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New insights into the formation and duration of flashbulb memories: Evidence from medical diagnosis memories

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Summary

Flashbulb memories are vivid and salient memories for the moment one hears about a surprising, emotional, and significant event. The current research examined flashbulb memories for a loved one's medical diagnosis, focusing on individual and situational factors associated with memory development and endurance over time. An online survey collected memory narratives and subjective ratings from 309 mothers who received a diagnosis of Down syndrome for their child. Time since diagnosis ranged from 1 month to 52 years. Using two independent measures, the Flashbulb Memory Checklist and the Autobiographical Memory Questionnaire, we found that a majority of diagnosis memories qualified as flashbulb memories, even 20 years or more after the event. Importantly, support from the medical staff at diagnosis emerged as a critical variable related to flashbulb memory development and the persistence of these flashbulb memories over time.

KEYWORDS

autobiographical memory, Down syndrome, flashbulb memories, medical diagnosis

1 | INTRODUCTION

Receiving an unexpected medical diagnosis for oneself or a loved one can have a profound impact on an individual. Not only is such news often perceived as highly negative, but it can also cause the individual to wonder how the diagnosis will interfere with his or her personal identity and plans for the future. Anecdotally, patients and family members often report that they will *never forget* the receipt of such significant diagnoses, and that the memory for when they first were given the news will stick with them for years to come. Critically, these long-term memories contain information about the news itself, and also contain vivid details surrounding the context of hearing the news (e.g., the time and date, what people were wearing, and peripheral details of the setting). Given the consequential nature of medical diagnoses, and the vivid, detailed memories that patients have of their diagnosis experience, it is likely that for many patients, receipt of a significant medical diagnosis results in a flashbulb memory (FBM). Furthermore, because of the somewhat unique phenomenology of these diagnosis memories, they offer important potential insights about the mechanisms and functions of FBMs.

FBMs are distinct, salient memories that people often believe they will 'never forget' (Brown & Kulik, 1977; Conway, 1995; Luminet & Curci, 2009; Neisser, 1982; Winograd & Neisser, 1992). Although people do seem to forget some of the details of FBMs over time (Hirst et al., 2009, 2015; Neisser & Harsch, 1992; Schmolck, Buffalo, & Squire, 2000; Talarico & Rubin, 2007), FBMs are nonetheless characterized by greater emotional involvement and rehearsal, a heightened confidence that the event occurred exactly as it is remembered, as well as reports of a sense that a person is reliving the experience (Talarico & Rubin, 2003, 2007). While no necessary and sufficient factors for FBM development have been definitively identified, events that evoke FBMs often share a number of common features, including distinctiveness, surprise, consequentiality, and emotional intensity (Edery-Halpern & Nachson, 2004; Finkenauer et al., 1998; Hirst & Phelps, 2016).

Although FBM studies have traditionally focused on memories for the moment one hears about a major pubic event (e.g., Brown & Kulik, 1977; Curci & Luminet, 2006; Hirst et al., 2015; Talarico & Rubin, 2003), researchers have also examined FBMs for private or personal events (see Pillemer, 2009). Notably, this research has revealed that individuals have FBMs both for events *experienced by* the participant, themselves—such as onset of a menstrual cycle (Pillemer, Koff, Rhinehart, & Rierdan, 1987) or an invitation to a desired social group (Kraha & Boals, 2014)—as well as for *hearing news* about something that is personally relevant—such as the death, illness, or accident of a loved one (e.g., Brown & Kulik, 1977; Demiray & Freund, 2015; Lanciano, Curci, Matera, & Sartori, 2018; Pillemer, 2009). The current study expands on this work by examining FBMs for a specific personal event common to all participants—the moment individuals received a Down syndrome diagnosis for their child.

Memories for a medical diagnosis offer a somewhat unique window into the mechanisms and functions of FBMs, as they allow an examination of important situational and individual factors that cannot be studied with a single, public event. For example, using this approach, we can evaluate emotional influences on FBMs that do not depend on pre-existing individual differences to shape interpretations of an event (e.g., fans of sports teams who win vs. lose; Kensinger & Schacter, 2006), but rather arise from situational factors during the event. Although the diagnosis news itself may be similarly surprising and consequential across patients, there may be significant differences in *how* news of a diagnosis is *delivered*, depending on the medical professional. Prior work has shown that news source can influence how an event is remembered (Bohannon, Gratz, & Cross, 2007; Schaefer, Halldorson, & Dizon-Reynante, 2011; Schmolck et al., 2000; Talarico, Kraha, Self, & Boals, 2019). In the current study, we expand these findings to determine whether *the way in which the news is delivered* is related to the likelihood and persistence of a FBM.

To this end, we explore whether the information provided at the time of diagnosis and the disposition of the medical staff are associated with the nature and intensity of the diagnosis experience, and thus the likelihood that individuals would experience a FBM. A handful of studies have examined parents' interactions with medical staff at the time of a Down syndrome diagnosis, and the evidence suggests that parents' perceptions of those interactions are more often negative than positive (Goff et al., 2013; Skotko, 2005), with parents reporting a lack of compassion on the part of medical staff, pressure to terminate their pregnancies, low expectations for their children, and a lack of information provided by medical staff about the diagnosis (Goff et al., 2013). There is also suggestive evidence that the nature of a medical diagnosis experience can affect attitudes about a Down syndrome diagnosis. One study of mothers who received a Down syndrome diagnosis for their children found that mothers whose doctors were more positive in conveying the diagnosis expressed more optimism and less fear and anxiety than those whose doctors were more negative when conveying the diagnosis (Skotko, 2005). The current study examines the possibility that the emotional tenor at the time of diagnosis might also be associated with the likelihood of having a FBM for the event, years later.

