

# Distinct processes shape flashbulb and event memories

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**Abstract** In the present study, we examined the relation between memory for a consequential and emotional event and memory for the circumstances in which people learned about that event, known as *flashbulb memory*. We hypothesized that these two types of memory have different determinants and that event memory is not necessarily a direct causal determinant of flashbulb memory. Italian citizens ( $N = 352$ ) described their memories of Italy's victory in the 2006 Football World Cup Championship after a delay of 18 months. Structural equation modeling showed that flashbulb memory and event memory could be clearly differentiated and were determined by two separate pathways. In the first pathway, importance predicted emotional intensity, which, in turn, predicted the frequency of overt and covert rehearsal. Rehearsal was the only direct determinant of vivid and detailed flashbulb memories. In the second pathway, importance predicted rehearsal by media exposure, which enhanced the accuracy and certainty of event memory. Event memory was also enhanced by prior knowledge. These results have important implications for the debate concerning whether the formation of flashbulb memory and event memory involve different processes and for understanding how flashbulb memory can be simultaneously so vivid and so error-prone.

**Keywords** Flashbulb memory · Event memory · Public events · Autobiographical memory

Walking the streets of a large Italian city at 10:40 PM on July 9, 2006, no one is around, and a mysterious silence enshrouds the city. Behind the windows, blue light flickers. Suddenly, an immense, unitary cry of joy pierces the silence. People flood the streets, honking car horns, setting off firecrackers, waving Italian tricolor flags, and chanting. A celebration explodes that will last the whole night everywhere in Italy: The Italian National Team had won the 2006 World Cup Football Championship. How did Italians appraise this event? How did they feel about it? A year and a half later, what would they remember about it? In the present study, we examined a positive flashbulb memory. We examined the factors that shaped people's memories of both the event itself and the circumstances in which they had learned about it. The aims were to determine whether event memory and flashbulb memory have different determinants, and thus different characteristics, shedding light on the enduring puzzle of why flashbulb memories often combine inaccuracy with striking vividness and subjective certainty.

## Autobiographical memory and emotion: The concept of flashbulb memory

*Autobiographical memory* refers to the maintenance of self-related information, especially experiences that are indispensable to our identities (Baddeley, 1990; Brewer, 1986). In Conway's model (e.g., Conway, 2005; Conway & Pleydell-Pearce, 2000), autobiographical memory includes information at three levels of specificity: lifetime periods (e.g., "When I was at university"), general events (e.g., "Our

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trip to Florence”), and event-specific knowledge (e.g., “When I saw Botticelli’s *Allegory of Spring* at the Uffizi Gallery”). Flashbulb memories fall into Conway’s third category, event-specific knowledge, and consist of representations of personal experience (e.g., “I remember seeing Messi score a goal”) rather than semantic knowledge (e.g., “I know that Messi scored a goal”). Proposed more than 30 years ago by R. Brown and Kulik (1977), the concept of “flashbulb memories” refers to detailed, long-lasting, and vivid memories of the personal circumstances in which people first heard about an unexpected, consequential, and emotion-arousing event. Some researchers have argued that flashbulb memories do not comprise a distinct subtype of episodic memory with special characteristics, and that the term has outlived its usefulness (e.g., McCloskey, Wible, & Cohen, 1988). Others have argued, however, that these memories are characterized by unusual vividness, subjective certainty, and longevity, if not accuracy (e.g., Talarico & Rubin, 2007). Because of these characteristics, flashbulb memory continues to be a topic of strong interest to both memory researchers and the public (e.g., Day & Ross, *in press*; Hirst et al., 2009; Koppel, Brown, Stone, Coman, & Hirst, 2013; Kraha & Boals, *in press*).

As originally defined by R. Brown and Kulik (1977), flashbulb memories are similar to photographs in their level of perceptual vividness. They are formed when an event elicits a high degree of surprise, is important to the individual, and/or evokes intense emotional arousal. By analyzing numerous events with these characteristics, R. Brown and Kulik showed that the resulting memories typically contain information that falls into the following categories: *place*, *ongoing activity*, *informant*, *own affect*, *other affect*, and *aftermath*. In addition to these “canonical” categories, flashbulb memories sometimes contain idiosyncratic information, (e.g., the color of clothing worn by people present when the news was received). Importantly, both the canonical and idiosyncratic details concern the context in which the news of the event was received rather than the event itself.

Since the original work by R. Brown and Kulik (1977), many studies of flashbulb memories have been conducted by examining people’s reports concerning dramatic and emotion-arousing events such as the explosion of the Challenger space shuttle (Bohannon, 1988; Neisser & Harsch, 1992), the September 11 terrorist attacks (Hirst et al., 2009; Kvavilashvili, Mirani, Schlagman, Foley, & Kornbrot, 2009; Lee & Brown, 2003; Luminet & Curci, 2009; Luminet et al., 2004; Pezdek, 2003; Silver, Holman, McIntosh, Poulin, & Gil-Rivas, 2002; M. C. Smith, Bibi, & Sheard, 2003; Tekcan, Ece, Gülgöz, & Er, 2003), or the death of important public people (e.g., W. J. Brown, Basil, & Bocarnea, 2003; Curci, Luminet, Finkenauer, & Gisle, 2001; Day & Ross, *in press*; Finkenauer et al., 1998; Tinti, Schmidt, Sotgiu, Testa, & Curci, 2009).

