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Psychopathic personality traits are linked with reduced false memories for negative events

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Introduction

The formation of emotional true and false memories has been in the spotlight of researchers, clinicians, and criminal justice professionals during the last four decades (Loftus, 2018; Schacter & Loftus, 2013). One reason for this increased attention in this area is because in the courtroom, testimonies usually refer to emotionally laden events (e.g., sexual abuse) and a critical question arises how valid such testimonies are. Typically, emotionally charged events – both positive (e.g., weddings, special journeys) and negative (e.g., losses, accidents) – lead to more accurate memories than neutral or mundane events (e.g., past Sunday lunch menu; see Kensinger, 2009). However, emotion does not immunize against the production of false memories (i.e., remembering events/items never encountered or remembering them in a very different way than their original encountering; Roediger & McDermott, 1995).

Indeed, several factors – pertaining to both the individual and the context – can interact with the emotional content of the to-be-remembered events thereby affecting the formation of false memories (for a review, see Bookbinder & Brainerd, 2017). For example, the following factors have been found to affect the formation of false memories: individual differences in working memory (Mirandola et al., 2017) and executive functions (Battista et al., 2020; Battista et al., 2021), the transient mood of the rememberer (Mirandola & Toffalini, 2016; Storbeck & Clore, 2005), the age of the rememberer (Howe, 2007; Brainerd et al., 2010, Melinder et al., 2017; Mirandola & Pazzaglia, 2021; Toffalini et al., 2018), the presence of anxious/depressive symptoms (Howe & Malone, 2011; Toffalini et al., 2014; 2015), certain psychopathological disorders (Otgaar et al., 2017) or neurodevelopmental and psychiatric disorders (Fairfield et al., 2016; Mirandola et al., 2014; Solomon et al., 2019).

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Debate exists on whether certain personality traits might foment the generation of false memories (Patihis, 2018). For example, Patihis (p.180) stated that “individual difference measures were poor predictors of false memories”. One reason for this debate is because past research has neglected to hone into traits that impact the way people remember (emotional) events.

Hence, the current work investigated the role of psychopathic traits on the proneness to create emotional false memories. Studying psychopathic traits in relation to emotional false memories is relevant for, at least, two reasons. First, psychophysiological and cognitive-oriented research has shown that individuals high in psychopathy process emotional material differently than individuals low in psychopathy (Patrick et al., 1993; Vaidyanathan et al., 2011). Second, people with varying degrees of psychopathy but who do not meet the criteria for a diagnosis of antisocial personality disorder might enter the legal arena as suspects or witnesses for a crime (Lanciano et al., 2019). It is relevant to examine whether such varying degrees of psychopathy are related to emotional false memory changes.

While antisocial personality disorder consists of several manifestations of criminal, antisocial, and violent acts (DSM-5, American Psychiatric Association, 2013), some studies have emphasized the dimensional conceptualisation of psychopathy by considering it as deviating from normal behavior in different degrees on a continuum (e.g., Edens et al., 2006). Therefore, conceptualizing psychopathy as a dimension explains why a variety of psychopathic traits may be found within healthy individuals in community samples (e.g., Lanciano et al., 2018). So far, a handful of studies have assessed effects of psychopathic personality traits on emotional *true* memory (e.g, Buchanan, 2007; Christianson et al., 1996; Dolan & Fullam, 2009), but interestingly, there is limited research on how psychopathic traits might foment the formation of emotional *false* memories. Given the available support for a dimensional conceptualisation of psychopathic personality that can be found in the normal population (for a review, Furnham et al., 2013; Lanciano et al., 2018), the current

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study addressed the presence of psychopathic personality traits in a community sample and how these traits may impact the proneness to facilitate the production emotional false memories.

Psychopathy

The hallmark of psychopathic personality is a constellation of traits characterized by low empathy, callousness, impulsivity and thrill-seeking (Lilienfeld & Andrews, 1996; Hare, 1999) and that lead individuals to engage in interpersonal and behavioural patterns characterized by manipulateness and interpersonal appeal (e.g., Cornell et al., 1996).

The investigation of emotional memory in individuals with psychopathic traits was driven by empirical evidence of an impaired emotional processing in these individuals. Indeed, the lack of empathy and the compromised recognition of emotional states in others (Blair, 2005; Lanciano et al., 2018) are examples of such reduced emotional processing. An interesting venue of research, combining psychophysiological, neurobiological, and cognitive approaches, has highlighted the link between high psychopathic traits and attenuated fear response toward aversive stimuli, underscoring the idea that emotional processing in these individuals is hindered at different levels (Patrick et al., 1993; Sadeh & Verona, 2008; Vaidyanathan et al., 2011). Furthermore, a well-established psychophysiological index of reactivity to fearful stimuli is the potentiation of the startle reflex. Typically, the startle reflex is measured as the blink response to an acoustic noise, recorded through the electromyography of the muscle surrounding the eyes (i.e., *orbicularis oculi*). In normal populations, the startle reflex is potentiated during viewing of threatening stimuli compared to neutral ones (Vrana et al., 1988) – an effect mediated by the amygdala (Davis, 1998). However, individuals high on psychopathic traits show an attenuated or absent startle reflex when exposed to aversive threatening stimuli (Patrick et al., 1993). It seems that the affective-interpersonal aspect of psychopathy is related to this effect.

Vaidyanathan and colleagues (2011) examined prisoners evaluated both for psychopathy and antisocial personality disorder (APD). The authors presented psychopaths and non-psychopaths

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with several aversive (e.g., threatening scenes such as guns pointed to the viewer), pleasant (e.g., erotic scenes and adventure-related ones such as skydiving) and neutral (e.g., commonplace objects) pictures derived from the International Affective Picture System (IAPS; Lang et al., 1999). To measure the startle reflex, a white noise tone occurred between 3-5 seconds after picture onset. Psychopaths differed from non-psychopaths in the emotional startle modulation: Non-psychopaths showed a strong startle potentiation for aversive stimuli compared to neutral ones, whereas psychopaths did not show this effect. The two groups, instead, did not statistically differ in the modulation of the startle reflex for pleasant pictures. Furthermore, it was the specific “threatening” content of the pictures that was linked to attenuated startle potentiation in psychopaths. The authors of this study concluded that the affective-interpersonal component of psychopathy – being reflected in callousness, shallow affectivity, and superficiality - is associated with diminished defensive reactivity, deriving from a hindered defensive motivational system leading to a low-fear disposition. Subsequent research confirmed this proposition for a diminished psychophysiological reactivity to aversive emotional stimuli in individuals high in psychopathy - and in particular in the affective-interpersonal facet – when community samples were tested (e.g., Vaidyanathan et al., 2009).

