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RESEARCH ARTICLE

ALCOHOL CLINICAL & EXPERIMENTAL RESEARCH

Social episodic memory in severe alcohol use disorder: Positive encoding bias and negative bias in accessibility of interpersonal information

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Abstract

Background: Alterations in higher-order social cognition are well documented in individuals with severe alcohol use disorder (SAUD). However, the basic mechanisms underpinning them are not well understood. This knowledge gap hampers the development of targeted therapeutic interventions. Here, we investigated whether individuals with SAUD show abnormalities in social episodic memory processes, which may represent relevant candidate mechanisms for alterations in social cognition.

Methods: Recently detoxified patients with SAUD and matched healthy controls (HCs) completed two experimental tasks. We first used a Social Recognition Task in 40 SAUD patients and 40 HCs to measure the participants' ability to implicitly memorize the facial identity and emotion of novel interpersonal cues (i.e., dynamic facial expressions of anger and happiness). We then used a Social Memory Accessibility Task in 29 SAUD patients and 30 HCs) to measure participants' access to and fluency for already existing social memories by asking them to retrieve as many specific positive and negative interpersonal events as possible within equal time limits.

Results: In the Social Recognition Task, we found that, compared to HCs, patients with SAUD had a globally lower recognition performance for the facial identities of novel social stimuli, but a preserved bias toward positive information. Conversely, in the social memory accessibility task, patients showed greater access to and fluency for negative interpersonal memories than controls (no group differences were observed for positive ones), resulting in a negative accessibility bias.

Conclusions: This exploration of episodic social memory in individuals with SAUD showed (1) a preserved bias for the encoding of positive versus negative novel social information, and (2) greater access to negative than positive interpersonal memories. These results enhance our understanding of socio-affective processing in individuals with SAUD and identify social memory alterations that may contribute to social cognition and interpersonal difficulties.

KEYWORDS
alcohol use disorder, emotion, memory, social cognition

INTRODUCTION

Numerous studies have documented alterations in high-level social cognition alterations (i.e., emotion recognition, Theory of Mind, attributional biases, social perception, and knowledge) in patients with severe alcohol use disorder (SAUD; Bora & Zorlu, 2017; Pabst et al., 2021), as well as their interpersonal/clinical correlates (e.g., Rupp et al., 2017). Social cognition is thus consensually considered a priority treatment target in this population (Verdejo-Garcia et al., 2023). Unfortunately, the current dearth of research investigating basic underlying mechanisms compromises conceptual progress and the development of precise and efficient interventions. We aimed to tackle this issue by investigating the presence of changes in memory for social information, as these may contribute to social cognition difficulties in SAUD.

Indeed, a growing and diverse body of fundamental evidence implicates memory in social cognition and behavior. For instance, affect sharing, mental state inference, and prosocial behavior can be increased by asking participants to retrieve specific social memories or to imagine future social events (a process heavily reliant on memory retrieval; van Genugten, 2022). Remembering aspects of past interaction partners relates to more adaptive social judgments and decisions upon reencounter (Kadwe et al., 2022; Sklenar et al., 2022). In addition, episodic memory and social cognition tasks elicit activations in overlapping regions of the default mode network (Spreng & Grady, 2010; Spreng & Mar, 2012; but see DiNicola et al., 2020). This literature substantiates proposals that memories of past social experiences and knowledge play a role in interpretations of novel interpersonal input and reaching social decisions (Smeijers et al., 2019). Accordingly, social memory disruptions or biases may negatively affect social cognition (Pabst, Heeren, & Maurage, 2020), in line with transdiagnostic observations that psychiatric groups featuring marked impairments in social skills (e.g., individuals with borderline personality disorder, schizophrenia) also show alterations in various aspects of memory for socio-affective information (e.g., Harvey & Lepage, 2014; Lee et al., 2018; Niedtfeld et al., 2020).

SAUD is linked with memory impairments, particularly for its episodic component (Stavro et al., 2013), and studies have highlighted associations between episodic, but not semantic, memory and emotion recognition as well as Theory of Mind in SAUD (Nandrino et al., 2014; Quaglino et al., 2015). This is again consistent with a functional link, with past interpersonal experiences being particularly relevant to current social cognitive abilities in this group. In spite of this, episodic memory research in SAUD has up to now mainly focused on nonsocial material. Therefore, it remains unclear whether the well-established episodic memory alterations in SAUD generalize to social stimuli, of which the encoding and retrieval may recruit partially different processes (Mitchell et al., 2004; Meyer et al., 2019). Beyond investigating general social episodic memory abilities, it is also important to determine if patients with SAUD show particular memory difficulties, or conversely, biases for, certain socio-affective categories. Indeed, SAUD is frequently associated with hostility biases. Patients have been found to misperceive neutral or sad facial expressions as displaying anger, contempt, or disgust (e.g., Freeman et al., 2018; Philippot et al., 1999) and attribute hostile intentions to others in ambiguous situations (Pabst, Peyroux, et al., 2020). Disproportionate memory for threatening, or a reduced preference for positive, social information may be involved in such biases (Barry et al., 2019).

