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RESEARCH ARTICLE

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A review of longitudinal studies on flashbulb memories. Where we started, are, and are going?

Rebecca Frinco[1] | Barbara Muzzulini[1] | Carla Tinti[1] | Olivier Luminet[2,3] | Susanna Schmidt[1]

[1]Department of Psychology, University of Turin, Torino, Italy

[2]Research Institute for Psychological Science, University of Louvain (UCLouvain), Louvain-la-Neuve, Belgium

[3]Fund for Scientific Research (FRS-FNRS), Brussels, Belgium

Correspondence
Carla Tinti, Department of Psychology, University of Turin, Via G. Verdi 10, 10124 Turin, Italy.
Email: carla.tinti@unito.it

Abstract

Since Brown and Kulik (1977) coined the term 'Flashbulb memories' (FBMs), there are still heated debates about their nature. We thus considered it useful to take stock of almost 50 years of research by reviewing 57 test–retest studies on FBMs for public events. The review aimed to answer six research questions by examining the target events and populations investigated (RQ1); the methods used to assess differences among groups and the effect of time on memory (RQ2); the assessment of FBMs' contents (RQ3), consistency (RQ4), vividness and confidence (RQ5); the criteria used to draw studies' conclusions (RQ6). Results show a huge methodological heterogeneity which may have contributed to the different conclusions about the special status of FBMs. The in-depth comparison of 9/11 studies suggests that results may differ depending on the methods used. Finally, the paper provides methodological suggestions for future FBMs studies and seeks to stimulate critical theoretical reflections.

KEYWORDS

9/11 attacks, autobiographical memory, flashbulb memory, longitudinal studies, memory consistency, public event

At the end of the 19th century, Colegrove, headed by the interest to grasp 'the abiding character of a vivid experience' (1899, p. 247), conducted a pioneering study on human memory: he asked 179 Americans to recall where they were when President Lincoln was assassinated and found that most participants (71%) could retain vivid and specific memories of the personal context in which they learned the news 30 years before. Colegrove paved the ground for a topic that yet fascinates and puzzles researchers: autobiographical memory for the reception context of emotional events. The study of these memories remained unexplored until 1977, when Brown and Kulik coined the term '*Flashbulb memory* (*FBM*)' to define the memory of the circumstances in which an individual first learns about the news of an event that is emotional, consequential, and highly self-relevant. They argued that FBM might be an appropriate term as it suggests 'illumination and brevity' and a 'live quality that is almost perceptual: […] it is very like a photograph that indiscriminately preserves the scene in which each of us found himself when the flashbulb was fired' (p. 74). In addition, Brown and Kulik (1977) treasured the distinctive features of vividness and longevity proposed by Colegrove (1899) and conjectured that these memories were somewhat more 'special' than other autobiographical records, as they were encoded in a privileged way by a brain mechanism called 'now print!' (Livingston, 1967) that rendered them unusually vivid, detailed and durable over time.

Rebecca Frinco and Barbara Muzzulini contributed equally to the work.

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Over the almost 50 years following Brown and Kulik's seminal work, the study of FBMs gained a research area on its own. Several major events have been the target of FBMs' investigation: the assassination of influential public figures like Swedish Prime Minister Olof Palme (Christianson, 1989) and Israel's Prime Minister Yitzhak Rabin (Nachson & Zelig, 2003); the death of famous persons like Princess Diana (Hornstein et al., 2003), Pope John Paul II (Tinti et al., 2009), Belgian King Baudouin (Finkenauer et al., 1998), Popstar Michael Jackson (Day & Ross, 2014); important sport events like World Cup Championship finals (e.g., Tinti et al., 2014); natural disasters like the earthquake in Loma Prieta (Neisser et al., 1996) and in the Turkish region Marmara (Er, 2003), and human-made disasters including the 9/11 attacks (e.g., Conway et al., 2009; Curci & Luminet, 2006; Rimmele et al., 2012; Schaefer et al., 2011; Schmidt, 2004; Smith et al., 2003; Talarico & Rubin, 2003) and Paris terrorist attacks (e.g., Muzzulini et al., 2020). In this huge body of studies, researchers sought to test Brown and Kulik's original hypothesis about the 'special' status of FBMs and to identify these memories' key characteristics.

Despite having a common goal, however, researchers often used heterogeneous definitions and methodologies to assess FBMs. We suggest that this theoretical and methodological heterogeneity may, at least to some extent, have contributed to the very different conclusions reached by different authors regarding the nature of FBMs, questioning in some cases even their existence (e.g., Neisser & Harsch, 1992).

We therefore considered it useful and worthy to:

1. Describe where we started;
2. Understand where we are through two steps: an analysis of the literature of nearly 50 years of research focusing on test–retest FBM studies for public events, and an in-depth qualitative analysis of the methods used in studies about 9/11 attacks;
3. Conclude with some critical reflections and suggestions on where we are going.

Where did we start?

In the first empirical attempt to investigate the contents of FBMs, Brown and Kulik (1977) surveyed 80 Americans upon nine representative public events of their time. Authors asked participants 'Do you recall the circumstances in which you first heard that…?'. If they answered 'yes' to this question, they were asked to describe the circumstances in which they learned the news through a free recall task. Using qualitative analyses, Brown and Kulik (1977) found that 'most of the, always unique, content could be easily and naturally placed' (p. 80) under six attributes called 'canonical categories': place, activity, informant, aftermath, own affect, and others' affect. They used the term 'canonical categories' 'in the sense that they were more likely to be recalled than any other content though, of course, no informant always used all six' (p. 80). In addition, the free recalls contained several idiosyncratic contents that could not be subsumed under any recurrent categories.

After Brown and Kulik (1977), many researchers have used these canonical categories as a priori categories presenting participants with prompted questions about their contents and verifying whether each of them were present in the participants' recalls. In addition, some researchers added other categories, like 'other people present' (Christianson, 1989), 'first thoughts' (Kızılöz & Tekcan, 2013), 'part of the day' (Bohannon III, 1988) and 'atmospheric conditions' (Berntsen & Thomsen, 2005).

Apart from their contents, Brown and Kulik (1977) pointed out that FBMs are vivid and '[…] fixed for a very long time, and conceivably permanently […]' (p. 85).

Regarding vividness, evidence has shown that FBMs actually carry vivid perceptive features (e.g., Kvavilashvili et al., 2009) which participants may retain in memory in the form of consistent mental images (e.g., Muzzulini et al., 2020). Regarding durability, although Brown and Kulik (1977) sustained that it is a defining characteristic of FBMs, they did not provide empirical evidence of FBMs' consistency over time. To examine this aspect, further research relied on test–retest methodologies. Some researchers found that people can recall the reception context attributes consistently (e.g., Conway et al., 1994; Curci & Luminet, 2006; Paradis et al., 2004; Shapiro, 2006; Tekcan et al., 2003; Tinti et al., 2009), while others found that FBMs are subject to forgetting, arguing that what makes FBMs 'special' is people's confidence upon their recalls rather than their consistency (e.g., Hirst et al., 2009, 2015; Neisser & Harsch, 1992; Schmolck et al., 2000; Talarico & Rubin, 2003).

Where are we?

Following Brown and Kulik's work (Brown & Kulik, 1977), researchers developed different methods to operationalise and assess FBMs. As regards the measurement of FBM's contents different methods were used: in some studies only canonical categories' contents were assessed (e.g., Curci et al., 2015), in others participants were asked to provide a free recall of the reception context of the news (e.g., Muzzulini et al., 2022), in still others participants had to provide a list of details of the reception context (e.g., Cordonnier & Luminet, 2021), or a combination of these different methods has been used (e.g., Conway et al., 1994). Also the experimental designs show variations across studies: some authors studied FBMs using a 'one-shot' design, assessing the richness of reception context details that participants could recall at one time point (e.g., Finkenauer et al., 1998); others used a test–retest design with the sake to assess FBMs' contents' consistency over time. In addition, test–retest studies differ according to the scoring procedures that have been adopted to assess FBMs' consistency. For example, Neisser and Harsch (1992) developed a procedure called WAS (Weighted Attributes Scores), in which they summed up the consistency scores of the so called 'major attributes' (i.e., 'place', 'informant', and 'ongoing activity') and then counted an additional bonus point whenever participants could also consistently recall at least one of the 'minor attributes' (i.e., 'other people present' and 'the time of the day when the news was learned'). Another methodology comes from Conway et al. (1994), who proposed a cut-off to determine the presence of a FBM according to the consistent recall of at least 90% of the context attributes.

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Notably, in test–retest studies there are also differences in the number of groups involved, the number of retests and the time lapses between test and retest/s according to the specific research objectives of each study. For example, some authors recruited more than one group to grasp differences based on participants' social or personal involvement (e.g., assessment of FBMs among national groups), others varied the time of the first assessment to test hypotheses about memory consolidation.

As this brief summary shows, the methodological approaches used to study FBMs are rather variegated. We therefore considered it useful and worthwhile to take stock of the situation. In doing so, we did not have the ambitious goal of reviewing the entire literature on FBM, but at least a significant proportion of studies by applying specific selection criteria (see Method section) with the intent to maximise the homogeneity of studies and make reliable comparisons.

The present review was conducted in two steps. The first step aimed to describe what has been done since Brown and Kulik (1977) until now through the creation of easily consultable tables that summarise 'at a glance' the methods used in the studies considered by addressing the following six research questions:

1. Which public events and populations were examined in longitudinal FBM studies?
2. Which methodologies did researchers use to study FBMs over time?
3. How did researchers assess FBMs' contents?
4. How did researchers assess the dimension of consistency?
5. What FBM dimensions were considered beside consistency (e.g., confidence, vividness) and how were they assessed?
6. What criteria did researchers use to draw conclusions upon the nature of FBMs?