In addition to these insights regarding the influence that the disposition of the medical staff has on FBMs for a diagnosis event, we also examine whether individual differences in those receiving the diagnosis might affect FBM development and persistence. The FBM literature has largely focused on describing the characteristics of an event—such as distinctiveness, surprise, consequentiality, and emotional intensity—that may lead to a FBM (Edery-Halpern & Nachson, 2004; Finkenauer et al., 1998; Hirst & Phelps, 2016). However, there is considerable evidence that individual differences—such as, social identity (Berntsen, 2009) and location at the time of the event (Sharot, Martorella, Delgado, & Phelps, 2007)—can also influence the formation of a FBM. The current study examines whether the prevalence of FBMs differs as a function of mother's level of education, mother's reported prior knowledge of Down syndrome, whether the diagnosis was received pre- or postnatally, and time since diagnosis. Such differences would highlight cultural and personal factors that might predispose an individual to form a FBM for a diagnosis experience.

As we examine the factors that influence FBM development for medical diagnosis events, we note that prior studies have not all taken the same approach to determining whether a memory can be characterized as a FBM. FBMs are associated with an increased vividness compared to memory for everyday events. However, the memory literature examines such changes in two different ways: (a) subjective phenomenology ratings provided by the participant and (b) detail ratings of the narrative provided by the researcher. In the FBM literature, researchers have frequently embraced the first approach; these studies ask participants to provide memory ratings using components of the Autobiographical Memory Questionnaire (AMQ; e.g., Rubin, Schrauf, & Greenberg, 2003, 2004; see Talarico & Rubin, 2007) and compare the subjective qualities of key event memories to those for everyday events. However, investigators have also measured the detail and specificity of memories by examining the content of the memory narratives (e.g., Brown & Kulik, 1977; Lanciano et al., 2018; Neisser & Harsch, 1992). Early investigations examined recall of details from different canonical categories (e.g., place, ongoing event, affect; Brown & Kulik, 1977), and Neisser and Harsch (1992) later created the Weighted Attribution Scale to quantify systematically the level of detail provided about different attributes. Lanciano et al. (2018) developed a similar tool for use with personal FBMs called the Flashbulb Memory Checklist (FBMC; Lanciano et al., 2018). The FBMC uses researcher ratings of specific details in a memory narrative to determine whether a memory qualifies as a FBM. We evaluated diagnosis memories using both participant-provided ratings (here, the AMQ) and researcher-provided measures (here, the FBMC).

Recent behavioral and neuroimaging research has shown that distinct results may be found when relying on participant-provided versus researcher-provided measures (e.g., Madore, Jing, & Schacter, 2019; Miloyan & McFarlane, 2018), suggesting that the AMQ and FBMC could potentially be capturing different facets of FBMs. To date, no one has utilized both measures in the same study to examine convergence on their classification of FBMs or on the influence of individual difference factors. A further goal of the current research is to determine the relationship between participant-provided and researcher-provided measures of FBMs and to investigate whether diagnosis memories qualify as FBMs using both measures.

2 | METHODS

2.1 | Participants

We recruited biological mothers of children with Down syndrome for this study through Down syndrome support groups on social media.[1] Seven hundred and fifty-two participants initiated the survey, but to be included in the analyses, mothers had to complete the diagnosis narrative at the start of the survey and respond to at least 85% of the remaining 126 questions.[2] Three hundred and nine mothers met the completion criteria. Some of these 309 mothers did not provide responses to some of the survey items, and thus the number of respondents varied among the questions. Mothers ranged in age from 21 years to 79 years (*M* = 46.3 years; *SD* = 10.2 years), and were predominantly Caucasian (94%) and college graduates (72%). Although a small percentage of mothers reported receiving their diagnosis outside of the United States (5%) and another 4% chose not to disclose their location, 91% of mothers reported receiving their diagnosis in the United States. With respect to geographic region of the United States, 23% of the total sample received their diagnosis in the Northeast, 37% in the South, 22% in the Midwest, and 9% in the West.

2.2 | Materials

All materials were approved by the Institutional Review Board at the College of Charleston, and all procedures followed APA guidelines for ethical behavior. A 127-item survey included a compilation of measures from the FBMC (Lanciano et al., 2018), the AMQ (Rubin et al., 2003, 2004; Talarico & Rubin, 2007), and a survey about the Down syndrome diagnosis experience developed by Skotko (2005). Our survey also included a series of demographic questions and outcome measures developed by the authors. Before distribution, the survey was reviewed by parents of children with Down syndrome as well as a board-certified medical geneticist who is a director of a Down syndrome clinic. After review, the survey was implemented online using Qualtrics. The full survey is available in the Supplemental Materials.

The survey began with a cover letter to parents explaining the motivation for the survey and emphasizing the fact that participation was voluntary. The cover letter was followed by a detailed consent form that participants were required to read and sign before accessing the survey. The survey gathered both qualitative and quantitative data with a combination of open-ended questions, factual questions, and a series of statements for which participants were asked to rate their agreement on a 7-point Likert scale.