Other theories (e.g., Sadeh & Verona, 2008) focusing more on cognitive processing posit that psychopaths allocate their attentional resources to motivationally salient stimuli, ignoring and, thus, reducing the elaboration of irrelevant stimuli regardless of the emotional content. This attentional focus would affect memory processing as well, leading to similar memory accuracy for relevant information between psychopaths and non-psychopaths but impaired memory performance for contextual cues relating to emotional stimuli in psychopaths. Overall, these findings suggest that individuals high in psychopathic traits may not easily create associations between emotional events and surrounding contextual cues (Glass & Newman, 2009).

Psychopathy and Emotional False Memories

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Within the realm of emotional memory, research shows that the typical memory-enhancing effect (i.e., superior memory performance of emotional content) is reduced in people with psychopathic personality (Christianson et al., 1996). Furthermore, the well-established superiority of memory for central vs. peripheral details is also attenuated in these individuals (Christianson et al., 1996). Psychopaths have also been found to have a qualitatively different autobiographical memory for emotional life experiences than non-psychopaths (Lanciano et al., 2019). In Lanciano and colleagues' study (2019), participants were first asked to retrieve an emotionally salient past autobiographical episode, and later evaluate the contextual details of the event, using a specific questionnaire (i.e., Flashbulb memory Checklist, FBMC). Results showed that the Fearless and Coldhearted traits of psychopathy were linked to hindered emotional evaluation of the contextual details of an autobiographical event (e.g., they evaluated the event as not emotionally intense and failed to acknowledge the consequences of the events itself).

To our knowledge, the relation between psychopathic traits and false memory production for emotional events has not been studied yet. One study (Thijssen et al., 2013) investigated emotional false memories in a sample of children with low or high callous-unemotional (CU) traits which can be regarded as precursors of psychopathy in adults (Frick, 2006), by using the emotional Deese-Roediger-McDermott paradigm (DRM; Roediger & McDermott, 1995). This widely used paradigm consists of the presentation of several wordlists containing associatively-related words (e.g., *sick, nurse, medicine*). The canonical effect is that a significant proportion of participants falsely remembers a non-presented, related word called the critical lure (i.e., *doctor*). In Thijssen et al.'s study (2013), the children high in CU produced fewer false memories for negative words than the children low in CU. Furthermore, high CU children produced fewer false memories for negative than neutral words.

What do false memory theories tell us about how psychopathic traits might affect the production of false memories? According to the associative-activation theory (AAT; Howe et al.,

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2009; Otgaar et al., 2019), associatively related but non-presented critical lures are activated at encoding, because the encoding of one word automatically leads to the spreading of activation of related concepts in our own lexicon. Not only the strength of semantic associations but also the speed with which these associations are accessed can result into false memories. This associative activation is amplified when the wordlists are negatively valenced, because the spreading activation of related stimuli is faster for negative than neutral words (Howe et al., 2010). Based on the tenets of AAT, the prediction is that people scoring high on psychopathic traits have difficulty in processing negative information which leads to a reduction of activation of related negative words. The consequence is that fewer emotionally negative false memories are formed.

According to fuzzy-trace theory (FTT; Brainerd et al., 2008), individuals store two separate representations of experiences: Verbatim traces (i.e., surface and item-specific information of experiences) and gist traces (i.e., semantic and thematic properties of an event). It is the processing of gist traces (when verbatim traces cannot be retrieved) that may lead individuals to incorporate conceptually similar but not presented items or events, thus facilitating false memories. Emotional content of to-be-remembered events support increased retrieval to gist (i.e., thematic) connections more than neutral events, thus resulting in higher probability of reporting false memories for emotional events. So, FTT makes a similar prediction of AAT. Since psychopathy is linked to impaired emotional processing, it is more difficult to retrieve the gist of an emotionally negative experience, thereby lowering false memory levels.

The Current Study

Given the available, albeit, limited evidence of reduced processing of emotional information in both adults (Vaidyanathan et al., 2009) and children (Thijssen et al., 2013) with psychopathic personality (-related) traits, we aimed to assess the specific relation of psychopathic personality traits and the production of false memories for emotional events. To this end, we used a recent and ecologically valid paradigm: the Emotional False Memory Paradigm (Mirandola et al., 2014; 2017)

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to induce emotional false memories. This paradigm has proven successful in studying emotional false memories in a variety of populations, including adults and older adults (Mirandola et al., 2020; Mirandola et al., 2014; 2017; Mirandola & Toffalini, 2016; Fairfield et al., 2016; Toffalini et al., 2019), adolescents with anxious/depressive symptoms (Toffalini et al., 2014, 2015), typically developing children (Melinder et al., 2017; Mirandola & Pazzaglia, 2021) and children with neurodevelopmental disorders such as autism spectrum disorder (Solomon et al., 2019) and nonverbal learning disability (Mirandola et al., 2014).

The paradigm consists of the presentation of color photographs depicting different life episodes or scripts (e.g., going grocery shopping, the morning routine, dating/meeting a friend). Each episode may have either a positive, negative, or a neutral ending. The episodes are presented at encoding, but the causal antecedent – that is, what happens in the story right before the episode ends – is instead presented only at recognition. Claiming to remember the causal antecedent (e.g., the girl and the boy meeting for the first time in the scene) of the viewed action ending (e.g., positive: the girl and the boy are fiancée and kiss each other; negative: the boy is aggressive toward the girl for being late; neutral: the girl and the boy are friends and exchange a book) represents committing an inferential causal error. The paradigm also allows eliciting another type of error, namely gap-filling error, which corresponds to erroneously remembering non-presented but episode-related pictures (e.g., remembering the girl combing her hair while she was brushing her teeth). An important distinction between the two types of errors is that while causal errors are linked to more punctual and specific happenings within the story, gap-filling errors stem from thematic associations within the script thereby being more related to false memories elicited by the DRM paradigm.