Following the analysis of the results of the first step, we decided to conduct a further analysis to understand whether the use of certain methods may lead to specific and sometimes contradictory results about the nature of FBMs. To achieve this goal, we conducted an in-depth qualitative analysis of the studies on the 9/11 attacks, the most studied event of the 21st century.

1 | STEP 1: FBM STUDIES "AT A GLANCE"

1.1 | Methods

1.1.1 | Search strategy and inclusion criteria

We identified an initial data set of 844 articles in October 2023 by submitting a search query to Scopus, Web of Science (WoS), and PubMed. We searched the keyword "*flashbulb memor**" in the field 'title, abstract, keywords' (in PubMed in the field 'title, abstract'). We sought to maximise homogeneity across studies to run reliable comparisons. Hence, we used the following inclusion/exclusion criteria:

1. Studies must carry a within-subject design for longitudinal assessment of FBMs (i.e., studies that did not measure consistency were excluded). We chose this criterion because although Brown and Kulik (1977) did not assess the consistency of FBM over time, they retained it as one of the fundamental characteristics of FBM, and since Pillemer (1984), researchers have assessed consistency using the test–retest method.
2. Studies must focus on general adult populations, while studies on clinical populations, elderly people, and minors were excluded. We decided to adopt this criterion in the sake of homogeneity and comparability among studies (see above).
3. Studies must focus on FBMs of public events. We adopted this criterion because studies on personal events are less comparable since the specific personal events are different for each participant (e.g., Rubin & Kozin, 1984). In addition, from a methodological point of view, there is a big difference in investigating the presence of a FBM for a public versus a personal event. As pointed out by Brown and Kulik (1977) when commenting on personal events: "There is, therefore, no named central event that one can use to retrieve possible FBMs. The best one can do is to ask each informant to search his memory for events of this order." (p. 75).

The articles were selected on the basis of the inclusion/exclusion criteria by reading the title, abstract and keywords and, if not sufficiently specific, by reading also the method section. After this inspection, 712 articles were excluded because they did not fit the criteria. Of the remaining 132 articles, 74 duplicates (i.e., the same article found in different web search engines) were removed and full-text assessment for eligibility was conducted for 58 articles. Further, 5 articles were removed because they included the same sample and the same procedure to assess FBMs used in a previous study to compute further analyses. In this case, we selected the longitudinal study in which the sample has first been described. The screening process resulted in 53 articles; of these, 4 articles involved two studies with independent population groups. A final set of 57 studies was therefore eligible for analyses. The article selection process is depicted in Figure 1.

1.1.2 | Research coding

Materials are presented in three tables following the six research questions. Table 1 describes the event and sample characteristics, Table 2 focuses on the methodologies used, and Table 3 focuses on the assessment of FBMs. Across all tables, studies were grouped under four main clusters reflecting the type of event.

Studies' description (Table 1). Starting from the second column, Table 1 shows (1) the target event and the year in which it took place, (2) the country in which the event took place, (3) the type of population included in the sample and (4) their country.

Methodologies (Table 2). The review of methodologies was based on how researchers grouped participants (*Sample*, columns 2–5) and how they assessed retest/s (*Test and retest/s*, columns 6–8). Starting

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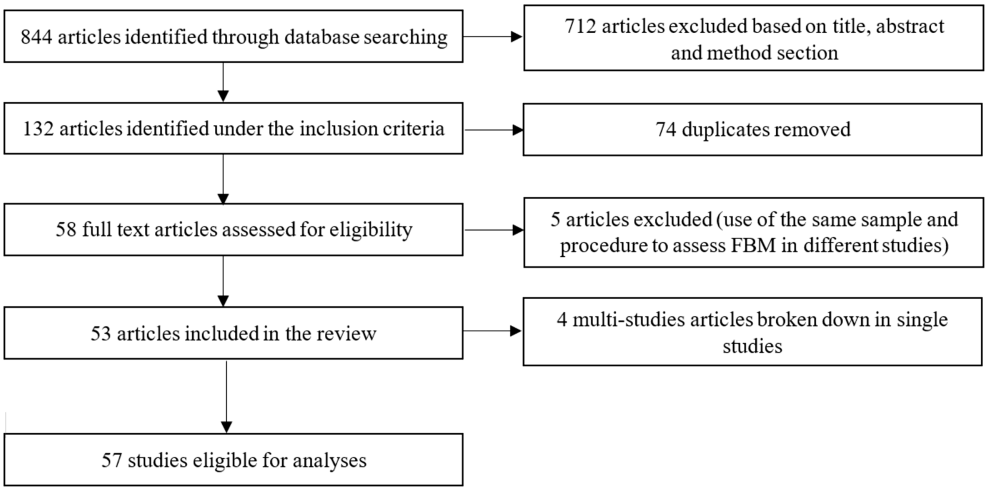


FIGURE 1 Flowchart of article selection.

from the columns grouped under *Sample*, Table 2 includes (1) the number of groups involved in each study, (2) the criteria used to divide the sample into groups, where 'unique group' indicates that no groups were created, (3) the groups involved if any, and (4) the sample size of each group and the whole sample. Turning to the columns grouped under *Test and retest/s*, Table 2 includes (5) the interval between the event and the first test (i.e., T1), (6) the number of retest/s, and (7) the interval between the event and the retest/s (e.g., T2, T3, T4).

Measurement of FBM (Table 3). The review of measurements was based on how researchers assessed FBMs' contents (*Assessment of FBMs' contents*, columns 2–10), how they measured FBMs' dimensions including consistency, vividness, and confidence (*Assessment of FBMs' dimensions*, columns 11–16), and what criteria researchers used to draw conclusions about FBM (*Criteria for conclusion*, column 17). Starting from the columns grouped under *Assessment of FBMs' contents*, Table 3 includes (1) whether researchers assessed if participants can recall the reception context when the news of an important public event was learned (*RCR, reception context recall*), (2) whether and which type of free recall task was used (narrative vs. list of details). For (3), the column *Canonical Categories* (*CCs*) shows whether researchers assessed Brown and Kulik's canonical categories (Brown & Kulik, 1977) of place, activity, informant, aftermath, others present (presence of each category was marked with a ✓), and the number of 'other' further categories used in each study (indicated by a numerical value). Turning to the columns grouped under *Assessment of FBMs' dimensions*, Table 3 includes whether and how consistency (4), vividness (5) and confidence (6) were measured. For each of these dimensions, we specified what they refer to (e.g., *RCR*, free recall, *CCs*, *event memory*) with the respective scales. Finally, the column called *Criteria for conclusion* (7) indicates the criteria that researchers used to draw conclusions upon the nature of FBMs.

All information reported in the tables was coded by the second author and, for 30% of the studies, the same information was also coded by the first author. The agreement between the two judges was 95% (see Table 1 in the supplementary materials for more details). The doubtful cases, which were mainly related to the difficulty of retrieving some information in the articles, were resolved by discussion.

1.2 | Results

Results are presented in three tables through which we provide answers to the six research questions. In Table 1 we describe the target events and the populations involved in the reviewed studies (RQ 1). In Table 2 we examine the methodologies used to study FBMs by focusing on the study design (i.e., use of between-subject conditions), on the sample, and on how the first test and the retest/s was/were assessed (RQ 2). In Table 3 we first review how researchers assessed FBMs' contents (RQ 3) and how they measured FBMs' dimensions of consistency (RQ 4); then, we review whether and how the dimensions of vividness and confidence were assessed (RQ 5) and which criteria researchers used to draw conclusions upon the nature of FBMs (RQ 6).

All materials can be found on OSF at the following link: https://osf.io/4nmfk/.

1.2.1 | Research question 1: Target events and populations in FBMs' research

Table 1 focuses on the target events and populations considered in the reviewed FBM studies. The first cluster (25% of the reviewed studies) includes natural disasters like earthquakes, and human-made disasters like terrorist attacks, nuclear accidents, and so forth. The second cluster focuses on the studies about the 9/11 attacks, which were grouped on their own as they represent almost a third (33%) of the reviewed studies. The third cluster (37%) includes events related to public figures and political events like the death or assassination of important political figures or celebrities or results of political votes. The last cluster (5%) includes sport events like baseball and football final games.

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TABLE 1 Target events and populations in FBMs' research.