A central goal of the current study was to understand factors that might be associated with FBM development and persistence. Demographic questions included information about mothers' race, ethnicity, date of birth, education level (eighth grade or less, some high school, high school graduate or GED, some college or 2-year degree, 4-year college degree, or more than a 4-year college degree), gender identity, religious affiliation, income, and United States state in which they received medical care for their pregnancy.[3] We asked participants the year in which they received their diagnosis—enabling us to calculate time since diagnosis—and whether they received their diagnosis during their pregnancy or after the birth of their child. Mothers also reported, on a scale of 1–7, the extent to which they agreed with the statement that they had *no prior knowledge* about Down syndrome prior to their child's diagnosis. This scale was reverse-scored so that 1 = no prior knowledge and 7 = considerable prior knowledge.

To assess memories of the diagnosis experience, we first asked mothers to write a narrative describing in detail how they received their child's Down syndrome diagnosis. In line with Lanciano et al. (2018), we asked mothers to freely recall as much specific information as they could about the date, day of the week, location, time of day, weather, and clothes. Unlike Lanciano et al., we did not include an additional probed recall for each of the above items, given the need to include other FBM measures and outcome measures, which together created a fairly lengthy survey. Following Talarico and Rubin (2007), the survey then included items from the AMQ (e.g., Rubin et al., 2003, 2004), a rating-scale measure used by a number of researchers to assess FBMs by evaluating key properties of memories like vividness, emotional intensity, and rehearsal. In the analysis, we included only those ten properties shown to distinguish FBMs from everyday memories in Talarico and Rubin (2007): remember/know, recollection, belief (confidence), vividness, valence, emotional intensity, same intensity, visceral reaction, rehearsal, and field perspective. To assess each property, mothers read individual statements (e.g., 'While remembering the event now, I feel that I travel back to the time it happened.") and rated their agreement with each statement on a 7-point scale. The specific questions (e.g., 'I can see the events of my son/daughter's diagnosis in my mind.") used to assess each property (e.g., vividness) were identical to those used in Talarico and Rubin (2007).

To understand the factors that contributed to the likelihood of experiencing a FBM, we included questions about the diagnosis experience from a survey developed by Skotko (2005). We were particularly interested in how interactions with medical professionals at the time of diagnosis affected memory formation and endurance. The current survey asked participants five questions about their interactions with medical staff (e.g., doctors, nurses, and genetic counselors). On a scale of 1–7, participants reported the extent to which medical staff provided (a) a positive perspective, (b) a negative perspective, (c) pity, (d) factual information, and (e) personal connections at the time of the diagnosis.

2.3 | Procedure

Participants were recruited for this study through Down syndrome support groups on social media. The initial invitation was posted on Facebook and shared directly with several Down syndrome groups on the platform. Sharing of the post was encouraged to increase participation rate. The social media post included a brief description of the survey, along with an online link to the full survey. Participants who followed the link first viewed an invitation letter that explained the motivation for the study and then read a formal consent document. Only participants who consented to the study were able to complete the survey. Once participants initiated the survey, they had the option of saving a partially completed response and continuing at a later time. This feature was enabled to allow participants to provide more detailed responses to the open-ended questions and accommodate for the needs of busy parents, thus increasing participation and completion rates. Only one submission was allowed for each IP address. Participants were informed that in exchange for their participation, they would have the option of entering their name into a raffle, and at the end of the study, 20 participants selected at random would receive $100 each. Once participants completed the full survey, they were automatically directed to a separate survey and had the option of providing their contact information for the raffle. To protect participant confidentiality and anonymity, participant contact information was received only when participants completed the second independent survey, and the contact data were in no way connected with the survey data. Two hundred and twenty-three of the 309 participants entered contact information. The survey was available from October 24, 2018 until December 1, 2018.

2.4 | Evaluating flashbulb memories

The current analysis used two independent measures to determine whether memories for a Down syndrome diagnosis qualified as FBMs, one that focused on the narrative responses and one that was based on responses to AMQ items.

Flashbulb Memory Checklist (FBMC; Lanciano et al., 2018): The FBMC was developed by Lanciano et al. to examine FBM-like features in memory narratives for private events. It was created to examine two separate aspects of FBMs: specificity and confidence. The current study used an adapted version of the specificity checklist: independent raters read the diagnosis narratives and coded them for the presence of specific details, including date, day of the week, time, location, activity, weather, clothes, and other pertinent information. Recall for the first seven items was scored on a scale of 0–2 for each detail:

- A score of 2 was assigned for total detailed recall (e.g., October 12, 2006).
- A score of 1 was assigned for partial detail (e.g., Fall of 2006).
- A score of 0 was assigned when an answer was missing.

Up to 10 additional points were given for any other relevant details (e.g., medical personnel present at the time of diagnosis, songs playing on the radio, specific language used by medical staff). Following Lanciano et al., we categorized scores above 14 as ‘High FBM’, scores of 11–14 as ‘Medium FBM’, and scores below 11 as ‘Low FBM.’ Two coders rated each narrative, and inter-rater reliability was high (88%). A third coder (C. P. M.) reviewed any discrepant ratings across narratives and resolved them through discussion with the original coders.

