Flashbulb memory: referring back to Brown and Kulik's definition

Abstract

Since Brown and Kulik's (1977) seminal work, a central issue in memory literature is whether flashbulb memories (FBMs) hold a special status within autobiographical recalls. To address this issue, we refer back to Brown and Kulik's definition of FBM as a *snapshot* of the reception context of an important public news and propose a method to identify the contents of this snapshot. Although Brown and Kulik found that the majority of FBM's contents could be classified within six canonical categories (CCs), here we claim that assessing the presence of FBMs through guided CCs' questions - as done by most researchers in this field - can be misleading. We suggest, instead, to use free recall reports to identify the consistent perceptual elements of the snapshot. Across two test-retest studies, we show that the contents of FBMs assessed by free reports and the contents of CCs assessed by guided questions, do not exactly coincide. Moreover, a structural equation model supports results of previous research about the determinants of FBM and reveals that FBM facilitates the recall of more consistent explicitly requested CCs' contents. Theoretical implications concerning the qualitative contents of FBMs and the debate about their consistency are discussed.

Keywords: autobiographical memory; flashbulb memory; perceptual recall; canonical categories; public event

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Every day, people's routines are coloured by news of public events of different levels of importance and emotional arousal. However, only a fraction of these events generates detailed and long-lasting memories of the personal circumstances in which the news was first learned (Kvavilashvili, Mirani, Schlagman, Foley, & Kornbrot, 2009). For example, most people of appropriate age may still have stored in mind a vivid, detailed image of the fleeting moment in which they first received the news of the 9/11 terrorist attack almost two decades ago: the worried look of a TV announcer, the colour of the dress one was wearing, a detail of that precise moment's visual range.

This phenomenon has captured the attention of memory researchers ever since Brown and Kulik (1977) proposed the existence of a 'special' memory, which is formed when individuals receive the news of a surprising, consequential, and emotionally arousing public event. The authors assessed that most contents of this 'special' memory carried evident perceptual features that were reported with exceptional vividness, almost like describing a snapshot of a moment. They argued that *flashbulb memory* (FBM) might be an appropriate name to define the phenomenon, as it suggested "illumination and brevity" and a "live quality that is almost perceptual" (Brown & Kulik, 1977, p. 74). In analysing people's accounts of the reception context of important public news of their time, Brown and Kulik (1977) observed that the majority of respondents could recall a set of recurrent details. Hence they subsumed these contents within the so-called *canonical categories* (CCs) of place, informant, ongoing activity, others present, own affect, and aftermath; whereas they defined the remaining details as *idiosyncratic* (e.g. "We all had on our little blue uniforms", Brown & Kulik, 1977, p. 80). Finally, the authors suggested a criterion to define FBMs' accounts (i.e., a 'yes' answer to the question 'Do you recall the circumstances in which you first heard the

news?' and the recall of at least one canonical category) which they used to investigate FBMs' determinants. Brown and Kulik hypothesised that FBMs were elicited by events with a critical degree of surprise and consequentiality, and that greater consequentiality for one's own and their community was associated to richer and more detailed FBMs' accounts. Importantly however, although Brown and Kulik's work characterized a new phenomenon, some facets of their theory remain uncovered. An outstanding gap is that the authors limited their focus to the analysis of FBMs' accounts, without analysing FBMs' perceptual properties, which they considered non-directly measurable because represented in imaginal ways.

Central issues after Brown and Kulik's seminal work

After Brown and Kulik's seminal work (1977), a central issue in literature concerns the debate as to whether FBMs hold a special status within autobiographical recalls (Conway et al., 1994; Kvavilashvili, Mirani, Schlagman, & Kornbrot, 2003; Tinti, Schmidt, Testa, & Levine, 2014). One argument in favour of the special status of FBMs is that a large part of the details of the reception context are retained over long periods of time in a vivid and consistent fashion (e.g. Brown & Kulik, 1977; Conway et al., 1994; Curci, Lanciano, Maddalena, Mastandrea, & Sartori, 2015; Curci & Luminet, 2009; Kvavilashvili et al., 2003; Paradis, Solomon, Florer, & Thompson, 2004; Pillemer, 2009; Tinti, Schmidt, Sotgiu, Testa, & Curci, 2009). Conversely, other researchers have claimed that FBMs might be considered 'special' only because of the high levels of subjective confidence that accompany their recall (e.g. Talarico & Rubin, 2003). Some empirical research has indeed shown that these memories include inconsistencies and distortions, as it typically occurs for autobiographical memories of mundane events, making them somewhat 'less special' (Cubelli & Della Sala, 2008, 2013; Hirst et al., 2009, 2015; McCloskey, Wible, & Cohen, 1988; Pezdek, 2003;

Schmolck, Buffalo, & Squire, 2000; Talarico & Rubin, 2003; see also Wright & Gaskell, 1995, for FBMs' conceptual issues).

Despite heated debates, four decades after Brown and Kulik's first empirical work (1977), the question as to whether FBMs are a special class of autobiographical memories yet remains unanswered. To tackle this question, we refer back to Brown and Kulik's definition of FBM. We draw a distinction between the *actual* FBM – defined as a snapshot of a fleeting moment that is stored in a perceptual format – and the FBM's *account* – defined as a narrative constructed from this perceptual trace. Bearing the distinction between FBMs and FBMs' accounts in mind, we argue that several researchers have somewhat lost sight of the *actual* FBM, as initially described by Brown and Kulik (1977). Researchers have in fact typically assessed the presence of CCs as the main indicator of FBMs[1], without disentangling the actual FBM from the FBM's account. Most importantly, by considering CCs as *a priori* categories, previous research has not assessed whether CCs' contents are actually part of the perceptual image captured by the flashbulb.

Toward the Heart of Flashbulb Memories

Researchers have long been questioning the special status of FBMs due to the lack of consistency observed in CCs' recalls (Neisser & Harsch, 1992; Talarico & Rubin, 2003). However, it is questionable whether the assessment of CCs' consistency through guided questions ("Where were you?", "What were you doing?", and so on) is the best method for

[1] Results of a systematic review involving 37 longitudinal studies (Muzzulini, Schmidt & Tinti, in preparation) highlight that only seven studies assessed FBMs through the use of free recalls and guided questions. More specifically, Curci et al., (2001) and Er (2003) asked participants to list a maximum of five details of the reception context; Conway et al. (1994) and Otani et al. (2005) asked participants to provide a short description of the reception event; Talarico & Rubin (2003) and Kraha et al. (2014) asked participants if there were any other distinctive details that they would like to share beyond canonical categories; and Schmidt (2004) assessed four questions tapping what were thought to be the 'thematically incidental or peripheral information' of the reception context. None of these studies, however, have tested the relationship between the perceptual details and the recall of canonical categories.

verifying the special status of FBMs. Referring back to Brown and Kulik's definition (1977), CCs may be seen as an expedient for summarising the principal elements identified when analysing people's FBMs' accounts. Therefore, we may conceive CCs as useful 'etiquettes' to categorize the narrative of a recall which has been stored in a perceptual, mostly iconic format.

We suggest that the question as to whether FBMs entail CCs' contents, should be preceded by the question as to whether a perceptual image of the reception context has been stored. As pointed out by Brown and Kulik (1977), "there is something strange about this [the flashbulb] recall. […] 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). According to this claim, the recall of the scene may contain details that fit under the CCs – for example, *'learning the news from the TV while at home'* – but also, or only, other idiosyncratic sensory elements of the news' reception context – for example, *'a red mug on the TV table'*.

We propose that, in order to be considered part of a FBM, the recalled elements must pertain to the abiding image stored by the flashbulb in the very precise moment in which the news was learned. Most importantly, we suggest that these perceptual elements may represent the elements that lead Brown and Kulik (1977) to claim in favour of FBMs' unusual live quality and long-lasting maintenance. Hence, we argue that FBMs contains the fleeting details of the scene that people captured when they learned about the news and that are consistently maintained over time. We claim that this consistent perceptual core *is* the FBM. Through two test-retest studies and by using free recall tasks, in this work we aim to (re)discover the actual FBM conceived as the consistent recall of the perceptual elements contained in the image captured by the flashbulb.

Overview of the Studies and Hypotheses

In this work, we refer back to Brown and Kulik's (1977) definition of FBM as the permanent snapshot of the moment in which the news of an important, emotion-arousing public event was first learned. In other words, we conceive FBMs' as a perceptual representation that is stored in memory in a consistent fashion. Stemming from this definition, we seek to investigate FBMs' qualitative elements. In their seminal work, Brown and Kulik (1977) did not propose a method to assess the actual FBM. They rather acknowledged the methodological challenge. For this reason, the present work firstly aims to suggest a method to quantify the qualitative elements of FBM's consistent perceptual core. We then make use of this method to test the relationship among FBM assessed through free recall, FBM's antecedents, and CCs' contents assessed throughout guided questions.