Most studies of flashbulb memories have focused on negative events, but a few have compared the characteristics of flashbulb memories for negative and positive events. The results have generally confirmed the presence of the “canonical” categories identified by R. Brown and Kulik (1977), regardless of the event’s valence (e.g., Berntsen & Thomsen, 2005; Kraha & Boals, *in press*; Scott & Ponsoda, 1996). Differences between positive and negative flashbulb memories have also been found, but the precise nature of these differences has varied from study to study. Several studies have indicated that, relative to negative events, flashbulb memories of positive events tend to be more rehearsed, more vivid, and accompanied by a greater sense of reliving (e.g., Berntsen & Thomsen, 2005; Bohn & Berntsen, 2007; Breslin & Safer, 2011; Talarico & Moore, 2012). The findings regarding accuracy have been less consistent, with some showing greater accuracy for positive events (e.g., Breslin & Safer, 2011; Kraha & Boals, *in press*), and others showing greater accuracy for negative events (e.g., Bohn & Berntsen, 2007; Kensinger & Schacter, 2006; see also Basso, Scheff, Ris, & Dember, 1996; Levine & Bluck, 2004) or no differences (Talarico & Moore, 2012).

Regardless of whether memory was assessed for positive or negative events, these studies partially challenge and partially confirm R. Brown and Kulik’s original claims concerning flashbulb memories. In contrast to those claims, flashbulb memories are far from being like photographs, because they change over time and contain numerous inaccuracies (Larsen, 1992; Neisser, 1986; Neisser & Harsch, 1992; Talarico & Rubin, 2003). Consistent with R. Brown and Kulik’s claims, however, flashbulb memories seem to have characteristics that render them different from other types of memories. For instance, they are characterized by a higher level of vividness and subjective certainty (Talarico & Rubin, 2003, 2007). People interviewed about the circumstances in which they learned about events that had a strong emotional impact have commonly affirmed that they had an extremely vivid memory for these circumstances even years later, and that they were fairly certain that they could report them accurately (R. Brown & Kulik, 1977; Christianson & Engelberg, 1999).

Given these unique features of flashbulb memories, the question arises as to why some emotional events seem to be so firmly fixed in memory that people claim they will never forget them and feel as if they are seeing the scene again exactly as it occurred. Researchers have attempted to answer these questions by creating and testing models of the determinants of flashbulb memory formation and maintenance (e.g., Conway et al., 1994; Er, 2003; Finkenauer et al., 1998; Tinti et al., 2009). Although they are not identical, most of these models share important determinants: surprise, importance or consequentiality, emotion, rehearsal, and event memory. We briefly review these features below. We then present a new model that

accounts for the vividness and certainty associated with flashbulb memories by positing that event memory and flashbulb memory result from independent processes.

First, although present in most models, the key role of *surprise* hypothesized by R. Brown and Kulik (1977) is controversial. Some studies have confirmed that surprise is a necessary determinant of flashbulb memory formation (e.g., Er, 2003; Finkenauer et al., 1998), whereas others have questioned its indispensability (e.g., Conway et al., 1994; Tinti et al., 2009). Second, there is a general consensus on the fundamental role of *importance or consequentiality* in flashbulb memory formation (Conway et al., 1994; Finkenauer et al., 1998; Er, 2003; Tinti et al., 2009). As was suggested by Finkenauer et al., the core role of this variable can be explained by referring to appraisal theories of emotion (e.g., Frijda, 1993; Lazarus & Smith, 1988; Scherer, 1984; C. A. Smith & Ellsworth, 1987). These theories postulate that appraising an event as important and consequential is a fundamental antecedent of a strong emotional reaction, which, in turn, promotes memory encoding and consolidation (for reviews, see Conway et al., 1994; Finkenauer et al., 1998; Levine & Edelman, 2009). A third determinant common to most models of flashbulb memory is *rehearsal*. The relation of rehearsal to other variables differs across models, however. In some models, rehearsal is enhanced by strong emotion (e.g., Er, 2003; Finkenauer et al., 1998), in others by importance (e.g., Conway et al., 1994). Moreover, in some models rehearsal directly promotes flashbulb memory formation (e.g., Conway et al., 1994), whereas in others, its influence on flashbulb memory is mediated by event memory (e.g., Finkenauer et al., 1998; Tinti et al., 2009).

Importantly, event memory is the final determinant of flashbulb memory in several models (e.g., Er, 2003; Finkenauer et al., 1998; Tinti et al., 2009). The more detailed and accurate an individual's memory for the facts about an event, the more vivid, detailed, and imbued with certainty is their memory for the personal context in which they received the news. As was pointed out by Luminet (2009), "among the direct predictors of flashbulb memory, importance and emotionality were very rarely found to be significant, while event memory seems to be a more systematic significant predictor" (p. 72). The view that event memory is a direct determinant of flashbulb memory deserves particular attention, not only because event memory was not considered by R. Brown and Kulik (1977), but also because it raises important questions about the specificity of the construct of flashbulb memory (Tinti et al., 2009).

In contrast to flashbulb memory, which refers to the autobiographical context in which a person learned about an event, *event memory* refers to memory for factual details concerning the event itself. As Pezdek (2003) argued, the details of the event and the autobiographical experience of the event "are perceived and processed separately, resulting in separate memories" (p. 1035). By definition, then, flashbulb

memory and event memory differ with respect to their contents. Flashbulb memories entail a first-person perspective and involve qualia, and can be considered part of what some philosophers (e.g., Malcolm, 1963) define as "experiential memory." In contrast, event memory consists of factual information about the original event. For this reason, flashbulb memory may differ for each person, whereas event memory, if correctly encoded and stored, should be identical for everyone.

Another important distinction between flashbulb memory and event memory may be their modes of rehearsal. The rehearsal of a flashbulb memory, for example during a conversation, can rely only on autobiographical memory, whereas the rehearsal of facts concerning an event can rely on either retrieval of information from autobiographical memory or consultation of the media. For example, in describing how they learned the news of the September 11th terrorist attacks (e.g., where I was, who was with me), individuals must rely on their autobiographical memories; rehearsal of these memories, in turn, reinforces the vividness of flashbulb memory. In contrast, individuals can be exposed to information about the original event again and again via the media (e.g., which tower collapsed first, at what time it collapsed), contributing to the vividness, completeness, and accuracy of event memory.