Author/s, year (study)	Event characteristics		Sample characteristics	
	(1) event (year)	(2) country	(3) population	(4) country
Cluster 1: Natural and Human Disasters				
Bohannon III & Symons, 1992	Challenger disaster (1986)	USA	General (students)	USA
Christianson & Engelberg, 1999	MS Estonia Ferry disaster (1994)	Sweden	General	Sweden
Coluccia et al., 2006	Columbia Space Shuttle disaster (2003)	USA	General (students)	Italy
Coluccia et al., 2010 (A)	Beslan massacre (2004)	Belarus	General (students)	Italy
Cordonnier & Luminet, 2021	Brussel terrorist attack (2016)	Belgium	General (students)	Belgium
Er, 2003	Marmara Earthquake (1999)	Turkey	General	Turkey
Kershaw et al., 2009 (A)	Columbia Space Shuttle disaster (2003)	USA	General (students)	USA
Koppel et al., 2013 (B)	Landing of US Airways Flight 1549 (2009)	USA	General (students)	USA
Ma and Wan (2022)	Breakout of Covid-19 in Shanghai (2022)	China	General	China
McCloskey et al., 1988	Challenger disaster (1986)	USA	General (students)	USA
Muzzulini et al., 2020 (B)	Paris terrorist attack (2015)	France	General (students)	Italy
Neisser & Harsch, 1992	Challenger disaster (1986)	USA	General (students)	USA
Neisser et al., 1996	Earthquake in Loma Prieta (1989)	USA	General (students)	USA
Otani et al., 2005	Nuclear accident (1999)	Japan	General	Japan
Weaver, 1993	Iraq bombing (1991)	Iraq	General (students)	USA
Cluster 2: 9/11 attacks				
Conway et al., 2009	September 11 (2001)	USA	General	USA
Curci & Luminet, 2006	September 11 (2001)	USA	General	Belgium, Italy, Japan, Romania, Netherlands, US
Ferré Romeu, 2006	September 11 (2001)	USA	General (students)	Spain
Hirst et al., 2009, 2015[a]	September 11 (2001)	USA	General	USA
Kershaw et al., 2009 (B)	September 11 (2001)	USA	General (students)	USA
Kvavilashvili et al., 2009	September 11 (2001)	USA	General	UK
Lee & Brown, 2003	September 11 (2001)	USA	General (students)	Canada
Paradis et al., 2004	September 11 (2001)	USA	General (students)	USA
Schaefer et al., 2011	September 11 (2001)	USA	General (students)	USA
Schmidt, 2004	September 11 (2001)	USA	General (students)	USA
Shapiro, 2006	September 11 (2001)	USA	General (students)	USA
Smith et al., 2003	September 11 (2001)	USA	General (students)	Canada
Talarico & Rubin, 2003, 2007[a]	September 11 (2001)	USA	General (students)	USA

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TABLE 1 (Continued)

Author/s, year (study)	Event characteristics		Sample characteristics	
	(1) event (year)	(2) country	(3) population	(4) country
Tekcan et al., 2003	September 11 (2001)	USA	General (students)	Turkey
Weaver III & Krug, 2004	September 11 (2001)	USA	General (students)	USA
Wolters & Goudsmit, 2005	September 11 (2001)	USA	General (students)	Netherlands
Cluster 3: Public Figures and Political Events				
Chiew et al., 2022	Donald Trump's Presidential Election (2016)	USA	General	USA
Christianson, 1989	Assassination of Swedish Prime Minister Olof Palme (1986)	Sweden	General	Sweden
Coluccia et al., 2010 (B)	Death of Pope John Paul II (2005)	Italy	General (students)	Italy
Conway et al., 1994	Resignation of British Prime Minister Margaret Thatcher (1990)	UK	General (students)	UK, others
Curci et al., 2001	Death of former President François Mitterrand (1996)	France	General	Belgium, France
Curci et al., 2015	Resignation of Pope Benedict XVI (2013)	Italy	Specific (religious)	Italy
Day & Ross, 2014	Pop star Michael Jackson death (2009)	USA	General	USA
Hornstein et al., 2003	Death of Princess Diana (1997)	UK	General (students)	USA
Koppel et al., 2013 (A)	US President Barack Obama inauguration (2009)	USA	General (students)	USA
Krackow et al., 2019	Donald Trump's Presidential Election (2016)	USA	General (students)	USA
Kraha et al., 2014	Assassination of Osama Bin Laden (2011)	Pakistan	General (students)	USA
Lanciano & Curci, 2012	Death of Pope John Paul II (2005)	Italy	General (students)	Italy, Romania, Japan
Lanciano et al., 2013 (B)	Death of the singer Lucio Dalla	Italy	General	Italy
Muzzulini et al., 2020 (A)	Resignation of Pope Benedict XVI (2013)	Italy	Specific (religious)	Italy
Muzzulini et al., 2022	UK's EU Referendum (Brexit) results (2016)	UK	General	UK
Nachson & Zelig, 2003	Assassination of Prime Minister Rabin (1995)	Turkey	General (students)	Israel
Pillemer, 1984	US President Ronald Regan assassination attempt (1981)	USA	General (students)	USA
Raw et al., 2023	UK's EU Referendum (Brexit) results (2016)	UK	General	UK, USA
Schmolck et al., 2000	O.J. Simpson verdict (1995)	USA	General (students)	USA
Tinti et al., 2009	Death of John Paul II (2005)	Italy	Specific (religious)	Poland, Italy, Switzerland
Winningham et al., 2000	O.J. Simpson acquittal (1995)	USA	General (students)	USA
Cluster 4: Sport				
Kensinger & Schacter, 2006	Final game of the Boston Red Sox – New York Yankees (2004)	USA	Specific (fans)	USA
Merck et al., 2020 (A)	Final game of the MLB World Series (2016)	USA	Specific (fans)	USA
Talarico & Moore, 2012	144th meeting of 'The Rivalry': Lafayette – Lehigh football game (2008)	USA	General (students)	USA

Note: In the first column, (A) and (B) are used to differentiate studies in multi-study articles.
[a]These two studies are reported in the same line since the second reported a further retest of the first, so the methodological aspects were the same.

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TABLE 2 Methodological approaches for the study of FBMs.

Author/s, year (study)	Sample					Test and retest/s					
	(1) No of group/s	(2) criterion	(3) group/s	(4) size		(5) interval between event and first test, in days T1	(6) No of retest/s	(7) interval between event and retest/s, in months T2	T3	T4	T5
Cluster 1: Natural and Human Disasters											
Bohannon III & Symons, 1992	1	None	Unique group	116		1 to 14	1	36			
Christianson & Engelberg, 1999	1	None	Unique group	139		0	1	14			
Coluccia et al., 2006	4	Time (date of first test)	2-days	30	345	2	2	5	12		
			18-days	181		18					
			27-days	84		27					
			51-days	50		51					
Coluccia et al., 2010 (A)	2	Time (date of first test)	3/4-days	17	39	3 to 4	2	6	12		
			39-days	22		39					
Cordonnier & Luminet, 2021	2	None	Unique group	18		0	1	15			
Er, 2003	2	Personal involvement	Earthquake victims	40	80	180	1	12			
			General population	40							
Kershaw et al., 2009 (A)	1	None	Unique group	26		2	1	3			
Koppel et al., 2013 (B)	1	None	Unique group	34		17	1	4			
Ma and Wan (2022)	1	None	Unique group	349		34 to 40	1	1.5			
McCloskey et al., 1988	1	None	Unique group	27		3 to 7	1	9			
Muzzulini et al., 2020 (B)	1	None	Unique group	151		3 to 5	1	18			
Neisser & Harsch, 1992	1	None	Unique group	44		1	1	34			
Neisser et al., 1996	3	City	Atlanta	76	161	1 to 20	1	18			
			Berkley	41							
			Santa Cruz	44							
Otani et al., 2005	1	None	Unique group	138		21	1	12			
Weaver, 1993	1	None	Unique group	18		2	2	3	12		
Cluster 2: 9/11 attacks											
Conway et al., 2009	2	Time (date of retest)	Pre-anniversary	223	319	2 to 21	2	11	24		
			Post-anniversary	235				13			
Curci & Luminet, 2006	6	Country	USA	120	985	21	1	18			
			Belgium	125							
			Italy	40							
			Netherlands	131							
			Romania	422							
			Japan	147							
Ferré Romeu, 2006	1	None	Unique group	32		14	1	8			
Hirst et al., 2009, 2015	1	None	Unique group	202		6 to 10	3	11	35	119	

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TABLE 2 (Continued)

Author/s, year (study)	Sample					Test and retest/s					
	(1) No of group/s	(2) criterion	(3) group/s	(4) size		(5) interval between event and first test, in days T1	(6) No of retest/s	(7) interval between event and retest/s, in months T2	T3	T4	T5
Kershaw et al., 2009 (B)	1	None	Unique group	30		3 to 4	1	2			
Kvavilashvili et al., 2009	2	Time (date of first test)	1/2-days	n/a	124	1 to 2	3	0.5	24	36	
			10/11-days	n/a		10 to 11					
Lee & Brown, 2003	2	Time (date of first test)	0-days	72	142	0	1	7			
			10-days	70		10					
Paradis et al., 2004	1	None	Unique group	18		7	1	12			
Schaefer et al., 2011	1	None	Unique group	46		1	1	6			
Schmidt, 2004	1	None	Unique group	211		1 to 9	1	2			
Shapiro, 2006	2	Time (date of retest)	follow-up 1	13	17	1 to 2	4	0.5	3	12	24
			follow-up 2	20				1.5			
Smith et al., 2003	1	None	Unique group	93		7	1	6			
Talarico & Rubin, 2003, 2007	3	Time (date of retest)	1-week delay	9	27	1	2	0.25			
			6-week delay	11				1.5	12		
			32-week delay	7				8			
Tekcan et al., 2003	1	None	Unique group	70		3	2	6	12		
Weaver III & Krug, 2004	1	None	Unique group	40		1 to 2	4	0.25	1	3	12
Wolters & Goudsmit, 2005	1	None	Unique group	34		14	1	2			
Cluster 3: Public Figures and Political Events											
Chiew et al., 2022	6	Political affiliation and surprise (based on anticipated election outcome)	Clinton – surprised	152	276	15 to 16	2	6	12		
			Clinton – non surprised	2							
			Trump – surprised	37							
			Trump – non surprised	31							
			Other – surprised	46							
			Other – non surprised	8							
Christianson, 1989	1	None	Unique group	36		41 to 43	1	12			
Coluccia et al., 2010 (B)	2	Time (date of first test)	3/4-days	41	70	3 to 4	2	6	12		
			39-days	29		39					
Conway et al., 1994	2	Country	UK citizens	215	369	10 to 14	1	11			
			non-UK citizens	154							
Curci et al., 2001	1	None	Unique group	229		30 to 60	1	15			
Curci et al., 2015	3	Religion	Churchgoers Catholics	20	51	12	1	3			
			Non-churchgoers Catholics	16							
			Evangelicals	15							
Day & Ross, 2014	1	None	Unique group	75		3 to 5	1	18			
Hornstein et al., 2003	3	Time (date of retest)	3-months	78	193	7	1	3			
			3 and 18-months	49			2	3	18		
			18-months	66			1	18			