Autobiographical Memory Questionnaire (AMQ; e.g., Rubin et al., 2003, 2004): The current survey included questions taken from the AMQ that have been shown to distinguish between FBMs and everyday memories (Talarico & Rubin, 2007). Participants responded to each question using a scale of 1–7. To enable comparison with Talarico and Rubin's results, these data were scored using their same scoring system:

- The *recollection* measure combined ratings of reliving the initial event during retrieval and feelings of traveling back in time to the event.
- The *remember/know* measure was a single response reflecting the extent to which the participant actually remembered the event occurring.
- *Belief in the memory* included a rating of participants' belief in the accuracy of their memory and a reverse-scored rating of how easily they could be convinced it occurred differently than how they remembered. Recent research has clarified that this measure should be considered a reflection of participants' belief in their memory accuracy, which is distinct from their belief that the event occurred (Scoboria, Talarico, & Pascal, 2015).
- *Vividness* was based on ratings of how well participants remembered what they heard and saw, and where the event took place.
- *Valence* was measured by calculating the difference between ratings of memory positivity and memory negativity (i.e., positive minus negative) and dividing by 2, resulting in scores that ranged from −3 (highest possible negativity score and lowest possible positivity score) to 3 (lowest possible negativity score and highest possible positivity score).
- *Intensity* was measured with a single rating of the strength of the emotion, while *same intensity* was measured with a scale asking participants to report the extent to which their retrieval experience was associated with the same intensity as the original event.
- *Visceral reaction* was based on responses to four questions that asked participants to indicate the extent to which they currently felt tense all over, felt their heart race or pound, felt sweaty or clammy, or felt knots, cramps, or butterflies in their stomach as they recalled the memory.
- *Rehearsal* ratings asked participants how often they thought about or talked about the event, and how often it came to them ‘out of the blue.’
- *Field/Observer* asked participants the extent to which they saw the event through their own eyes (i.e., ‘field perspective’) rather than as an outside observer (i.e., ‘observer perspective’). Higher scores on this measure indicated that participants saw the event through their own eyes.

Participant scores for each property were calculated and compared to scores for both FBMs and everyday memories from Talarico and Rubin (2007). We also used a Principal Component Analysis to identify the primary memory components (e.g., negative emotion).

3 | RESULTS

3.1 | Flashbulb memories for a medical diagnosis

A preliminary goal of this research was to investigate whether receiving a serious medical diagnosis for a loved one can result in a FBM. To address this question, we examined scores on two well-established, independent measures, the FBMC and the AMQ.

Flashbulb Memory Checklist (FBMC; Lanciano et al., 2018): On average, participants' descriptions of their diagnosis experience (*M* = 13.47, *SD* = 4.38) could be categorized as 'Medium FBM' (11–14), with 43% categorized as 'High FBM', 34% categorized as 'Medium FBM', and only 23% categorized as 'Low FBM' (see Figure 1 for distribution).

Autobiographical Memory Questionnaire (AMQ; Rubin et al., 2003, 2004): With the exception of valence, FBMs are associated with higher ratings on all AMQ measures. Average AMQ ratings for diagnosis memories are presented in Table 1. For comparison, we included ratings of FBMs for 9/11 as well as ratings of everyday memories, both reported in Talarico and Rubin (2007), next to the ratings for the medical diagnosis experience from the current study. Ratings for *Recollection*, *Belief*, *Remember/Know*, *Vividness*, *Same Intensity*, *Intensity*, and *Field Perspective* of diagnosis memories were all above the midpoint of the scale (3.5). To explore the similarity of the current ratings to prior AMQ ratings, one-sample *t* tests were conducted to compare the current data to ratings of flashbulb (i.e., 9/11) and everyday memories reported by Talarico and Rubin (2007). The ratings from Talarico and Rubin were obtained approximately 1 year after the events occurred from undergraduate students attending a southeast university. All current ratings were significantly greater (or in the case of valence, more negative) than the everyday memory ratings from Talarico and Rubin (Table 1). A majority of the ratings—recollection, remember/know, vividness, same intensity, intensity, visceral response, and field perspective—were also significantly greater than the FBM ratings from Talarico and Rubin; the only ratings in which our value fell in-between the everyday and FBM ratings provided by Talarico and Rubin were *valence* and *rehearsal*.

Factor Analysis of AMQ Memory Characteristics: The 10 AMQ categories were entered into a Principal Components Analysis (PCA) to identify factors associated with memory for diagnosis experience (see Table S1 for correlation matrix of all AMQ Memory Characteristics). PCA was employed using a Promax rotation with Kaiser normalization due to the expectation that underlying latent variables were not orthogonal. A Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy of 0.77 surpassed the requirement of 0.5 (Kaiser, 1974), suggesting an appropriate sample for the PCA. The Bartlett Test of Sphericity (χ^2[45, *n* = 308] = 875.45, *p* < .001) supported the use of a dimension reduction method such as PCA. Using the Kaiser's criterion of retaining factors with an eigenvalue of greater than one, two components were extracted (Table S2).

AMQ ratings of Visceral Response, Emotional Intensity, Same Intensity, and Rehearsal all loaded positively on component 1, while Valence loaded negatively on this same component, which reflected the amount of negative emotion associated with the event (Table S3). Ratings of Remember/Know, Belief, Vividness, and Recollection loaded on component 2, reflecting the subjective memory richness and detail retrieval. Using a threshold of 0.4 for 'substantive' loadings (Stevens, 2002), Field Perspective did not load onto either component.