Across two studies, we used a test-retest design (with time-delays of 6 and 18 months respectively) to 1) identify the perceptual elements contained in the free recalls, 2) assess their frequency and vividness, 3) identify the consistent perceptual elements that constitute the FBM, 4) test the eliciting factors of FBM, and 5) the relationship between FBM and CCs' contents assessed by guided questions. In relation to the eliciting factors, we examined the variables that have been traditionally considered in FBM's literature: surprise (Brown & Kulik, 1977), background knowledge related to the event (e.g. Conway et al., 1994), event memory (i.e. the memory of the original event, Finkenauer, Luminet, Gisle, El-Ahmadi, van der Linden, & Philippot, 1998), subjective appraisals of the event (novelty and importance/consequentiality, e.g. Finkenauer et al., 1998; Tinti et al., 2009), emotions, and rehearsal (for complete reviews, see Dumas & Luminet, 2016; Luminet & Curci, 2017).

Study 1 aimed to develop a method to assess the presence of perceptive elements used to describe the exact moment when the news was learned and to ascertain their consistency in order to identify the FBM defined by the presence of at least one consistent perceptual element. We investigated whether participants with vs. without a FBM scored differently for:

1) vividness of the reported mental image, 2) the variables generally considered as the antecedents of FBMs' formation, and 3) the consistency of explicitly requested CCs' contents. Furthermore, we sought to identify the amount of consistent perceptive elements that could either be categorized within CCs or as idiosyncratic to better grasp FBMs' contents in light of Brown and Kulik's (1977) definition. Finally, we compared FBMs assessed by free recall and explicitly requested CCs' contents in terms of quantity and vividness to gather evidence that CCs' guided recalls do not necessarily overlap with FBMs' free recalls. To achieve our aims, we assessed Italian Catholics' reactions and memories related to an important unexpected event: the resignation of Pope Benedict XVI, who announced his intention on 28 February 2013, after an 8-year papacy. Pope Benedict XVI was the first Pope to resign, at his own initiative, since Pope Celestine V in 1294. Thus, not only was the event surprising, but it was also unique for the modern Catholic Church and for the Italian population more generally.

The aim of Study 2 was twofold: 1) to replicate Study 1 to gather further evidence that, although related, FBMs assessed by a free recall task, and the CCs' contents, assessed by guided questions, do not exactly coincide, and 2) to propose and test a model relating FBM to the variables generally considered as their antecedents and with CCs' contents assessed by guided questions. To achieve these aims, we examined people's recalls of the terrorist attacks that struck Paris during the night between 13 and 14 November 2015. Due to its brutality, this unfortunate event threw the whole Europe into a state of anguish and fear. For ethical reasons, and with respect to the climate of terror that spread all over the French nation during the days after the event, we chose not to interview French people. Rather, we addressed our study to Italian students; a population we expected to be strongly affected by the event given the country's close proximity to the French border. Using structural equation modelling, we first assessed whether FBMs and CCs can be considered as two separate,

although related, latent variables. Then, drawing on previous FBM models (for a review, see Luminet & Curci, 2017), we created a model to test the relationship between FBMs and the variables generally considered as their antecedents (appraisals of novelty and importance/consequentiality, surprise, other emotions, rehearsal, background knowledge, event memory), and the consistency of the CCs' contents assessed through guided questions.

Study 1: The Resignation of Pope Benedict XVI

Materials and Method

Participants

The first survey (Time 1) was distributed to and completed by 403 Italians, 212 of whom also took part in the re-test phase (Time 2). Eight participants were excluded from the analyses either because it was not possible to match their surveys (n = 2), or they did not fully complete the surveys (n = 6). The final sample consisted of 204 participants, 80.9% of whom were Catholics. Their ages ranged from 18 to 80 (M= 37.45; SD= 16.60), and 74.5% were women. In total, 39.7% of the participants were students from the University of […], while 60.3% were recruited from communities of the Catholic Church of […]. Among the latter, 45% were employed and self-employed workers, and 15.3% were retired or housewives.

Procedure

The participants completed the Time 1 survey between 5 and 15 days after the Pope's resignation. During this time range, trained research assistants from the University of […] distributed the questionnaires in pencil and paper. We did not run a power analysis prior to data collection, but we sought to gather as many participants as possible within a short time delay after the event. Furthermore, to avoid overlapping with a new flashbulb-like event, recruitment was suspended concurrently with the election of the new Pope. Six months after the event, the participants completed the second survey via Google form. Because the surveys were anonymous, to match them, each participant was asked to provide a personal code made up of six characters (date of the person's birthday, the first two letters of the mother's name, the last two letters of their own name). All participants took part in the study voluntarily; they signed an informed consent and completed both surveys in Italian.

Survey and scoring of qualitative contents

The survey was created to investigate FBMs' antecedents and CCs' contents by adapting instruments of previous studies (Brown & Kulik, 1977; Conway et al., 1994; Finkenauer et al., 1998; Tinti et al., 2014), while an *ad-hoc* procedure was developed to assess FBMs' contents. Below, we describe the investigated variables in the order in which they were assessed.

Vividness. At both times, we asked the participants to picture the moment when they first learned about the news of Pope Benedict XVI's resignation, and to rate on an 11-point scale the extent to which this representation was vivid, where 0 = *not vivid at all* and 10 = *extremely vivid.*

FBM. Using a free-recall task, we then asked the participants to recall, if any, the details of their mental representation. Here, our goal was to assess the perceptive contents of the stored image while avoiding any suggestions related to the use of guided questions about the news' reception context. Accordingly, we developed a procedure drawing on methods used in previous research (e.g., Curci et al., 2001 and Conway et al., 1994) assessing the participants' spontaneous recall by presenting them with 5 separate blank spaces in which they could report any details they wished. The free recall was assessed *before* the guided recall to minimize any inferences based on CCs' recall. Although we acknowledge a 'carry-over' effect on CCs, we appositely chose this order to gather participants' most spontaneous recall of the perceptual details of the stored image. In addition, we provided participants with detailed instructions: "*Please report up to 5 details of the image you have in mind of the exact moment when you first learned about Pope Benedict XVI's resignation. The details you report may be of any type and any length. Note that you do not necessarily need to report the details in a coherent form. Rather, we encourage you to report any details as they come to your mind, even ones that might seem irrelevant*".

To identify the perceptual elements that could pertain to FBM, we adapted the criteria Finkenauer et al. (1998) used to measure FBMs' specific details (see box 1).

A score of 1 was awarded when the reported detail encompassed one or more of these criteria. A score of 0 was given either when no details were reported, or the reported detail had none of the above-mentioned properties. We first quantified the presence of the perceptual elements at Time 1 and Time 2 respectively. To do so, all details reported at the two time-point assessments were summed up to obtain two indices reflecting the frequency of the perceptual elements at Time 1, and at Time 2 respectively. Both indices could range between 0 and 5. Subsequently, we compared the perceptual elements reported at re-test with the ones reported at the first assessment. We awarded a score of 1 when the detail was reported with essentially the same level of precision at both Time 2 and Time 1 (e.g. Time 1: *'The TV titles in overlay of the resignations'*, Time 2: *'The overlaying news of the resignations that flowed on the TV screen'*); and a score of 0 either when the detail reported at Time 2 did not match with the detail reported at Time 1, or when no information was provided. The consistency scores assigned to each detail were added together in a composite index ranging from 0 to 5, which represents the number of consistent perceptual elements retained in FBM. All contents were scored by the first author, and by a trained research assistant from the University of […], who was instructed in the use of the criteria described above. The average measure of intraclass correlation (ICC) showed a good agreement

Box 1

- Explicit statement/s regarding the relative position of entities within the environment or directions relating to the participant's point of view (e.g. '*My husband was sitting on my left hand side'*, '*The cat was curled up on the left side of the couch'*);
- Explicit reference/s to distinct entities that the participant could 'see' in his/her mental representation (e.g. '*I was laying in my bed with the book of biology on my legs'*, '*I clearly remember the shape of my friend's eyebrows'*);
- Statement/s describing specific properties of an entity (e.g. '*I was drinking coffee from a red mug*', '*I was wearing a light blue cardigan*'), as well as weather and atmosphere descriptions, and auditory, olfactory, and tactile details about an object (e.g. '*I could hear the washing machine noise on the background*', '*There was an intense smell of cigarette smoke*').

between the two coders (ICC = .84, F (203, 203) = 6.28, $p < .001$, 95% CI [.79, .88]). Any divergences between the two judges were resolved by consensus.

Considering that the contents of the FBMs can be classified into CCs and idiosyncratic details, we carried out a qualitative analysis. All consistent perceptual details were coded by a trained research assistant in terms of CCs and idiosyncratic details. A second coder (last author), did the same analysis on 50% of randomly selected cases. The average measure of intraclass correlation (ICC) showed an excellent agreement between the two coders for the perceptual elements that could be classified as CCs (ICC = .96, F (101, 101) = 23.23, $p < .001$, 95% CI [.94, 97]), as well as for the idiosyncratic ones (ICC = .99, F (101, 101) = 69.46, $p < .001$, 95% CI [.98, 99]).