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TABLE 2 (Continued)

Author/s, year (study)	Sample					Test and retest/s					
	(1) No of group/s	(2) criterion	(3) group/s	(4) size		(5) interval between event and first test, in days T1	(6) No of retest/s	(7) interval between event and retest/s, in months T2	T3	T4	T5
Koppel et al., 2013 (A)	1	None	Unique group	36		17	1	4			
Krackow et al., 2019	1	None	Unique group	71		7 to 10	1	5			
Kraha et al., 2014	3	Time (date of retest)	follow-up 1	60	124	2 to 4	2	0.25	8		
			follow-up 2					1.5			
			follow-up 3					8			
Lanciano and Curci (2012)	1	None	Unique group	385		9	1	9.5			
Lanciano et al., 2013 (B)	1	None	Unique group	42		11	1	1.8			
Muzzulini et al., 2020 (A)	1	None	Unique group	204		15	1	6			
Muzzulini et al., 2022	1	None	Unique group	200		335	1	21			
Nachson & Zelig, 2003	1	None	Unique group	61		14	1	11			
Pillemer, 1984	1	None	Unique group	44		30	1	7			
Raw et al., 2023	3	Voting choice	Leave	153	560						
			Remain	190		7 to 17	3	4	9.5	16	
			US (control group)	217							
Schmolck et al., 2000	2	Time (date of retest)	15-months	28	63	3	1	15			
			32-months	35				32			
Tinti et al., 2009	3	Country	Catholics in Poland	49	314	1 to 6	1	8			
			Catholics in Italy	205							
			Catholics in Switzerland	60							
Winningham et al., 2000	2	Time (date of first test)	0-days	35	65	0	1	2			
			10-days	30		10					
Cluster 4: Sport											
Kensinger & Schacter, 2006	1	None	Unique group	76		1 to 6	1	6.5			
Merck et al., 2020 (A)	1	None	Unique group	64		1	2	4	12		
Talarico & Moore, 2012	2	Fandom	Lafayette	81	112	1 to 8	1	2			
			Lehigh	31							

Note: n/a stands for 'not assessed'. 'Unique group' implies that there was no between-sample design; for studies involving more than one group, the sample size is reported for groups at the left and for the total at the right. '(2) Criterion' refers to how participants were grouped in between subject studies. '(4) Size' refers to the number of participants in the retest(s).

The second and third columns include information about the target event (see 1, *event*) and the country where it took place (see 2, *country*). More than half of target events (61%) took place in the USA, 28% took place in Europe and 11% in Middle East countries or Asia.

The fourth and fifth columns include information about the sample like the population (see 3, *population*) and the country (see 4, *country*) in which participants were recruited. Most samples (91%) were composed of general adult populations (among which 61% were student samples); a small proportion involved specific adult populations (9%) (e.g., Italian Catholics, Curci et al., 2015, Muzzulini et al., 2020, Tinti et al., 2009; fans of opponent sport teams, Merck et al., 2020 and Talarico & Moore, 2012). Half of the study samples (53%) were recruited in the USA, 35% in Europe and 12% in other

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TABLE 3 Assessment of FBMs' contents and dimensions (i.e., consistency, vividness, and confidence) and criteria used for conclusions.

Author/s, year (study)	Assessment of FBMs' presence and contents								Assessment of FBMs' dimensions							(7) criteria for conclusions
	(1) RCR (reception context recall)	*(2) free recall*	*(3) CCs (canonical categories)*						*(4) consistency*			*(5) vividness*		*(6) confidence*		
			Place	Activity	Informant	Aftermath	Others present	Other attributes	Scoring	What consistency refers to	Scale	What vividness refers to	Scale	What confidence refers to	Scale	
Cluster 1: Natural and Human Disasters																
Bohannon and Symons, 1992	n/a	narrative	✓		✓			5	Combined	CCs; free recall	0–1	n/a	n/a	CCs	1–5	Consistency of place assessed by CCs and free recall
Christianson & Engelberg, 1999	n/a	n/a	✓	✓	✓		✓	1	Independent	CCs	0–1	n/a	n/a	CCs	1–3	CCs consistency
Coluccia et al., 2006	n/a	n/a	✓	✓	✓		✓	2	Combined	CCs	0–1	n/a	n/a	CCs; event memory	0–100	CCs consistency
Coluccia et al., 2010 (Study A)	n/a	n/a	✓	✓	✓		✓	1	Combined	CCs	0–10	n/a	n/a	Event memory	1–7	CCs consistency
Cordonnier & Luminet, 2021	n/a	list of details	✓	✓	✓	✓	✓	1	Independent	CCs; list of details	0–2	CCs	1–4	CCs	1–7	CCs consistency; number of details; vividness and confidence
Er, 2003	n/a	list of details	✓	✓			✓	1	Independent	CCs	0–2	n/a	n/a	n/a	n/a	CCs consistency
Kershaw et al., 2009 (A)	n/a	narrative	✓	✓	✓		✓	1	Combined	CCs	0–5	n/a	n/a	n/a	n/a	Consistency of 90% of CCs; Number of words and propositions in narrative free recall
Koppel et al., 2013 (B)	n/a	n/a	✓			✓	✓	3	Independent	CCs	0–1	n/a	n/a	n/a	n/a	CCs consistency
Ma and Wan (2022)	n/a	n/a	✓	✓	✓	✓	✓	1	Combined	CCs	0–2	n/a	n/a	CCs	1–5	CCs consistency; confidence
McCloskey et al., 1988	n/a	n/a	✓	✓	✓			1	Independent	CCs	0–1	n/a	n/a	CCs	1–7	CCs consistency
Muzzulini et al., 2020 (B)	n/a	list of details	✓	✓	✓	✓	✓		Independent	CCs; list of details	0–2	Mental image	1–10	n/a	n/a	CCs and perceptive details consistency
Neisser & Harsch, 1992	n/a	narrative	✓	✓	✓	✓	✓	3	Combined (weighted)	CCs	0–7	Visual scene	1–7	CCs	1–5	CCs consistency
Neisser et al., 1996	n/a	narrative	✓	✓	✓		✓	1	Combined	CCs	0–6	n/a	n/a	CCs	1–5	CCs consistency
Otani et al., 2005	n/a	narrative	✓	✓	✓		✓	6	Combined	CCs	0–10	n/a	n/a	n/a	n/a	Consistency of 90% of CCs
Weaver, 1993	n/a	n/a	✓	✓	✓		✓	3	Independent	CCs	0–1	n/a	n/a	CCs	1–3	CCs consistency

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TABLE 3 (Continued)

Author/s, year (study)	Assessment of FBMs' presence and contents								Assessment of FBMs' dimensions							(7) criteria for conclusions
	(1) RCR (reception context recall)	*(2) free recall*	*(3) CCs (canonical categories)*						*(4) consistency*			*(5) vividness*		*(6) confidence*		
Cluster 2: 9/11 attacks																
Conway et al., 2009	n/a	n/a	✓	✓	✓		✓	3	Independent	CCs	0–1	n/a	n/a	CCs	1–5	Consistency of CCs (place, activity, informant, others present), confidence
Curci & Luminet, 2006	n/a	n/a	✓	✓	✓	✓	✓	1	Combined	CCs	0–10	n/a	n/a	n/a	n/a	CCs consistency and specificity
Ferré Romeu, 2006	n/a	n/a	✓	✓	✓	✓	✓	3	Independent	CCs	0–2	Perceptual details	1–7	CCs	1–7	CCs consistency; vividness and confidence
Hirst et al., 2009, 2015	n/a	n/a	✓	✓	✓	✓		2	Combined	CCs	0–6	n/a	n/a	CCs	1–5	CCs consistency, confidence
Kershaw et al., 2009 (B)	n/a	narrative	✓	✓	✓		✓	1	Combined	CCs	0–5	n/a	n/a	n/a	n/a	Consistency of 90% of CCs; number of words and propositions in narrative free recall
Kvavilashvili et al., 2009	n/a	narrative	✓	✓	✓		✓	1	Combined (weighted)	CCs; free recall	0–7	Reception context	1–10	CCs; free recall	1–10	CCs consistency; distortion and specificity of narrative free recall over time
Lee & Brown, 2003	n/a	narrative	✓	✓			✓		Combined	CCs	0–6	n/a	n/a	n/a	n/a	Consistency combined score >5; free recall word count at each test
Paradis et al., 2004	n/a	n/a	✓	✓			✓		Independent	CCs	0–1	n/a	n/a	CCs	1–10	Consistency of 90% of CCs
Schaefer et al., 2011	n/a	narrative							Independent	CCs[a]; free recall	0–1	n/a	n/a	n/a	n/a	Consistency and specificity of CCs identified in the free recall
Schmidt, 2004	n/a	n/a	✓	✓	✓			6	Independent	CCs	0–1	n/a	n/a	CCs	1–3	CCs consistency and confidence
Shapiro, 2006	n/a	n/a	✓	✓	✓				Combined (weighted)	CCs	0–6	n/a	n/a	n/a	n/a	CCs consistency
Smith et al., 2003	n/a	n/a	✓	✓	✓		✓	1	Combined (weighted)	CCs	0–7	n/a	n/a	Event memory	1–7	CCs consistency
Talarico & Rubin, 2003, 2007	n/a	n/a	✓	✓	✓		✓	2	Combined	CCs	0–12	Combined	1–7	CCs	1–7	CCs consistency; vividness and confidence
Tekcan et al., 2003	n/a	n/a	✓	✓	✓		✓	1	Independent	CCs	0–2	n/a	n/a	n/a	n/a	CCs consistency
Weaver III & Krug, 2004	✓	n/a	✓	✓	✓		✓	3	Independent	CCs	0–1	n/a	n/a	CCs	0–100	CCs consistency; confidence
	✓	n/a	✓	✓	✓		✓	1	Combined	CCs	0–5	n/a	n/a	CCs	1–7	Consistency of 90% of CCs

