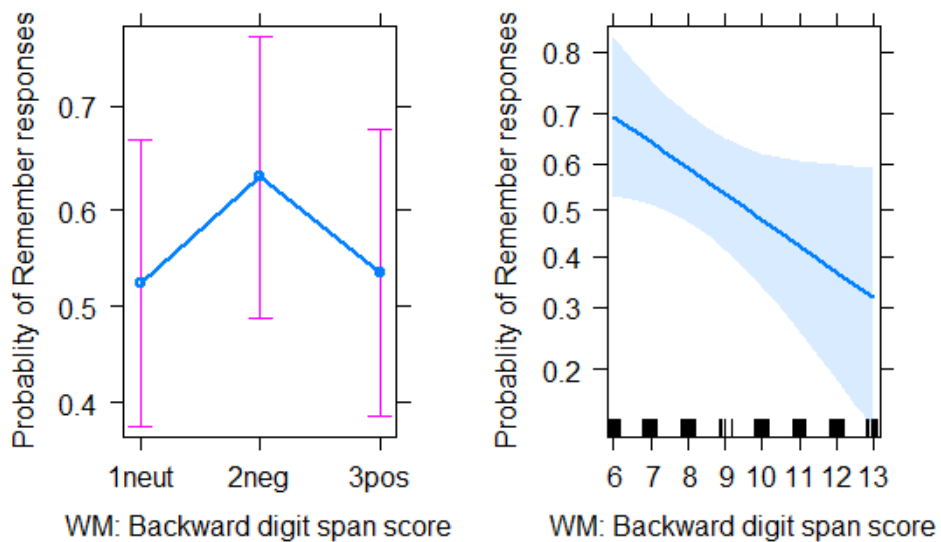
Figure 4: Probability of Remember responses associated to gap-filling errors as a function of valence and the backward digit span task score. Shaded blue areas represent 95% CIs.

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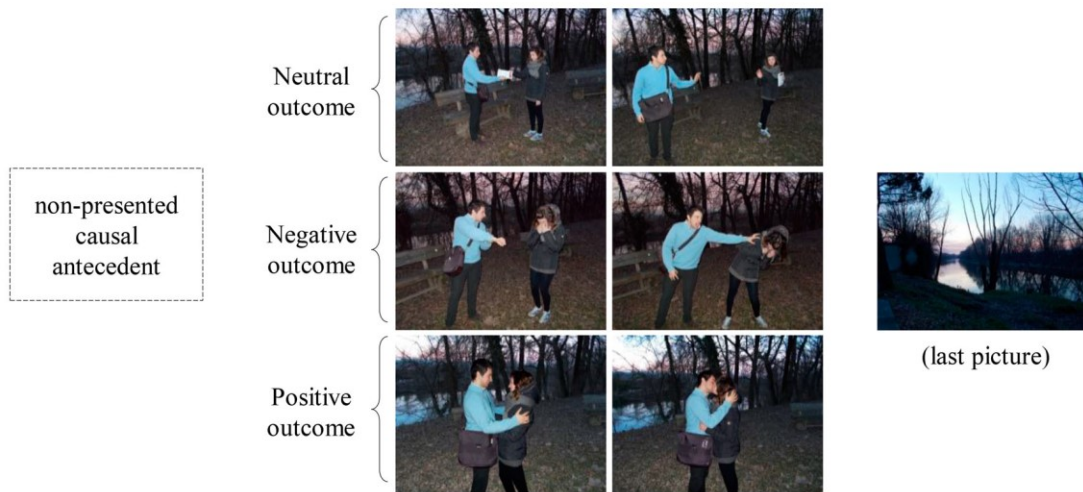
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Example of the "dating/meeting a friend" script*

Encoded pictures

Neutral outcome

non-presented causal antecedent

Negative outcome

Positive outcome

(last picture)

Tested pictures

TARGETS

GAP-FILLING DISTRACTORS

CAUSAL ANTECEDENT DISTRACTOR

* Appendix published in Mirandola et al. (2017).