Furthermore, given that psychopaths have been showing a qualitatively different autobiographical memory for emotional life experiences (Lanciano et al., 2019), we were also interested in studying the qualitative phenomenological experiences associated to false memories

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through the Remember-Know paradigm (Tulving, 1985). This paradigm requires individuals to introspect their memories and provide either a Remember or Know judgment after having claimed to recognize a certain given item. Specifically, Remember judgments are to be given when the person claims that a certain item is old, i.e. experienced at the encoding phase, but is also able to retrieve specific qualitative details related to the item, such as its perceptual characteristics or some emotions or thoughts that came to mind when first encountered. The person is instead required to judge as “known” the item that seemed to be presented at encoding, but that the person does not connect with any particular detail or thought. In other words, the person only “knows” that the item was presented, but he/she is not able to retrieve any further information related to that particular event. Finally, given the implication of working memory for emotional false memories emerged in previous studies (e.g., Mirandola et al., 2017; Mirandola & Pazzaglia, 2021), we included a WM task as a control measure.

Based on the available psychophysiological and cognitive evidence that psychopaths process emotional material differently than non-psychopaths (Buchanan, 2007; Christianson et al., 1996; Patrick et al., 1993; Sadeh & Verona, 2008; Vaidyanathan et al., 2011), we expected the following. First, we either expected a general impairment in emotional memory (i.e., attenuated memory-enhancing effect of emotional versus neutral events and lower true recognitions of target events) or a more specific influence of psychopathic personality on false memories, with a lower production of negative false memories in participants scoring high on the PPI-R. Second, based on the available evidence showing a reduced production of semantically-based negative false memories in children with CU traits (Thijssen et al., 2013) and given the different nature of the two types of false memories elicited by the Emotional False Memory Paradigm, we expected a lower production of gap-filling errors (i.e., semantic-based false memories) for negative episodes compared to the neutral ones in individuals with high psychopathic personality traits. Finally, the investigation of

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subjective remembering (i.e., phenomenological experiences of Remember-Know judgments) associated to false memories was explorative.

Methods

Participants

One-hundred and twenty adults participated to this study ($M_{age} = 32.5$ years, $SD = 16$; age range: 18 - 65 years; females = 73). As the design was within-participants, a G*power (Faul et al., 2007) analysis for a within-subjects ANOVA with a power=.90 and effect size $f = .25$ suggested a sample of 36 participants. However, given that we were interested in studying psychopathy traits on a continuum, we needed a bigger sample in order to being able to detect individual differences in personality. All individuals provided their written informed consent before participating. The study was approved by the Local Ethical Board of the University xx (nr. ET-20-12). Before data collection, the study was pre-registered on OSF (https://osf.io/jrw2q/?view_only=796ee4b57acf4f63bda98fe99611eabb).

Materials

Emotional False Memory Paradigm

Encoding phase. A sequence of color photographs depicting 9 scripts or episodes was used. The episodes were the following: Going grocery shopping, waking up, going on a bike trip, rock climbing, track competition, homecoming after a long trip, dating, birthday party, playing at the slot machine (see Mirandola & Pazzaglia, 2021; Mirandola et al., 2017; Solomon et al., 2019 for pictorial examples of some of the episodes). For each episode, 14 photographs depicted actions that typically occur during the event (of which 11 represented target photographs shown during the encoding phase and 3 represented gap-filling distractors shown during the recognition phase), and 2 photographs depicted cause-effect scenes (the effect scene was studied during encoding whereas the cause scene was presented only during the recognition test). For example, in the dating episode, a boy and a girl are getting ready to go out on a date (e.g., getting dressed, brushing their teeth,

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combing their hair, text messaging on the cellphone etc.). The episode may end in a positive (the boy and the girl are fiancée, and they are shown while they kiss each other), negative (the boy shows an aggressive act toward the girl for being late) or neutral (the boy and girl are friends and meet for exchanging a book) way. The emotional valence of the effect scenes was balanced across episodes, such that the same cause could have three different outcomes: positive, negative, and neutral. 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 (i.e., photographs of the episodes). Participants viewed a sequence of the 9 episodes, presented without any interruption between them.

Recognition phase. Participants received a surprise recognition memory 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 had been presented during the encoding phase). Furthermore, 18 photographs inconsistent with any of the episodes were included (9 targets and 9 distractors).

Psychopathy personality traits. The Italian version of the Psychopathic Personality Inventory-Revised, PPI-R (La-Marca et al., 2008) was administered. The questionnaire allows for a self-report measure of psychopathic personality traits. It consists of one hundred and fifty-four items, based on a 4-point Likert scale (1 = false; 2 = mostly false; 3 = mostly true; 4 = true). For the purpose of the current study, three scores were considered: Self-Centered Impulsivity (SCI; Cronbach's alpha = .91. Example of item:¹ "I have never really thought of what I would like to do in my life"), Fearless Dominance (FD; Cronbach's alpha = .85. Example of item: "I am able to stay calm in situations that would lead to panic many others"), and Coldheartedness (C; Cronbach's

¹ The examples reported are translations of the Italian version.

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alpha = .65. Example of item: “Sometimes I am worried about the fact that I might have hurt someone else’s feelings”).

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

Given the protecting role of working memory against emotional false memories’ production emerged in previous studies (e.g., Mirandola et al., 2017), the forward and backward digit span tasks were employed. The forward digit span task requires participants to immediately recall strings of digits – read aloud by the experimenter – in their correct presentation order. The backward digit span task requires individuals to immediately recall strings of digits in the reversed order of presentation. In both tasks, the sequence of digits increases in length; the task is self-paced, such that it stops when the participant fails two consecutive trials of the same length.

State-Trait Anxiety Inventory (STAI-Y; Italian adaptation, Pedrabissi & Santinello, 1989) is a self-report questionnaire, consisting of 20 items related to life situations that the participants have to rate on a 5-point Likert scale (based on how the situation described refers to their own mood), ranging from 0 (i.e., “not at all”) to 4 (i.e., “very much”).