(Continues)

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TABLE 3 (Continued)

Author/s, year (study)	Assessment of FBMs' presence and contents								Assessment of FBMs' dimensions							(7) criteria for conclusions
	(1) RCR (reception context recall)	*(2) free recall*	*(3) CCs (canonical categories)*						*(4) consistency*			*(5) vividness*		*(6) confidence*		
Wolters & Goudsmit, 2005																
Cluster 3: Public figures and Political Events																
Chiew et al., 2022	n/a	n/a	✓			✓	✓	3	Combined	CCs	0–1	Event memory; CCs	1–7	CCs	1–7	CCs consistency; vividness and confidence
Christianson, 1989	n/a	n/a	✓	✓	✓		✓	3	Independent	CCs	0–1	n/a	n/a	CCs	1–3	CCs consistency
Coluccia et al., 2010 (B)	n/a	n/a	✓	✓	✓		✓	2	Combined	CCs	0–10	n/a	n/a	Event memory	1–7	CCs consistency
Conway et al., 1994	✓	narrative; list of details	✓	✓	✓		✓		Combined	CCs	0–10	n/a	n/a	CCs	1–3	Consistency of 90% of CCs
Curci et al., 2001	n/a	list of details	✓	✓	✓	✓	✓	1	Independent	CCs	0–1	n/a	n/a	CCs	1–7	CCs consistency
Curci et al., 2015	n/a	n/a	✓	✓	✓		✓	2	Combined	CCs	0–12	n/a	n/a	CCs; free recall	1–5	CCs consistency and specificity
Day & Ross, 2014	n/a	n/a	✓	✓	✓	✓	✓	2	Mean of Independent	CCs	0–1	n/a	n/a	CCs; free recall	1–7	CCs consistency
Hornstein et al., 2003	n/a	narrative	✓	✓	✓		✓	1	Combined (weighted)	CCs; free recall	0–7	n/a	n/a	CCs; free recall	1–5	Consistency of 90% of CCs; consistency of free recall
Koppel et al., 2013 (A)	n/a	n/a	✓			✓	✓	3	Mean of Independent	CCs	0–1	n/a	n/a	n/a	n/a	CCs consistency
Krackow et al., 2019	n/a	narrative	✓	✓	✓	✓	✓	2	Independent	CCs; free recall	0–2	n/a	n/a	Free recall	1–7	Consistency of free recall and CCs
Kraha et al., 2014	n/a	n/a	✓	✓	✓		✓	1	Combined	CCs	0–12	Combined	1–7	CCs	1–7	Consistency of free recall and CCs
Lanciano and Curci (2012)	n/a	n/a	✓	✓	✓		✓	3	Independent	CCs	0–3	n/a	n/a	n/a	n/a	CCs consistency
Lanciano et al., 2013 (B)	n/a	n/a	✓	✓	✓		✓	3	Combined	CCs	0–14	n/a	n/a	CCs	1–5	CCs consistency and specificity; confidence
Muzzulini et al., 2020 (A)	n/a	list of details	✓	✓	✓	✓	✓		Combined	CCs; list of details	0–10	Mental image	1–10	n/a	n/a	CCs consistency; consistency of details; vividness
Muzzulini et al., 2022	n/a	narrative							Combined	CCs[a]; perceptive details	0–6	n/a	n/a	n/a	n/a	Consistency of CCs and perceptive details

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TABLE 3 (Continued)

Author/s, year (study)	Assessment of FBMs' presence and contents								Assessment of FBMs' dimensions							(7) criteria for conclusions
	(1) RCR (reception context recall)	*(2) free recall*	*(3) CCs (canonical categories)*						*(4) consistency*			*(5) vividness*		*(6) confidence*		
Nachson & Zelig, 2003	n/a	narrative	✓	✓	✓	✓		3	Combined	CCs; free recall	0–14	n/a	n/a	CCs	1–5	CCs consistency and specificity
Pillemer, 1984	✓	narrative	✓	✓	✓	✓		2	Combined	CCs; free recall	0–6	n/a	n/a	n/a	n/a	'Yes' to the question "*Do you recall the circumstances in which you first heard of this event?*"; number of consistent CCs
Raw et al., 2023	n/a	n/a	✓	✓	✓	✓	✓	1	Combined	CCs	0–1	Reception context	1–7	CCs	1–7	CCs consistency; vividness and confidence
Schmolck et al., 2000	n/a	narrative	✓	✓	✓	✓	✓	3	Combined (weighted)	CCs; free recall	0–9	n/a	n/a	CCs	1–5	Consistency of 90% of CCs
Tinti et al., 2009	n/a	n/a	✓	✓	✓		✓	3	Combined	CCs	0–7	Mental image	0–10	n/a	n/a	CCs consistency
Winningham et al., 2000	n/a	n/a	✓	✓	✓			1	Combined	CCs	0–8	Mental image	1–7	n/a	n/a	Consistency of 90% of CCs; number of words and propositions in CCs
Cluster 4: Sport																
Kensinger & Schacter, 2006	n/a	n/a	✓			✓	✓	3	Combined	CCs; event memory	0–1	CCs; event memory	1–7	CCs; event memory	1–5	CCs consistency and confidence
Merck et al., 2020 (A)	n/a	n/a	✓	✓	✓			2	Combined (weighted)	CCs	0–7	CCs of 'activity'	1–7	CCs	1–7	CCs consistency
Talarico & Moore, 2012	n/a	n/a	✓				✓	2	Combined	CCs	0–12	Combined	1–7	CCs; event memory	1–7	CCs consistency; vividness and confidence

Note: RCR stands for Reception Context Recall and refers to the assessment of the presence/absence (dichotomic yes/no answer) of a vivid recall of the reception context when the news of an important public event was learned. n/a stands for 'not assessed'. CCs stands for Canonical Categories. In the column 'scoring', 'combined' indicates that researchers first calculated the score for each attribute individually, and then reported the sum of all attributes (e.g., by summing up 0–2 scores attributed to five individual attributes, the final combined score is 5*2, range 0–10).; 'combined (weighted)' indicates the use of the WAS procedure (Neisser & Harsch, 1992); 'independent' indicates that consistency was reported for each CC independently. In the column "what vividness refers to", "combined" indicates that vividness refers to different dimensions of FBMs, for example, the use of AMQ (Autobiographical Memory Questionnaire).

[a]The CCs were coded a posteriori from the free recall.

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countries including Japan, Canada, and Israel. Six studies (10% of the total) included multi-country comparisons. For example, Tinti et al. (2009) recruited Catholics in Italy, Switzerland, and Poland to examine differences in FBMs' formation and maintenance based on participants' appraisal of personal importance towards the death of Polish Pope John Paul II; Curci et al. (2001) examined FBMs of the death of French President Mitterrand among different national groups in Europe; Curci and Luminet (2006) compared memories of September 11 across different national groups.

Finally, we need to point out that most studies focused on samples that received the news of the event, while three studies involved groups of persons who directly lived the event (Er, 2003; Neisser et al., 1996; Talarico & Moore, 2012).

1.2.2 | Research question 2: Methodological approaches for the study of FBMs

Table 2 summarises the designs used in each study to investigate FBMs. The first chunk of columns, labelled from (1) to (4), provides information about the sample including between-subject conditions when present. Starting from the number of groups involved (see 1, *n° of group/s*), it emerged that in most of the reviewed studies (62%) researchers involved a unique group; others used a between-subject condition and divided the sample into two (21%), three (14%), or six (3%) groups. The column after (see 2, *criterion*) shows the criterion used to create between-subject conditions (see 3, *group/s*), namely how researchers defined experimental conditions to test whether memory consistency varied across groups with different characteristics or times of assessment. Among studies in which researchers used a between-subject design ($n = 22$ studies), in 60% of the studies "time" was used as a criterion to group participants (i.e., manipulation of the date of the first test and/or the date of the retests); in 40% of the studies other criteria were used based on how participants experienced the event (e.g., some studies assessed FBM across groups that differed for participants' personal involvement in the event, including nationality, religious involvement, levels of fandom). Sample size at the retest(s) largely varied across studies (see 4, *size*), with a minimum of 17 participants and a maximum of 985.

The second chunk of columns, labelled from (5) to (7), includes information about the test and retest/s namely the within-subject condition. The interval between the event and the first test, expressed in days (see 5, *interval between the event and the first test*), generally varied between 0 days (i.e., T1 was conducted on the event's day) and 60 days, with the exception of two studies with the first test about six (Er, 2003) and twelve (Muzzulini et al., 2022) months after the event.

As shown by the number of retests (see 6, *n° of retest/s*), in most studies (71%) researchers used one single retest; 21% used two retests; 5% used three, 3% used four. The interval between the event and the retest/s, expressed in months (see 7, *interval between the event and the retest/s, in months*), ranged from roughly one week to 10 years and greatly varied across studies. More in detail, among studies in which researchers used one retest ($n = 41$ studies), 39% used a time interval between the event and the first retest ranging from 1 week to 6 months, 32% used an interval ranging from 7 to 12 months, 29% used a time interval of more than 12 months. Among studies with more than one retest ($n = 16$ studies), the time intervals vary greatly.

1.2.3 | Research questions 3–6: Assessment of FBMs' contents and dimensions and criteria used to draw conclusions upon FBMs

The first chunk of columns in Table 3 ('*Assessment of FBMs' contents*'), labelled from (1) to (3), focuses on how researchers assessed FBMs' contents.