Relation between AMQ ratings and FBMC scores. A structural equation model was generated to determine which AMQ rating factors predicted scores on the FBMC. Structural equation models were created and tested using the lavaan program within R studio (https://www.rstudio.com/). This model examined the effects of Negative Emotion (Visceral Response, Emotional Intensity, Same Intensity, Valence, and Rehearsal), Memory Richness, (Remember/Know, Belief, Vividness, and Recollection), and Field Perspective on FBMC scores, while also examining the relation among the three AMQ rating factors (i.e., Negative Emotion, Memory Richness, and Field Perspective). The model converged with an RMSEA of 0.11. The three AMQ rating factors were all related to one another (*z* = 3.98, *p* < .001 for Memory

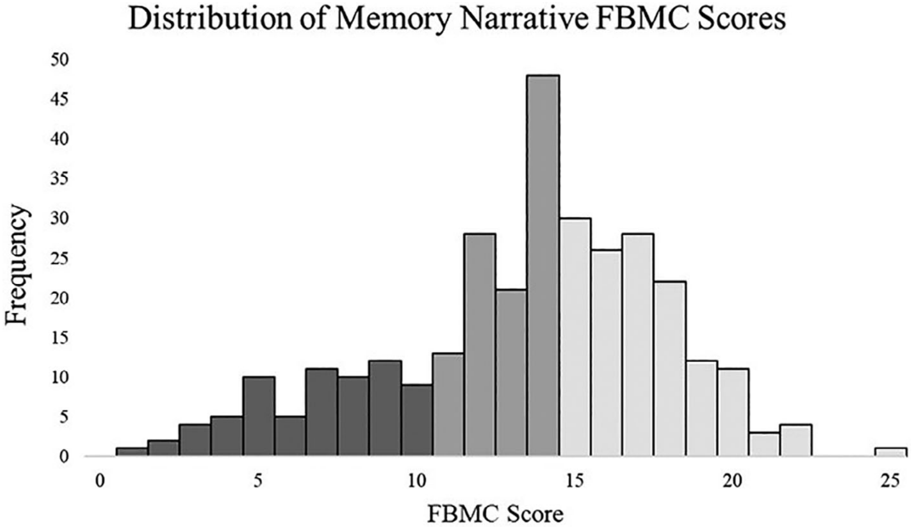

FIGURE 1 Distribution of FBMC scores. Dark gray represents 'Low Flashbulb Memory' (0–10); Medium gray represents 'Medium Flashbulb Memory' (11–14); Light gray represents 'High Flashbulb Memory' (15+). FBMC, flashbulb memory checklist

TABLE 1 Average scores on Autobiographical Memory Questionnaire ratings in the current study and in comparison to prior research (Talarico & Rubin, 2007)

	Current data *M* (*SD*)	Flashbulb memory (Talarico & Rubin, 2007)	Everyday memory (Talarico & Rubin, 2007)
Recollection	5.09 (0.09)	3.97***	2.60***
Belief	5.78 (0.05)	5.71	4.41***
Remember/Know	6.07 (0.08)	5.81***	3.89***
Vividness	6.11 (0.06)	4.66***	3.78***
Valence	−0.86 (0.10)	−1.56***	−0.62*
Same intensity	3.78 (0.11)	3.01***	1.79***
Intensity	5.46 (0.09)	3.40***	1.61***
Visceral	3.45 (0.09)	2.22***	1.15***
Field/Observer	5.65 (0.09)	4.34***	3.32***
Rehearsal	3.23 (0.09)	4.05***	1.78***

*Data in current study is significantly smaller than this value at $p < .05$.

***Data in current study is significantly greater or smaller than this value at $p < .001$.

Richness and Field Perspective; $z = 2.29$, $p = .02$ for Negative Emotion and Field Perspective; $z = 4.06$, $p < .001$ for Memory Richness and Negative Emotion). FBMC scores were significantly predicted by Memory Richness ($z = 3.63$, $p < .001$) and Negative Emotion ($z = 3.01$, $p = .003$), but not Field Perspective ratings ($z = 0.42$, $p = .68$).

3.2 | Factors influencing memory characteristics

A second goal of this research was to examine the relation between FBM formation and situational and individual difference factors. First, we explored whether the nature of the interactions with medical professionals at the time of diagnosis was associated with memory formation and endurance. Participants in the current study differed in how supported they felt by medical staff at the time of their diagnosis. Some mothers reported positive experiences:

> *Example 1*: 'A nurse gave me a website to check out. Our pediatrician came to see us and just listened and loved on my daughter. The lactation consultants were amazing and totally supported us.'
>
> *Example 2*: 'Our doctor quickly connected us with two other families with young ones with DS from his practice. My friendship with those two moms continues to this day.'

However, the majority of mothers reported negative experiences:

> *Example 3*: 'The doctor said, "Your baby will never walk or talk, and she will be a burden on you. You should just leave her here and put her in an institution. Don't even take her home". Then he turned around and left.'
>
> *Example 4*: 'The high-risk doctor did an ultrasound … he determined that my child was "not a keeper" as this child had Down syndrome and a heart condition. He probably would not survive birth and if he did then wouldn't live long afterwards. He had a long discussion with me telling me every bad thing that he could think of and to inform me that my child will be a "burden to society and my family". He also included that 70 percent of fathers of children with disabilities leave the family and the cost of my child will be hard to afford.'