We, therefore, assessed two important and complementary aspects of social episodic memory in patients with SAUD to obtain fine-grained mechanistic insights. We first examined the encoding (and initial retrieval) of *novel* socio-affective stimuli. We did so using an updated incidental Social Recognition Task with a Remember/Know/Guess (R/K/G) paradigm (D'Argembeau et al., 2003; Jermann et al., 2008). Briefly, participants viewed clips of dynamic negative (angry) and positive (happy) facial expressions. Afterward, they were presented with pictures of the same individuals presenting neutral expressions, along with foils, and had to indicate if they had previously seen the face and, if so, what its emotional expression was. They also specified whether they had a specific recollection of the faces and expressions or a general sense of familiarity, indexing the strength of the memory trace. One previous study assessed episodic memory for facial expressions in SAUD using a similar paradigm (Oscar-Berman et al., 1990) and did not find SAUD effects. However, this study employed a restricted set of black and white static photographs lacking ecological validity, did not investigate valence effects, and comprised small samples, underlining the need to replicate and extend these preliminary findings. Second, we investigated the accessibility of or fluency for already existing interpersonal memories, as well as their level of specificity, using an adaptation of the Good Day Bad Day Task (Hitchcock et al., 2019), the Social Memory Accessibility Task. Participants had to separately retrieve as many specific memories of positive and negative interpersonal events as possible within equal time limits. They later described each memory so that they could be coded for specificity. We preferred this task over those timing participants' retrieval of memories related to individual cues (e.g., Joormann & Siemer, 2004), as we were interested in the accessibility of broad categories of interpersonal memories. As a whole, we tested whether patients with SAUD differ from controls in (1) the amount and/ or valence of new socio-affective information that they initially store in memory and (2) the ease with which they can bring to mind previously experienced interpersonal events of different valences. Both processes are relevant to social cognition because they might influence the interpersonal memory content that is generally available, and the content most likely to be selected, when interpreting current social interactions.

Based on previous work showing generally impaired cognitive functioning (Stavro et al., 2013), and reduced nonsocial episodic encoding and retrieval, as well as reduced specificity in SAUD (Nandrino et al., 2014, 2016; Noël et al., 2012; Pitel et al., 2007; Poncin et al., 2015; Whiteley et al., 2009), we expected patients to exhibit lower performance than controls on both tasks (i.e., lower recognition of faces and emotions with lower levels of awareness/strength of memory trace, and fewer and less specific interpersonal memories retrieved across valences). In addition,

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and centrally, we hypothesized that whereas controls would show marked positivity biases on both tasks, in line with previous findings (D'Argembeau et al., 2003; D'Argembeau & van der Linden, 2011; Hitchcock et al., 2019), patients would lack this bias or even show a negativity bias (Pabst, Heeren, & Maurage, 2020). This rests on recent evidence that SAUD is linked with a lack of bias toward positive social stimuli in the attentional domain (Pabst, Bollen, et al., 2023), as well as with an increased spontaneous recall of negative memories (Cuervo-Lombard et al., 2016; Nandrino & Gandolphe, 2017).

METHOD

Transparency and openness

We preregistered our hypotheses, design, sample size rationale, and analytic plan for the Social Recognition Task on the Open Science Framework: https://osf.io/r7cd5. We did not preregister the use of the Social Memory Accessibility Task but our hypotheses and analyses closely aligned with those of the Social Recognition Task. We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. All procedures complied with the Declaration of Helsinki and were approved by the biomedical ethical committees of UCLouvain. The data and code underlying this article can be found at https://osf.io/3chxt.

Participants

We recruited 40 patients with a DSM-5 diagnosis of SAUD (≥6 criteria) from specialized detoxification centers in Belgium, as well as 40 age, gender, and education-matched healthy control (HC) participants. We determined this sample size following a power analysis conducted on G-power, which revealed that 34 participants per group were necessary to detect small-to-medium ($f=0.175$) 2×2 mixed-design interaction effects (corresponding to our central effects of interest) with a power of 0.80, setting significance at 0.05. We increased this number to 40 to maximize power for our other analyses. Patients had all abstained from alcohol for a minimum of 8 days and a maximum of 3 months at testing time. All patients reported SAUD as their primary problem and had no lifetime diagnosis of psychiatric or neurological disorder besides depression, anxiety, and nicotine use disorder. HCs were recruited using social media advertisement, study flyers, and University participant pools. HCs and their first-degree relatives (parents and siblings) reported no history of alcohol use disorder and HCs were free of lifetime psychiatric or neurological disorders besides nicotine use disorder. They had an Alcohol Use Disorder Identification Test (AUDIT; Babor et al., 2001) score below eight, indicating low-risk consumption, and reported drinking less than 10 alcohol units (1 unit = 10 g of ethanol) per week and no more than three units per day. All participants provided informed written consent.