The header "RCR" (Reception Context Recall) in column 1 refers to the assessment of the presence/absence (dichotomic yes/no answer) of the recall of the reception context when the news of an important public event was learned. Results show that in a small proportion of the reviewed studies (7%), researchers assessed the presence/absence of RCR (see 1, *RCR*). Around a third of the reviewed studies (36%) used a free recall task (see 2, *free recall*), asking participants to provide a narrative of the circumstances in which they learned the news (*narrative*, *72%*) or a list of details of that moment (*list of details*, *24%*) and one study used both (Conway et al., 1994). All reviewed studies except two (Muzzulini et al., 2022; Schaefer et al., 2011) used open-ended guided questions to assess information pertaining to the reception context attributes (see 3, *Canonical Categories*, *CCs*). Results show that, in all reviewed studies, researchers assessed the place in which the news was learned. The following most frequently assessed canonical categories were the activity in which participants were involved (90%), how they were informed about the news (86%), whether there were others present in that moment (82%), and what they did in the immediate aftermath (37%). Most studies (90%) also assessed other CCs (e.g., time of the day in which the news was learned, atmospheric conditions, first thoughts).

The second chunk of columns ('*Assessment of FBMs' dimensions*'), labelled from (4) to (6), focuses on how researchers measured FBMs' consistency, vividness, and confidence.

Researchers used different methods to score FBMs' consistency (see 4, *consistency*). In 65% of the reviewed studies, researchers summed up the scores assigned to each CC into a cumulative index (i.e., *combined*). In a small proportion of the studies using combined scores, researchers used the WAS procedure in which different weights were attributed based on the relevance of each attribute (Neisser & Harsch, 1992) (i.e., *combined (weighted)*). In 35% of the reviewed studies, researchers scored each CC and either reported the score for each independent attribute, a mean score calculated across all attributes, or a percentage of participants reporting each attribute consistently (i.e., *independent*). In most of the reviewed studies (79%), consistency was measured considering the CCs; in other studies (21%), consistency was gathered for both the CCs and the free recall. Scales ranged from 0–1 or 0–2 for independent scores and either 0–5 to 0–14 for combined scores.

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It further emerged that 30% of the reviewed studies measured vividness (see 5, *vividness*), referring to different aspects (e.g., mental image, CCs, event memory, free recall). Overall, scales ranged from 0–1 to 0–10. As shown in the column after (see 6, *confidence*), confidence was measured in 66% of the reviewed studies. Among these, in the vast majority researchers measured confidence in the recall of the CCss; others measured confidence of event memory; and only a few measured confidence of the reception context. Overall, scales ranged from 1–3 to 1–10.

In 20% of the reviewed studies, researchers measured all three dimensions of FBMs (i.e., consistency, vividness, and confidence); 54% of researchers measured two dimensions (i.e., consistency + either confidence or vividness); 26% measured one dimension (i.e., consistency).

The last column of Table 3 (see 7, *criteria for conclusion*) shows the criteria that researchers used to draw conclusions about FBMs, that is, the dimensions that researchers looked at to establish the presence of FBMs and to discuss their nature. The criteria reflect the dimensions of FBMs namely consistency (of the CCs and/or of the free recall), vividness, and confidence.

Results show that in 44% of the reviewed studies, researchers used one criterion namely the consistency of the CCs; 40% of researchers used one additional criterion (i.e., consistency of the CCs + one criterion among consistency of the free recall, vividness, and confidence); 14% used two additional criteria (i.e., consistency of the CCs + two criteria among consistency of the free recall, vividness, and confidence); 2% used three additional criteria (i.e., consistency of the CCs + three criteria among consistency of the free recall, vividness, and confidence).

More in detail, among researchers using consistency as the sole dimension to draw conclusions about the nature of FBMs (44%), there was great variation on what and how contents were measured. In about two thirds of these studies, researchers considered the consistency for all the CCs (Table 3, (7), *CCs consistency*); others established that the recall of at least 90% of the CCs indicated the presence of a FBM (Conway et al., 1994) (Table 3, (7), *consistency of 90% of CCs*). A little number of researchers additionally considered the level of specificity of these contents, namely they not only looked at consistency, but also at the level of detail reported across each test (Table 3, (7), *CCs consistency and specificity*).

Among researchers using one additional dimension beside consistency of the CCs (40%), the vast majority considered the consistency and the specificity of the free recall (Table 3 (7), *consistency of free recall and CCs*), whereas one study (Pillemer, 1984) considered the answer 'Yes' to the question "*Do you recall the circumstances in which you first heard of this event?*" following Brown and Kulik's criteria.

Among researchers considering two additional dimensions beside consistency of the CCs (14%), all looked at vividness and confidence (e.g., Table 3 (7), *CCs consistency*; *vividness* and *confidence*). Finally, researchers considering three additional dimensions beside consistency of the CCs (2%) looked at the free recall, vividness, and confidence (e.g., Table 3 (7), *CCs consistency*; *number of details*; *vividness* and *confidence*).

1.3 | Discussion

In studying FBMs researchers often used heterogeneous methodologies, which may have contributed to the different conclusions reached regarding their nature. We therefore considered it was of central importance to review the different methodological innovations brought by the studies published in almost 50 years of research after Brown and Kulik's work (Brown & Kulik, 1977). To reach this aim we reviewed 57 test–retest studies on FBMs for public events. In what follows we will summarise and comment on the main results according to the six research questions which guided the analysis of the reviewed studies.

1.3.1 | Research question 1: Which target events and populations were examined in FBMs studies?

Studies were grouped according to the type of event in four main clusters: natural and human-made disasters, 9/11 attacks, events involving public figures and political decisions and sport events. Not surprisingly, the most studied event was the 9/11 attacks.

Most studies were conducted in the USA and Europe, while there are only a few studies conducted in the rest of the world (e.g., Middle East countries and Asia). This suggests that there is an urgent need to conduct longitudinal FBM studies in other cultural contexts.

It also emerged that most of the studied events (84%) carried negative emotional valence, while a small number of remaining events could either be positive or negative, depending on participants' subjective experience (e.g., government elections, court verdicts, sport games). This raises the question why the studied public events are rarely positive (for a discussion on this topic see Stone & Jay, 2017).

Regarding the involved populations, researchers mostly recruited student participants. From a pragmatic point of view it is probably more straightforward to realise studies with student participants, but it should be noted that students have socio-cultural and demographic characteristics that are not representative of the whole population. This raises the question whether the results obtained with students can be generalised to the rest of the population.

Another important aspect that should be pointed out is that in almost all studies participants received the news about the target event, while in some rare cases participants were directly involved in the event (Er, 2003; Neisser et al., 1996; Talarico & Moore, 2012). There is an important difference between these two situations, since in persons who directly lived the event there is an overlap between the reception context and the experience of the event. In this case, are we still speaking about FBMs? The question arises whether FBMs of the reception context of the news of an important public event can be compared to those related to the direct involvement in an event and whether they should be assessed differently (e.g., the question about the informant is not necessary).

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1.3.2 | Research question 2: Which methodologies did researchers use to study FBMs over time?

In most of the reviewed studies, researchers recruited a unique group and assessed the long-term recall of FBMs at one retest. In about one third of the reviewed studies, researchers examined the differences in FBMs recall between two or more groups to test whether memory consistency varied across groups with different characteristics or times of assessment.

The delay between the event and the first test varied a lot across studies. This observation deserves particular attention. If we assess the memory of the reception context the first time after several months the event occurred, we cannot exclude that in the meantime reconstruction processes took place (for example due to rehearsal). If we want to demonstrate that a FBM is an indelible memory of the moment in which the news of a public event was learned, it is necessary to carry out the first test as close as possible to the event (but see also the consolidation hypothesis, e.g., Schmidt, 2004; Weaver III & Krug, 2004; Winningham et al., 2000). In fact, even if we find a consistency of the memory investigated months after the event and then again at a later time, we do not know if we actually assess a FBM.

Another aspect that varies a lot among studies is the delay between the test and the retest/s. The heterogeneity of retention times may lead to unreliable comparisons when trying to retrieve conclusions about FBM; for example, we cannot compare results of a study using retention times of a few weeks with a study using retention times of several months.

1.3.3 | Research questions 3: How did researchers assess FBMs' contents?

In general, the methods used to assess FBMs' contents are very different among studies. Only a small part of researchers included an opening dichotomous question (e.g., "Do you recall the circumstances in which you first heard of this event?"), using Brown and Kulik's method (Brown and Kulik (1977)).

Nonetheless, the assessment of the presence of a vivid recall of the reception context is a core issue in studies on FBMs. The absence of the question whether a person has a sort of perceptual memory of the circumstances, in which the news was learned, yields the risk to take for granted he/she has a FBM. If this perceptual memory is not present, the eventual lack of consistency in the answers to questions referring to the canonical categories should not be interpreted as evidence of the fallibility of FBM itself.

In addition, to study FBMs' contents, most of the reviewed studies used prompted questions about the canonical categories proposed by Brown and Kulik (1977). It should be pointed out that by "canonical" the authors meant the contents that are the most frequent ones, but they also highlighted that not all canonical categories were always present in the free recalls and that there were contents that could not be classified within them (i.e., idiosyncratic details). By considering canonical categories as a priori categories, research has not assessed whether canonical categories' contents are actually part of the reception context memory.

In other studies, participants were asked to provide a free recall to assess the presence of a FBM, as done by Brown and Kulik. This method, although challenging and time consuming, has at least two advantages. First, it allows one to grasp those idiosyncratic details that go beyond the canonical categories; second, this method consists in an approach that does not take for granted that a person's FBM contains all the details investigated through questions about canonical categories contents, asking in reality something that might not be present in the FBM, but that could be inferred from the context. Among the studies that used the free recall method there are still differences, since some used a narrative free recall and others asked participants to provide a list of details of the recall.