Beck Depression Inventory (BDI-II; Italian adaptation, Ghisi et al., 2006) is a self-report questionnaire that assesses depressive symptoms in the past two weeks. It is composed of 21 items, each item based on a 4-point Likert scale. In the Italian version, a score of 12 (range = 0-63) is considered the cut-off to discriminate between individuals with and without depressive symptoms (Ghisi et al., 2006).

Procedure

The experimental session was entirely held online, via Zoom. Participants were tested individually. They were first welcomed by the experimenter, who explained the general procedure of the session, registered personal information, and asked to provide informed consent.

Encoding phase. Once the preliminary actions were taken, the experimenter shared the screen with the participant and administered the Encoding phase of the Emotional False Memory

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paradigm. Participants were instructed that they would watch several photographs depicting other young actors performing different daily activities and that they would have to pay close attention and try to understand what the stories represented. The encoding phase consisted of a series of 126 photographs; each photo was presented for 2 s and was followed by a black screen lasting 2 s. The nine episodes were presented – using Microsoft PowerPoint program — in a fixed order, with target-distractor photographs and valence of the episode-ending varying across participants. The encoding phase was followed by a 15-min retention interval. During this interval, participants were administered the forward and backward digit span tasks.

Retrieval phase. The memory test consisted of a self-paced recognition task. For each photograph, participants had to utter “yes” or “no” whether they could, respectively, remember having seen the photograph during the encoding phase or not. Furthermore, for each recognized photograph participants had to tell whether they “remembered” it or thought it was “familiar”. Specifically, they were instructed to select the option “remember” when they had a clear memory of the encounter with the photograph and could also remember any qualitative feature related to it (such as something that came to mind when they viewed it). Participants had to select the option “familiar” when they felt they had seen the photograph before but could not recollect any detail or thought related to its encounter during the study phase.

At the end of the recognition phase, participants were required to fill the questionnaires in the following order: PPI-R, BDI-II, STAI-Y. As for the Emotional False Memory Paradigm, all questionnaires were administered through Google Modules during a Zoom session with the presence of the experimenter. Once participants had finished with all the questionnaires, they were debriefed about the main goals of the current project.

Data analyses

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As responses were of a binomial type (“yes”: 1, or “no”: 0), a logistic mixed-effects model approach was used (Baayen, 2008; Jaeger, 2008), using R software (R Core Team, 2017)². Causal and gap-filling errors were the “yes” responses to causal and script-consistent distractors, respectively. Hits were the “yes” responses to target photographs. Participants were treated as random effects. Valence was treated as the fixed effect of interest. 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.

Furthermore, given the available evidence of the influence of WM (Mirandola et al., 2017) and depressive/anxious traits (Toffalini et al., 2014; 2015) on emotional false memories, we included WM, BDI and STAI scores as control variables.

Results

Control variables – depressive/anxious traits

The STAI total score did not show any main effect, $\chi^2(1) = 0.43, p = .50$, nor any interactive effect with Valence, $\chi^2(3) = 3.080, p = .37$, on the production of causal errors. Furthermore, the BDI total score did not show any main effect, $\chi^2(1) = .96, p = .33$, nor any interactive effect with Valence, $\chi^2(3) = 3.38, p = .33$ on the production of causal errors. Similarly, the STAI total score did not have any main effect, $\chi^2(1) = .15, p = .70$, nor any interactive effect with Valence, $\chi^2(3) = 2.83, p = .41$, on the production of gap-filling errors. Finally, the BDI total score did not have any main effect, $\chi^2(1) = .76, p = .38$, nor any interactive effect with Valence, $\chi^2(3) = 6.40, p = .093$, on the production of gap-filling errors. Given the absence of any effect of the STAI and BDI scores on false memories, we did not include these variables in the following analyses.

² In the pre-registration we stated that we would have run regression analyses. However, given the dichotomous nature of the memory responses and given that the response variables were repeated by the participants, we decided the use the more appropriate linear logistic mixed-effect models.

False Memories

Inferential causal errors

For causal errors, concerning the fixed effect of Valence, a significant main effect did not reach statistical significance, $\chi^2(2) = 3.77, p = .15$ (model with Valence: AIC = 1224.8; model without Valence: AIC = 1224.6). Considering WM, we included the Backward digit span in the model, following previous studies (e.g., Mirandola & Toffalini, 2018) and because the Backward digit span is considered an active task, tapping the central executive (Baddeley, 1996). The main effect of WM (Backward digit span) was significant: $\chi^2(1) = 6.20, p = .012$ (AIC = 1220.6), with lower probability of producing causal errors with increasing WM. The interaction between Valence and WM was not significant $\chi^2(2) = 3.55, p = .17$ (AIC = 1221.1). The probability of producing causal errors as a function of WM is reported in Figure 1 (A).

Gap-filling Errors

For gap-filling errors, concerning the fixed effect of Valence, a significant main effect was not found, $\chi^2(2) = 1.42, p = .49$ (model with Valence: AIC = 3207.6; model without Valence: AIC = 3205). The main effect of WM was significant: $\chi^2(1) = 8.37, p = .003$ (model with WM: AIC = 3201.2; model without WM: AIC = 3207.6), with lower probability of producing gap-filling errors with increasing WM. The interaction between Valence and WM did not reach statistical significance: $\chi^2(2) = 5.93, p = .052$ (AIC = 3199.3; model without interaction: AIC = 3201.2). The probability of producing gap-filling errors as a function of WM is reported in Figure 1 (B).

Psychopathy and False Memories

The three factors of the PPI-R were included as predictors in the analyses. Coldheartedness (C) did not show any main effect on causal errors, even after controlling for WM, $\chi^2(1) = .87, p = .35$; the interaction with Valence (controlling for WM) did not reach statistical significance, $\chi^2(2) = 5.50, p = .064$. Fearless dominance (FD) did not show any main effect on causal errors, even after controlling for WM, $\chi^2(1) = 1.79, p = .18$, nor any interactive effect with Valence as well, $\chi^2(3) =$

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2.81, $p = .42$. Finally, Self-centered impulsivity (SCI) did not show any main effect on causal errors, $\chi^2(1) = .63$, $p = .42$, nor any interactive effect with Valence, $\chi^2(2) = .056$, $p = .97$.

