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# “I remember the attack”: a pilot study investigating flashbulb memory in individuals with schizophrenia

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## Abstract

Flashbulb memories are autobiographical memories for important and emotional events, which have the particularity of being at the intersection of personal and public events. Autobiographical memory impairments are highly prevalent in schizophrenia, a psychiatric condition intrinsically linked to self-disorders. Thus, we aimed to evaluate flashbulb and event memory functioning in individuals with schizophrenia. Twenty-four individuals diagnosed with schizophrenia and 25 control participants were tested on a flashbulb memory questionnaire about the July 14th, 2016, Nice (France) terrorist attack, including questions on flashbulb and event memory, certainty, vividness, rehearsal, emotion, novelty, consequentiality, implication, and importance. Participants also underwent cognitive assessments. Analysis showed lower scores for both flashbulb and event memories in patients compared to control participants. Subjective ratings of the phenomenological characteristics of flashbulb memory were similar between the two groups overall. However, individuals with schizophrenia reported having higher levels of emotion when they first learned about the attack compared to the control group. Our results replicate findings of impaired autobiographical memory functioning in schizophrenia and extend these findings to public events. Our findings also indicate that flashbulb memories may lead to substantial contextual recall in schizophrenia patients and that collective memories, such as a terrorist attack, can have a profound emotional impact on patients.

**Keywords** Schizophrenia · Autobiographical memory · Episodic memory · Flashbulb memory · Public event

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On July 14th, 2016, a terrorist attack occurred at the end of the Bastille Day fireworks in Nice, France. A single assailant drove a truck on the famous and crowded Promenade des Anglais, leading to the deaths of 86 people, with 458 others injured. If one asks a French person about the moment they first learned about this event, they will often be able to recall where, when, and with whom they were, and sometimes the exact thing they were doing at this moment. A similar phenomenon has been found for other important public events in other countries, even long after the event (e.g., the assassinations of John F. Kennedy and Martin Luther King in the USA; Brown & Kulik, 1977). This has led researchers in psychology to investigate the characteristics of memories for major and traumatic public events that reach a broad audience (Luminet & Curci, 2009). In 1977, Roger Brown and James Kulik labelled these as flashbulb memories (FBM; Brown & Kulik, 1977). FBM are highly personal, detailed and vivid recollections of the context in which an individual first found out about an important, unexpected, and emotional event (Brown & Kulik, 1977; Hirst & Phelps, 2016). As such, they are

considered autobiographical memories which importantly differ from factual event details (i.e., event memory: facts associated with the FBM-eliciting event, such as the number of victims or the exact place where that attack occurred).

Although research has highlighted that FBM seem to be prone to inaccuracy and inconsistency, the vividness and ratings of subjective feelings of certainty remain relatively high (Conway et al., 1994; Hirst & Phelps, 2016; Talarico & Rubin, 2003, 2009). This might be due to an overconfidence bias associated with emotional memories in comparison to non-emotional ones (Kensinger & Ford, 2020). There are several predictors of FBM occurrence for both positive and negative public events, including the appraisal of personal importance, emotion, rehearsal, mental visual images, and event memory (Piolino, 2000; Tinti et al., 2009). In their review, Hirst and Phelps (2016) classified the factors influencing the formation of FBM into two categories. The first refers to factors directly relating to the moment someone first hears about an essential piece of news or any information pertaining to the event itself (e.g., emotions felt at the moment of the discovery, the consequentiality and significance of the event or the appraisal of novelty). The second category refers to factors that characterize how people process the event over time (e.g., the extent of rehearsal, through social interactions, thoughts, or media).