Social recognition task

Stimuli

For the study phase, we selected 64 three-second morphed video clips of individual faces transitioning from a neutral to an emotional expression (32 actors, 16 women, each expressing both happiness and anger) from the validated FACES database (Holland et al., 2019). To control for potential actor effects on memory, we formed two sets (A & B). Both contained 32 clips of different actors, with half (eight women) expressing happiness and the other half expressing anger, but the actors expressing anger in set A expressed happiness in set B and vice-versa. Happy and angry expressions did not differ between sets in terms of intensity (happy: $p=0.18$, angry: $p=0.87$), naturalness (happy: $p=0.62$, angry: $p=0.72$), and recognition accuracy (happy: $p=0.80$, angry: $p=0.90$), as per the ratings provided in the validation study (Holland et al., 2019). For the test phase, we used video clips from the 32 actors presented in the study phase, albeit with a neutral expression, as well as 16 additional neutral video clips from previously unseen actors (eight women), which served as distractors.

Procedure

During the learning phase, participants viewed all video clips from set A or B (counterbalanced across participants) once in a random order. Participants were instructed to imagine that the actors' emotional expressions were directed toward them. To make sure participants properly processed the stimuli and their valence, and to rule out the possibility that any memory effects would be due to differences in initial evaluation, we instructed participants to carefully attend to each actor and to rate, as accurately as possible, the interpersonal signal expressed on a 10-point Likert scale (from 0 "extremely hostile" to 9 "extremely friendly"). This was preferred over explicit judgments of specific emotions (i.e., identifying anger or happiness) to minimize potential interferences of emotional decoding impairments on encoding performance and intensity ratings (e.g., Maurage et al., 2021, see Harvey et al., 2009, for a similar reasoning). A pilot study using all selected video clips, along with sad ones from the same database, conducted in 24 healthy individuals who did not take part in the final experiment, ensured that (1) angry clips were rated as more hostile than neutral ($p<0.001$) and sad ($p<0.001$) ones, (2) happy clips were rated as more friendly than neutral ones ($p<0.001$), and (3) there were no between-set differences in ratings of angry ($p=0.57$) or happy ($p=0.75$) clips.

Immediately after the learning phase, participants underwent an unexpected memory test in which they viewed the neutral video clips of all the actors from the study phase and from 16 distractors. For each clip, they were asked to indicate: (1) whether they had previously seen ("YES"/"NO") the actor (facial identity recognition). For "YES" responses, participants had to specify whether they *Remember* (i.e., the clip brings back a conscious recollection of the

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actor's appearance or of an associated thought or feeling; R), *Know* (i.e., the clip elicits a feeling of familiarity without triggering a specific memory; K), or *Guess* (G) having seen the actor; (2) the expression of the actor during the study phase (expression recall, hostile, or friendly), and again to report the associated state of awareness (R/K/G). Throughout both phases, participants sat in a quiet room approximately 50 cm (eye distance) away from a 15.6-inch Dell Latitude E5530 laptop screen equipped with a mouse. We collected all responses via mouse clicks.

Social memory accessibility task

A subsample of 29 patients with SAUD and 30 HCs (whose characteristics were comparable to those of the general sample, see Supplemental Material S1) agreed to also complete this adaptation of Hitchcock et al.'s Good Day Bad Day Task (Hitchcock et al., 2019). We asked participants to retrieve as many specific autobiographical memories of positive and negative social interactions from their recent or distant past as possible during two periods of 3 min and to write down a single keyword per memory. The order (negative, positive) was counterbalanced across participants. The keywords had to be evocative of these memories and allow for later description. After 3 min, participants described the events associated with each keyword without time limits. We provided detailed instructions defining specific autobiographical memories as events in which they were personally involved, that happened at a particular time and place, and that lasted less than a day. Positive/negative interpersonal memories were defined as memories in which one or more person(s) did or said something to participants that made them view the interaction as positive/negative. To ensure their understanding of both concepts, participants underwent a nonsocial training session with feedback in which they had to retrieve as many specific memories related to nature as possible and were provided with three examples of both positive and negative interaction memories.

Additional measures

We assessed depression, state and trait anxiety, and social anxiety symptoms using the short form of the Beck Depression Inventory (BDI; Beck & Steer, 1987), the State–Trait Anxiety Inventory (STAI; Spielberger, 1983), and the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), respectively. We measured interpersonal problems with the eight subscales of the 64-item Inventory of Interpersonal Problems (IIP; Horowitz et al., 2003).

Data analysis

Because preliminary visual inspection of our data indicated potential deviations from distribution assumptions and the presence of outliers in some of our variables of interest, we extended our preregistered analysis plan and compared the results of each statistical model presented below to those of a robust alternative (Field & Wilcox, 2017). Specifically, we used the *bwtrim* (a method based on trimmed means) and *pbcor* functions from the *WRS2* R package with default settings for ANOVAs and Pearson correlations, respectively. The conclusions from classical and robust models did not differ for all our primary analyses. In our exploratory correlational analyses, when differences occurred, we explicitly highlighted them and based our results on the robust alternative.

Social recognition task

We first verified that angry and happy video clips were rated differently on the hostile-friendly scale, and tested whether there were group differences by submitting ratings to a 2 (Group: SAUD vs. HC, between)×2 (expression: angry vs. happy, within) mixed ANOVA. Ratings from one patient with SAUD are missing due to a technical failure.