Concerning gap-filling errors, Coldheartedness did not show any main, $\chi^2(1) = .002$, $p = .96$, nor interactive effect with Valence (controlling for WM), $\chi^2(3) = 1.09$, $p = .77$. Fearless dominance did not show the main effect on false memories ($\chi^2(1) = 1.68$, $p = .19$), however, interestingly it did interact with Valence, $\chi^2(3) = 8.68$, $p = .033$ (AIC = 3198.5; model without interaction: AIC = 3201.2), such that at increasing scores in the Fearless dominance subscale, the probability of committing gap-filling errors for negative events decreased (see Figure 2). Self-centered impulsivity did not show any main effect on gap-filling errors (controlling for WM), $\chi^2(1) = 2.47$, $p = .11$, nor the interactive effect with Valence, $\chi^2(2) = 1.71$, $p = .42$.

Subjective remembering: Inferential causal errors

We first checked whether WM and anxiety-depressive symptoms would influence Remember-Familiar responses associated to causal errors³. We found that only WM had a main effect on the Remember responses (as for causal errors, higher WM ability is associated to lower selection of Remember responses associated to these memory errors) and thus included it in the subsequent analyses. We further analysed whether Psychopathic personality traits would have an impact on subjective remembering. Concerning Coldheartedness, a main effect on the Remember responses associated to causal errors (controlling for WM) did not emerge, $\chi^2(1) = .018$, $p = .66$, nor the interaction with Valence, $\chi^2(2) = 1.36$, $p = .50$. Similarly, neither the main effect on the Familiar responses associated to causal errors was significant, nor the interaction between C and valence (all

³ **Remember responses associated to causal errors.** Working memory: main effect, $\chi^2(1) = 4.88$, $p = .02$; interaction with valence, $\chi^2(3) = .68$, $p = .71$. STAI: main effect, $\chi^2(1) = .03$, $p = .84$; interaction with valence, $\chi^2(2) = .79$, $p = .67$. BDI: main effect, $\chi^2(1) = .71$, $p = .39$; interaction with valence, $\chi^2(2) = 3.05$, $p = .21$. **Familiar responses associated to causal errors.** Working memory: main effect, $\chi^2(1) = .01$, $p = .90$, interaction with valence, $\chi^2(3) = 3.21$, $p = .20$. STAI: main effect, $\chi^2(1) = .195$, $p = .16$; interaction with valence, $\chi^2(2) = .97$, $p = .61$. BDI: main effect, $\chi^2(1) = .02$, $p = .89$; interaction with valence, $\chi^2(2) = 262$, $p = .26$.

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ps > .07). Concerning Fearless dominance, neither the main effect on the Remember responses associated to causal errors (controlling for WM), $\chi^2(1) = .23, p = .62$, nor the interaction between FD and valence reached statistical significance, $\chi^2(2) = .95, p = .62$. Nonetheless, the main effect of FD on Familiar responses associated to causal errors emerged, ($\chi^2(1) = 6.49, p = .01$), such that at increasing scores in the FD scale corresponds a lower selection of the Familiar option (see Figure 3). Concerning Self-centered impulsivity, a main effect on the Remember responses associated to causal errors (controlling for WM) did not emerge, $\chi^2(1) = .71, p = .39$ as well as no statistically significant interaction effect with Valence was found, $\chi^2(2) = .20, p = .90$. No significant effects were found for the Familiar responses (all ps > .11).

Subjective remembering: Gap-filling errors

We first checked whether WM and anxiety-depressive symptoms would influence Remember-Familiar responses associated to gap-filling errors.⁴ We found that WM had a main effect on the Remember responses (higher WM ability is associated to lower selection of Remember responses associated to gap-filling errors) and that BDI interacted with valence such that at increasing BDI scores correspond a lower selection of Remember responses for positive events compared to neutral ones. We thus included these variables in the subsequent analyses.

Concerning Coldheartedness, neither a main effect on the Remember responses associated to gap-filling errors (controlling for WM and BDI), $\chi^2(1) = .10, p = .74$, nor the interaction with Valence, $\chi^2(2) = 2.74, p = .25$, did emerge. Similarly, neither the main effect of Coldheartedness on Familiar responses associated to gap-filling errors, $\chi^2(1) = .16, p = .68$, nor the interaction between

⁴ **Remember responses associated to gap-filling errors.** Working memory: main effect, $\chi^2(1) = 4.19, p = .04$; interaction with valence, $\chi^2(3) = 2.21, p = .33$. STAI: main effect, $\chi^2(1) = .08, p = .77$; interaction with valence, $\chi^2(2) = 4.46, p = .10$. BDI: main effect, $\chi^2(1) = .05, p = .81$; interaction with valence, $\chi^2(2) = 7.79, p = .02$. **Familiar responses associated to gap-filling errors.** Working memory: main effect, $\chi^2(1) = 3.71, p = .054$; interaction with valence, $\chi^2(3) = 2.93, p = .23$. STAI: main effect, $\chi^2(1) = .24, p = .62$; interaction with valence, $\chi^2(2) = .08, p = .95$. BDI: main effect, $\chi^2(1) = .89, p = .34$; interaction with valence, $\chi^2(3) = 2.23, p = .32$.

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Coldheartedness and Valence did emerge, $\chi^2(2) = .35, p = .84$. Concerning Fearless dominance, the main effect on Remember responses associated to gap-filling errors (controlling for WM and BDI) did not emerge, $\chi^2(1) = .22, p = .64$; however, the interaction between FD and valence was significant, $\chi^2(2) = 7.48, p = .02$, such that increasing scores in the FD subscale corresponded to decreasing Remember responses associated to gap-filling errors for negative events (compared to neutral ones; see Figure 4.). The main effect on Familiar responses associated to gap-filling errors was also significant, $\chi^2(1) = 6.11, p = .01$, such that at increasing scores in the FD correspond decreasing probability to select the Familiar response (see Figure 5.A). The interaction between FD and valence was not significant, $\chi^2(2) = .85, p = .65$. Concerning Self-centered impulsivity, the main effect on Remember responses associated to gap-filling errors was not significant, $\chi^2(1) = .26, p = .6$, as well as the interaction between SCI and valence, $\chi^2(2) = 1.33, p = .51$. Finally, the main effect on Familiar responses associated to gap-filling errors was significant, $\chi^2(1) = 10.36, p = .001$, such that at increasing scores in the SCI correspond decreasing probability to select the Familiar response (Figure 5.B); the interaction between SCI and valence was not significant, $\chi^2(2) = .40, p = .81$.