To our knowledge, FBM have never been studied in psychiatric disorders. One single-case study investigated FBM in Alzheimer's disease (El Haj, Gandolphe, et al., 2016). This is somewhat surprising, as autobiographical memory functioning has been extensively studied in mental disorders such as depression (Sumner, 2012; Williams & Scott, 1988) and more recently in schizophrenia (see Berna et al., 2016 for a meta-analysis). There is a large amount of evidence that autobiographical memory is impaired in individuals with schizophrenia (Cuervo-Lombard et al., 2007; Elvevåg et al., 2003; McLeod et al., 2006; Raffard et al., 2009; Riutort et al., 2003). Their autobiographical memories are less specific (i.e., contain few elements about where and when the event was encoded), contain less phenomenological details, and are associated with reduced conscious recollection compared to healthy controls (for reviews see Berna et al., 2017; Ricarte et al., 2017; Zhang et al., 2019). This is referred to as overgeneral memory or overgeneralized memories. Research has also suggested an impaired ability to give meaning to personal events (Berna et al., 2011; Raffard et al., 2009; Raffard, D'Argembeau, et al., 2010), corresponding to a diminished capacity to create coherent narratives about their own life. From a clinical perspective, autobiographical memory functioning in schizophrenia might be a better predictor of patients' social performance than psychopathological symptoms, in stabilized patients at least (Mehl et al., 2010).

Only a couple of studies have investigated memory for public events in patients with schizophrenia (Venneri et al., 2002; Warren & Haslam, 2007). Venneri et al. (2002) highlighted difficulties at the encoding stage rather than at the retrieval stage for remote memories in chronic patients with schizophrenia. Warren and Haslam (2007) concluded that their participants had overgeneralized memories for public events. Overgeneral memory retrieval was similarly found in individuals with a diagnosis of schizophrenia and individuals diagnosed with depression, and in both autobiographical and event memory (Warren & Haslam, 2007). Importantly, these two studies asked participants to remember public events (e.g., "A British princess died in a fatal accident. What was her name?" in Venneri et al., 2002), but none of these events was considered as either autobiographical or highly emotional as are FBM. Studying FBM functioning in schizophrenia in comparison to healthy controls might provide complementary information to understand autobiographical memory deficits and whether these deficits extend to important emotional public events. If FBM are similarly impacted by an overgenerality bias as personal autobiographical memories, using them to study autobiographical memory functioning in psychiatric disorders presents an ecological advantage. Indeed, FBM are by nature shared by a large number of individuals, but remain specific to each of them. As such, they hold autobiographical qualities while controlling for the specifics of the event itself. Schizophrenia is considered a highly self-related disorder, in which identity construction and elaboration of meaning throughout life experiences are often impacted (Burgin et al., 2022; Raballo et al., 2021). Thus, clarifying the entirety of autobiographical memory functioning is crucial to help inform current knowledge and existing or future interventions for this population.

## Goals and Hypotheses

The main goal of the present study was to explore flashbulb and event memory functioning in individuals with schizophrenia in comparison to control participants. The public event was the July 14th 2016 terrorist attack in Nice (France). We chose to investigate memories of this event because it occurred in the South of France (not far from Montpellier, where we recruited participants) and was one of the most recent and major (86 victims) attacks that happened in France since the Charlie Hebdo and Bataclan attacks in Paris. The second goal was to compare the phenomenological characteristics of FBM between groups. Finally, executive functioning and binding processes (i.e., a cognitive process allowing stimulus features, for example colours, location, time, objects, to form an integrated

**Table 1** Sociodemographic, cognitive, and clinical characteristics of the sample

	Control participants ( <i>n</i> = 25)		Schizophrenia patients ( <i>n</i> = 24)		Statistics
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Age	27.72	8.35	30.04	9.26	$U = 268.0, p = 0.528$
Education (years)	15.36	1.89	13.00	2.55	$U = 134.0, p < 0.001$
Sex	10	40	18	75	$\chi^2(1) = 6.125, p = 0.021$
Male <i>n</i> / %					
Episodic memory					
Immediate	26.92	6.49	18.71	8.67	$t(47) = 3.763, p < 0.001$
Long-term	24.16	6.30	15.21	8.10	$t(47) = 4.327, p < 0.001$
Recognition	24.36	2.02	21.33	3.90	$t(47) = 3.393, p < 0.01$
Verbal fluency					
Formal	26.52	6.42	19.67	7.24	$t(47) = 3.507, p < 0.01$
Semantic	34.56	8.13	24.04	7.79	$t(47) = 4.622, p < 0.001$
Binding	19.48	0.87	18.04	3.53	$U = 224.5, p = 0.097$
PANSS (total)			58.33	11.94	
Positive			14.25	5.62	
Negative			16.50	5.76	
Disorganisation			17.79	6.02	
Excitement			13.13	3.04	
Emotional distress			17.96	5.57	

episode) are crucially involved in the recall of past events narratives (Yonelinas et al., 2019 for a review). These are frequently impaired in individuals with schizophrenia (Burglen et al., 2004; Sejunaite et al., 2020), therefore several cognitive tests were administered to investigate whether FBM characteristics are related to these processes in our schizophrenia group. We also explored correlations between FBM and event memory in both groups.

