Emotional arousing events as an integral part of understanding flashbulb memories mechanism

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Abstract. In this paper, researchers specializing in emotional arousal are most likely to benefit from studying the formation of FBM. Regarding the three different mechanisms of FBM formation, the key similarities between them, a detailed analysis of emotional arousal memory from a physiological and psychological perspective, and a comparison of the different models built for FBM are presented.

Keywords: Emotional arousing; FBM.

1. Introduction

Previous research has shown that people who experienced the terrorist attack of September 11, 2001, the explosion of the space shuttle Challenger, or the assassination of President John Kennedy could recall those memories more accurately and vividly than neutral events (Brown, Kulik, 1977a; McCloskey, Wible, Cohen, 1988a), which were summarized into a vibrant, permanent imprint of the circumstances in the scene, reported as a consequence of emotional public or personal events (Davidson, 2008; Brown, Kulik, 1977b; McCloskey, Wible, Cohen, 1988b; Pillemer, 1988).

Flashbulb memory (FBM) – the name suggested by Brown and Kulik, is postulated as a vivid, detailed image of the moment when a surprising, high-importance event occurs, which seems to capture a snapshot of the scene (Brown, Kulik, 1977c; Muzzulini et al., 2020). This phenomenon has led to a heated discussion in academia, with researchers debating whether FBM has a special mechanism.

Supporters of special mechanism put forward three seminal hypotheses (HouChao, Min, 1999): a photographic model, which requires surprising and high-consequentiality events to trigger FBM (Brown, Kulik, 1977d); a comprehensive model, which holds more factors distributing the formation of FBM including prior knowledge, importance/consequentiality, surprise, emotional feeling state, overt rehearsal (Conway et al., 1994a); and an emotional-integrative model which highlights the significance of emotional arousal, adds novelty to the model and changes the causal correspondence among the elements (Finkenauer, Luminet, Gisle, 1998a). However, few authors have been able to carry out any systematic research on the common feature shared by the three models – emotional arousal, which is believed to be pivotal in the discussion of the special mechanism underlying flashbulb memories.

It is generally acknowledged that the memory elicited by an emotionally-arousing event remains more accurate, vivid, and long-lasting than neutral events, affecting memory consolidation positively (Bremner et al., 1996a; Rolls et al., 1990b; van Giezen et al., 2005b; McGaugh et al., 2018a). Because FBM also requires the enhancement of memory, it might indicate a possible link between emotionally-arousing memory and FBM. Therefore, the arguments described below are going to illustrate the efficacy of the emotional system in memory consolidation from the standpoints of physiology and psychology, provide evidence for the comparison of the consolidated memory activated by emotional arousal and FBM and attempt to evaluate the extent of utility by taking advantage of the emotional system to explain the phenomenon of FBM.

2. Overview

In terms of the FBM special mechanisms, three different models are put forward: a photographic model, a comprehensive model, and an emotional-integrative model (Brown, Kulik, 1977e; Conway, 1994b; Finkenauer, Luminet, Gisle, 1998b).

Brown and Kulik introduced the first model and an explanation of the FBM source, hypothesizing the existence of two determinants – surprise and consequentiality. When an event possessed a sufficient level of surprise and was highly related to individuals, a permanent and complete record of the moment was captured, followed by frequent rehearsals which affected memory consolidation by fully or partially reinforcing the flashbulb memory, resulting in the initialization of FBM formation (Brown, Kulik, 1977f; Finkenauer, Luminet, Gisle, 1998c). However, there is an incompleteness with this argument owing to the number of determined factors being far larger than the photographic model demonstrated.

Therefore, to resolve the gap, Conway and Anderson (1994) set an empirical study to verify and extend the photographic model by examining original factors of affective reaction (surprise, emotional feeling state), consequentiality/importance, rehearsal, and the extra possibility of prior knowledge. Through the structural equation, Conway and Anderson (1994) developed a comprehensive model based on the anticipation that FBM could be elicited when individuals possessed prior knowledge as a basis and embraced a highly personally-importance and effective event, while emotional arousal seemed to affect inferiorly (Conway, Anderson, 1994; Finkenauer, Luminet, Gisle, 1998d). However, they failed to give adequate consideration to all the possibilities, whereas the subordinate impact of emotional arousal was doubted by other scholars (Lu H., Li M., 1999).

Consequently, Finkenauer, Luminet, and Gisle (1998) put forward a controversial stance that emotion and rehearsal mainly impacted the formation of FBM. Surprise, as a factor, could trigger FBM directly when consequentiality/importance was linearly associated with an emotional feeling state and determines FBM twofold (overt rehearsal, memory for the neutral event) parallelly. Affective attitude (i.e. the same as the effect of prior knowledge in the comprehensive model) caused the extent of consequentiality/importance, emotional feeling state, and overt rehearsal (Finkenauer, Luminet, Gisle, 1998e).