Hits

The main effect of Valence, $\chi^2(2) = .45, p = .79$, the main effect of WM, $\chi^2(1) = 1.71, p = .19$, as well as the interaction between the two factors, $\chi^2(2) = .99, p = .60$, were not found on true recognitions of target photographs. Whereas the STAI did not have main or interactive effects on the hits (all $ps > .53$), the BDI showed a main effect on the production of hits, $\chi^2(1) = 6.8, p = .008$, such that at increasing BDI scores correspond decreasing true recognitions. The interaction between Valence and BDI shows a tendency toward significance ($p = .06$), indicating that this is more evident for positive events.

Concerning the influence of psychopathic personality on hits, even controlling for BDI scores, the interaction between Valence and Coldheartedness was significant, $\chi^2(1) = 5.9, p = .01$, such that only for neutral and negative events did true recognitions decrease (see Figure 6). Neither

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main nor interactive effects of Valence and each of the other two dimensions of PPI-R (FD and SCI) were found to be significant (all p s > .055).

Discussion

In the current study, we investigated whether psychopathic personality traits would be connected with true and false memory production for emotional events. Due to the available psychophysiological and cognitive evidence of a reduced processing of emotional material in individuals high in psychopathic traits (Buchanan, 2007; Christianson et al., 1996; Patrick et al., 1993; Sadeh & Verona, 2008; Vaidyanathan et al., 2011), we hypothesized a general emotional memory impairment (i.e., attenuated superiority of memory for emotional vs neutral events; reduction of true recognitions). More specifically, we hypothesized a tendency of individuals with high psychopathic traits to process negative material differently than individuals with low psychopathic traits turning into a reduction of semantic-based negative false memories (i.e., gap-filling errors in the current paradigm). The results regarding false and true memories are discussed in turn.

Psychopathy and False Memories

The factor of Fearless Dominance (FD) of the PPI-R interacted with valence showing decreasing false memories for negative events with increasing Fearless Dominance scores. This effect was specific for gap-filling errors. Gap-filling errors are committed when an individual erroneously remembers having seen an action that is consistent with the encoded episode (e.g., in the morning routine episode: remembering the girl brushing her teeth while she was washing her face). We argue that individuals high in psychopathic traits do not encode the episodes with negative content to the same extent as individuals with low psychopathic traits. For this reason, they may fail to create a “familiar” script in their mind when they encode negative information leading to a reduction in inferential thinking regarding the same script. Therefore, this lower inferential thinking at encoding would then prevent them from forming false memories. This result is

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conceptually similar to that found by Thijssen and colleagues (2013). Thijssen et al. found that children with high callous unemotional traits (CU) produced the fewest emotionally negative false memories. The authors interpreted this finding according to AAT (Howe et al., 2019; Otgaar et al., 2019): Children with CU traits have deficient emotional processing leading to less associative activation among nodes in their knowledge base thereby reducing false memory proneness. Similarly, in the current study, we argue that deficient processing of negative events prevented people high in fearless dominance from incorporating non-presented but inferred events into their memory outcome.

The Emotional False Memory Paradigm permitted us to examine emotions from a dimensional perspective (i.e., rated on valence -negative vs positive vs neutral- and arousal or level of activation). However, our result that only the Fearless dominance subscale of the PPI-R was related to reductions in negative false memories begs the question why not other scales were related to false memory formation. Fear is the predominant emotion within the negative content, and this may influence individuals high in psychopathy with a specific difficulty at elaborating fearful images, i.e., Fearless dominance. Fearlessness does not refer to any specific component of psychopathic personality. Instead, it refers to a complex pattern of psychological and physiological characteristics, such as, for example, immunity to stress, hindered threat sensitivity, low levels of anxiety, and in general shallow affective states (Anderson et al., 2021; Blickle & Genau, 2019). This general tendency to perceive shallow emotional states has also been linked to a hindered subjective evaluation of past emotionally salient autobiographical memories (see Lanciano et al., 2019). Even if individuals with high Fearless dominance can retrieve emotional autobiographical memories, they fail to remember and evaluate from a subjective point of view the contextual details of those memories and the emotional intensity. For example, one of the questionnaires used to pursue such evaluation of one own's memories were the Autobiographical Memory Characteristics Questionnaire (AMCQ; Boyacioglu & Akfirat, 2015). High Fearless dominance traits negatively

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correlated with the following phenomenological dimensions of autobiographical memories:

Emotional upsetting and emotional implication (i.e., the belief that the emotional event is not affected by other related emotions; Lanciano et al., 2019). Nonetheless, their objective ability to form true and false memories for emotional events has not been studied before. Within the Emotional False Memory Paradigm in the current study false memories stem from the inferential thinking relative to scripted events. The lower propensity to incur negative false memories found in individuals with high Fearless dominance may be attributable to their lower ability to perceive the emotional intensity of the viewed episodes, especially the fearful ones. Furthermore, Fearless dominance has also been associated to thrill-seeking behaviors, due to a different conscious elaboration of fear (Hoppenbrouwers et al. 2016). A different approach to fearful images may be explained also by the typical reduction of the startle potentiation in response to negative stimuli found in psychopaths (Patrick et al., 1993), reflecting a hindered defensive motivational system which leads to a low-fear disposition in these individuals.

The analyses on subjective remembering were included in order to gain more information on the qualitative phenomenological experiences of memory in individuals high in psychopathy. Indeed, psychopaths show a qualitatively different autobiographical memory for emotional life experiences than non- psychopaths (Lanciano et al., 2019). First, Fearless dominance was associated to decreasing selection of Familiar responses associated to causal errors, regardless of emotional content. The tendency to find the causal antecedents as less familiar in high FD individuals may help explain why they did not produce – from a quantitative perspective - more false memories of this type (i.e., inferential causal errors). Second, and most importantly, not only did high FD individuals produce fewer gap-filling errors for negative events, but they also selected less frequently the Remember judgment associated to these errors within the negative context. This finding further supports the idea that negative events may be less efficiently processed in people high in FD traits, such that once negative false memories occur, they are not subjectively perceived

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as vivid and memorable. Furthermore, regardless of emotional content, also the perceived familiarity of the not-presented but script-consistent pictures decreased in individuals high in psychopathy and specifically for FD and Self-centered impulsivity subscales. This finding suggests that false memories may be reduced in psychopaths but, even when they are not produced to a lesser extent at the objective level (for example in individuals high in SCI), they are not so familiar and compelling at the subjective level.