For facial identity recognition, we categorized answers as hits (answering "YES" for previously seen actors), misses (answering "NO" for previously seen actors), false alarms (answering "YES" for previously unseen actors; FA), and correct rejections (answering "NO" for previously unseen actors).

We computed corrected facial identity recognition scores for each participant and separately for each expression category by subtracting the percentage of FAs from the percentage of hits. Since expression-specific FAs could not be computed as all actors had a neutral expression during the recognition phase, general FAs were subtracted. We computed expression recall scores for each participant and each expression by calculating the percentage of correctly recalled expressions relative to the number of facial identity recognition hits for that expression.

To address our central hypotheses and determine whether patients with SAUD differ from controls in their encoding and initial retrieval of novel socio-affective information, we submitted facial identity recognition and expression recall scores to two separate 2 (group: SAUD vs. HC, between)×2 (expression: hostile vs. friendly, within) mixed ANOVAs.

Second, to examine differences in the level of awareness (R/K/G) for facial identity recognition, we submitted recognition scores (percentage of hits minus percentage of FAs) separately calculated for R, K, and G responses and each expression to three (one for each response type) separate 2 (group: SAUD vs. HC, between)×2 (expression: angry vs. happy, within) mixed ANOVAs. We performed separate ANOVAs for each awareness level instead of adding awareness level as a third factor because percentages of responses at different levels are dependent. Similarly, we analyzed differences in the level of awareness in relation to emotion recall by submitting the percentage of R, K, and G responses for correctly recognized emotions to three separate 2 (group: SAUD vs. HC, between)×(expression: angry vs. happy, within) mixed ANOVAs.

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Social memory accessibility task

We recorded participants' descriptions of positive and negative events. The first author, as well as a graduate student who was unrelated to the current study and blind to hypotheses and participants' group status coded each memory to determine if it was valid (i.e., it was interpersonal in nature; percent agreement: 0.88) or not and specific (i.e., it referred to a particular event lasting less than a day; percent agreement: 0.85) or not.

To examine differences in accessibility and specificity of autobiographical interpersonal memories, we submitted the number of (1) valid and (2) valid and specific (hereafter referred to as specific) memories to two separate 2 (group: SAUD vs. HC, between) × 2 (valence: negative vs. positive, within) mixed ANOVAs.

Additional analyses

We finally conducted Pearson correlations to explore associations between memory variables for which a group difference was observed and psychopathology, interpersonal problems, and alcohol consumption variables in the group of patients with SAUD.

RESULTS

Table 1 displays sample characteristics. As planned, groups did not differ in age, gender, or education. However, patients with SAUD had significantly higher depression, state and trait anxiety, social anxiety, and, as expected, AUDIT scores than HCs. They also reported

TABLE 1 Socio-demographic, psychopathological, interpersonal problems, and alcohol consumption measures in patients with severe alcohol use disorder (SAUD) and healthy controls (HC): Mean (SD).

	SAUD	HC	t/χ^a	*p*
Socio-demographic measures				
Gender (M/F)	20/20	20/20	0.00	1.00
Age	49.90 (10.14)	47.75 (10.75)	0.92	0.36
Education level (in years since starting primary school)	14.45 (2.30)	14.125 (2.43)	0.61	0.54
Psychopathological measures				
BDI[b]	**10.99 (5.81)**	**2.98 (3.68)**	**7.30**	**<0.001**
STAI-State[a]	**33.30 (9.58)**	**28.15 (7.33)**	**8.09**	**0.009**
STAI-Trait[a]	**53.75 (8.70)**	**37.50 (9.26)**	**8.09**	**<0.001**
LSAS[c]	**54.87 (28.95)**	**35.27 (24.78)**	**2.23**	**0.02**
Interpersonal problems				
Total IIP[d]	**99.15 (32.77)**	**56.70 (29.01)**	**6.09**	**<0.001**
Domineering	**7.31 (3.04)**	**4.65 (3.13)**	**3.83**	**<0.001**
Self-centered	**8.74 (5.25)**	**5.05 (3.83)**	**3.51**	**<0.001**
Cold/Distant	**10.64 (7.36)**	**5.10 (4.22)**	**4.09**	**<0.001**
Socially inhibited	**12.69 (9.80)**	**6.30 (6.24)**	**3.45**	**<0.001**
Nonassertive	**15.05 (8.67)**	**9.18 (6.66)**	**3.37**	**0.001**
Overly accommodating	**15.69 (7.10)**	**10.10 (5.49)**	**3.91**	**<0.001**
Self-sacrificing	**18.69 (6.29)**	**10.85 (6.04)**	**5.65**	**<0.001**
Intrusive	**13.00 (7.37)**	**5.33 (3.75)**	**5.81**	**<0.001**
Alcohol consumption measures				
Alcohol use disorder identification test	**30.00 (5.55)**	**3.00 (2.36)**	**27.04**	**<0.001**
Number of abstinence days	27.46 (21.80)			
Number of previous detoxification stays	1.60 (2.16)			
Duration of SAUD (in years)	11.53 (9.90)			
Number of alcohol units per day[e]	17.64 (10.39)			

Note: Bold lines indicate a significant difference between groups.