These differences between flashbulb memory and event memory raise questions about how they are related and about their respective determinants. The methodological constraints of previous studies have made it difficult to address these questions. For example, in some studies event memory was not assessed (e.g., R. Brown & Kulik, 1977). In others, the circumstances in which people learned of the event overlapped with the event itself (e.g., Er, 2003). In still others, the questions used to assess event memory and flashbulb memory overlapped (e.g., Tinti et al., 2009). Because of these methodological issues, the relationship between event memory and flashbulb memory, and whether event memory is a determinant of flashbulb memory, remain unclear (e.g., Er, 2003; Finkenauer et al., 1998; Tinti et al., 2009). In the present study, we addressed these questions by considering an event for which these two types memory could be clearly distinguished and assessed separately by questionnaire.

## Hypotheses

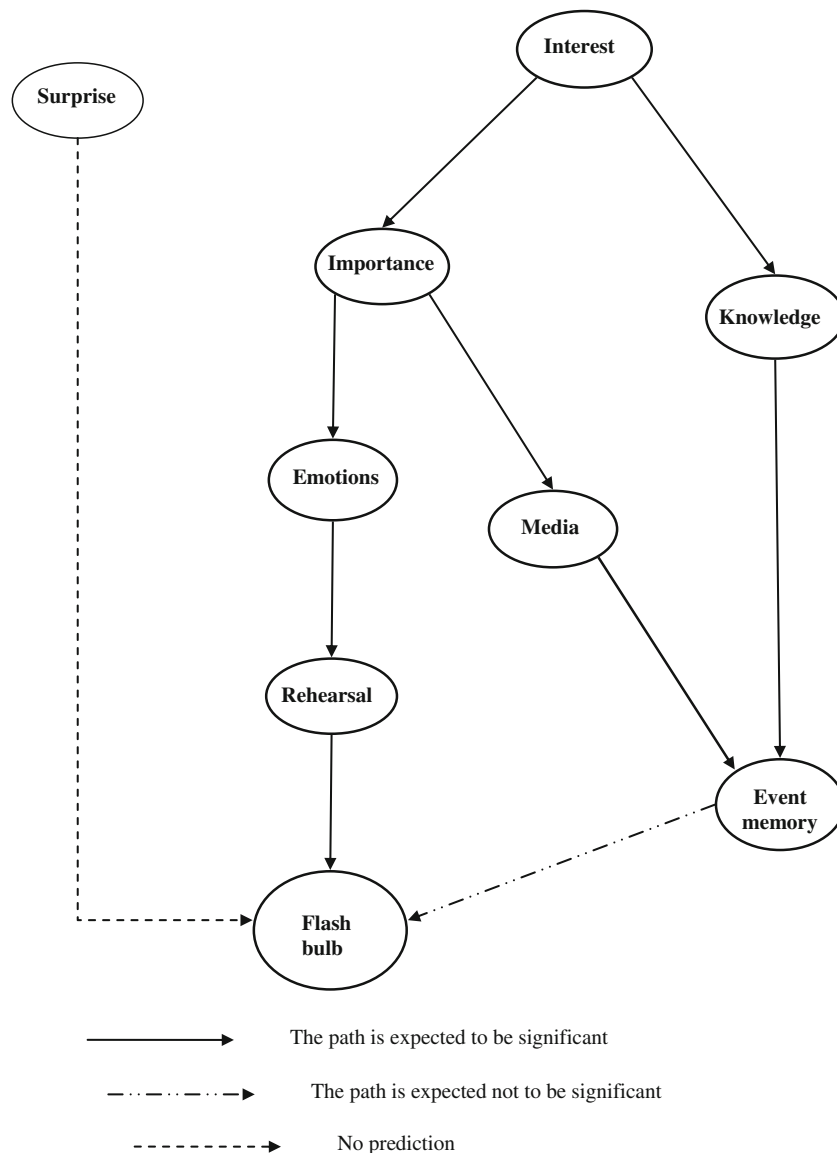
This study was conducted to test two primary hypotheses: (1) that event memory and flashbulb memory have different determinants, and (2) that event memory is not necessarily a direct causal determinant of flashbulb memory. To test these hypotheses, we identified an emotionally arousing event in which these two types of memory could be clearly distinguished, and tested a model in which event memory

and flashbulb memory are the results of independent processes. This model is shown in Fig. 1.

As is illustrated in Fig. 1, the hypothesized model starts with interest. For a public event to lead to the formation and maintenance of flashbulb memory and event memory, it must capture a person's interest because it pertains in some way to his or her concerns (Pezdek, 2003; Tinti et al., 2009). From interest, two possible paths to event memory were hypothesized. According to the first, a fundamental determinant of event memory is the rehearsal of information about the event through exposure to the media, which, in turn, is enhanced by the appraisal of the event's importance. Importance is not always essential for event memory, however. As Conway et al. (1994) noted, "an event of little or no personal importance associated with only minimal levels of affect may nonetheless be encoded into long-term memory in terms of the knowledge structures

employed in the processing of that event" (p. 339). That is, the more we know about a certain topic, the easier it is to integrate and assimilate information about an event related to it. Thus, a second path is hypothesized in which prior knowledge promotes event memory. With respect to the formation and maintenance of flashbulb memory, a separate path from importance was hypothesized. Appraising an event as important can evoke an intense emotional reaction, which is expected to lead to the rehearsal of the reception context of the news. This rehearsal may consist of mentally reviewing the scene or speaking about one's personal experience with others.

If event memory is a direct determinant of flashbulb memory, it is much harder to explain why flashbulb memories have been shown to contain so many errors. However, if, as hypothesized, event memory and flashbulb memory have different determinants, with correct event memory being



**Fig. 1** Theoretical model of flashbulb memory and event memory formation and maintenance

reinforced by media exposure and flashbulb memory arising separately from emotion and the rehearsal of subjective experience, then the vivid yet error-prone nature of flashbulb memories is more easily explained.