Psychopathy and True Memories (hits)

Coldheartedness (C) was associated to true recognitions of target images (i.e., hits). Indeed, increasing scores in Coldheartedness corresponded to decreasing probability of truly recognizing target images within negative and neutral events. Coldhearted people are characterized by a tendency to be shallow and insensitive to deep emotions (Lilienfeld & Widows, 2005) and they have been found to have a qualitatively impaired autobiographical memory in terms of poor memory for contextual details (Lanciano et al., 2019). Furthermore, in Lanciano et al.'s study, high Coldhearted traits were negatively correlated to emotional upsetting, emotional distance and emotional implication. In the current study, individuals high in this psychopathy trait tended to have a poorer episodic memory but only for negative and neutral events. It may be that their difficulty at feeling strong emotions, especially if negative, led them to discard emotional content of to-be-remembered events and perceive negative events in a similar manner as neutral ones. This similar perception of negative and neutral events at encoding influenced subsequent true recognitions in a detrimental way. According to this view, although it was a tendency without reaching statistical significance, higher values in the Coldheartedness subscale were associated to decreasing probability to produce positive causal errors, while negative and neutral false memories were produced to a similar extent, again showing a similar elaboration of negative and neutral material. We may argue that the coldhearted people do not focus their attention at encoding toward positive content, failing to producing inferential thinking that would drive them to form causal errors.

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To conclude, our findings provide important information on whether and how psychopathy traits can influence the likelihood to report false (and true) memories of emotional content. Of course, our results need to be taken into consideration considering some limitations. For instance, we ran an experiment on a sample of participants mainly composed of undergraduate students not prototypical of the legal population. In addition, we asked participants to watch a pool of emotional pictures (i.e., negative, positive, and neutral). Although the pictures of the adopted paradigm were developed considering different levels of valence (i.e., negative vs positive vs neutral), and arousal or level of activation, the emotional experience elicited in participants may not reflect the one that could be experienced in a real situation. These factors might have impaired the generalizability of our results. Future research could try to overcome these limitations.

Despite some limitations, this work is significant not only for a broader understanding of how personality traits affect emotional memory but also for legal practitioners. Indeed, legal professionals (e.g., judges, criminologists, police officers) oftentimes deal with the evaluation of testimonies' reliability and people's credibility. However, research so far has shown that memories and, in turn, testimonies can be prone to false memories (for a review see Loftus, 2005), therefore leading to possible miscarriages of justices (e.g., wrongful convictions) (Nash et al., 2015; Saks & Koehler, 2005; Smeets et al., 2004; Wells & Quinlivan, 2009; see also www.innocenceproject.org). In addition, data on real cases suggest that many offenders show psychopathic personality traits (Edens et al., 2018; Morse, 2013; Viljoen et al., 2010). For instance, in the United States around 25% of offenders exhibit these traits (McMillan & Malatesti, 2010). Consequently, our findings might be of relevance for legal professionals in correctly performing their job when they are called to evaluate the reliability of people's statements showing these specific personality traits (i.e., psychopathy). Many offenders claim amnesia for the critical event on which they are asked to testify, and some of these individuals will eventually come up with a description of what happened within the episode. These descriptions might be affected by false memories (especially for

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negatively intense events) and thus a special attention to observe the eyewitnesses' personality traits might be of importance. By shedding light on the conditions of their emotion-processing difficulty, future research should be directed to the understanding of the specific mechanisms that impair memory (in particular the encoding of the event) in individuals high in psychopathy.

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Figures

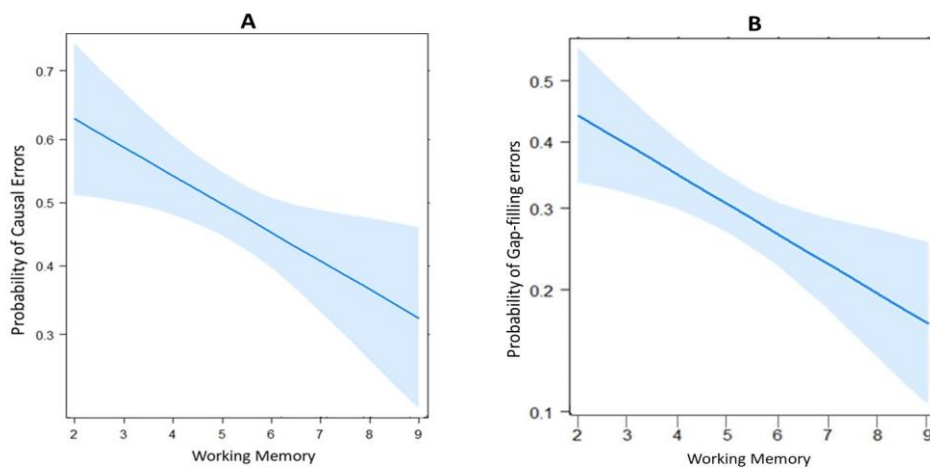


Figure 1. Probability of Causal errors (A) and Gap-filling errors (B) as a function of WM. Shaded blue areas represent 95% CIs.