Canonical categories. The CCs' contents were assessed by a guided-recall task in which the participants were asked to report the *source of the news*, the *place* in which they were located when they first learned about it, the *activity* in which they were involved, the *other people present* at that moment, and what they did in the *immediate aftermath* of receiving the news. To score the consistency of these contents, we compared Time 2 answers with Time 1 answers by using a three-point scale, where 0 = *not consistent*; 1 = *partially consistent*; 2 = *consistent*. For example, when, in both surveys, the participant reported the same information with the same richness of detail, a score of 2 was awarded (e.g. for the category 'ongoing activity', at Time 1: '*I was cooking dinner while speaking with my husband'*; at Time 2: '*I was chatting with my husband, and I was preparing the dinner'*). If, at Time 2, the participant only recalled part of the details reported at Time 1, a score of 1 was given. For example, in the category 'place', if at Time 1 the participant reported: '*I was on the sofa in my living room*', and then at Time 2 reported '*I was at home*', a score of 1 was attributed. Finally, when either at Time 1 or at Time 2 the participants failed to provide an answer, or when they provided different answers between the two times, a score of 0 was

given. Consistency scores assigned to each canonical category were summed up into a composite index that could range between 0 and 10. The CCs' contents were scored by the first author among all participants, while a trained research assistant provided a second scoring for 102 (50%) randomly selected participants. The average measure of intraclass correlation (ICC) showed an excellent agreement between the two coders (ICC = .98, F (101, 101) = 46.66, $p < .001$, 95% CI [.96, .99]).

Event Memory. We operationalised event memory according to its accuracy at Time 2 (Talarico & Rubin, 2003), by using 12 open-ended questions to assess the participants' recall of factual information about the event (e.g. '*What were the main reasons why Pope Benedict XVI resigned?'*, '*On what occasion did the Pope announce his resignation?*'). A score of 1 was attributed when the answer was complete and accurate, a score of 0.5 when it was partially accurate, and a score of 0 when it was inaccurate or missing (e.g. for the occasion of the announcement, *'Consistory for the canonisation of the martyrs of Otranto'* = 1, *'Proclamation of new saints'* or *'Meeting with the cardinals'* = 0.5). Accuracy scores were added together in a composite score that could range from 0 to 12 (α = .73). For each question, the participants were also asked to rate from 0 (*not at all*) to 10 (*extremely*) how confident they were about the answers they provided. A mean of the confidence scores was calculated for further analyses (α = .84).

Cognitive Appraisals. We measured cognitive appraisals in terms of the participants' initial evaluation (i.e. at Time 1) of the novelty, personal importance, and consequentiality of the event. Novelty was measured through one item on an 11-point scale (0 = *not expected at all*, 10 = *extremely expected*) assessing the extent to which the event was expected. For further analyses, the values were reverse coded. Personal importance was measured with one item on an 11-point scale (0 = *not important at all*, 10 = *extremely important*) assessing the extent to which the event was important for the participants personally. Consequentiality was

measured on three 11-point scales (0 = *not consequential at all*, 10 = *extremely consequential*) assessing, respectively, the extent to which the event could have consequences on the participants' personal life, on the Catholic Church's followers, and on the Catholic Church in general. For further analyses, we averaged the scores obtained on the three items into a mean reflecting consequentiality (α = .65).

Surprise. At Time 1, on a scale ranging from 0 (=*not surprised at all*) to 10 (= *very surprised*), we assessed the intensity to which the participants were surprised about the news.

Other Emotions. Participants were asked to rate from 0 (= *no intensity*) to 10 (= *very intense*) the intensity they felt for a set of 8 emotions at Time 1. On a separate item, we measured the intensity of the general emotional reaction (scale 0 – 10). For further analyses, we averaged fear, anger, sadness, and anxiety into a mean reflecting negative emotions (α = .71), and happiness, satisfaction, hope, and relief into a mean of positive emotions (α = .72).

Rehearsal. At Time 1, the participants were asked to report on two 11-point scales (0 = *not at all*, 10 = *extremely*) how frequently they had spoken about the event and the personal circumstances in which they were when they first learned about it. In addition, they were asked to rate from 0 (no time) to 7 (more than 5 hours) how much time they had spent following the news about the event in the media coverage.

Background Knowledge. We assessed the participants' background knowledge about religion and the Catholic Church by using 16 guided questions entailing knowledge of 26 pieces of information in total (e.g. *'What was the name of the Pope who resigned in 1294?'*, *'Please list the seven sacraments'*). The answers were assessed at Time 1 and scored according to their correctness (0= *incorrect or missing*; 1= *correct*). Because almost all of the participants scored 0 in two questions, these were excluded from the analysis. The scores awarded to each question were added together in a cumulative score (range 0 to 24) reflecting the background knowledge (α = .83).

Demographic Information: At the end of the survey, the participants were asked to report some demographic information about their gender, age, profession, nationality, and religious affiliation.

Results and Discussion

The results will be reported in four sections: (1) in the first, we report the number of the perceptual elements that could pertain to FBM at both tests and we analyse whether their frequency remains stable over time; then we report the frequency of participants with at least one consistent perceptual detail over time, i.e., participants who carry a FBM; 2) in the second section, we investigate the vividness of the participants' mental image over time, and whether the participants with vs. without a FBM score higher for vividness; 3) in the third section, we assess whether participants with vs. without a FBM score higher for the variables generally considered as antecedents of FBM formation and CCs' consistency; 4) in the fourth section, we report the results of the categorization of FBMs' contents in terms of CCs and idiosyncratic details and compare them with the frequency of consistent answers to the explicitly requested CCs. We also assess whether there is a difference between the vividness of FBMs and CCs' contents. Finally, we report a scatterplot to show that the CCs assessed by guided questions do not necessarily overlap with FBMs' contents assessed by a free recall task.

Frequency and consistency of the perceptual elements of the reception context

Since we defined FBM as the perceptual elements' consistency, the recalled perceptual elements were first scored according to their frequency at Time 1 and Time 2 respectively, on a scale ranging from 0 to 5. At Time 1, on average, the participants reported 2.32 perceptual details (SD = 1.62). At Time 2, the mean score was 1.79 (SD = 1.49). A paired-samples t-test showed a significant decrease in the reported perceptual elements over time, t (203) = 5.72, p < .001, 95% CI [.35, .71], d = .40. However, the vast majority (85%) of the details reported at Time 2 (M = 1.52, SD = 1.42) were consistent with the details reported at Time 1, and over two-thirds of the participants (67.6%, n = 138) retained one or

more consistent perceptual elements (1 element: 20.1%, 2 elements 24%, 3 elements: 13.7%, 4 elements: 5.9%, 5 elements: 3.9%).

Vividness of the mental image

The vividness ratings of the mental image that the participants had in mind were above the mid-point in both tests (M_{T1} = 7.05, SD_{T1} = 3.22; M_{T2} = 5.94, SD_{T2} = 3.16), although they significantly decreased over time, $t(203) = 5.21$, $p < .001$, 95% CI [.69, 1.53], $d = .36$. In addition, by splitting the sample in two groups (i.e., participants with no consistent perceptual element vs. participants with at least one consistent perceptual element), we computed a 2 (groups: presence vs. absence of FBM) by 2 (times) GLM (General Linear Model) repeated measures which showed that participants with a FBM scored higher for vividness (EMM = 7.67, ESE = 0.19) than participants without it (EMM = 4.05, ESE = 0.28), $F(1, 202) = 116.97$, $p < .001$, 95% CI [2.96, 4.28], $n_p^2 = .37$. The results also confirmed a significant decrease in vividness over time (EMM_{T1} = 6.48, ESE_{T1} =0.21; EMM_{T2} = 5.23, ESE_{T2} = 0.19), $F(1, 202) = 30.29$, $p < .001$, 95% CI [-1.69, -.80], $n_p^2 = .13$, whereas the interaction group by time did not reach significance, $F(1, 202) = 13.63$, $p = .086$, $n_p^2 = .02$. Nonetheless, descriptive statistics suggest that vividness ratings of participants with a FBM decreased less over time (EMM_{T1} = 8.04, ESE_{T1} = 0.24; EMM_{T2} = 7.24, ESE_{T2} = 0.22), as compared to participants without a FBM (EMM_{T1} = 4.86, ESE_{T1} = 0.85; EMM_{T2} = 3.23, ESE_{T2} = 0.31).

Differences between participants with vs. without FBMs regarding their antecedents and the consistency of CCs' contents

Table 1 reports the overall means, the means by group (presence vs. absence of a FBM), and the results of the GLM computed to investigate whether participants with vs. without a FBM scored higher for FBMs' antecedents, and the consistency of the explicitly requested CCs' contents.