In summary, we hypothesized that interest and importance could simultaneously engender “cold cognition,” leading to the formation of event memory, and “hot cognition” (cf. C. A. Smith, Haynes, Lazarus, & Pope, 1993), stemming from intense emotion, and leading to the formation of a flashbulb memory. Importantly, we did not expect to find a significant relation between event memory and flashbulb memory. Finally, on the basis of the conflicting findings in previous research regarding the role of surprise, we tested whether or not surprise was necessary for flashbulb memory formation, without making a prediction.

### The present study

To test this model, we assessed the memories of Italian citizens for Italy’s victory in the 2006 Football World Cup Championship. The final match between the Italian and French national teams was held on Sunday July 9th in Berlin, Germany, at the Reuters Olympic Stadium. Italy defeated France by 5 goals to 3, in a final penalty shootout after a 1–1 draw at the end of the supplemental time.

This event was of great interest for most Italian citizens, since football is viewed as the national sport of Italy. Furthermore, Italy’s victory was an important event because of its implications for Italian football, and because a national victory of this type unifies people and gives high prestige to the nation. Thus, people could consider the event important because they were football fans, had a strong affective bond with the national team, or simply because they were Italian. Whatever its source, the appraisal of high importance was expected to increase the intensity of emotion aroused.

Appraised importance was also expected to promote two types of rehearsal. One type of rehearsal is mediated by emotion and focuses on the person’s experience in the moment that he or she learns about the victory (e.g., his or her own happiness and the happiness of others around, the noise of the honking cars and bursting firecrackers, etc.). The other type of rehearsal is more akin to a “diary” of the event and refers to what happened (e.g., who scored a goal, what was the score when the regular game time elapsed, who failed to make the decisive penalty kick, etc.). In the first case, rehearsal would consist in thinking and talking about people’s own experience, thereby enhancing flashbulb memory, whereas in the second case, rehearsal would involve repeated consultation of information about the event in different media, thereby enhancing event memory. Event memory was also expected to be enhanced by the individual’s general knowledge about football (e.g., the players’ names and

positions, the time schedule of a match, etc.), without being mediated by the importance attributed to the event.

Finally, given its controversial role, we also tested whether surprise influences the formation of flashbulb memory. In the present case, the final match was an expected event, but given the excellence of the two teams involved, people could not definitively predict the outcome, and thus were expected to feel some degree of surprise at the end of the match.

## Method

### Participants and procedure

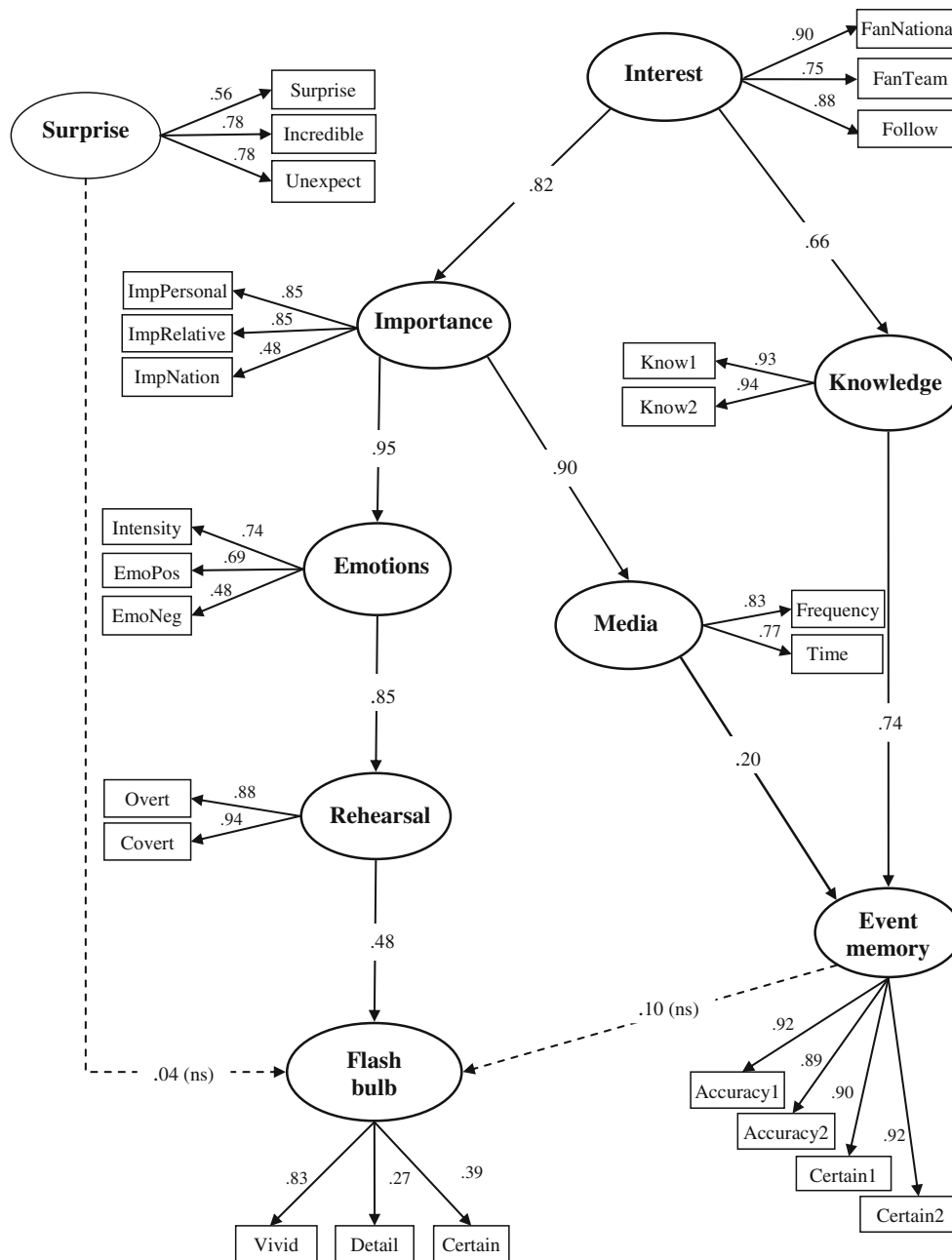
The participants were 352 Italians. Their ages ranged from 18 to 51 years ( $M = 23.4$  years,  $SD = 7.3$ ), and 44 % were males. About 18 months after the championship (December 2007–January 2008), questionnaires were distributed to students during classes at Turin University in Italy by two trained research assistants. The assistants explained the aims of the study and distributed the questionnaire to the students who consented to participate (98 %). Completion of the questionnaire took about 20 min. All of the participants were informed that the questionnaire was anonymous and that data would be used for research purposes only.