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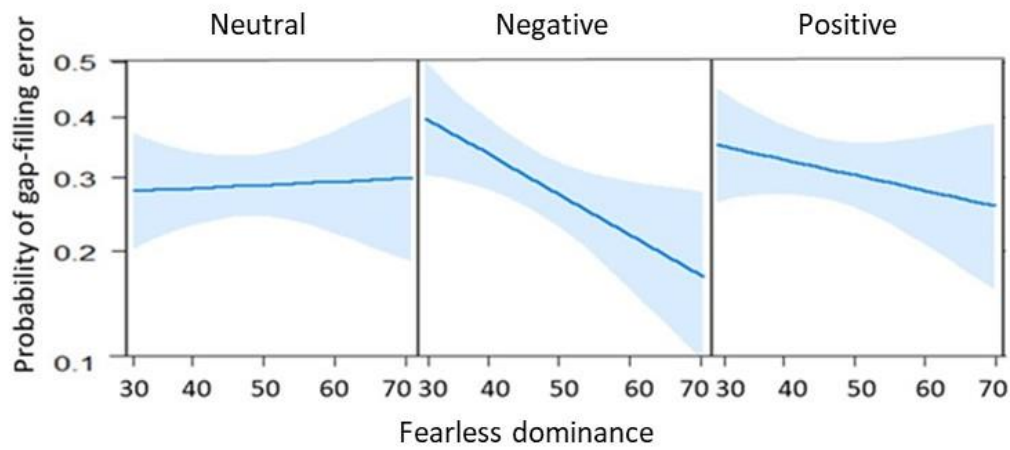


Figure 2. Probability of saying “yes” to gap-filling distractors as a function of the interaction between Valence and Fearless dominance. Shaded blue areas represent 95% CIs.

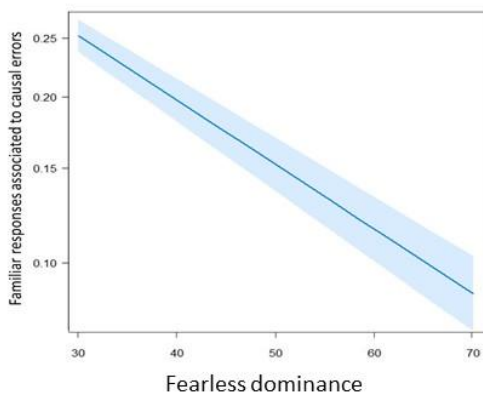


Figure 3. Probability of associating Familiar responses to causal errors as a function of Fearless dominance personality trait. Shaded blue areas represent 95% CIs.

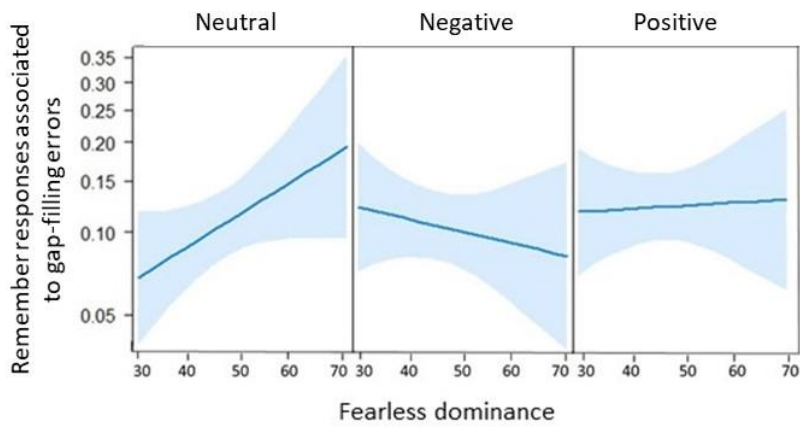
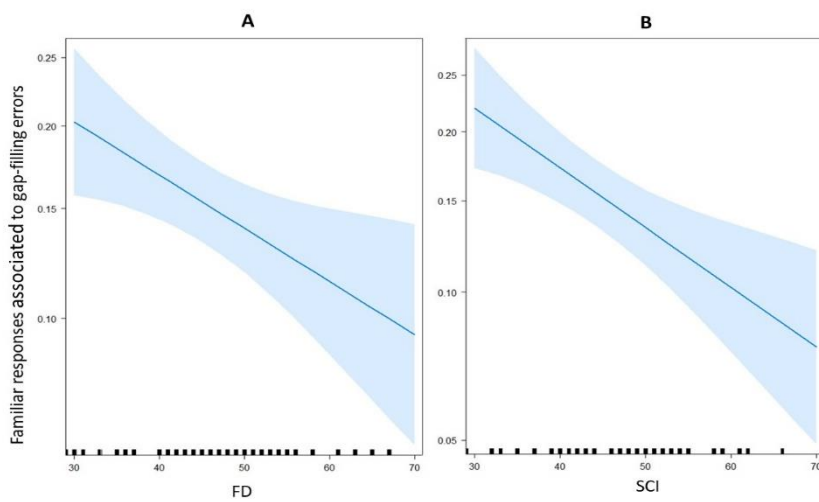


Figure 4. Probability of associating Remember responses to gap-filling errors as a function of the interaction between Valence and Fearless dominance. Shaded blue areas represent 95% CIs.



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Figure 5. Probability of associating Familiar responses to gap-filling errors as a function of Fearless dominance - FD (A) and Self-centered impulsivity - SCI (B) personality traits. Shaded blue areas represent 95% CIs.

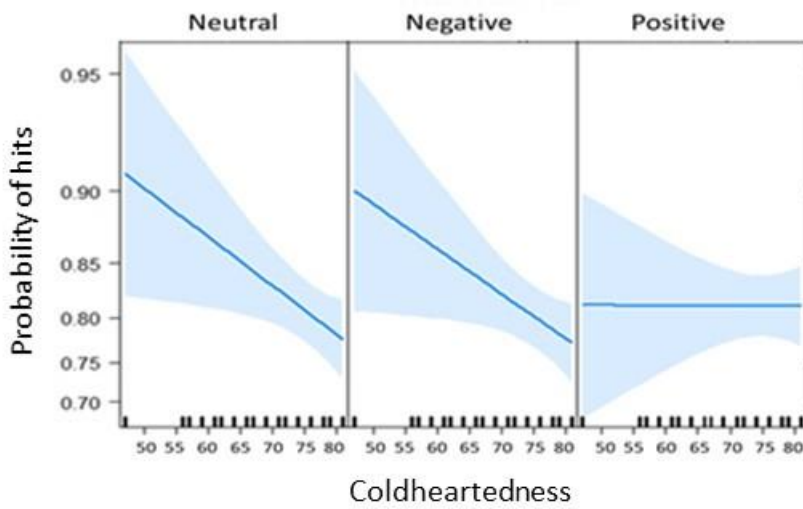


Figure 6. Probability of hits as a function of the interaction between Valence and Coldheartedness personality trait. Shaded blue areas represent 95% CIs.