We hypothesized that individuals with a schizophrenia diagnosis would exhibit lower scores in the FBM subscale (i.e., encoding context of the moment) compared to controls. Given recognised semantic memory impairments in schizophrenia (Doughty & Done, 2009), we also hypothesized that patients would score lower in the event memory subscale (i.e., memory for the event facts) compared to controls.

## Methods

### Participants

Twenty-five individuals with a diagnosis of schizophrenia according to the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013) criteria and 25 non-clinical controls were recruited. Participants with a diagnosis of schizophrenia were stable outpatients from the University Department of Adult Psychiatry in Montpellier (France), recruited over a 21-month period (October 2017 to June 2019). Inclusion criteria were: (a) age between 18 and 60 years old, (b) a diagnosis of schizophrenia according to DSM-5 criteria

and (c) to be in a phase of the illness allowing the evaluation according to the current treating psychiatrist. Exclusion criteria were: presence of neurological disorders or cranial trauma antecedents, and substance abuse or dependence (except cannabis and tobacco). One participant was excluded because he could not remember the event we were investigating, making the flashback memory questionnaire impossible to administer. To ensure the absence of psychotic disorders in controls, we assessed participants with the 7th version of the Mini-International Neuropsychiatric Interview (M.I.N.I. 7.0.0; Sheehan et al., 1998). The final sample used for data analysis included 24 patients with schizophrenia and 25 control participants. Sociodemographic and clinical characteristics of the sample are presented in Table 1.

The study was carried out according to the code of ethics of the World Medical Association (Declaration of Helsinki). All study procedures were approved by the Institutional Review Board (Local Ethics Committee of the Laboratory Epsilon). All participants provided written informed consent and were not compensated.

### Materials

#### Flashbulb memory questionnaire

To assess memory for Nice terrorist attack, a 49-item paper questionnaire was adapted from the version of Gandolphe and El Haj (2017) Charlie Hebdo FBM questionnaire. Participation occurred 18 to 36 months after the attack. The questionnaire is composed of nine subscales sequentially assessing: event memory, FBM, certainty, vividness,

rehearsal, emotion, appraisals of novelty, consequentiality, importance, and implication. All items were based on previous classic FBM questionnaires (Brown & Kulik, 1977; Finkenauer et al., 1998; Luminet & Curci, 2009; Tinti et al., 2009, 2014). The questionnaire can be found in Supplementary Material 1. No validation study has yet been made for this questionnaire, but internal consistency data is available in Supplementary Table 3.

*Event memory* was assessed by 5 questions about the attack. It included spatio-temporal information: date, time, place; and contextual details: number of assailants, number of victims and tools employed for the attack. Each item was rated with 1 point for a correct answer and 0 for a wrong answer, no answer, or an 'I don't know' answer. The accurate answer for the date was July 14th, 2016; for the time the event took place, accepted answers included: evening, around 10:30 pm, right after the fireworks; for the place where the event happened the correct answer was Promenade des Anglais; for the number of assailants: 1; and for the number of victims: 86 with a margin of  $\pm 16$ . *Flashbulb memory*: 8 questions assessed the encoding context of the moment in which participants first acknowledged the attack. It was similarly designed as the event memory subscale, including spatio-temporal information: date, time, place; and contextual details: how they first learned about the event, what they were doing at this moment, with whom they were, what clothes they were wearing and who was the first person they announced it to. Scoring was 1 point when an answer was given or 0 when no answer or an 'I don't know' answer was given.