### Measures

The questionnaire assessed flashbulb memories and eight possible determinants of their formation and maintenance (e.g., R. Brown & Kulik, 1977; Conway et al., 1994; Finkenauer et al., 1998; Luminet et al., 2004).<sup>1</sup> These determinants, and the indicators used to measure them, are described below. The labels of the indicators used in the tables and in the model path diagram in Fig. 2 are reported in parentheses. To decide which items to include in composite variables, we relied on the definition of the theoretical construct represented by the latent variable, with the restriction that each latent variable should have at least two indicators.

*Flashbulb memory vividness, detail, and certainty* Participants indicated how vivid (Vivid) their image was at the moment they learned that Italy had won the Championship, using an 11-point scale ranging from 0 (*not at all*) to 10 (*extremely*). They were then asked, in an open-ended question, to report all the details of the image they had in mind. The number of words produced in response to this question was used as a measure of the level of detail of participants’ memories (Detail). In three additional open-ended questions, participants were asked where they were, who they were with, and what they did when they heard the news. For each of these three questions, participants also

<sup>1</sup> The questionnaire can be requested from the corresponding author.



**Fig. 2** Standardized parameters of the empirical model of flashbulb memory and event memory formation and maintenance

indicated how certain they were of their answers using 11-point scales ranging from 0 (*not at all*) to 10 (*completely*). The mean of these three ratings was used as an indicator of certainty of flashbulb memories (FB\_Certain).

*Event memory accuracy and certainty* Twelve open-ended questions assessed participants’ ability to recall factual information about Italy’s victory in the 2006 Football Championship (e.g., At the end of the regular time, what was the result of the match? Against which player did Zidane commit a foul before being expelled?). Responses were scored 1 if correct and 0 if incorrect. As is common in

analyses involving achievement scales with items scored as correct or incorrect, items were parceled to improve the normality and continuity of the variables’ distributions (Bandalos & Finney, 2001; Landis, Beal, & Tesluk, 2000). We first estimated a Rasch model to ascertain the unidimensionality of the 12-item scale (Rasch, 1960). Then we constructed two equivalent event-knowledge subscales by summing odd items and even items separately. Accuracy of event memory was thus measured by the number of correct answers to the six odd questions (scores ranged from 0 to 6, Accuracy1) and the number of correct answers to the six even questions (scores ranged from 0 to 6, Accuracy2). Participants

also indicated how certain they were of their response to each question using an 11-point scale ranging from 0 (*not at all*) to 10 (*completely*). To balance the number of accuracy and certainty measures (providing two measures of each), we calculated the mean certainty for each participant separately for the six odd items and the six even items (EV\_Certain1, EV\_Certain2).

**Importance** Participants rated how important the event was for them (ImpPersonal), for family members (ImpRelatives), and for Italy (ImpNation), using three 11-point scales ranging from 0 (*not at all*) to 10 (*very much*).

**Emotion** Participants were asked to think of the moment they learned that Italy had won the championship and to rate the overall intensity of their emotional reaction on an 11-point scale ranging from 0 (*no emotional reaction*) to 10 (*extremely intense emotional reaction*) (Intensity). They also rated the intensity of nine discrete emotions (sadness, pride, anger, relief, fear, satisfaction, happiness, regret, fulfillment), using 11-point scales ranging from 0 (*not at all*) to 10 (*extremely*). The mean of the ratings for happiness, pride, relief, fulfillment, and satisfaction was used as an indicator of the intensity of positive emotion (EmoPos), and the mean of the ratings for anger, sadness, fear, and regret as an indicator of the intensity of negative emotion (EmoNeg).

**Surprise** Participants rated how surprising (Surprise), unexpected (Unexpect), and incredible (Incredible) they considered Italy's victory, using three 11-point scales ranging from 0 (*not at all*) to 10 (*very much*).

**Rehearsal via media exposure** Participants rated how frequently they followed news about the Italian victory via TV, radio, newspaper, and the Internet, using four 11-point scales ranging from 0 (*never*) to 10 (*very often*). The mean of these four ratings was used as an indicator of exposure to media (Frequency). In addition, they indicated how many hours and minutes they spent during the 24 h after the victory following news about the event (Time). Answers to this open-ended question were transformed into minutes.

**Rehearsal via speaking and thinking** Participants rated how frequently they spoke about Italy's victory and the circumstances in which they learned about it, using two 11-point scales (0 = *never*, 10 = *very often*). The mean score on the two scales was considered an indicator of overt rehearsal (Overt). Participants also rated how frequently they thought about Italy's victory and the circumstances in which they learned about it, using two 11-point scales ranging from 0 (*never*) to 10 (*very often*). The mean rating on these two scales was considered an indicator of covert rehearsal (Covert).