1.3.4 | Research questions 4: How did researchers assess the dimension of consistency?

Consistency is the operationalisation of FBM's durability over time and is measured by comparing the answers provided at the first test with the answers provided at retest(s).

Consistency has been measured through different methodologies. In about two thirds of the studies, researchers summed up the consistency scores awarded to each CC and reported a cumulative index for consistency. In other cases, researchers reported a weighted cumulative score based on the hypothesised relevance of each attribute (see Neisser & Harsch, 1992); still others reported consistency for each CC independently.

In most studies, consistency measures were based exclusively on the CCs and few researchers provided consistency scores for other elements like the free recalls.

These different methodological approaches to assess consistency should be kept in mind: consistency not only is one of the main attributes of FBM, but also the most controversial one since the debate on the existence of FBMs revolves around their indelibility or not (see also the comparison between studies about the 9/11 attacks below).

1.3.5 | Research questions 5: What FBMs' dimensions were considered beside consistency (i.e., vividness and confidence) and how were they assessed?

Vividness is considered a defining element of FBMs based on Brown and Kulik's definition. Despite that, vividness was assessed in less than one third of the reviewed studies. More importantly, among these studies, there is a marked heterogeneity in what vividness refers to: some researchers asked a specific question about how vivid a mental image was, others assessed vividness for the CCs or for the memory of the event itself, still others used the AMQ (Autobiographical Memory Questionnaire) to assess vividness.

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Confidence was measured in two thirds of the reviewed studies and mostly referred to the recall of the CCs. Deeper inspection of the reviewed studies revealed that some studies assessed confidence both at test and retest, while in most of them confidence was assessed only at retest. Although confidence was not a central element for FBMs according to Brown and Kulik (1977), it is yet a debated topic, with some authors sustaining that high levels of confidence may uniquely distinguish FBMs from ordinary autobiographical memory (Talarico & Rubin, 2003).

It is worth noting that not all studies assessed vividness and confidence. Among those, which assessed these dimensions, different methodologies were used, therefore rendering comparisons across studies difficult.

1.3.6 | Research question 6: What criteria did researchers use to draw conclusions upon the nature of FBMs?

The criteria used by researchers to conclude on the presence of FBMs and discuss their nature are very different.

In almost half of the studies, researchers drew conclusions based exclusively on the consistency of CCs. The remaining part of researchers used the criterion of consistency of CCs and, at least, one additional dimension (e.g., consistency of the free recall, vividness or confidence). Overall, a very limited number of researchers used all these dimensions to draw conclusions about the nature of FBMs. We argue that it is important to use a multi-component approach to measure FBMs, which takes consistency, vividness and confidence into account (Luminet, 2022).

It should be noticed that also when the same criteria were used to draw conclusions about FBMs' existence and nature, they are not comparable since the defining dimensions were measured referring to different aspects. For example, we cannot compare studies in which vividness has been measured with respect to a mental image with studies in which vividness was referred to event memory. In our opinion, vividness should be measured above all with respect to a mental image reflecting Brown and Kulik (1977) initial idea that FBMs are vivid snapshots of the moment in which an individual learned the news of an emotion-arousing event.

A second point is that in several reviewed studies, researchers collected a lot of information about FBMs (e.g., CCs, free recall, vividness, confidence), but nevertheless based their conclusions only on the levels of consistency of the CCs, neglecting the importance of other dimensions.

2 | STEP 2: ANALYSIS OF THE STUDIES ON 9/11 ATTACKS

The first step of our analysis has shown that there is great heterogeneity in the methods used to study FBMs. In this second step we have therefore tried to assess whether the different conclusions reached by different researchers on the nature of FBM may depend on this methodological heterogeneity. This question is not easy to answer because, as our literature review shows, studies differ in terms of the target event, the population(s) involved, the assessment times, the variables used to measure FBM, and so forth, making it difficult to disentangle which methodological aspect might influence the results. One could try to isolate certain factors and then directly compare studies that are almost identical except for the factor of interest, in order to analyse what might be the cause of any differences. Efforts in this direction have been made, for example, by (Stone et al., 2015; but see also Koppel et al., 2013) who analysed FBMs associated with two similar events (political resignations) that occurred around the same time in Japan and Australia to at least control for the timing of the events and the type of event for both populations. In line with this rationale, we decided to make a post-hoc analysis focusing on the 9/11 attacks in order to limit at least one aspect that complicates the comparison between studies (i.e., the target event). We chose the 9/11 attacks because this was the event on which the highest number of studies on FBMs were conducted, allowing us to compare the possible effects of the different methodologies used. In addition, the characteristics of the event (e.g., novelty, importance, level of rehearsal, ...) made it one of the most likely to trigger FBMs in the 21st century.

More specifically, through an in-depth qualitative analysis, we compared the methodological aspects of the 18 studies about 9/11 attacks considered (see Tables 1–3, Cluster 2: 9/11 attacks) to understand whether the use of certain methods may lead to certain results. In particular, we focused on the FBM dimensions of consistency, vividness and confidence and the criteria used to draw conclusions about their nature.

Regarding consistency, the in-depth analysis of the studies dealing with this issue yields contradictory results: while some authors claim that FBMs are characterized by high consistency over time (e.g., Conway et al., 2009; Curci & Luminet, 2006; Shapiro, 2006; Tekcan et al., 2003), others come to the opposite conclusion (e.g., Hirst et al., 2009; Lee & Brown, 2003; Talarico & Rubin, 2003, 2007). To understand whether this discrepancy could be due to methodological factors, we tried to compare the studies that had some aspects in common but came to different conclusions. For example, the studies by Conway et al. (2009) and Hirst et al. (2009) share many methodological aspects: both were conducted on the general US population and involved similar sample sizes; in both studies, the first test was conducted a few days after the event (3 to 21 days in Conway et al., 2009, 6 to 10 days in Hirst et al., 2009), and the first retest was conducted after 11 months; both studies examined consistency by assessing only the CCs (no free recall) and using a dichotomous scoring system (0–1 scale) to measure their consistency. Despite these methodological similarities, the authors of the two studies came to different conclusions. Eleven months after the event, Hirst et al. (2009) reported a FBM's consistency of 63%, while Conway et al. (2009) a consistency of around 80% for single CCs (range between 74% and 87%). On a methodological level, there are two main differences between these two studies that could explain the

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different results: the respective CCs used to calculate the consistency score and how it was calculated. Conway et al. (2009) considered the CCs of place, activity, informant and others present, whereas Hirst et al. (2009) considered the CCs of place, activity, informant, own feeling, aftermath and the first person with whom one communicated. This may have affected the results because, as Christianson (1989) noted, not all information contained in FBMs is subject to the same forgetting pattern. Indeed, there is growing evidence that responses to some key CCs (place, activity, informant) are more consistent than answers to questions probing other aspects (i.e., peripheral information). However, literature shows that there is poor agreement on which categories are key versus peripheral (e.g., Ferrè Romeu, 2006; Schmidt, 2004). To know which categories are the most recalled, it is necessary to assess and report the consistency score for each single CC.

This is closely related to the second difference, that concerns the way in which the consistency scores have been calculated. Conway et al. (2009) reported the consistency score for each CC individually (i.e., independent scoring system), whereas Hirst et al. (2009) averaged the consistency scores for each CC into an overall measure of consistency (i.e., combined scoring system). These two types of scoring have very different implications. In the combined scoring system, where all CCs are considered together (i.e., a sum or average is calculated), it is assumed that an individual has all the required information stored in memory; consequently, the absence of even a single piece of information could affect the overall consistency score. In contrast, in independent scoring, where responses to each question remain separate, it is possible to show which specific information remains consistent, and even without having all the required information in memory, participants can achieve high consistency scores. Indeed, in several studies where low consistency scores were obtained, the combined scoring system was used (e.g., Lee & Brown, 2003; Talarico & Rubin, 2003), although the use of this scoring system did not always result in low scores (e.g., Curci & Luminet, 2006). We hypothesise that this depends on the CCs considered to determine the combined score. As mentioned above, scores tend to be higher when authors consider key CCs (e.g., place, activity, informant, see Schmidt, 2004), whereas the inclusion of questions on other information is likely to reduce the overall consistency score (e.g., informant's emotions, clothes, aftermath, etc.) (see Kvavilashvili et al., 2009 for similar considerations). By using an independent scoring system it is possible to evidence, which CCs are effectively more or less consistent.

Besides the methodological differences in the studies by Hirst et al. (2009) and Conway et al. (2009), the in-depth analysis of the studies about the 9/11 attacks revealed that other methodological aspects can influence the results of FBM consistency. For example, the results can be influenced by the scale used to code the responses to the CC questions. Some authors used Neisser and Harsch (1992) 3-point classification system (0 = absent/totally different, 1 = partially consistent, 2 = essentially the same information, e.g. Smith et al., 2003), while others used a 2-point coding scheme (consistent vs. inconsistent responses, e.g., Paradis et al., 2004). Still others used a more qualitative criterion to measure consistency and capture possible reconstruction errors by categorising responses into six possible categories: blank/can't remember, major distortion, minor distortion, less specific, more specific, the same (e.g., Kvavilashvili et al., 2009; Schmidt, 2004). However, even those who used the same coding system did not use the same criterion for awarding points. For example, some authors used a strict criterion requiring the two answers (test–retest) to be exactly the same, while others used a more lenient criterion requiring a semantic correspondence between the answers to the two tests (for a comparison between these two criteria, see Weaver III & Krug, 2004).