To capture this variability in experience, the five relevant ratings of the medical professionals—their positive perspective, their negative perspective, offering pity, offering factual information, and offering personal connections to other families—were entered into the model. A PCA revealed that these five ratings all loaded strongly (i.e., all loadings larger than 0.7 or smaller than −0.7) onto a single component, reflecting medical staff support and explaining 57.6% of the variance in the data. Positive Perspective, Personal Connections, and Factual Information loaded positively on this component, while Pity and Negative Perspective loaded negatively on this component.

To examine the relation between individual difference factors and FBMs, we included the mother's self-reported knowledge of Down syndrome prior to diagnosis, mother's highest education level, time since diagnosis, and whether it was a pre- or postnatal diagnosis. On average, participants reported slightly higher prior knowledge than the midpoint of the scale ($M = 3.95$; $SD = 2.13$), with ratings spanning the entire range of the scale. Nearly 93% of mothers had graduated high school, 72% had graduated from a 4-year college program, and 39% completed a degree beyond their 4-year college degree. Related to the timing of the diagnosis, time since diagnosis ranged from 1 month to 52 years ($M = 10.8$ years; $SD = 12.6$ years; see Figure 2) and 32% of mothers received their child's diagnosis prenatally.

Model 1: An initial predictor model was generated that examined the relation between our five predictor variables (Medical support, Mom's education level, Prior knowledge of Down syndrome, Time since diagnosis, and Pre/Postnatal diagnosis) and four memory characteristics: Negative Emotion (Visceral Response, Emotional Intensity,

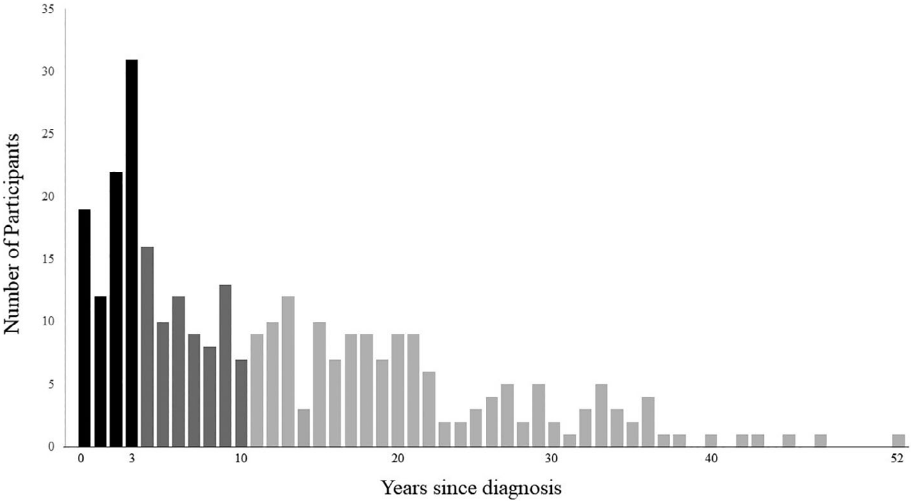

FIGURE 2 Time since diagnosis for all participants. Black depicts those who received their diagnosis within 0–3 years; dark gray depicts those who received their diagnosis 4–10 years ago; light gray depicts those who received their diagnosis more than 10 years ago

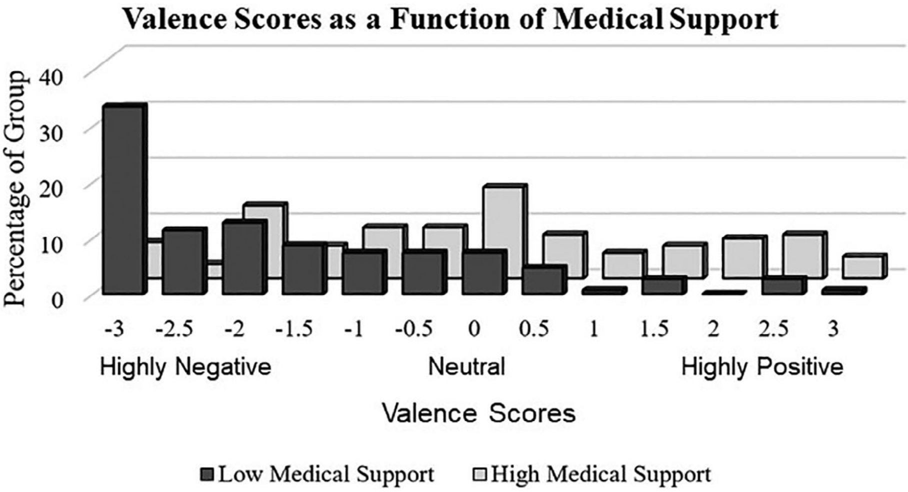

FIGURE 3 Distribution of valence ratings as a function of Medical Support. Participants were assigned to a 'Low Medical Support' or 'High Medical Support' group based on the factor scores from the Medical Support factor. Percentages of participants from the Low Medical Support group (dark gray) and the High Medical Support group (light gray) reporting each valence score are depicted

Same Intensity, Valence, and Rehearsal), Memory Richness (Remember/Know, Belief, Vividness, and Recollection), Field Perspective, and FBMC score. This model converged with an RMSEA of 0.09.