**Knowledge** Participants' general knowledge about football was assessed using 14 questions (e.g., "What is the name of the Cagliari stadium?" "How many players can be substituted during a major league match?"). We followed the same strategy of item parceling used for event memory, for the reasons explained above. General knowledge of football was thus measured by the total numbers of correct answers to the seven odd questions (scores thus ranging from 0 to 7; Know1) and to the seven even questions (scores also from 0 to 7; Know2).

**Interest in football** Participants indicated how strongly they supported the Italian national football team (FanNational), how strongly they supported their favorite football team (FanTeam), and how much they followed football generally (Follow), using three 11-point scales ranging from 0 (*not at all*) to 10 (*very much*).

## Data analysis

The data analysis was conducted in two steps: (1) descriptive analysis and (2) structural equation modeling to test the relationships between the different hypothesized determinants of flashbulb memory and event memory.

## Results

### Descriptive analyses

The means and standard deviations for study variables are reported in Table 1. As the table shows, participants reported that they were rather strong supporters of football, especially of the national team (FanNational). Their knowledge about football was moderate, and the standard deviations indicated large differences among participants in their levels of knowledge (Know1, Know2). With respect to importance, participants appraised Italy's victory as being a very important event for the nation (ImpNation) and for their relatives (ImpRelatives), whereas personal importance was evaluated as being slightly lower (ImpPersonale). Participants had a very strong overall emotional reaction when they learned about Italy's victory (Intensity). Specifically, they reported having felt intense positive emotion (EmoPos), whereas negative emotion was reported only at very low intensity (EmoNeg). Participants rehearsed the circumstances in which they learned of Italy's victory frequently, talking about it with others (Overt), as well as thinking about it (Covert). They also consulted mass media frequently (Frequency), spending an average of 100 min following the news about the event during the 24 h after its occurrence (Time). Participants' mean ratings of how surprising, unexpected, and incredible (Surprise,

**Table 1** Descriptive analyses

Latent Variables	Indicators	<i>M</i>	<i>SD</i>
Interest	FanNational	6.15	2.95
	FanTeam	5.73	3.39
	Follow	5.51	3.11
Knowledge	Know1 <sup>a</sup>	3.31	2.27
	Know2 <sup>a</sup>	3.35	2.00
Importance	ImpPersonal	5.42	3.05
	ImpRelatives	7.15	2.48
	ImpNation	7.48	2.53
Emotions	Intensity	7.96	2.21
	EmoPos	7.07	2.56
	EmoNeg	2.37	1.61
Rehearsal	Overt	5.77	2.66
	Covert	5.20	2.87
Media	Frequency	4.36	2.69
	Time (in minutes)	99.91	109.11
Surprise	Surprise	6.83	2.40
	Unexpect	6.62	2.64
	Incredible	5.58	2.97
Event memory	Accuracy1 <sup>b</sup>	2.42	1.83
	Accuracy2 <sup>b</sup>	3.77	1.42
	EV_Certain1	5.61	2.34
	EV_Certain2	5.03	3.05
Flashbulb memory	Vivid	7.07	2.96
	Detail (no. of words)	28.12	16.76
	FB_Certain	9.08	1.10

<sup>a</sup> Scale ranged from 0 to 7; <sup>b</sup> Scale ranged from 0 to 6. If not indicated otherwise, all scales ranged from 0 to 10

Unexpect, Incredible) they found Italy's victory were above the average value for each of the three scales.

With respect to event memory, participants provided correct answers to about 50 % of the event memory questions concerning the football game (Accuracy1, Accuracy2) and were moderately confident about their answers (EV\_Certain1, EV\_Certain2). With respect to flashbulb memory, participants reported very vivid memories of the circumstances in which they learned about Italy's victory (Vivid). Open-ended reports of the details that participants recalled about the moment they learned about the event (Details) averaged 28 words in length, with large individual differences in the richness of the reports (range = 2 to 92 words). Almost all participants were able to report where they were (99.1 %), whom they were with (96.3 %), and what they did (99.1 %) when they learned the news.<sup>2</sup> Finally,

<sup>2</sup> Given this ceiling effect, results relative to the canonical categories were not retained in the model building.

participants were extremely certain about their flashbulb memories (FB\_Certain).

### Structural equation model

The proposed structural model was tested using LISREL 8.7 (Jöreskog & Sörbom, 2005). In the structural diagram presented in Fig. 2, the hypothesized factors underlying the observed variables are represented by circles, and the observed variables are represented by squares. The single-headed arrows indicate the relations between latent factors and between latent factors and their indicators. The correlation matrix of the variables used to compute the structural model is shown in Table 2. Since variables were not multinormal [Mardia's test with Prelis,  $\chi^2(2, N = 352) = 529.39, p < .001$ ], we used MLR (the robust maximum likelihood method) for estimation. No error terms were allowed to correlate.

The goodness of fit of the model was evaluated by several indices. Two global fit measures ( $\chi^2$  and SRMR) were used to indicate the degree of discrepancy between the sample covariance matrix and the covariance matrix implied by the model. A comparative fit measure (CFI) was used to compare the fit of the hypothesized model with that of the null model. Finally, the root mean square error of approximation (RMSEA) was used to evaluate the approximation of the model-implied matrix to those of the population. Following the rules of thumb summarized by Schermelleh-Engel, Moosbrugger, and Müller (2003), we used the following criteria for evaluating a model as acceptable:  $\chi^2/df < 3$ , SRMR < .10, CFI > .95, RMSEA < .08. On the basis of these conventional cutoffs, the model provides a good statistical fit to the data,  $\chi^2 = 668.79$  ( $df = 264, N = 352$ ),  $\chi^2/df = 2.53, p < .001$ ; SRMR = .080; CFI = .97; RMSEA = .066. Since the main hypothesis of this work was that event memory does not causally influence flashbulb memory, we compared this model to a model in which the path from event memory to flashbulb memory was constrained to be zero. The Satorra–Bentler chi-square difference test showed no difference between the two models, SB  $\chi^2(1) = 1.13, p > .05$ .