Summarizing different FBM formation models (Table 1), surprise and emotional arousal seem to be their common feature, while importance/consequentiality affects the formation of FBM with overt rehearsal having a tendency to result in its maintenance. While both factors are influential, emotional arousal is supposed to be more direct and inevitable, which significance has been extensively approved for memory formation and consolidation (McGaugh, 2018b; Bremner et al., 1996b; Rolls, 1990b; van Giezen et al., 2005b; Jay, Caldwell-Harris, King, 2008; Ritchey et al., 2011). Therefore, the following paragraph will provide a further look on the impact of emotionally-arousing events while the rest will suggest the directions for future studies.

Table 1 Psychological factors in 3 models determine FBM

Model	Authors	Factors determining FBM
Photographic model	Brown, Kulik (1977)	Surprise; importance/consequentiality; emotional feeling state; overt rehearsal
Comprehensive model	Conway, Anderson (1994)	Prior knowledge; importance/consequentiality; surprise and emotional feeling state; overt rehearsal
Emotional-integrative model	Finkenauer, Luminet, Gisle (1998)	Surprise; importance/consequentiality; emotional feeling state; affective attitude; overt rehearsal; memory for the original event

3. Physiological evidence

Concerning physiological evidence, it ascertains that the activation of the emotional system caused by emotionally arousing events leads to the formation and consolidation of memory. Mclntye, Roozendaal, and McGaugh (2004) demonstrated that adrenal glands exert a powerful effect on the organism by releasing stress hormones such as epinephrine, glucocorticoids, and their receptors' agonists. These studies verified the abovementioned stimulating effects and provided evidence that the application of epinephrine could enhance memory in humans by post-learning administration of the hormone whereas the delivery of propranolol, the β-adrenergic antagonist which possesses an opposing effect, impairs memory significantly (Cahill et al., 1994; Cahill, McGaugh, 1995; Cahill, Alkire, 2003; Segal, Cahill, 2009; Cahill, Gorski, Le, 2003). Moreover, glucocorticoids could moderate the activation of glucocorticoid receptors triggering neuronal excitability and regulating the synaptic activity to promote memory consolidation (Xiong, Krugers, 2015). The more emotionally-arousing consequences were initiated by the event, the more stress hormones adrenal glands released, affecting memory consolidation positively, which determined the lively, long-term stored memory at last (Gold, McGaugh, 1975; Paré, Collins, Pelletier, 2002a).

In addition, researchers also provide a significant amount of evidence that the basolateral amygdala has an impact on memory consolidation in several aspects. According to McGaugh (2000), the amygdala possessed the utility to mediate the outcome of memory modulation and control the effects of stress hormones relevant to memory. Furthermore, studies found that the activation of the basolateral amygdala had links with better performance in long-term recall prompted by emotionally arousing events (Cahill et al., 1996). Additionally, the basolateral amygdala could facilitate synaptic plasticity and neuronal oscillations, intensifying the consolidation of emotionally arousing memories (Cahill, McGaugh, 1998; Paré, Collins, Pelletier, 2002b). Brain imaging studies showed that theta oscillations, a kind of neuronal activity in slow-wave sleep which influences memory consolidation, emerged in the amygdala during emotional arousal and built the pathway between neocortical storage sites and the declarative memory system of the temporal lobe (Paré, Collins, Pelletier, 2002c).

4. Models of memory consolidation elicited by emotionally arousing events

Comprehensive models of memory consolidation in psychology have been substantially discussed in a number of studies. Christian (1992) developed a special memory processing model underlying emotional arousal, including preattentive processing and poststimulus elaboration elicited by extremely unexpected events. Preattentive processing occurred automatically when an emotionally-arousing event happened, leaving an unconscious image in the mind. Then, poststimulus elaboration

was activated, increasing the selectivity and narrowing of the attention, thereby attracting the individual's concentration and enhancing the memory of central details instead of the peripheral ones. This phenomenon has been reported in other studies as the focal effects of emotion, affect-biased attention and biased attention via the norepinephrine model (Talmi, 2013; Markovic, Anderson, Todd, 2013a). Hence, the processing pattern of Christian (1992) could be concluded as a fundamental rudiment that possesses perceptual, attentional, and emotional facets that improve memory consolidation (Hulse et al., 2016).

However, the main limitation of the study is the failure to construct the possible factors into a scientific and verifiable model. As a result, Talmi (2013) postulated an integrative model that included a modulation model (McGaugh, 2004a; Schmidt, Saari, 2007a) and a mediation theory (Talmi et al., 2007a) focusing on memory consolidation, encoding, and retrieval. Regarding the emotionally-arousing event, the mediation theory showed that cognitive factors (attention, distinctiveness, and organization) enhanced the created and retrieved emotional memory first (Talmi et al., 2007b). Following that, the modulation model was activated, manifesting in the release of stress hormones and yielding the excitability of the amygdala to foster the enhancement of consolidation (McGaugh, 2004b; Schmidt, Saari, 2007b).