In this model, FBMC score was significantly associated with all AMQ variables: Negative emotion (z = 4.31, p < .001), memory richness (z = 4.64, p < .001), and field perspective (z = 2.13, p = .03). Within the AMQ variables, memory richness was associated with negative emotion (z = 3.77, p < .001) and field perspective (z = 4.07, p < .001).

Regarding predictor variables, situational factors—specifically medical staff support—played an important role in how people remembered their diagnosis experience. Individuals who reported more support from medical personnel were less likely to retrieve their memory from field perspective (z = −2.54, p = .02) and were less likely to report negative emotion (z = −4.64, p < .001). Follow-up examination of the valence scores revealed that mothers with low medical support overwhelmingly reported highly negative experiences: 74% had the most negative valence ratings (−3 through −1.5), while only 20% had moderate valence ratings (−1 through 1) and 6% had the most positive valence ratings (1.5 through 3). In contrast, mothers with high medical support most frequently reported moderate valence ratings (38%) with an almost identical number reporting the most negative valence ratings (37%). Although the percentage of this group reporting positive experiences (25%) was higher than the low support group, it was still the least common valence (see Figure 3 for visual depiction of the distribution for each group).

Individual difference factors also affected diagnosis memories. Mothers who reported more prior knowledge of Down syndrome were less likely to report negative emotion (z = −1.93, p = .05), and mothers with higher levels of education were less likely to retrieve their memory from field perspective (z = −2.67, p = .008). These mother-related variables were significantly related to one another (z = 2.26, p = .02), where mothers with higher education also reported more prior knowledge of Down syndrome. Notably, support from medical staff was not significantly related to either variable (z = 1.68, p = .09 and z = .62, p = .53 for prior knowledge and education, respectively). No memory characteristics were affected by whether individuals received their diagnosis prenatally or postnatally (all ps > .05), and pre versus postnatal timing was not related to medical staff support ($z = -.68$, $p = .5$), mom's prior knowledge ($z = -.34$, $p = .73$), or mom's education ($z = -.49$, $p = .62$).

Time since diagnosis was not associated with changes to any variables associated with memory detail retrieval, including memory richness ($z = .09$, $p = .93$), field perspective ($z = -.49$, $p = .62$), or FBMC scores ($z = -1.58$, $p = .12$). In other words, recent diagnoses were no more subjectively rich than remote diagnoses, and were not more likely to be categorized as High FBM. The one variable predicted by time since diagnosis was memory negativity ($z = -2.32$, $p = .02$), where individuals who received their diagnosis longer ago were less likely to report intense negative emotions associated with their diagnosis than those who received their diagnosis recently.

To further explore this effect of time, the five ratings contributing to this factor (Visceral Response, Emotional Intensity, Same Intensity, Valence, and Rehearsal) were examined separately for individuals who received their diagnosis in the past 3 years ($n = 84$) and those who received their diagnosis 20 or more years ago ($n = 76$; Figure 4). Despite being lower in individuals with more remote diagnoses, average ratings of intensity, same emotion, and same intensity were all still above the midpoint of the scale for participants who received their diagnosis 20 or more years ago. In addition, ratings of visceral response, intensity, same emotion, and same intensity for remote diagnoses were significantly higher than ratings for everyday memory reported in Talarico and Rubin (2007). In other words, although increasing time since diagnosis was associated with decreased emotionality ratings, remote diagnosis memories were still more emotional than prior reports of everyday memories. In contrast, valence ratings were significantly lower (i.e., more negative) than everyday memory ratings for individuals with recent diagnoses ($t[83] = -2.44$, $p = .02$) but not for those with remote diagnoses ($t[73] = 0.12$, $p = .90$). Although the average valence rating for those with the most remote diagnoses was not significantly lower than previously reported everyday memories, this was not driven by individuals in this group reporting positive memories. Instead, it was driven by a shift toward more neutral memories. Mothers with the most remote diagnoses most frequently reported moderate valence ratings (46%), followed by the most negative valence ratings (35%), and the smallest percentage reporting positive memories (19%).

Participants who received their diagnosis more recently were more likely to receive a prenatal diagnosis ($z = 5.50$, $p < .001$), likely driven by the increased availability of prenatal testing in recent years. Further examination confirmed that 50% of individuals who received their diagnosis in the past 3 years ($n = 86$) received a prenatal diagnosis, while that was true for only 9.5% of participants who received their diagnosis 20 or more years ago ($n = 76$). There was also a significant relation between mother's education and time since diagnosis ($z = -2.74$, $p = .006$), where mothers who received their diagnosis more recently had higher levels of education.

Model 2: A second model was created that considered the fact that receiving support from medical staff might influence the effects of when the diagnosis was delivered, both as far as how long ago the diagnosis was given and whether it was pre or postnatal. Two interaction factors were added to the model (time-by-support and pre/postnatal-by-support), and examined as predictors of the memory characteristic variables. The RMSEA for this model was 0.08.