[a]State/Trait Anxiety Inventory (Spielberger, 1983).

[b]Beck Depression Inventory (Beck & Steer, 1987).

[c]Liebowitz Social Anxiety Scale (Liebowitz, 1987).

[d]Inventory of Interpersonal Problems (Horowitz et al., 2003).

[e]Before detoxification (an alcohol unit corresponds to 10 g of ethanol).

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significantly more interpersonal problems on every subscale of the IIP than HCs.

Social recognition task

Ratings during the learning phase

There was a significant effect of expression [$F(1,77)=1315.71$, $p<0.001$, $\eta^2_p=0.945$], with angry video clips receiving lower ratings ($M=1.77$, SD = 0.78) than happy ones ($M=6.98$, SD = 0.77). Furthermore, angry [$t(78)=31.14$, $p<0.001$] and happy [$t(78)=28.64$, $p<0.001$] video clip ratings were significantly lower and higher than the hostility-friendliness scale's midpoint, respectively. The group effect [$F(1,77)=0.84$, $p=0.36$, $\eta^2_p=0.011$] and the group × expression interaction effect [$F(1,77)=0.80$, $p=0.37$, $\eta^2_p=0.010$] were not significant. Hence, angry and happy video clips were indeed clearly distinguished and rated as hostile and friendly, respectively, with no differences between groups.

Facial identity recognition scores

Corrected recognition scores are shown in Figure 1A, as a function of group and expression (descriptive statistics are provided as Supplementary Material S2). The ANOVA on facial identity recognition scores revealed a marginal effect of the group [$F(1,78)=3.34$, $p=0.07$, $\eta^2_p=0.041$], with facial identity recognition being lower in patients with SAUD, as well as a significant effect of expression [$F(1,78)=17.47$, $p<0.001$, $\eta^2_p=0.183$], with better facial identity recognition for happy compared to angry video clips. Importantly, the group × expression interaction was not significant [$F(1,78)=0.02$, $p=0.89$, $\eta^2_p=0.0002$], see Figure 1A. We obtained similar results from the ANOVA on R responses: the group effect was marginal [$F(1,78)=3.92$, $p=0.051$, $\eta^2_p=0.041$], the expression effect was significant [$F(1,78)=12.23$, $p<0.001$, $\eta^2_p=0.136$], and the group × expression effect was not significant [$F(1,78)=0.37$, $p=0.54$, $\eta^2_p=0.005$]. The ANOVAs conducted on K and G responses showed no significant effects (all $ps>0.36$).

Expression recall scores

Expression recall scores are shown in Figure 1B, as a function of group and expression (descriptive statistics are provided as Supplementary Material S3). The ANOVA on expression recall scores revealed a significant effect of expression [$F(1,78)=4.48$, $p=0.037$, $\eta^2_p=0.054$], with better recall for happy compared to angry expressions, but both the group effect [$F(1,78)=1.35$, $p=0.25$, $\eta^2_p=0.017$], and the group × expression interaction effect [$F(1,78)=0.01$, $p=0.91$, $\eta^2_p=0.0002$] were not significant, see Figure 1B. The ANOVAs conducted on R, K, and G responses showed no significant effects (all $ps>0.14$).

Importantly, all results from the Remember/Know/Guess Task were replicated in the subsample of participants completing the Social Memory Accessibility Task.

Social memory accessibility task

The proportion of valid memories was high in both groups (SAUD: negative = 0.90, positive = 0.90; HC: negative = 0.98, positive = 0.95), although it was slightly lower in patients ($p=0.015$). Importantly, however, there was no main effect of valence ($p=0.627$) and there was no group × valence interaction ($p=0.484$).

Because numbers of valid and specific memories were highly correlated (SAUD: $r=0.90$ for positive memories, $r=0.97$ for negative