5. Comparison between emotionally-arousing memory and FBM

So far, this essay's focus was memory consolidation in the context of emotional arousal. The following section will discuss how FBM research could benefit from considering emotionally-arousing memory studies.

As mentioned above, the most prominent common feature of the three known FBM mechanisms is the presence of emotional arousal. According to Talarico and Rubin (2017), the features of FBM can recapitulate into longevity, accuracy, consistency, vividness, and confidence, which means that FBM manifests as a more accurate, vivid, highly important and long-lasting memory compared to an ordinary one. At a glance, the outcomes of the emotionally-arousing memory are similar to those of FBM in several key features. It is rather universally agreed that memory activated by emotional arousal retains for longer periods compared with generic memory, being difficult to forget and sharing the same longevity characteristic with FBM (Bohannon, Symons, 1992; Burke et al., 1992; Christianson, 1984; Christianson, Lofius, 1987; Heuer, Reisberg, 1990; Pillemer, 1984; Koss, Tromp, Tharan, 1995a).

Despite this, pieces of evidence in the special memory processing model (Christian, 1992) and the integrative model (Talmi, 2013) imply that emotionally-arousing memory tends to be more vivid and precise when it comes to the central details, which is proved by empirical and experimental investigations (Koss, Tromp, Tharan, 1995b; Markovic, Anderson, Todd, 2013b). Possessing the same perspective as the characteristic of FBM by Brown and Kulik (1997), only several essential pieces of information in the circumstance could be stored accurately in FBM. Moreover, from the physiological standpoint, theta oscillations are generated in the amygdala when an emotionally-arousing event occurs no matter what the nature of the event is (i.e. positive or negative) (Paré, Collins, Pelletier, 2002d). Therefore, traumatic and joyful events share the same intensity of emotional arousal to an extent.

A similar stance in the field of FBM studies is shared by Hirst (2016), who suggested that it is not only negative public events that might provoke FBM but also personal and positive experiences that might trigger those specific memories. Thus, common features are similar to that of emotionally-arousing memory and FBM, increasing the importance of studies on emotional arousal in the context of FBM research and inspiring directions for future discoveries.

6. Conclusion

In summary, this essay provided a range of arguments that researchers specializing in emotional arousal would most likely benefit from investigating FBM formation. Concerning the three different mechanisms of FBM formation, the key similarity between them is emotional arousal, and based on this observation, a detailed analysis of emotionally-arousing memory from the viewpoints of physiology and psychology was carried out, as well as a comparison between different models of FBM establishment. Thus far, due to the high-similar characteristics of the two types of memory, the results indicated by the described research on the consolidation mechanisms in emotionally-arousing memory could potentially aid researchers to specify the mechanism underlying FBM operation.

Regarding future research directions, Talarico and Rubin (2017) inferred that the constitutions of FBM failed to be sustainable as it was insufficient to separate FBM from other autobiographical memories, which accounted for the unclear implication (Davidson, 2008). Once the conceptual issues are solved, studies can pay more attention to FBM's deeper analysis and applications. From the perspective of physiology, preliminary results support the activation of the amygdala and hippocampus during FBM recall, however, the lack of connectivity analysis makes the mechanisms underlying FBM remain unclear (Metternich et al., 2020).

From the psychological viewpoint, research should be more rigorous in controlling irrelevant variables to verify the independence of FBM, such as Davidson (2008) illustrated by mentioning the sources of stimulating events that affected memory consolidation by offering information from the same context. The material for triggering emotional arousal could also impose an influence on consolidation and, as a result, could be disparate in the experiments performed in the laboratories compared to the real-world events and experiences.

As for the application of emotionally-arousing memory research, the feature comparison above shows the matching relationship between FBM and emotionally-arousing memory shaped by shared longevity, vividness, and accuracy. The features of consistency and confidence in FBM are not directly comparable to emotionally-arousing memory in the existing literature. However, Smeets, Candel, and Merckelbach (2004) discovered the testimonies of experiencing typical forgetting effects as a result of inconsistency, which indicated that it could be particularly consistency that is the ruling factor for memory consolidation. Rimmele, Davachi, and Phelps (2012) stated that people are more confident in the accuracy of emotional memory based on the experimental data, proving the correlation but leaving an incomplete explanation at last. The research might have been more comprehensive if it had included the comparisons of all the relevant factors.

Furthermore, researchers might benefit from concentrating not only on the negative emotional outcomes but also on private and positive emotionally-arousing events as it can enable the community to significantly advance the understanding of FBM (Hirst, Phelps, 2016; Christianson, 1992). In addition to that, ongoing works propose much more diverse variables in FBM than currently described, suggesting the existence of relationships between personality type, imaginary memory and anxiety about the future (Abbas, 2021). Especially with the social media culture offering a suitable context for FBM formation and, surprisingly, not being investigated enough (Talarico, 2019), this direction is worthwhile pursuing in future research.

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