As expected, more interest in football predicted greater prior knowledge and attributing greater importance to the event. Furthermore, greater importance predicted enhanced flashbulb memory and event memory via two separate pathways. The first pathway linked importance with the intensity of emotion, which, in turn, predicted the frequency of overt and covert rehearsal. Rehearsal was the only direct determinant of the formation and maintenance of vivid and detailed flashbulb memories. This pathway explained 26 % of the variance for flashbulb memory. The second pathway linked importance with mass media exposure that enhanced the accuracy and certainty of event memory. Event memory was also enhanced by prior knowledge. The second pathway and prior knowledge explained 74 % of the variance for event



**Table 2** Correlation matrix of the observed variables used in the structural equation model

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1 FanNational	1																								
2 FanTeam	.626	1																							
3 Follow	.814	.651	1																						
4 Know1	.498	.674	.537	1																					
5 Know2	.512	.678	.564	.869	1																				
6 ImpPersonal	.632	.515	.592	.419	.427	1																			
7 ImpRelatives	.254	.250	.184	.052	.064	.368	1																		
8 ImpNation	.399	.377	.342	.290	.276	.378	.240	1																	
9 Intensity	.570	.386	.457	.189	.193	.562	.304	.312	1																
10 EmoPos	.502	.367	.397	.211	.233	.517	.352	.363	.579	1															
11 EmoNeg	.314	.235	.271	.077	.111	.380	.223	.190	.385	.356	1														
12 Overt	.570	.463	.526	.290	.290	.603	.375	.297	.529	.454	.344	1													
13 Covert	.576	.494	.514	.298	.317	.645	.410	.324	.579	.530	.352	.826	1												
14 Frequency	.564	.547	.575	.451	.453	.626	.348	.404	.446	.488	.328	.567	.614	1											
15 Time	.413	.409	.389	.349	.374	.514	.213	.273	.313	.311	.321	.477	.496	.533	1										
16 Surprise	.118	.071	.095	-.100	-.062	.181	.213	.064	.215	.091	.191	.145	.146	.128	.034	1									
17 Incredible	.162	.096	.154	-.071	-.009	.190	.193	.039	.229	.137	.186	.186	.215	.128	.067	.611	1								
18 Unexpect	.160	.160	.091	-.011	.029	.234	.275	.100	.312	.379	.307	.216	.245	.180	.126	.439	.432	1							
19 Accuracy1	.469	.609	.475	.707	.718	.436	.096	.247	.253	.253	.163	.329	.386	.454	.437	-.023	.019	.112	1						
20 Accuracy2	.487	.582	.463	.692	.706	.417	.058	.275	.258	.277	.124	.297	.343	.441	.381	-.036	-.020	.063	.793	1					
21 EV_Certain1	.497	.612	.468	.704	.706	.432	.093	.320	.272	.265	.139	.331	.367	.448	.371	-.022	-.011	.025	.827	.844	1				
22 EV_Certain2	.517	.649	.507	.734	.726	.454	.132	.267	.290	.293	.188	.366	.425	.461	.429	-.021	.061	.132	.863	.821	.797	1			
23 Vivid	.372	.329	.322	.193	.216	.353	.266	.214	.372	.306	.112	.381	.365	.278	.224	.122	.036	.138	.237	.193	.233	.211	1		
24 Detail	.019	-.050	-.024	-.153	-.151	.014	.137	.057	.069	.127	.114	.124	.113	-.057	.037	.039	.062	.030	-.058	-.127	-.062	-.074	.253	1	
25 FB_Certain	.230	.267	.239	.291	.283	.228	-.014	.192	.197	.126	-.067	.201	.214	.172	.126	.126	.018	.086	.216	.226	.261	.256	.317	.040	1

memory. Importantly, the link between event memory and flashbulb memory was not statistically significant. Finally, surprise was not a significant predictor of flashbulb memory.

## Discussion

An important unresolved issue in studies of flashbulb memory has been whether event memory is necessarily a causal determinant of flashbulb memory. This issue is important from a theoretical standpoint because discovering that flashbulb memories have different determinants than event memories would support the view that processes specific to flashbulb memories during encoding invest these memories with unique characteristics and justify us in considering them special memories (Christianson, 1989). Finding that flashbulb memory and event memory originate from two different processes would also suggest that the processes that maintain these two types of memories differ. For event memory, details can be maintained through exposure to media accounts. In contrast, for flashbulb memory, remembered details originate from an individual's own experience and can only be maintained by thinking about the experience and discussing it with others. This could facilitate reconstructive processes, undermining the accuracy of flashbulb memory, while subjective certainty could remain very high.

Methodological difficulties have hindered investigators' ability to address whether flashbulb memory and event memory have unique determinants, however. In some studies, event memory was not assessed (e.g., R. Brown & Kulik, 1977); in other studies, memory for the circumstances in which people learned about an event (such as an earthquake) overlapped with memory for the event itself (e.g., Er, 2003); in still other studies, some of the questions assessing event memory and flashbulb memory overlapped (e.g., Tinti et al., 2009). These methodological difficulties may have led investigators to propose that event memory and flashbulb memory formation are determined by the same factors (Er, 2003) or that event memory has a direct causal impact on flashbulb memory (Finkenauer et al., 1998; Tinti et al., 2009). In the present study, we made use of an event for which it was possible to clearly distinguish information pertaining to event memory from information pertaining to flashbulb memory. This allowed us to assess, through the creation of a structural equation model, the specific determinants of flashbulb memory and event memory, and to show that these two types of memory need not be related.