As regards vividness, it has only been investigated in three studies using different methods. Kvavilashvili et al. (2009) asked participants to rate the vividness of their memory for the reception context on a 10 points scale (1 = no image at all, 10 = extremely vivid image, almost like normal vision), while the other two studies used some items from other questionnaires to measure vividness. Specifically, Ferrè Romeu (2006) considered vividness together with other phenomenal characteristics, which she measured with the Memory Characteristics Questionnaire (MCQ) on a 7 points scale (1 = vague; 7 = very vivid), while Talarico and Rubin (2003, 2007) averaged some responses of the Autobiographical Memory Questionnaire (AMQ) (i.e., how much one could "see it in my mind," "hear it in my mind," and "know the setting where it occurred," from 1, not at all, to 7, as clearly as if it were happening now) into one vividness measure. Regardless of the method used, a high level of vividness was found in all three studies.

Confidence was instead investigated by 70% of the studies. In general, a homogeneity of results is observed, as the confidence levels are always very high and remain high over time. Despite this homogeneity of results, different methods were used to investigate this aspect: some researchers asked to report overall confidence in their memory (e.g., Paradis et al., 2004; Talarico & Rubin, 2003, 2007), others asked to report confidence for each CC (e.g., Conway et al., 2009; Hirst et al., 2009, 2015; Ferrè Romeu, 2006). Among the latter, some calculated an average score of the confidence ratings associated with canonical features (e.g., Hirst et al., 2009, 2015; Wolters & Goudsmit, 2005), while others reported the confidence scores for each CC separately, observing that they do not have the same trend over time (e.g., Conway et al., 2009; Ferrè Romeu, 2006; Weaver III & Krug, 2004). For example, two years after the attacks, Conway et al. (2009) observed a decline in confidence for the question "time", but not for the other CCs assessed (place, activity, informant, others present). An average score of CCs confidence does not allow these differences to be captured.

Finally, to draw conclusions on the nature of FBMs, authors mostly relied on consistency. Nonetheless, there is not a shared criterion to define a memory as a consistent FBM. For example, Conway et al. (2009), to consider a memory as consistent FBM required that participants were consistent in answering questions to all of the 4 CCs considered as key (place, activity, informant, others present). Using this criterion, 11 months after the event, only 48% of the participants resulted having a consistent FBM while the consistency scores for the single CCs was around 80%. More generally, to prove

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the existence of an FBM, several authors sought perfect consistency for all (e.g., Ferrè Romeu, 2006) or almost all (e.g., Wolters & Goudsmit, 2005) of the CCs assessed, assuming that every respondent has stored all this information in memory. This type of approach is very far from the idea proposed by Brown and Kulik (1977) who emphasised that a FBM could represent an image of some details of the context in which the news of an important public event was learned, and that these details are not necessarily covered by CCs. As pointed out by Kvavilashvili et al. (2009), there is indeed no consensus among authors on what level of consistency is required to classify a memory as a flashbulb. Since none of the studies on FBMs found 100% consistency, the authors of studies who found, let's say 85% of consistency, may argue either for or against the special status of FBMs, depending on their theoretical framework. For example, some authors (e.g., Ferrè Romeu, 2006; Weaver III & Krug, 2004; Wolters & Goudsmit, 2005), although reporting a high FMB consistency, concluded that there is no special mechanism underlying their formation because they failed to find a perfect consistency over time. This example highlights that the heterogeneity of results in studies about FBMs probably also mirrors theoretical divergences about the construct of FBM itself.

3 | WHERE ARE WE GOING? SUGGESTIONS FOR FUTURE STUDIES ON FBMs

In light of the above, it becomes clear how important it is to pay attention to the methodological aspects when studying FBMs. In future studies, we encourage researchers to keep in mind the possible effects of different methods on the results. In our opinion, the following three aspects deserve particular attention: the assessment of the content of FBMs, the assessment of the dimensions of FBMs, and the criteria used to draw conclusions about the nature of FBMs.

Regarding the assessment of FBM's contents, it is important to start from the premise that we cannot know a priori which contents are present in the FBM of a person. As pointed out by Brown and Kulik (1977), a FBM may be composed by some (but not necessarily all) contents which can be subsumed within CCs. Furthermore a FBM could entail idiosyncratic details. How can we grasp all the effective contents of FBMs? One possibility would be to present participants with a long list of prompted questions in the attempt to be exhaustive. Apart from the side effect of the length of the resulting questionnaire, the difficulty could be to decide which questions have to be inserted in the questionnaire. In our opinion, a valid alternative is to use a free recall task. As already mentioned in the discussion of step 1 (see RQ3), the free recall task has the advantage that it allows to grasp the effective contents of the participants' memory, including idiosyncratic details, without assuming that a person's FBM contains all the details probed by a priori questions about CCs. Furthermore, this could avoid biases due to inferential processing, that is, the tendency for individuals to infer information in response to a specific question (Muzzulini et al., 2020). Regarding the type of free recall task (list of details vs. narrative), we suggest asking participants to provide a list of details. By asking participants to write a narrative of their memory, there is a risk that they will include information that they could have added with the sake to make this account coherent and exhaustive for a potential recipient (Larsen, 1992). Future studies could compare methods using free recall and questions formulated as specific CCs, in order to examine whether these different methods influence the consistency results (e.g., Cordonnier & Luminet, 2021).

With respect to the assessment of FBM's dimensions, we argue that it would be important to assess concurrently consistency, vividness and confidence within each study. As regards consistency, we suggest considering the implications of using one scoring system instead of another. In line with what we said above, we believe that reporting the consistency score for each CC individually (i.e., independent scoring system) is better suited to understand which information remains consistent and which does not. Future studies might examine the effect of different scoring systems (independent vs. combined) on consistency results. Regarding vividness, we suggest that future studies should not leave out this dimension. It is indeed surprising that few studies have assessed vividness, since it is one of the main characteristics of FBM as defined by Brown and Kulik (1977), and moreover, the studies that have investigated this dimension found very high scores, suggesting that it is indeed a key feature of FBM. As regards confidence, we argue that it is important to assess this dimension in any FBM study, taking into account the potential impact of reporting confidence scores for each CC versus an average confidence score.

Finally, another aspect that merits consideration concerns the criteria used to draw conclusions about FBM consistency and, more generally, their nature. We encourage researchers to examine the phenomenon of FBM in its totality, hence, to consider results for all FBM dimensions (i.e., consistency, vividness and confidence), before drawing conclusions. Furthermore, particular attention should be paid to the criterion chosen by researchers to establish the presence of a FBM, since this decision may heavily influence the overall conclusions of a study, and, in turn, influence the debate about the special nature of FBMs (Luminet, 2022).

To sum up, we suggest that in future studies it would be worth paying more attention to the possible effects of the different methods used to study FBMs. The goal is not to apply a "standard" methodology to all FBM studies; rather, we argue that using different methods to study a particular psychological phenomenon is fundamental to its deeper understanding.[1] However, to understand how different methodological choices might influence the results of FBM studies, we believe it is essential to control specific methodological aspects (e.g., Cordonnier & Luminet, 2021; Koppel et al., 2013; Stone et al., 2015).

4 | CONCLUSIONS

In the present review, in a first step we focused on describing the methodological aspects of longitudinal studies on FBMs. We found

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great heterogeneity between the studies analysed, which might have contributed to the different conclusions reached about the nature of FBMs. Therefore, in a second step, we compared studies on the same event (the 9/11 attacks in the US in 2001) to determine whether the results differed depending on the methods used. This comparison focused on consistency, vividness and confidence and showed that the methodologies used can influence the results. Finally, based on our analyses, we provide some suggestions for conducting future FBM studies. Our more general goal was indeed to invite FBM researchers to reflect on the implications of using one particular method rather than another and on the possible theoretical conclusions arising from these choices.

This work is not without limitations. First, we have chosen to consider only test–retest studies that focus on public events. One-shot studies and those on private events represent an important body of research in the FBM literature and in some cases are the only ones that can be conducted (e.g., psychology of testimony). The exclusion of these studies limits the generalizability of the results, but it allowed us to focus on the studies that provided an empirical measurement of one of the founding aspects of FBMs, namely their consistency over time.

Second, we conducted an in-depth analysis of the studies on the 9/11 attacks to identify methodological factors that might influence the results of FBM studies. Yet, it should be pointed out that this was a very exceptional event, thus not fully representative of other events that have been studied as triggers for FBMs. Therefore, caution should be exercised when extrapolating the results of the 9/11 studies to other FBM events. However, this was the best option we had at the current state of the literature, because it is the only event on which a huge body of studies has been conducted, allowing us to analyse a large set of studies examining how different methods can lead to different results. The analysis we did can be seen as a first step that could help to clarify how different methods might influence the results. For the future, we believe it is important to continue working in this direction and to conduct further studies that examine these methodological aspects manipulating them a priori instead of analysing them, as we did, a posteriori.

To conclude, we hope that this review will trigger a constructive debate between researchers and stimulate new constructive discussions and research on this topic.

AUTHOR CONTRIBUTIONS

Rebecca Frinco: Writing – original draft; writing – review and editing; data curation; conceptualization; methodology; investigation. **Barbara Muzzulini:** Conceptualization; investigation; writing – original draft. **Carla Tinti:** Conceptualization; writing – review and editing; supervision. **Olivier Luminet:** Writing – review and editing; supervision. **Susanna Schmidt:** Conceptualization; writing – review and editing; methodology; supervision; data curation.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there is no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in Open Science Framework at https://osf.io/4nmfk/.

ORCID

Rebecca Frinco https://orcid.org/0000-0002-3069-3798
Carla Tinti https://orcid.org/0000-0002-9235-4185
Susanna Schmidt https://orcid.org/0000-0001-7505-0676

ENDNOTE

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