*Degree of certainty* was assessed by 2 items on a 5-point Likert-type scale. Participants were asked how they would remember these details in a few months (ranging from 1-no recall to 5-exact recall) and how sure they were of their memory (ranging from 1-not sure at all to 5-completely sure). *Vividness* of the memory was rated on 4 items, each evaluating subjective feelings of visual imagery, auditory perception, physiological sensations, and mental reliving at the time of recollection (e.g., When you remember the moment you first acknowledged the event, do you visualise the scene in your head?). Items were rated on a 5-point Likert-type scale ranging from 1-not at all to 5-totally, assessing metacognitive judgements of autobiographical reliving, as in Rubin et al. (2003) Autobiographical Memory Questionnaire.

*Rehearsal*: 5 items assessed media consumption, rumination (i.e., thoughts frequency) and social sharing (i.e., frequency, quantity, and time delay before sharing), in relation to the event. *Emotion*: emotional valence was assessed on a scale from -2-very negative to +2-very positive and 13 other items evaluated emotional state within different emotions (e.g., scared, sad, angry, anxious, etc.) rated on 5-point

Likert-type scales ranging from -2 to +2. *Appraisal of novelty* was assessed by 1 item on a 5-point Likert-type scale ranging from -2-unusual to +2-usual. *Consequentiality*: on the same type of scale, participants rated the past and present impact of the event. *Importance* was similarly assessed by four items evaluating importance to oneself, to family / friends, nationally and internationally. *Implication*: three items evaluated whether participants knew someone that was present at the moment of the attack, if they had friends or family living in Nice or visiting the city at the time of the attack, and whether they got involved in actions of support to the victims.

### Cognitive and clinical assessments

We used the subtests Logical Memory I & II of the Wechsler Memory Scale 4th edition (WMS-IV; Wechsler, 1945; French version MEM-IV ECPA) to assess episodic memory. Participants listen to two short stories orally told and must retrieve each story in 3 conditions: immediate recall, deferred recall, and recognition. Each story has a maximum of 25 points. In the recognition condition, 15 questions (maximum 15 points) are asked about each story. Fidelity studies support moderate to strong internal consistency. Both subtests have a mean reliability index of 0.86.

We used an adapted task from Mitchell et al. (2000) to assess binding processes, which are essential in episodic memory processes (Mitchell et al., 2000). This task evaluates visual and spatial capacities and features binding in working memory. It contains 20 trials and 2 training trials. Each trial is composed of four grids: in three of these, participants have to memorize letters and their spatial location and one testing grid. Participants must determine whether they saw the same letter in the same location as before. Each grid is presented to the participant for one second on a computer screen.

Verbal fluency was assessed using validated French adaptations of phonemic and semantic fluency tasks (Cardebat et al., 1990). Participants were given 2 min to generate as many words starting with the letter P as possible (phonemic task) and as many animals as possible (semantic task).

In patients, psychotic symptoms were assessed by a trained examiner using the Structured Clinical Interview for the PANSS (SCI-PANSS) and rated on the Positive and Negative Syndrome Scale (PANSS; Kay et al., 1987). The scale has a total of 30 items, rated on a scale from 1 (asymptomatic) to 7 (extremely symptomatic). In our statistical analysis, we used the five-factor model of van der Gaag et al. (2006). Using ten-fold cross-validation on an extensive data set, their final model included five factors of symptomatology: positive, negative, and disorganisation symptoms, excitement and emotional distress, and showed adequate

goodness-of-fit (Comparative Fit Index = 0.905; Root Mean Square Error of Approximation = 0.052).

## Procedure

The protocol was conducted in the Adult Psychiatry Department of Montpellier CHU, La Colombière Hospital (France). Participants completed tasks in the following order: Logical Memory I, binding task, demographics questionnaire, Logical Memory II, verbal fluency, FBM questionnaire. The clinical interviews (SCI-PANSS and M.I.N.I., for patients and controls respectively) were conducted at the end of the protocol. All participants were evaluated in a quiet and similar environment to control for external sources of distraction.