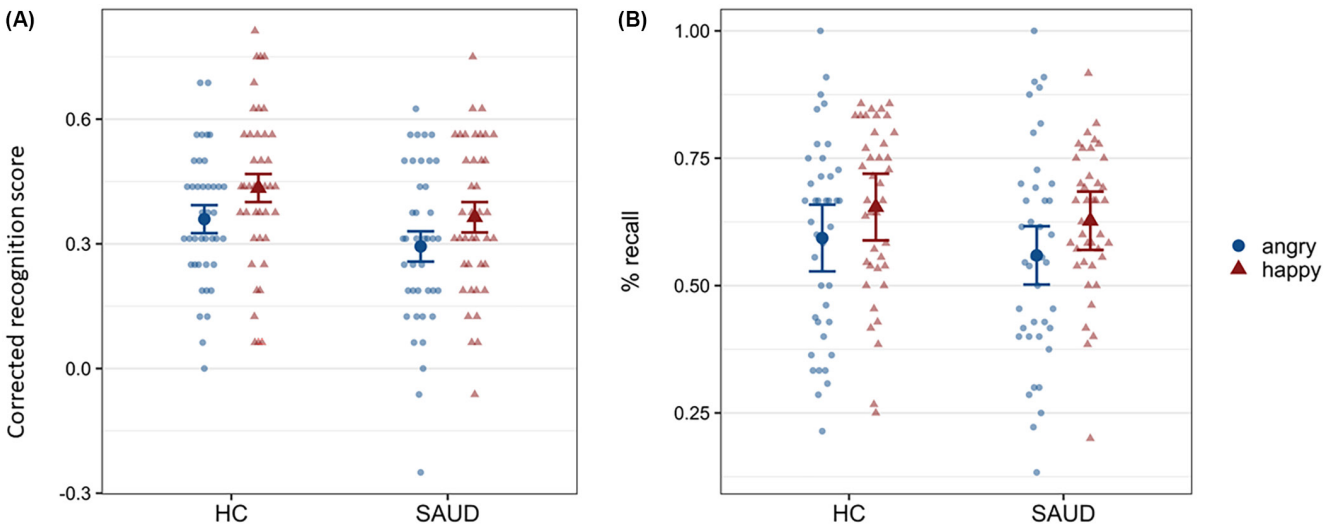


FIGURE 1 Corrected recognition scores for face recognition as a function or emotional expression during the study phase and group (A) and proportions of correct emotional expression recalls as a function emotional expression and group (B).

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ones; HC: $r=0.85$ for positive memories, $r=0.86$ for negative ones), we only present results from analyses focusing on specific memories here. The (largely redundant) results pertaining to valid memories, and the corresponding figure can be found in Supplementary Materials S4 and S5. The number of specific memories reported as a function of group and valence is shown in Figure 2. The ANOVA on the number of specific memories revealed no significant effect of valence [$F(1,57)=0.42$, $p=0.838$, $\eta^2_p=0.001$] but a significant effect of group [$F(1,57)=9.72$, $p=0.003$, $\eta^2_p=0.146$] and a significant group×valence interaction [$F(1,57)=9.54$, $p=0.003$, $\eta^2_p=0.143$]. Follow-up contrasts showed that patients with SAUD recalled more specific negative memories than HC [$t(1,57)=2.49$, $p<0.001$, $d=1.10$], but that groups did not differ on specific positive memories [$t(1,57)=1.45$, $p=0.153$, $d=0.38$]. Finally, HC recalled more positive than negative specific memories [$t(1,57)=2.34$, $p=0.022$, $d=0.59$], while the opposite was true for patients with SAUD [$t(1,57)=2.02$, $p=0.048$, $d=0.31$].

Associations between memory scores and relevant variables

Given the above-mentioned results, we investigated facial identity recognition scores (averaged across expressions) as well as the difference between the number of specific negative and positive memories (which correlated at more than 0.95 with the difference between valid negative/positive memories that were therefore not independently considered) in the exploratory correlational analyses within the SAUD sample. We provide correlation coefficients as Supplementary Material S6. There were no significant correlations between interpersonal problems or consumption variables and either memory index, except a positive correlation between facial identity recognition scores and "cold/distant" interpersonal problems ($r=0.38$), and a negative correlation between the difference between the number of specific negative and positive valid memories and "socially inhibited" interpersonal problems ($r=0.38$). The first might be explained by the fact that patients with SAUD experience more negative social situations, and hence, a better encoding of social situations overall would lead to colder, more detached behavior, whereas the second might suggest that patients who are more socially inhibited generally avoid risky social situations altogether and may thus less readily access specific negative social memories. However, given the overall absence of significant relations, the exploratory nature of these analyses, the fact that these were uncorrected, and in light of the limited sample sizes for correlational analyses, we refrain from definitive interpretations until replication is provided. Importantly, psychopathology variables were not significantly related to any social memory index in either the SAUD or HC sample and were hence not considered potential confounders.

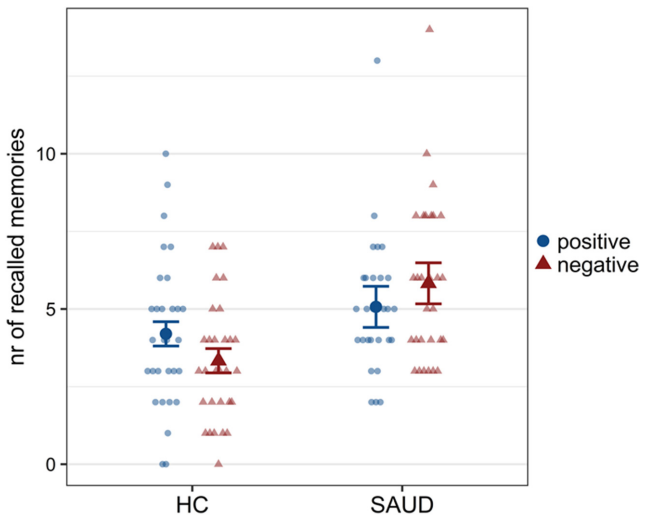


FIGURE 2 Number of specific memories recalled as a function of valence and group.