As we can observe from the overall means reported in Table 1, the participants appraised the event as highly unexpected and fairly important and consequential. Surprise was found to be the most intensely experienced emotion, whereas the ratings of positive and negative emotions almost reached a floor effect. The general intensity of emotions was around the mid-point of the scale, indicating that, overall, the event was experienced as fairly emotional. The participants rehearsed the event fairly often talking about it with others and following it on the media, but they rehearsed the reception context of the news quite rarely. With regard to the participants' background knowledge of the Catholic Church and religion, the overall mean is around the mid-point, whereas the overall means of event memory accuracy and confidence were somewhat below. For CCs' consistency, the mean score indicates that the participants recalled CCs' elements quite consistently. Finally, at least on a descriptive level, the participants who could retain a FBM scored higher across almost all of the investigated variables.

To test whether the differences between participants who carried a FBM (i.e., retained at least one consistent perceptual detail) vs. those who did not were significant, we computed a GLM with group as between subject factor on all investigated variables. The results revealed a multivariate effect of group, $F(14, 189) = 4.33$, $p = .001$, $n_p^2 = .24$. In more detail, univariate statistics showed that participants with a FBM appraised the event as more unexpected and consequential than those without a FBM. In addition, participants with a FBM felt significantly more surprised and were more accurate and confident in recalling information about the event. Finally, they showed more consistent CCs' recall (see Table 1).

Table 1. Descriptive statistics and results of the GLM computed to assess whether the presence of a FBM accounted for greater levels in the investigated variables.

Variables	*F (1, 202)*	*M* [95% CI]		Range
		Absence of a FBM (*n* = 66)	Presence of a FBM (*n* = 138)	
Appraisals				
Novelty	4.88*	9.09 [8.73, 9.46]	9.59 [9.34, 9.84]	0 – 10
Personal importance	0.06	4.89 [4.07, 5.72]	5.02 [4.45, 5.59]	0 – 10
Consequentiality	7.26**	4.86 [4.38, 5.33]	5.64 [5.32, 5.97]	0 – 10
Emotions				
Surprise	11.18**	6.73 [6.08, 7.38]	8.07 [7.62, 8.52]	0 – 10
Negative emotions	0.02	1.12 [0.82, 1.52]	1.09 [0.82, 1.37]	0 – 10
Positive emotions	0.51	1.25 [0.79, 1.71]	1.45 [1.14, 1.77]	0 – 10
General intensity	1.25	4.62 [3.86, 5.38]	5.14 [4.62, 5.67]	0 – 10
Rehearsal of the event				
Talking event	0.02	5.77 [5.14, 6.41]	5.72 [5.29, 6.16]	0 – 10
Talking circumstances	0.01	2.18 [1.57, 2.79]	2.22 [1.80, 2.65]	0 – 10
Media	0.01	3.38 [3.05, 3.71]	3.36 [3.13, 3.58]	0 – 7
Background Knowledge	0.51	11.59 [10.43, 12.75]	12.10 [11.30, 12.90]	0 – 24
Event memory				
Accuracy	6.55*	4.42 [3.84, 4.99]	5.32 [4.93, 5.73]	0 - 12
Confidence	5.01*	3.76 [3.25, 4.28]	4.50 [4.12, 4.84]	0 - 10
CCs	30.76***	5.50 [4.95, 6.05]	7.38 [7.00, 7.77]	0 – 10

Note. *$p < .05$, **$p < .01$, ***$p < .001$. For CCs, the cumulative index was obtained by adding together the consistency scores (range 0 – 2) awarded to each of the five canonical categories when comparing Time 1 and Time 2 answers in the guided-recall task; for event memory, the cumulative index was obtained by adding together the accuracy scores (range 0 – 1) awarded to each of the 12 question assessed at Time 2; for background knowledge, a cumulative index was obtained by adding together the correctness scores (range 0 – 1) of the 24 pieces of information assessed at Time 1. The values of the remaining variables refer to the Time 1 assessment.

Comparison between FBMs assessed by free recall and explicitly requested CCs' contents in terms of quantity and vividness

We compared FBMs assessed by free recall and explicitly requested CCs' contents in terms of quantity and vividness to gather evidence that CCs' guided recalls do not necessarily overlap with FBMs' free recalls. Figure 1 outlines the percentage of participants who recalled a consistent answer in relation to each explicitly requested CC and the percentage of participants who spontaneously reported consistent perceptual details that could pertain to the CCs or were idiosyncratic. In regard to the explicitly requested CCs, we can observe that over half of participants could report consistent information relative to others present, place, informant, and ongoing activity; 34.8% of them could also report a consistent information about the immediate aftermath.

We then compared the above-mentioned percentages with the percentages of participants who reported consistent perceptual contents that could pertain to the CCs in the free recall. It emerges that the latter are much lower, whereas more than half of the participants reported at least one idiosyncratic detail. In addition, it is worth observing that, the most frequent details captured by the flashbulb beside the idiosyncratic details, are the others present and the place, also within the consistent perceptual image; whereas nobody reported a detail pertaining to the category 'immediate aftermath'. This result seems rather plausible if we consider that the 'immediate aftermath' refers to actions succeeding the moment in which the picture was captured.

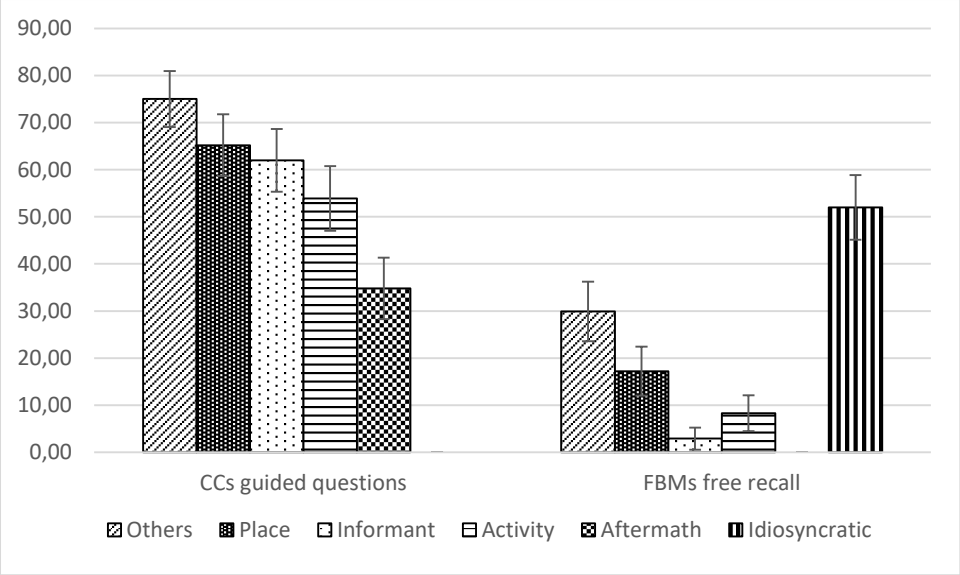

Figure 1. *Percentages of participants who reported consistent answers for each explicitly requested CC and who spontaneously reported consistent perceptual elements, i.e. FBMs, recoded into CCs or idiosyncratic details (error bars represent 95% confidence intervals)*

In order to evaluate the correlations of vividness with FBMs and CCs, the scores obtained for each CC were summed up (range 0-10), as well as the number of perceptual details (range 0-5). The correlation between vividness and FBM (r = .605, 95 % CI [.510, .685]) was significantly higher than the correlation between vividness and CCs (r = .264, 95 % CI [.131, .387], Z = 4.161, p < .001).

Finally, the relationship between the summed score of FBM and the summed score of CCs is shown in Figure 2. As we can observe, when participants obtained a high score for FBM, they also reported quite high scores for the CCs. Conversely, participants with a low score for FBM, could have high as well as low scores for CCs. This result suggests that FBMs (as defined and assessed here) and CCs can partially overlap yet being distinguishable.