## Statistical analysis

We used IBM SPSS software (version 27) to analyze data. Exploratory analysis showed non-normal distribution for some variables. Missing data were found for one item of the FBM questionnaire in two participants, which were replaced by the median in each group (i.e., median imputation). No transformation enabled a normal distribution, thus we used non-parametric tests. For non-normal distributed variables, we used Mann-Whitney *U* exact test (Field, 2009; Mann & Whitney, 1947) to analyze group differences. For normally distributed variables, we used the independent two-sample *t*-test. We reported  $|r|$  values to show effect sizes. For normal distributions, we used Pearson's *r* to explore correlations, while for non-normal distributions, we used Kendall's Tau ( $\tau$ ). We chose Kendall's Tau over Spearman's Rho because of our small sample size (Field, 2009). Moreover, it seems that Kendall's Tau is a better estimate of the correlation in the population (i.e., allows a more accurate generalization; Howell, 1997). Finally, to correct for multiple testing, we applied the Benjamini-Hochberg correction. We chose this procedure because it is less conservative and seems to be more powerful than familywise error type of corrections, such as the Bonferroni correction (Benjamini & Yekutieli, 2001). All statistical tests were two-tailed unless otherwise mentioned (analyses conducted on the a priori hypotheses were one-tailed). The alpha level for testing significance of effects was  $p < 0.05$ , except for the correlational analysis where the corrected significance level is noted *q*.

## Results

### Sample characteristics

Demographic, cognitive and clinical characteristics of each group, and differences between samples are summarised in

**Table 2** Pearson and Kendall correlations of FBM and event memory with years of education in both groups

	Control participants ( <i>n</i> = 25)		Schizophrenia patients ( <i>n</i> = 24)	
	Flashbulb memory	Event memory	Flashbulb memory	Event memory
Education (years)	$\tau = 0.228$ ; $p = 0.182$	$\tau = 0.190$ ; $p = 0.257$	$r = 0.132$ ; $p = 0.537$	$r = 0.152$ ; $p = 0.478$

Table 1. Our samples were matched in age but not in sex and years of education. Thus, we conducted preliminary analyses with variables of interest.

### Preliminary analyses

Because our samples were not matched in educational level, and as current evidence suggests educational attainment has positive effects on cognitive functioning including episodic memory (Lövdén et al., 2020), we ran a correlation analysis between education and both flashbulb and event memory scores in both groups. As shown in Table 2, no significant correlation emerged (all  $p > 0.05$ ).

The clinical group was mainly composed of men (75%). Some evidence suggests sex differences in autobiographical memory (Gryzman & Hudson, 2013; Manns et al., 2018) and in FBM (Davis, 1999; Morse et al., 1993). Thus, we compared FBM and event memory functioning between males and females in both groups, using exact Mann-Whitney *U* tests. No significant differences were found in both FBM (patient group:  $U = 47.50$ ,  $p = 0.673$ ; control group:  $U = 43.50$ ,  $p = 0.063$ ) and event memory (patient group:  $U = 49.50$ ,  $p = 0.763$ ; control group:  $U = 63.00$ ,  $p = 0.506$ ).

### FBM and event memory

As shown in Table 3, patients with schizophrenia had a significantly lower FBM score compared to healthy controls ( $U = 196.50$ ,  $p$  (one-tailed) = 0.017), with a medium effect size  $|r| = 0.303$ . In addition, group differences in the two types of information (i.e., spatio-temporal vs. contextual) reached significance for spatio-temporal information, showing poorer performance in patients ( $U = 160.00$ ,  $p$  (one-tailed) < 0.001,  $|r| = 0.483$ ) but not for contextual details ( $U = 238.5$ ,  $p$  (one-tailed) = 0.103). Event memory functioning was poorer in patients compared to controls ( $U = 195.50$ ,  $p$  (one-tailed) = 0.016,  $|r| = 0.306$ ). Both event spatio-temporal and contextual information in this subscale were less recalled by patients than controls (respectively,  $U = 208.00$ ,  $p$  (one-tailed) = 0.030,  $|r| = 0.274$ ;  $U = 211.00$ ,  $p$  (one-tailed) = 0.022,  $|r| = 0.287$ ).