DISCUSSION

To identify basic mechanisms contributing to social cognition alterations in patients with SAUD, and thereby address a gap in the memory literature, we investigated two aspects of social episodic memory in this patient population. We tested whether patients differed from HC in (1) their initial encoding of novel socio-affective material (i.e., angry and happy dynamic facial expressions), and (2) their access to/fluency for already existing specific negative and positive interpersonal memories.

On the Social Recognition Task, patients with SAUD tended to recognize facial identities less accurately than HC, regardless of their emotional expression. This effect was specific to "Remember" responses, suggesting weaker memory trace possibly due to reduced encoding depth (Gardiner, 1988; Gardiner & Parkin, 1990). This effect aligns with our hypotheses and previous studies investigating the encoding of nonsocial material (e.g., Pitel et al., 2007). Patients did not, however, show difficulties recalling the emotional expressions of correctly recognized identities. Regarding valence effects, the scores for facial identity and emotion recognition were higher for happiness than anger, and, centrally, this effect was not modulated by the group. The effect of expression valence in HC is in full agreement with previous studies (e.g., D'Argembeau et al., 2003; D'Argembeau & Van der Linden, 2011) and supports the validity of our task. The fact that patients with SAUD *also* displayed a positivity bias in the encoding of socio-affective information, on the other hand, contradicts our hypothesis and the recent social cognition literature, notably evidencing reduced attentional biases to positive facial expressions (Pabst, Bollen, et al., 2023). Indeed, we expected this attentional pattern to translate into the encoding of information in memory (Craik et al., 1996). However, these discrepant results may be reconciled by considering task demands. Indeed, contrary to Pabst, Bollen, et al. (2023), who presented happy faces simultaneously with neutral faces with no instruction to focus on either, here we displayed stimuli sequentially, emphasized the importance of closely attending to each, and ensured that these were at least

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minimally processed by requiring hostility-friendliness ratings. The discrepancy in positive bias effects across the two paradigms may thus reflect the fact that patients devoted more attention to positive stimuli in the current study. We discuss the implications of this possibility below.

On the Social Memory Accessibility Task, we found no support for our hypothesis that patients with SAUD would generally recall fewer and less specific memories than HC. This deviates from past reports, and notably studies investigating the retrieval of emotional but not explicitly social autobiographical memories (Whiteley et al., 2009). This discrepancy may be due to the interpersonal nature of the current stimuli, suggesting that patients with SAUD fully benefit from the memory-enhancing effects of social cues (e.g., Stewardson et al., 2023), to the extent that these compensate for more general difficulties. Alternatively, the difference might be accounted for by a methodological factor. Indeed, whereas we imposed only broad category constraints on the nature of memories participants had to retrieve, previous studies required memories to correspond to more specific cue words. Thus, and as proposed by Hitchcock et al. (2019), previous results might reflect patients' reduced ability to retrieve specific autobiographical memories in response *to particular cues*, rather than a reduced ability to generate and specify memories in general (e.g., in less constrained retrieval situations). Executive difficulties reported in SAUD (Stavro et al., 2013) may compromise the implementation of search strategies or the inhibition of irrelevant material, and selectively impact the retrieval of cue-specific memories. Future work is needed to disentangle the sources of this discrepancy, as support for the latter option would warrant an important reconsideration of the generalizability of previous studies' interpretations.

Importantly, the effect of valence on the recall of interpersonal memories differed between patients with SAUD and controls. In line with our hypotheses, HC showed the expected positivity bias (Hitchcock et al., 2019), whereas patients with SAUD displayed the opposite pattern and recalled more negative than positive interpersonal memories. This effect was due to patients recalling more negative memories than HC, with no group difference for positive memories. The negative bias observed in patients with SAUD echoes those reported in studies focused on the recall of self-relevant memories (Cuervo-Lombard et al., 2016; Nandrino & Gandolphe, 2017). Besides generalizing previous results to social stimuli, the present findings make original contributions to the memory literature in SAUD by introducing a novel paradigm and domain of inquiry (i.e., memory accessibility for categories of interest) in SAUD, as well as by clarifying the mechanism through which negative biases might arise. Indeed, while it has been hypothesized that reduced encoding or access to positive material might be responsible (Nandrino & Gandolphe, 2017), the current data support neither view and instead point to increased access to or fluency for negative memories, with past evidence of reduced recall of positive ones likely reflecting restrictions on the maximum number of memories to be retrieved.

Together, our results thus provide a novel, rich, and detailed description of social episodic memory functioning in SAUD. They suggest that patients show a tendential difficulty to encode interpersonal cues as indexed by impoverished short-term recognition of newly encountered individuals' facial identities. Furthermore, centrally, they highlight a dissociation between a preserved positive bias in the encoding of novel social information and a negative bias in terms of access to/fluency for already established interpersonal memories. Of note, the discrepancy in valence biases cannot be attributed to sample differences since all results from the Social Recognition task were replicated in the subsample that performed the Social Memory Accessibility Task. Since categorical memory fluency partly depends on the level of integration between category items (Hitchcock et al., 2019), it is possible that although they do not preferentially encode negative social stimuli, patients subsequently spend more time elaborating and coherently linking them together, in line with reports of increased rumination tendencies in SAUD (Caselli et al., 2013; Grynberg et al., 2016). Another nonexclusive explanation is that patients with SAUD, a highly stigmatized group (Schomerus et al., 2011), encounter more negative interpersonal situations than HCs.