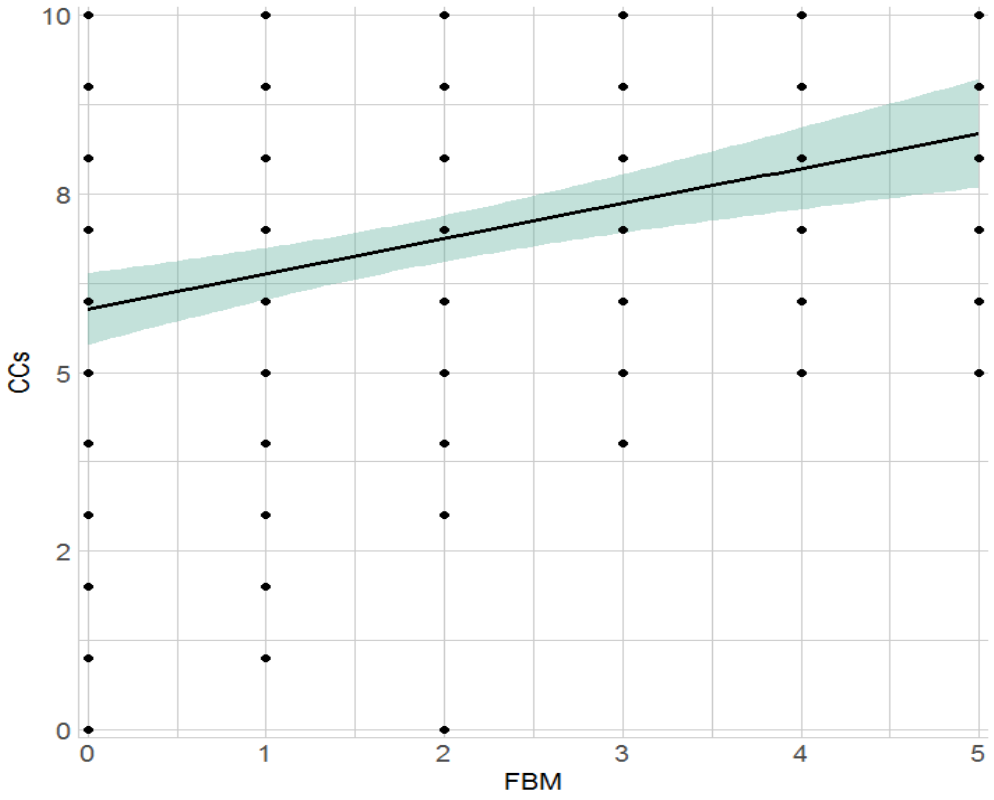

Figure 2. *Scatterplot of the relation between FBM and CCs (error bounds correspond to 95% confidence region, R^2=0.114).*[2]

To sum up, in this study, we identified the perceptual details of the reception context's free recalls and analysed their frequency, consistency, and vividness. In addition, we analysed the difference between the participants who carried a FBM vs. those who did not, with respect to the variables traditionally considered as antecedents of FBM's formation and the consistent recall of the CCs' contents. The results showed that over two-thirds of the participants retained one or more consistent perceptual details of the reception context, i.e. they carried a FBM. Moreover, when comparing the ratings of participants with a FBM with

[2] In the Supplemental materials (S1) we also report the scatterplot with jittered points to provide information about the number of cases underlying the points.

participants without a FBM, three main findings emerged: (1) participants with a FBM retained more consistent CCs' contents over time, (2) at both times, these participants could retrieve a more vivid mental representation of the news' reception context, and (3) at initial assessment, they scored higher in the appraisals of novelty and consequentiality, intensity of surprise, and accuracy and confidence of event memory. Finally, when comparing FBMs as here defined and assessed and CCs, two main results emerge: (1) the correlation between FBM and vividness was significantly higher than the correlation between CCs and vividness, (2) FBMs and CCs could partially overlap but were also distinguishable.

These results support the idea that a strong emotion may create a mental image and that the details of this image may be consistently retained over time, confirming the key definition of FBMs as proposed by Brown and Kulik (1977). We suggest that this mental image should be assessed by a free recall task that does not require a coherent narrative, rather than by explicitly requested CCs' contents. However, the event we considered has not been appraised as highly personally important, and, except from surprise, it did not trigger very intense emotional feelings. In addition, the vividness ratings of the image stored in participants' mind significantly decreased over time. Considering a different population and a public event that we hypothesised to trigger greater emotions, Study 2 addresses these limitations by replicating and extending the results of Study 1.

Study 2: The Terrorist Attacks of Paris, November 2015

In this study, we sought to replicate our methodology to identify the FBM conceived as consistently recalled perceptual details, and to create a model to test its relations with the whole set of variables considered in Study 1. In particular, we focused on the terrorist attacks that struck Paris in November 2015, by using the same test-retest methodology as in Study 1. We first assessed the frequency of the freely recalled perceptual elements and the vividness of the mental image of the reception context that participants retained in mind. Then we analysed the consistency of the perceptual elements to identify the ones that could fit within our definition of FBM. Finally, we used structural equation modelling to test whether FBMs' contents and consistent CCs' contents could be considered as two separate, yet related, latent variables. Once we ascertained this important theoretical aspect, we drew on previous models (see Luminet & Curci, 2017 for a review), to create a model (see Figure 1) by which we tested the following hypotheses: (HP1) greater appraisal of novelty enhances higher intensity of surprise, (HP2) higher intensity of surprise enhances the formation of FBM, (HP3) greater appraisals of importance and consequentiality enhance the formation of FBM, and this effect is mediated by emotions, (HP4) more accurate background knowledge enhances the recall of more accurate event memories, (HP5) more intense emotions enhance the recall of more accurate event memories through rehearsal, (HP6) more frequent rehearsal enhances more consistent recall of CCs' contents assessed by guided questions, (HP7) more accurate event memory enhances more consistent CCs' recalls. Finally, we hypothesised that (HP8) FBM enhances the recall of more consistent CCs' contents, because the image stored in mind should facilitate the recall of other related details of the reception context.

Materials and Method

Participants

305 participants took part in the first stage of the study (Time 1). At the second phase (Time 2), 158 participants completed the survey. Seven participants were excluded from the analyses: three of them failed to provide the information needed to match the Time 1 and Time 2 surveys, and four of them did not fully complete the survey. The final sample was therefore composed of 151 participants. The participants were psychology students from the University of […] (68.7% undergraduate, 31.3% master students). Their ages ranged from between 18 and 32 (M= 21.17; SD= 3.04), and 79% of them were women.

Procedure

The participants completed the first survey within 3 to 5 days after the event. While in Study 1 we allowed 15 days for data collection, here, we imposed a shorter time frame to minimize the massive effects of the media coverage. The terrorist attacks of Paris have in fact received great media attention, including the spread of gory images of the shooting site, and dysphoric videos of those who survived. Because this might have biased the recall of one's subjective reception context, we urged to recruit as many participants as possible within the most immediate aftermath of the event. The survey was distributed among university students during scheduled lessons and completed with pencil and paper. Similar to Study 1, we did not compute an a priori power analysis, but we sought to recruit as many participants as possible within the proposed timeframe. After 18 months, the participants were sent an email in which they were asked to complete the Time 2 survey via the online survey platform Qualtrics. As opposed to Study 1, in which we used a 6-month time delay, here, we used an 18-month time delay as we were interested in testing the consistency of the perceptual details of the image of the reception context over a longer latency. All participants completed both surveys in Italian and took part voluntarily. They were informed that the surveys were anonymous and that the data would be used for research purposes only.

Survey

The survey was structured like the one we used in Study 1. Hence, for the sake of brevity, we will not outline the specific details of the scoring procedure, but we remind to the methods section of Study 1. Below, we will describe the latent variables of the model and the indicators (labels are reported in brackets) that we used to measure them.

FBM. At both times, we first asked participants to rate the extent to which the image of the reception context of the news was vivid in their mind (0 = *not vivid at all*, 10 = *extremely vivid).* The participants were then asked (see instruction for Study 1) to report up to 5 details of their mental image. The contents were scored at Time 1 and Time 2 according to the criteria that we previously outlined in Study 1. Consistent perceptual details were then added together in a cumulative score reflecting the number of consistent perceptual elements forming FBM that could range from 0 to 5. The obtained score (Consistent), together with vividness measured at Time 2 (Vivid), were used as indicators of FBM. All contents were scored by the first author. A trained research assistant from the University of […] provided a second scoring for the whole sample, achieving good inter-judge agreement (ICC = .86, F (150, 150) = 8.44, $p < .001$, 95% CI [.77, .91]).

Canonical categories. CCs were assessed at both times in a guided recall task (see Study 1). To create the latent variable, we used the consistency scores (range 0 – 2) awarded to *source* (Source), *place* (Place), *activity* (Activity), *other people present* (Others), and *aftermath* (After) as indicators. All contents were scored by the first author, and a second scoring was provided for 74 (49.0%) randomly selected cases. The reliability between the two judges was very high (ICC = .93, F (73, 73) = 20.70, $p < .001$, 95% CI [.77, .97).

Event Memory. Event memory entailed 14 questions focusing on factual information about the event (e.g. '*How many victims did the event involve?*', '*Which group was playing at the Bataclan Theatre?*'). Each answer was scored according to its accuracy (range 0 – 1, see Study 1) at Time 2. To create the first two indicators (EM_1 and EM_2) of the latent

variable, we verified the unidimensionality of the scale using item factor analysis as reported in the Supplemental materials (S2.A), and separately added together the even and odd questions (range 0 – 7). To create the third indicator (EM_Conf), we used the mean value of subjective confidence ratings – ranging 0 (= *not confident at all*) to 10 *(= extremely confident*) – reported by participants at the end of each given answer.

Novelty. The appraisal of novelty was assessed through one item on an 11-point scale in which participants were asked to rate the extent to which the event was expected (0 = *not expected at all*; 10 = *extremely expected*). The ratings were subsequently reverse coded to gain the indicator of novelty (Unexp).