**Table 3** Group differences in FBM and event memory functioning

	Control participants ( <i>n</i> = 25)		Schizophrenia patients ( <i>n</i> = 24)		Statistics
	median	minimum; maximum	median	minimum; maximum	
Flashbulb memory					
Spatio-temporal information	3	0; 3	2	0; 3	$U = 160.00, p$ (one-tailed) $< 0.001,  r  = 0.483$
Contextual information	4	2; 5	4	2; 5	$U = 238.50, p$ (one-tailed) $= 0.103$
Total	7	2; 8	6	2; 8	$U = 196.50, p$ (one-tailed) $= 0.017,  r  = 0.303$
Event memory					
Spatio-temporal information	2	0; 3	1	0; 3	$U = 208.00, p$ (one-tailed) $= 0.030,  r  = 0.274$
Contextual information	2	1; 3	2	0; 3	$U = 211.00, p$ (one-tailed) $= 0.022,  r  = 0.287$
Total	4	1; 6	3.50	0; 5	$U = 195.50, p$ (one-tailed) $= 0.016,  r  = 0.306$

**Table 4** Group differences of FBM phenomenological characteristics

	Control participants ( <i>n</i> = 25)		Schizophrenia patients ( <i>n</i> = 24)		Statistics
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Certainty	6.36	2.18	6.54	2.02	$t(47) = -0.302, p = 0.764$
Vividness	11.40	3.65	10.00	3.35	$t(47) = 1.397, p = 0.169$
Rehearsal	14.00	2.78	14.21	4.50	$t(47) = -0.196, p = 0.846$
Emotion	48.04	10.81	56.04	9.37	$U = 163.0, p = 0.006$
Novelty	2.92	1.15	3.42	1.44	$U = 240.0, p = 0.224$
Consequence	5.44	2.65	6.25	2.74	$U = 249.5, p = 0.313$
Importance	15.40	3.43	16.33	3.25	$U = 252.0, p = 0.340$
Implication	1.68	1.22	1.25	0.53	$U = 248.0, p = 0.198$

### FBM phenomenological characteristics

Group differences for the remaining subscales, including usually claimed predictors of FBM (i.e., Rehearsal, Emotion, Novelty, Consequence, Importance, and Implication) are presented in Table 4. More detailed data (i.e., frequencies, minimum and maximum) are reported in Supplementary Table 1.

As reported in Table 4, schizophrenia patients rated the emotion subscale significantly higher than control participants ( $U = 163.0, p = 0.006, |r| = 0.392$ ). In this analysis, we included all items of the emotion subscale, including the emotional valence item.

### Correlation between FBM and event memory

We explored relationships between flashbulb and event memory functioning in our sample, using a non-parametric correlation analysis. This led to a non-significant association in the patient group ( $\tau = 0.197; p = 0.232$ ), but a significant correlation ( $\tau = 0.351; p = 0.040$ ) in the control group.

**Table 5** Correlations between the flashbulb and event memory subscales and cognitive assessments in the patient group

Schizophrenia patients ( <i>n</i> = 24)	Flashbulb memory (total)	Event memory (total)
Logical memory	$r = 0.056; p = 0.793$	$\tau = 0.108; p = 0.490$
immediate recall	$r = -0.062; p = 0.774$	$\tau = 0.101; p = 0.522$
deferred recall	$r = 0.093; p = 0.666$	$\tau = 0.170; p = 0.291$
recognition		
Verbal fluency	$r = 0.163; p = 0.446$	$\tau = -0.045;$
formal	$r = 0.137; p = 0.522$	$p = 0.778$
semantic		$\tau = 0.235; p = 0.137$
Binding	$\tau = -0.064; p = 0.707$	$\tau = 0.051; p = 0.765$

### Correlations between cognitive performance, flashbulb and event memory scores

Correlation coefficients and corresponding  $p$ -values for the correlation analysis between the total score at the FBM subscale and scores at the cognitive tests in the schizophrenia group are reported in Table 5. Corrected significance level was  $q = 0.004$ . No significant correlations between cognitive measures and both flashbulb and event memory subscales were found (all  $p > 0.05$ ). We also ran a correlation analysis between both FBM and event memory subscales with the PANSS dimensions, and none were significant (all  $p > 0.05$ ; see Supplementary Table 2).

## Discussion

The main goal of this study was to explore FBM in adults diagnosed with schizophrenia in comparison to FBM in those without schizophrenia. As hypothesized, patients had more difficulties than controls in recalling both the precise details of the event itself (i.e., event memory) and the encoding context of the moment in which they first learned about the attack (i.e., FBM).