In addition to clarifying the memory profile associated with SAUD, our findings also meaningfully extend our understanding of the basic mechanisms involved in patients' social difficulties. Given the wealth of theoretical and empirical work stressing the role of memory in social cognition (Nandrino et al., 2014; Quaglino et al., 2015; Smeijers et al., 2019; van Genugten, 2022), the current evidence supports alterations in social memory as a novel class of potentially clinically relevant mechanisms in their own right. Indeed, lower facial identity recognition and negative biases in accessing interpersonal memories may interfere with social cognitive judgments. Failing to recognize counterparts as acquaintances may deprive them of knowledge derived from past interactions and consequently lead to erroneous inferences about the mental states underlying current expressions and behaviors (Stolier & Freeman, 2016). Likewise, facilitated access to negative versus positive interaction memories may negatively taint one's social worldview and increase pessimistic apprehensions of future interactions (MacLeod & Campbell, 1992; Pabst, Billaux, et al., 2023). Crucially, and analogously to recent reasoning in schizophrenia (Barry et al., 2019), this bias may further lead patients to rely more frequently on negative social experiences to interpret incoming social information and partially explain the well-documented hostile attributions (Freeman et al., 2018; Pabst, Peyroux, et al., 2020) that characterize SAUD. That said, we argue that our insights should also be contextualized alongside previous research, notably highlighting modifications in social attention in SAUD as additional mechanisms. Integrating both lines of results indeed improves models of the natural unfolding and interrelations of the basic social processes that culminate in patients' higher-level social cognition alterations. This, in turn, allows for precise localizations of preserved and perturbated functioning along the processing stream, as well as for better clinical decisions. For instance, lower encoding and recognition of facial identities may partly flow from patients' modified facial attention. Indeed, SAUD is linked with reduced attention to the eyes (Pabst, Bollen, et al., 2023), an important region not only for emotion but

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also for facial identity recognition (Chuk et al., 2017). Normalizing facial attention may, therefore, be beneficial/necessary to rehabilitate this ability. In a similar vein, one might hastily conclude from our observed positivity bias finding that patients will normally encode more positive than negative social stimuli provided these are equally encountered. While this may be true and constitute an interesting lever in conditions where attention to, and a minimal level of processing of, positive stimuli are ensured, recent findings of a lack of attentional bias toward positive social cues (Pabst, Bollen, et al., 2023) indicate that this would likely not hold in naturalistic situations where several social cues compete for cognitive resources. Again, this indicates that considering attention would be essential for interventions aimed at ensuring the proper storage of positive interactions. As a whole, we suggest that episodic social memory processes should form an integral part of cognitively oriented mechanistic conceptualizations of social cognition and behavior in SAUD.

Our study comprises several strengths. It is based on a substantial clinical sample that was gender balanced and carefully matched with a control group in terms of demographics. It also relies on a rich experimental paradigm comprising two complementary memory tasks, allowing for nuanced mechanistic insights. We further strove to maximize the ecological validity of our paradigm, notably by using dynamic instead of static faces and increasing the total number of stimuli in the Remember Know Guess Task. However, some limitations must also be acknowledged. Although we asked participants to imagine that the faces from the Remember Know Guess task were directed toward them, it is possible the stimuli lacked personal relevance. In addition, our two tasks differed in terms of the nature of stimuli (facial expressions vs. interactions), which may partly underlie the discrepancy in terms of valence biases.

To conclude, we conducted the first proper investigation of episodic social memory in SAUD. We found evidence of generally impoverished encoding of novel social material (facial identity recognition) with a preserved bias for the encoding of positive versus negative ones. Further, patients did not show general difficulties in terms of the number and specificity of social interactions memories recalled, but contrary to HC, they showed greater access to or fluency for negative compared to positive memories. These results only partially align with nonsocially focused memory studies and, therefore, extend our knowledge about memory in SAUD. Most importantly, our results refine the basic understanding of how patients with SAUD process socio-affective information, and shed light on memory mechanisms that may contribute to patients' higher-order social cognition difficulties and that may be targeted in clinical settings.

AUTHOR CONTRIBUTIONS

Conceptualization: A. PABST, A. D'ARGEMBEAU, P. DE TIMARY, X. DE LONGUEVILLE, and P. MAURAGE; Methodology: A. PABST, A. D'ARGEMBEAU, and P. MAURAGE; Formal Analysis: A. PABST, A. D'ARGEMBEAU; Investigation: A. PABST, Resources: P. DE TIMARY, X. DE LONGUEVILLE; Writing—Original Draft: A. PABST; Writing—Review & Editing: A. PABST, A. D'ARGEMBEAU, P. DE TIMARY, X. DE LONGUEVILLE, and P. MAURAGE; Supervision: P. MAURAGE; Project Administration: P. MAURAGE.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there were no conflicts of interest with respect to the authorship or the publication of this article.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/3chxt, reference number 3chxt.

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SUPPORTING INFORMATION

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