Importance. Measured at Time 1, the appraisals of importance entailed 5 items associated with 11-point scales (0 = *not important/consequential at all*, 10 = *extremely important/consequential*) assessing the extent to which the event was (a) important for participants personally, and consequential for (b) themselves personally, (c) Italy, (d) France, and (e) internationally. Based on the results of the confirmatory factor analysis reported in the Supplemental material S2.B, the item (a) was used as indicator of personal importance (Pers_Imp), and the mean of the (b) to (e) items was used to create the indicator of consequentiality (Conseq).

Surprise. At Time 1, participants rated on an 11-point scale (0 = *not surprised at all*; 10 = *extremely surprised*) the intensity to which they were surprised about the news (Surprise).

Emotions. We used 11-point scales (0 = *not intense at all*, 10 = *very intense*) to assess the intensity of eight different emotions (i.e. fear, anxiety, anger, hate, sadness, compassion, frustration, distrust), and one separate item to assess the general intensity of emotional reaction. A parallel analysis and an explorative factor analysis were computed on the eight emotions. There were two correlated factors differentiating fear and anxiety from the other emotions. To create the indicators of the latent variable, we averaged the means of fear and

anxiety (Emo_1), and the means of anger, hate, sadness, compassion, frustration, and distrust (Emo_2). The general emotional intensity (Emo_Int) was considered as a third indicator of emotions. The raw means of each emotion and the loadings of the explorative factor analysis are reported in the Supplemental material's section (S2.C).

Rehearsal. At Time 1, on two 11-point scales (0 = *never*; 10 = *very frequently*), the participants rated the frequency with which, in the 48 hours after receiving the news, they had talked about the event (Tlk_Ev) and the circumstances in which they had learned about it (Tlk_Circ). On a scale ranging from 0 (= *never*) to 7 (= *more than 5 hours a day*) they also indicated the frequency with which they had followed the news in the media (Media).

Background Knowledge. Background knowledge was measured using 8 open-ended questions focusing on international politics (e.g. '*Who is the current president of Syria?*', '*When did the Charlie Hebdo terrorist attack happen?'*). The questions were assessed at Time 1 and scored according to their accuracy (range 0 – 1). We first verified the unidimensionality of the scale by using item factor analysis as reported in the Supplemental material's section (S2.D); then, we added together the odd and even questions respectively (range 0 – 4) to create two separate indicators (BKK_1 and BKK_2) of the latent variable.

Results and Discussion

The statistical analyses consisted of two steps: (1) descriptive analyses of the variables assessed and used in the structural equation model; (2) structural equation modelling to test (a) whether FBM and CCs may be considered as two separate latent variables, (b) the relationships between the different determinants of FBMs' and CCs' contents long-term recall.

Descriptive statistics

The descriptive statistics (*M* and *SD*) and Pearson's correlations among the variables used in the structural equation model are reported in Table 2.

Table 2. Descriptive statistics and Pearson's correlations among the variables used in the structural equation model.

	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	FBM																						
1	Consistency (Consist)	1																					
2	Vividness (Vivid)	.42**	1																				
	CCs' contents																						
3	Source of news (Source)	.13	.15	1																			
4	Place (Place)	.25**	.27**	.26**	1																		
5	Activity (Activity)	.23**	.25**	.24**	.52**	1																	
6	Others present (Others)	.38**	.39**	.17**	.41**	.27**	1																
7	Aftermath (After)	.24**	.25**	.25**	.23**	.32**	.25**	1															
	Event memory																						
8	Event memory 1 (EM_1)	.17*	.31**	.19*	.16*	.21*	.26**	.25**	1														
9	Event memory 2 (EM_2)	.16	.24**	.10	.15	.18*	.17*	.24**	.61**	1													
10	Confidence (EM_Conf)	.12	.30**	.09	.13	.09	.25**	.31*	.78**	.71**	1												
	Importance																						
11	Personal importance (Pers_Imp)	.23**	.15	.07	.12	.20*	.17*	.18*	.17*	.25**	.19*	1											
12	Consequentiality (Conseq)	.25**	.20**	.05	.09	.16	.24**	.05	.17*	.13	.13	.54**	1										
	Novelty																						
13	Unexpected (Unexp)	.18**	.12	-.05	.03	.04	.04	.04	.20*	.12	.14	.12	.13	1									
	Surprise																						
14	Surprise (Surprise)	.07	.11	.03	.05	.19*	.06	.05	.23**	.17*	.11	.29**	.18*	.31**	1								
	Emotions																						
15	Emotions 1 (Emo_1)	.14	.19**	.00	.00	.10	.21*	.06	.14	.08	.10	.50**	.54*	.13	.18*	1							
16	Emotions 2 (Emo_2)	-.05	.09	-.09	.01	.07	.16	.09	.18*	.16	.20*	.47**	.26*	.01	.30*	.46*	1						
17	General intensity (Emo_Int)	.18*	.15	.11	.09	.02	.18*	.18*	.20*	.18*	.18*	.43**	.27*	.16	.32**	.51**	.42**	1					
	Rehearsal																						
18	Talked event (Tlk_Ev)	.17*	.23**	.02	.10	.11	.06	.10	.18*	.16	.10	.34**	.39*	.15	.32**	.28**	.21*	.31**	1				
19	Talked circumstances (Tlk_Circ)	.17*	.07	.01	.10	.10	.13	.12	.22**	.16	.20*	.22**	.17*	-.06	.11	.18*	.16*	.34**	.37**	1			
20	Media (Media)	.01	.04	.002	.11	.07	.13	.06	.26**	.34**	.24**	.26**	.20*	.03	.20*	.14	.29**	.23**	.37**	.30**	1		
	Background knowledge																						
21	Knowledge 1 (BKK_1)	.02	-.03	.04	.09	.05	.08	.22*	.34**	.30**	.35**	.17*	-.05	.11	.09	-.14	.09	-.03	.12	.05	.30**	1	
22	Knowledge 2 (BKK_2)	-.06	.08	.10	.01	.07	.11	.16*	.31**	.25**	.35**	.01	-.10	-.05	.05	-.11	.02	-.07	.07	.02	.23**	.53**	1
	M	1.77	7.53	1.30	1.52	1.25	1.55	.93	2.80	2.12	3.22	8.41	8.25	7.81	7.24	6.79	6.37	7.58	7.77	3.27	3.79	1.71	.98
	SD	1.54	2.32	.85	.65	.84	.75	.92	1.59	1.40	1.84	1.60	1.09	2.26	2.68	2.85	2.14	2.20	1.87	3.04	1.38	.89	.89
	Range	0–5	0–10	0–2	0–2	0–2	0–2	0–2	0–7	0–7	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–10	0–7	0–4	0–4

Note. *$p < .05$; **$p < .01$.

FBM. For the model, we operationalised the FBM according to the number of consistently recalled perceptual elements (Consist), and their vividness (Vivid). At Time 1, the participants reported on average 2.21 (*SD* = 1.65) perceptual elements. At Time 2, they reported on average 2.08 (*SD* = 1.54) perceptual elements. A paired-samples t-test showed that the effect of time was not significant, $t(150) = 1.87$, $p = .064$, 95% CI [-.007, .256], $d = .15$. In fact, 84% of the details reported at Time 2 were consistent with the details reported at Time 1, and 73.8% of the participants ($n = 110$) retained at least one consistent element pertaining to FBM.

Vividness ratings were high both at Time 1 ($M = 8.05$, $SD = 2.30$) and Time 2 ($M = 7.53$, $SD = 2.32$). In addition, a between subject (presence vs. absence of a FBM*)* repeated measures GLM on vividness ratings at Time 1 and Time 2 revealed a significant interaction of time by group, $F(1, 149) = 4.25$, $p = .04$, $n_p^2 = .03$. This result indicates that the vividness ratings of participants with a FBM were almost stable over time ($EMM_{Time\ 1} = 8.34$, $ESE = .21$; $EMM_{Time2} = 8.00$, $ESE = .20$), unlike the ratings of participants without a FBM ($EMM_{Time\ 1} = 7.27$, $ESE = .35$; $EMM_{Time2} = 6.00$, $ESE = .33$), which decreased over time.

CCs' contents. The means of all CCs' contents, except for '*Aftermath'* indicate that the participants were overall quite consistent in reporting information pertaining to the CCs.

Event Memory. The ratings of both even (EM_1) and odd questions (EM_2) indicate that the participants retained rather a poor memory of the facts of the event. Consistently with this observation, the subjective confidence ratings (EM_Conf) were low.

Appraisals, Emotions, Rehearsal, and Background Knowledge. The ratings of the appraisal of novelty indicate that participants evaluated the event as quite unexpected (Unexp). The ratings of the appraisals of personal importance and consequentiality indicate that participants evaluated the event as very personally important (Pers_Imp), and consequential (Conseq). The intensity of experienced emotions such as surprise (Surprise),

the two sets of averaged negative emotions (Emo_1, Emo_2), and the general emotional intensity (Emo_Int) indicate that the event triggered quite intense emotional reactions. The ratings pertaining to the rehearsal of the event (Tlk_Ev) indicate that the participants talked quite frequently with others about the event, while the ratings pertaining to the rehearsal of the circumstances (Tlk_Circ) indicate that they did not talk frequently about the circumstances in which they learned about it. The ratings of rehearsal through the media (Media) suggest that participants followed the development of the event with fair frequency. Finally, ratings of even (BKK1) and odd (BKK2) background knowledge questions indicate that participants had quite limited knowledge of international politics.