The resulting model included determinants that are common to previous models of flashbulb memory (e.g., Conway et al., 1994; Er, 2003; Finkenauer et al., 1998), including prior knowledge, importance, emotion, and rehearsal. Our model differs from prior models in three

important ways, however. First, our model distinguishes between interest, or how closely the event is related to an individual's concerns (e.g., interest in politics; Conway et al., 1994), and prior knowledge (e.g., facts known about Thatcher's administration; Conway et al., 1994). We found that interest and prior knowledge have differing influences on memory for public events: Greater interest promotes both event memory and flashbulb memory, whereas greater knowledge is related only to event memory. Specifically, the greater their interest, the more prior knowledge people have about an event. Prior knowledge, in turn, enhances the organization and assimilation of incoming information, thereby leading to more detailed and accurate event memory.

Interest also promotes more detailed and accurate event memory in a manner that need not require prior knowledge. An event that captures interest is frequently something considered to be important, reflected in our model by a direct link between interest and importance. Viewing an event as important also promotes searching for, and attending to, information about the event in the media, thereby enhancing event memory. With respect to flashbulb memory formation, as suggested by previous models (e.g., those of Er, 2003; Tinti et al., 2009), events viewed as important or consequential evoke emotional arousal, which, in turn, leads to more rehearsal of the personal circumstances in which the individual learned about the event. In our model, rehearsal of personal circumstances was the only direct determinant of flashbulb memory.

A second way in which our model differs from prior models is that, as hypothesized, we found no significant relation between event memory and flashbulb memory. This finding was possible because we studied an event for which these two types of memory were dissociable, and because we further distinguished between different forms of rehearsal. Thus, a third way in which our model differs from prior models is by distinguishing between rehearsal through reexposure to factual details concerning the event as reported by media and rehearsal of the individual's personal experience in the moment that he or she learned the news of the event. These variables are often combined in models of the determinants of flashbulb memory (e.g., Finkenauer et al., 1998). This distinction is crucial, however, because it helps to explain one of the most discussed and problematic issues in the research literature on flashbulb memories: their accuracy (Christianson, 1989; Larsen, 1992; Neisser & Harsch, 1992; Talarico & Rubin, 2003). As R. Brown and Kulik (1977) pointed out, rehearsal of the personal context in which an event was experienced serves to maintain the flashbulb memory but can also promote memory reconstruction, rendering flashbulb memories far less complete and accurate than photographs. They noted that "An actual photograph, taken by a flashbulb, preserves everything within its scope;

it is altogether indiscriminate. Our flashbulb memories are not . . . a flashbulb memory is only somewhat indiscriminate and is very far from complete. In these respects, it is unlike a photograph” (1977, p. 75). Thus, R. Brown and Kulik did not intend their use of the metaphor of a photograph to imply that flashbulb memories include all details of the scene of the reception context, nor did the use of this metaphor deny the possibility that details might be added over time as a result of reconstructive memory processes.

Our model suggests that flashbulb memories may be composed of incomplete images of a small number of perceptual details of the reception context. Since these images are far from complete, when people retrieve and rehearse a flashbulb memory, they may attempt to reconstruct the whole context by relying on those few details, and this reconstructive process may promote false memories. For example, a person who learned the news about the September 11th terrorist attacks while in a bar might have encoded the image of a coffee cup and the counter. When the person is later asked to recall the context in which he or she learned the news, he or she may start from this image and add other details that were not part of the original experience but that are plausible according to a script (e.g., they may also recall that the usual bartender was there, even if this detail could not be correct because the usual bartender was at home ill that day). Thus, even if accuracy is not a defining characteristic of flashbulb memory, and those representations differ from what actually occurred, they may still be vivid and detailed representations of past events.

Moreover, the finding that event memory and flashbulb memory result from distinct processes suggests that they may be independent of each other in some cases. People may recall details about an event without remembering the circumstances in which they first learned about it. People may also recall how they first learned about an event without recalling many details about the event itself. Both the fact that flashbulb memories can result from reconstructive processes and the fact that they can exist independently from event memory merit further research, because they have important implications for real-world concerns such as the accuracy of eyewitness testimony. Another issue that should be addressed in future research is whether our findings, especially the absence of a significant relation between event memory and flashbulb memory, can be replicated with a negative event. Research that tests this model using an event that evokes positive emotion in some people and negative emotion in others would be especially valuable, because it would shed light on the effects of valence on both event memory and flashbulb memory.

Finally, it should be noted that this study was carried out 18 months after the Italian football victory. Thus, we assessed people’s recall of the determinants of event and flashbulb memories. In future research, it would be interesting to test whether the model can be replicated when assessing flashbulb

memories, event memories, and their determinants immediately after the event occurred and months later. This would allow for an assessment of the consistency of flashbulb memories, as well.

In conclusion, our findings support R. Brown and Kulik’s (1977) original definition of flashbulb memory as memory of a person’s own circumstance when first hearing the news of a striking public event that is characterized by a “primary, ‘live’ quality that is almost perceptual” (p. 74). The main contribution of this work has been the demonstration that the contents of flashbulb memory and event memory need not be related and that their main determinants can be clearly differentiated. Because flashbulb memory relies on the rehearsal of personal circumstances, whereas event memory relies on prior knowledge and media exposure, flashbulb memory contains idiosyncratic elements and may entail distortions due to reconstructive processes, whereas the content of event memory is ideally the same for everyone and is objectively verifiable. These findings have important implications for a longstanding debate in the field about the nature of flashbulb memory (Christianson, 1989; Conway et al., 1994; Finkenauer et al., 1998; Pezdek, 2003; M. C. Smith, Bibi, & Sheard, 2003). They support the view that flashbulb memory—defined as memory of a person’s own circumstances when first hearing the news of a striking public event—can be considered a distinct type of memory.

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