Our sample of patients showed significantly poorer overall FBM performance compared to healthy controls. This result is the first evidence of a potential FBM deficit in individuals diagnosed with schizophrenia and supports our first hypothesis. More specifically, our clinical sample performed significantly worse on average than the control sample for spatio-temporal items. This is in line with some previous studies suggesting a deficit in temporal context processing in schizophrenia (Brébion et al., 2020; Polyn et al., 2015), but not with others (Ben Malek et al., 2019). Importantly, in the study of Ben Malek et al. (2019), the remembered event was considered ‘located in time’ if the year of the event was provided. In contrast, a precise date and time was requested in our study. Interestingly, schizophrenia patients and controls did not differ in their memory for contextual details unrelated to time or spatial information (e.g., remembering what they were wearing when they first learned about the attack). If this finding adds to a well-established autobiographical memory deficit in this mental condition (Berna et al., 2016; Riutort et al., 2003), it also supports the idea that FBM may lead to substantial contextual recall in schizophrenia patients, as previously shown in Alzheimer’s disease (El Haj, Gandolphe, et al., 2016). This suggests that schizophrenia patients can retrieve some phenomenological characteristics of past events despite an impaired ability to combine primary elements of a memory into a coherent narrative (Diaz-Asper et al., 2007; Raffard, D’Argembeau, et al., 2010; Rizzo et al., 1996).

Event memory (i.e., memory for factual details of the event) was significantly poorer in patients compared to control participants, supporting our second hypothesis. Patients with schizophrenia had lower scores in both the spatio-temporal dimension and other contextual details, compared to controls. Once more, it supports the idea of an overgeneralized episodic memory and lack of specificity in schizophrenia (Berna et al., 2016; Zhang et al., 2019). This result replicates previous findings on an overgenerality bias in memory of public events found in individuals with schizophrenia (Warren & Haslam, 2007), as well as difficulties in dating remote events and recalling information related to them (Venneri et al., 2002).

The second aim was to compare the FBM phenomenological characteristics between groups. Results showed that

all ratings were similar across groups except for the emotion subscale. Therefore, FBM as a whole may not be particularly different in people with schizophrenia when compared to healthy controls. However, because we found a significant difference in the FBM subscale, another explanation would be that the usual predictors of FBM are neither necessary nor sufficient factors for the formation of FBM. This hypothesis was not further explored in this study due to the small sample size, but it would be worthwhile to investigate in future research with larger samples. Besides, it could also mean that even though patients seem to have more difficulties remembering or encoding contextual details of a major public event, they are experiencing it similarly to non-clinical subjects. In this way, the lack of significance in our group analysis for predictors is of great interest because it puts forward the idea that people with schizophrenia might process collective memories in the same way as other people, but still experience difficulties when retrieving details of their memories. Results on the vividness subscale highlight that subjective mental reliving could be similar in patients and controls when assessed in the context of an important public event, despite difficulties for retrieving details of their memories. Yet, patients reported significantly higher ratings of emotion than controls. Intensity was rated on several emotions that were mainly negative (e.g., fear, insecurity, anxiety, sadness). This result could be explained either by an elevated emotional reactivity to stress or a difficulty to cope with it when they learned that the event had occurred (Myin-Germeys & van Os, 2007). Previous research has also shown that emotion regulation is markedly impaired in individuals with schizophrenia (Ludwig et al., 2019; van der Meer et al., 2009). Whether higher emotions reported during FBM recall relate to disrupted emotion regulation / reaction at stage of encoding or during retrieval requires further investigation.

Our final aim was to explore associations between FBM, event memory and cognitive functioning. Interestingly, a positive correlation was found between event memory and FBM in controls but not in patients. A possible explanation would be that non-clinical participants tend to use information from the event itself to better recall autobiographical features of the moment when they first learned about the event (i.e., FBM) and/or vice-versa. As mentioned in a previous study by Cubelli and Della Sala (2008), one could argue that FBM are linked to a specific ‘spatio-temporal window’ of the event itself (i.e., the event studied here: July 14th, which is National Bastille Day in France), that could serve as a cue for individuals to remember the encoding context and retrieve autobiographical details. The non-significant correlation between FBM and event memory in our clinical sample extends on previous results on the use of strategies to recall autobiographical events in schizophrenia. For



instance, Ben Malek et al. (2019) found that patients tended to use less contextual details and temporal landmarks to recall autobiographical events and relied more on semantic strategies than episodic ones. As such, our patient sample could have been less efficient in using strategies to recall and associate event memory and FBM.