Structural equation modelling

The proposed structural model was tested using LISREL (Version 8.7; Jöreskog & Söbom, 2005). In the structural diagram presented in Figure 3, the hypothesised factors underlying the observed variables are represented by circles and observed variables are represented by squares. The single-headed arrows indicate the relationships among the latent factors, and between the latent factors and their indicators. The correlation matrix of the variables used to compute the structural model is shown in Table 2.

Model fit was evaluated by the following indices: the Steiger's Root Mean Square Error of Approximation (RMSEA) to evaluate the approximation of the model-implied matrix to those of the population, the Comparative Fit Index (CFI) to compare the fit of the hypothesised model with that of the null model, and the Standardised Root Mean square Residual (SRMR) to indicate the degree of discrepancy between the sample covariance matrix and the covariance matrix implied by the model. We used the following criteria to evaluate the fit of our models as acceptable: RMSEA $\leq$.08, CFI $\geq$.95, SRMR $\leq$.10 (Schermelleh-Engel, Moosbrugger, & Müller, 2003). Because the variables were not

multinormal (Mardia's test with Prelis: $\chi^2(2, N = 151) = 33.22, p < .001$)**,** we used the Robust Maximum Likelihood method (MLR) for the model's estimation.

The first step toward testing the model was to verify whether FBM and CC could be considered as two distinct latent variables. A major theoretical concern was that the two variables could overlap, as their contents might be closely related. To assess whether FBM and CC's consistency could be considered as separate variables, we estimated a unidimensional model in which Vividness (Vivid), Consistent recalled perceptual elements (Consist) and Consistence of explicitly request CC's (Source, Place, Action, Others and Aftermath) were indicators of a common latent variable (FBM) and compared the goodness of fit of this model to that of a bidimensional model in which Vivid and Consist were indicators of the FBM latent variable and Source, Place, Action, Others and Aftermath were indicators of a CC latent variable. Models' comparison was performed by means of the Satorra-Bentler scaled chi-square difference test and the Akaike information criterion (AIC). In the onedimensional model, the goodness of fit measures were: SRMR = 0.0601; CFI = 0.933; RMSEA = 0.0900, whereas in the bidimensional models they were: SRMR = 0.0528; CFI = 0.968 ; RMSEA = 0.0652. The Satorra-Bentler scaled chi-square difference test was statistically significant (Chi Square (1) = 7.2957, p = 0.006912), with a chi-square/df ratio of 7.30, a value greater than the traditional rule of thumb of 3 and AIC was better for the bidimensional model (AIC=51.771), than for the unidimensional model (AIC=60.790). Thus, the fit measures used to compare the two models indicated that the bidimensional model was better than the unidimensional model (the standardized loadings of the two solutions are reported in the Supplemental materials' section, S3).

In a second step, we tested the model depicted in Figure 3. Overall, the model showed an acceptable statistical fit to the data (RMSEA = .054; CFI = .943; SRMR = .083) and most of the hypothesised paths linking the factors were significant. The three non-significant paths

were observed for the link between event memory and consistent CCs' contents (HP7), the link between rehearsal and consistent CCs' contents (HP6), and the link between surprise and FBM (HP2). The first non-significant path is not new in flashbulb memory research as shown by Tinti et al. (2014) who have previously reported the absence of a relationship between FBM - assessed by guided questions on CCs' contents - and event memory. The interpretation of the second non-significant path, on the other hand, requires more caution. The results of some studies show that rehearsal facilitates FBMs' consistent recall (e.g. Conway et al., 1994; Er, 2003), while others do not report any significant relationships between the two (e.g. Day & Ross, 2014; Koppel, Brown, Stone, Coman, & Hirst, 2013). Indeed, as recently suggested by Luminet (2018), "the direct link between rehearsal and flashbulb memory might be among the most complex ones to understand" (Luminet, 2018, p. 28). Here, we suggest that reiterative processes are more likely to address information about the event (i.e. event memory), rather than that relating to the reception context of the news (i.e. CCs' contents). Consistently with this framework, we observed a significant link between rehearsal and event memory. The third non-significant path was observed in the relationship between surprise and FBM. Despite the fact that no previous studies have defined FBM as the presence of consistently recalled perceptual elements pertaining to the image captured by the flashbulb, the result reported here is in line with, and further extends, previous findings concerning the role of surprise in FBMs' formation. In fact, several studies have questioned the role of surprise as a necessary antecedent to FBM, showing that also expected events can trigger FBMs (Coluccia, Bianco, & Brandimonte, 2010; Curci & Luminet, 2009; Tinti et al., 2009).

With regard to the significant paths, in support of our first hypothesis (HP1), we observed a significant link between the appraisal of novelty and surprise. In addition, our hypothesis on the link between background knowledge and event memory (HP4) was confirmed, as more

accurate background knowledge facilitated the recall of more accurate event memories. Further in line with our hypotheses, we observed a significant path between emotions and event memory, which relationship was mediated by rehearsal (HP5).

Finally, we found empirical support for our hypotheses regarding FBM. We observed a significant link between the appraisals of importance and consequentiality and FBM, mediated by emotions. This result supports the hypothesis that the more the event was initially evaluated as important and consequential, the more it was experienced as emotionally intense, and the higher was the number of consistently recalled perceptual elements forming FBM and its vividness (HP3). In support of our last hypothesis (HP8), we found that FBM facilitated the recall of consistent explicitly requested CCs' contents. This result suggests that the consistent recall of contents pertaining to CCs may start from the perceptual image that emotion (the flashbulb) fixed in memory, i.e. the FBM as defined here.

Flashbulb memory: Referring back to Brown and Kulik's definition

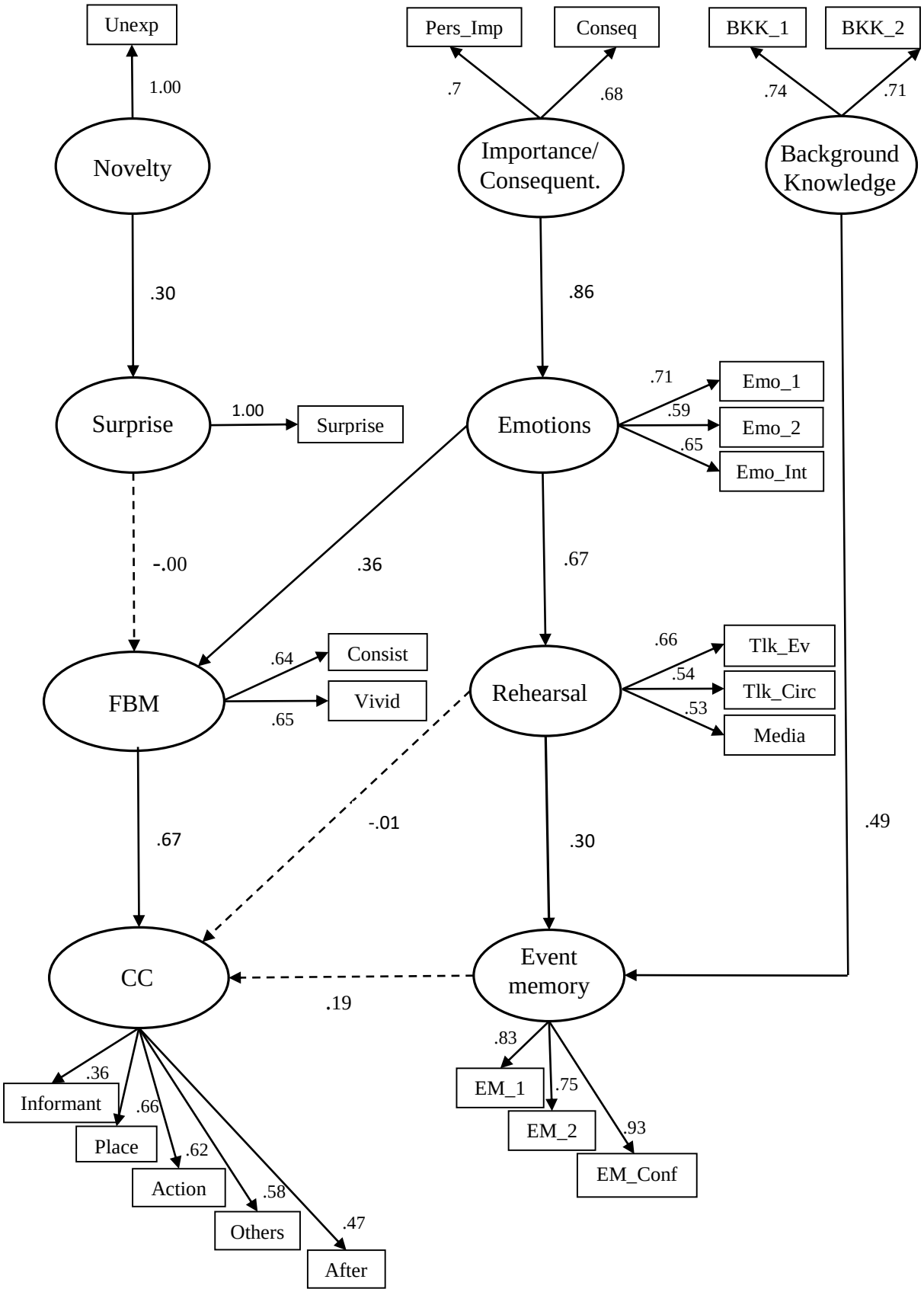

Figure 3. *Standardised model parameters derived from the empirical model testing the relationships between the different determinants of FBMs' and CCs' contents long-term recall.*

Note. Continuous arrows represent significant relationships between factors. Dashed arrows represent non-significant relationships between factors. The model provides acceptable fit to the data: RMSEA = .054; CFI = .943; SRMR = .083.

General Discussion

Forty years after Brown and Kulik's seminal work (1977), the concept of FBM is still central in several studies on memory of emotion arousing events. An outstanding divisive issue, however, is whether FBMs are 'special' autobiographical memories. We suggest that this issue taps into the definition and the associated methodologies that researchers have adopted to study FBMs. In the present work, we refer back to Brown and Kulik's seminal definition of a photo-like and long-lasting recall of the circumstances in which an individual first learned about an important emotion-arousing news (p. 78), and attempt to disentangle the FBM's perceptive image from the FBM's account. Starting from this definition, we questioned whether the extensive use of guided questions to assess CCs' contents is an appropriate method to measure FBMs. To address these overarching issues, we conducted two test-retest studies in which we conceived FBM as a snapshot of a fleeting moment that is stored in a perceptual format. Hence, we investigated FBM's recall not only in terms of *a priori* CCs' contents, but also and foremost, in terms of any spontaneously recalled perceptual fragments of the reception context.

The first study targeted the resignation of Pope Benedict XVI whereas the second study focused on the terrorist attacks in Paris of November 2015. In both studies, we assessed the perceptual elements of the participants' recalls through a free-recall task, and examined the frequency, consistency and vividness of the perceptual elements, defining FBM as these elements' consistent recall over time. We then investigated whether participants with a FBM also reported more consistent contents pertaining to the explicitly required CCs' contents, higher scores in appraisals, emotional feelings, rehearsal, event memory and background knowledge (Study 1). In study 2, we replicated the methodology to identify the actual FBM, as defined above, with another target event. We used structural equation modelling techniques to test 1) whether FBM and CCs can be considered as two separate latent

variables, and 2) the relationship between FBM and the whole set of variables considered in Study 1.

In both studies, qualitative analyses of the free recalls of the news' reception context showed that over two-thirds of participants had a FBM, that is, they were able to recall one or more consistent perceptual elements over time. The results of Study 1 also indicated that participants with a FBM reported greater levels of vividness at both tests, and recalled CCs' contents more consistently at Time 2. Participants with a FBM also scored higher in the appraisals of novelty and importance/consequentiality, the intensity of surprise, and event memory's accuracy and confidence. Results of Study 2 primarily confirmed that FBM and explicitly requested CCs could be considered as two separate latent variables. Consistent with previous research, results of the structural equation model revealed significant relationships between novelty and surprise (e.g. Finkenauer et al., 1998), background knowledge and event memory (e.g. Tinti et al., 2014), appraisals of importance/consequentiality and FBM through emotions (e.g. Finkenauer et al., 1998), and emotions and event memory through rehearsal (e.g. Finkenauer et al., 1998). Conversely, the relationships between surprise and FBM, rehearsal and CCs, as well as the relationship between event memory and CCs, were not significant. Results of the structural equation model extends previous research by introducing a novel finding: the consistent long-term recall of explicitly requested CCs' contents was facilitated by FBM conceived as the consistent free recall of the perceptual image captured by the flashbulb.

Our results support the hypothesis that the nature of FBM as initially defined by Brown and Kulik (1977) is a perceptual image. The main characteristic of FBMs is, indeed, their 'live quality', a component that may ultimately explain why people tend to retrieve FBMs with striking vividness and subjective confidence even after long periods of time (e.g., Kvavilashvili et al., 2009). The retrieval of this image could ground the subsequent recall in a

narrative form (i.e., the FBM account), as well as the elements assessed by guided questions concerning the CCs. More specifically, we argue that, starting from the elements contained in the image, the individual reconstructs the reception context's elements and reports them in a coherent narrative. For example, when telling a friend about the moment in which a certain news was first learned, the image evoked in one's mind could be that of *'carrying in hands a red coffee mug'* (FBM). However, it may be more plausible to report the reception moment as: *'I was at home and I was having breakfast'* (i.e. contents that may be included in the CCs of 'place' and 'ongoing activity'). In other words, although the vivid memory of the reception moment may be the image of a red coffee mug, the individual will nevertheless tend to report the memory in a more narrative-like, coherent structure. In fact, the image does not carry narrative functions, but it is a trace that helps the individual to ground the memory over long term. More importantly, this fleeting image may be sufficient to trigger the recall of the elements that researchers have traditionally included under CCs. We may also hypothesise that the presence of a perceptual image in itself does not prevent the formation and the recall of inconsistent memories. With reference to the example provided before, we may suppose that, starting from the consistent and vivid image of a red coffee mug, the individual may yet engage in a biased recollection. For example, the person may include inconsistent details (especially if assessed by guided questions), and improperly recall that the news was learned when taking breakfast with the partner, while actually being alone. The resulting reconstruction would fit well with the image of a red coffee mug, but it does yet embody major discrepancies in the CCs of 'others present', making the resulting FBM (as classically assessed) somewhat inconsistent. This argument in particular, may shed light on the enduring puzzle of why FBM of important events are often recalled with striking vividness, even after long periods of time (Neisser & Harsch, 1992; Talarico & Rubin, 2003), while also carrying inconsistencies (e.g. Hirst et al., 2015).

To sum up, the present work supports the hypothesis that FBMs represent a special class of autobiographical memories. Based on this conclusion, we may wonder what the function of a 'special recall' is for the individual, and what the implications of our theoretical framework are for memory, and especially, autobiographical memory researchers. Concerning their function, the hypothesis that FBMs carry adaptive purposes dates back to Brown and Kulik's work (1977). The authors suggested that, a prompt and long-lasting record of the reception context of an arousing event – for example, a serious injury to one's group member – was pivotal for our ancestors to guarantee the survival under similar circumstances in the future. From an evolutionary perspective, FBMs may therefore have the adaptive function of preparing the individual for a swift response in a situation similar to the one that originally triggered a strong emotion or even a trauma (see Pillemer, 2003). In reference to trauma specifically, our understanding of FBM as a snapshot of a fleeting moment is very close to the intrusive memories characterizing post-traumatic stress disorder. Traumatic memories as well involve isolated details of the scene that one had in front during the event, take place through brief perceptual fragments, and often reoccur in the form of visual images carrying sensory representations that remain unchanged over time (Ehlers, Hackmann & Michel, 2004). These characteristics tap so well into our definition of FBM, that we may wonder whether, in some circumstances, traumatic memories and FBMs overlap. Consistently with this idea, several researchers suggest that traumatic memories stand out from ordinary autobiographical memories (e.g. Ehlers & Clark, 2000), especially because they are "initially recollected in a sensory form, without any semantic representation […] and experienced primarily as fragments of the sensory components of the event" (van der Kolk & Fisler 1995, p. 513; see also Ehlers, Hackmann & Michel, 2004).

Finally, the definition of FBM as a perceptual fragment of the reception scene, may have implications relevant to the legal field, particularly when eyewitnesses are asked to

recall and describe the exact moment in which a highly emotion-arousing event took place. Specifically, two considerations are pertinent to the legal context. First, the FBM and the FBM's account are related but do not exactly coincide. Second, the recall of a fleeting moment may heavily rely on an image that has been conserved in memory, but that may not always contain information relevant to the witnessing. Importantly, when the perceptual fragment is transformed into a narrative (Brown & Kulik, 1977), it may yet include information that the person has merely inferred (Larsen, 1992). This involves the risk that, in the attempt of maintaining a coherent narrative, the individual recalls the event with major distortions or even, creates a false memory.

To conclude, our work issued a theoretical challenge to address the FBM's phenomenon and highlighted important implications for the study of autobiographical memories among several domains. We hope future research to address the limitations of the present work – in study 1, the rather low emotion-arousing nature of the target event beyond surprise; in study 2, the small sample size used to test the model – and to take into account the perceptive nature of FBMs.

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