Finally, in patients with schizophrenia, there were no associations between FBM, event memory, episodic memory (as assessed by the MEM-IV), semantic memory, binding processes, and executive functioning (as assessed by the verbal fluency task). Likewise, most studies investigating the relationship between memory performances and/or executive functioning and autobiographical memory specificity failed to highlight significant correlations (Alexiadou et al., 2018; Berna et al., 2016; Raffard, D'Argembeau, et al., 2010). Our results suggest that FBM deficits in patients were not secondary to more generalized episodic memory impairments but could also mean that cognitive and executive functions evaluated in our study are neither essential nor sufficient processes for the retrieval of FBM. Other cognitive processes remain to be explored within FBM, such as inhibition, updating, and other executive functions.

### Limitations

The present study holds several limitations and available results should be cautiously considered. First, our sample size was relatively small, which might have hindered statistical power. Second, we did not counterbalance tasks and it is possible that fatigue have impacted FBM performance, since it was assessed at the end of the protocol. However, pauses were offered to participants between assessments. Third, in our statistical analyses we used the median imputation method for two missing values which could have biased our results. Fourth, we used a non-validated instrument to assess FBM. Even though it has been used in a previous study (Gandolphe & El Haj, 2017), it was not for the same event. There is currently no validated instrument to assess FBM and previous studies published on this topic did not use validated scales. We reported internal consistency (Cronbach's alpha values) for each subscale of our questionnaire in Supplementary Table 3. Cronbach's alpha for the full questionnaire was excellent (0.901) but some of the subscales had lower internal consistency (see Supplementary Table 3). Some cognitive assessments did not have normative data available (i.e., binding and verbal fluency tasks), although they have been used in previous research (El Haj, Kessels, et al., 2016; El Haj et al., 2013). Fifth, we did not use a personal autobiographical memory task to control for a potential overlap between FBM and autobiographical memories that relate to personal events rather than public ones. Future studies should include this type of task.

Finally, as we did not assess the presence of other psychiatric disorders, we did not control for potential confounding effects of these comorbid conditions in our clinical sample.

### Implications for research

The main finding of this research highlights a potential FBM deficit in people diagnosed with schizophrenia, despite the singularity of FBM (i.e., they are supposed to be particularly vivid and long-lasting; Brown & Kulik, 1977). Whether this is of the same nature as other autobiographical memories remains to be investigated. Research comparing FBM formation with personal autobiographical memory in individuals with schizophrenia is needed. It would allow us to not only make further conclusions about the nature of FBM, but also to improve our understanding of autobiographical memory functioning in schizophrenia. Future research is thus needed and should aim at replicating this type of study in larger clinical samples alongside investigating potential links with psychopathological factors, such as illness duration.

### Implications for clinicians

Individuals with schizophrenia in our sample reported significantly higher ratings of emotion than controls during the recall of FBM. This suggests that emotionally arousing public events, such as natural disasters or terrorist attacks, might have a profound impact in this population at high risk for depression, attempted and completed suicide, and loneliness. Facilitating access to evidence-based treatment following highly stressful public events for individuals with schizophrenia is needed. Finally, ongoing research on autobiographical memory functioning in schizophrenia will inform existing and future interventions targeting autobiographical memory, a crucial aspect of identity construction and coherence (e.g., Blairy et al., 2008; Dassing et al., 2020).

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## Declarations

**Conflict of interest** On behalf of all authors, the corresponding author states that there is no conflict of interest.

**Compliance with ethical standards** The study was carried out according to the code of ethics of the World Medical Association (Declaration of Helsinki). All study procedures were approved by the Institutional Review Board (Local Ethics Committee of the Laboratory Epsilon). All participants provided written informed consent.

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