As in the prior model, pre versus postnatal timing of diagnosis had no effect on memory characteristics, and individuals who had more support from medical staff were less likely to report negative emotion ($z = -4.62$, $p < .001$) and less likely to recall their diagnosis from field perspective ($z = -2.52$, $p = .01$). Mother's prior knowledge predicted less negativity ($z = -1.94$, $p = .05$), and mother's education level was associated with reduced field perspective ($z = 2.64$, $p = .008$). Time since diagnosis predicted reduced negative emotion ($z = -2.35$, $p = .02$). In this new model, there was now a significant time-by-support interaction on FBMC score ($z = -2.30$, $p = .02$), suggesting that time is associated with greater decreases in FBMs for individuals who have had more support.[4] Indeed, there was a

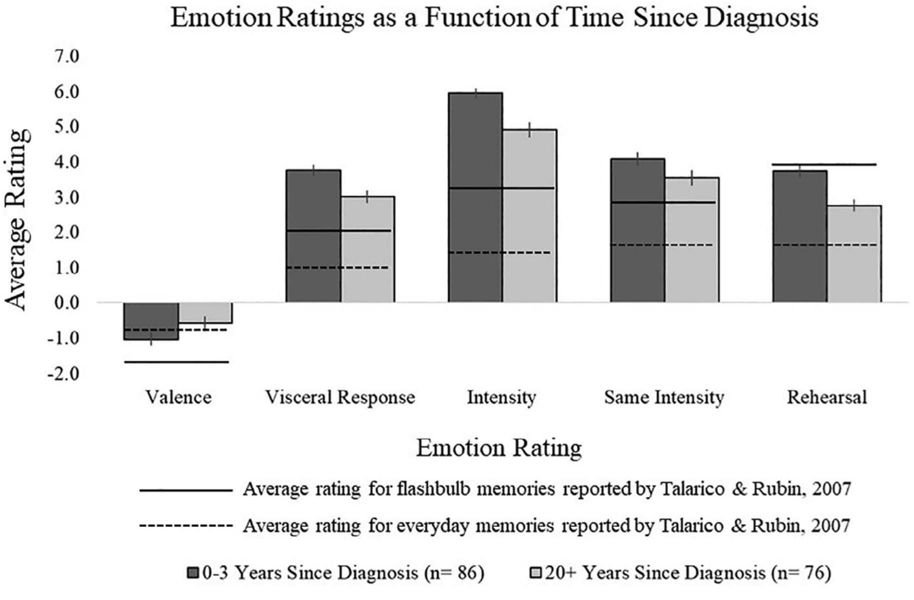

FIGURE 4 Emotion ratings as a function of *Time Since Diagnosis*, presenting participants receiving their diagnosis in the past 3 years (dark gray) and 20 or more years ago (light gray). Average scores for flashbulb memory (solid line) and everyday memory (dashed line) from Talarico and Rubin (2007) are presented for comparison. All ratings, for both time periods, are significantly different than everyday memory ratings

significant negative relation between FBMC scores and time since diagnosis in individuals who reported more support ($r = -.22$, $p = .006$), but no relation in individuals who reported less support ($r = -.03$, $p = .72$).

Patterns of covariance were not affected by the addition of interaction factors. FBMC score was still positively associated with negative emotion ($z = 4.29$, $p < .001$), memory richness ($z = 4.50$, $p < .001$), and field perspective ($z = 2.10$, $p = .04$). Memory richness was associated with negative emotion ($z = 3.75$, $p < .001$) and field perspective ($z = 4.06$, $p < .001$). Participants who received their diagnosis more recently were more likely to receive a prenatal diagnosis ($z = 5.50$, $p < .001$) and had high education levels ($z = -2.74$, $p = .006$). Mother's education level was also associated with more reported prior knowledge of Down syndrome ($z = 2.26$, $p = .02$). The two new interaction variables were related to one another ($z = 5.37$, $p < .001$).

4 | DISCUSSION

The current study was the first to examine how a specific personal FBM, the medical diagnosis of a loved one, may be influenced by one's initial experiences going into the event, the manner of delivery, and the amount of time that has passed since the event. Learning about a significant medical diagnosis can be a traumatic experience that affects one's self-perception, relationships, and future plans, and the current findings support preliminary findings from related work (Brown & Kulik, 1977; Demiray & Freund, 2015) in demonstrating that a diagnosis experience can, in some instances, result in a FBM that remains vivid, intense, and salient even decades after the event. More significantly, the present findings showed that the development and persistence of these personal FBMs depends not only on the news itself, but also on the nature of interactions with medical personnel who delivered the news at the time of the diagnosis.

The current study assessed memories for a medical diagnosis in two ways: (a) Researcher ratings of specific details in narratives based on the FBMC (Lanciano et al., 2018), and (b) mothers' subjective ratings for key phenomenological characteristics from the AMQ (Rubin et al., 2003, 2004; Sheen, Kemp, & Rubin, 2001; see Talarico & Rubin, 2007). Using the FBMC criteria, we found that the majority of diagnosis memories (~80%) qualified as FBMs, with an average score in the Medium FBM range. AMQ measures in the current study echoed this pattern, as average ratings for medical diagnosis memories were greater than those for everyday memories reported by Talarico and Rubin (2007). Furthermore, with the exception of rehearsal and valence, diagnosis memories had higher ratings than FBMs (Talarico & Rubin, 2007), despite the fact that the diagnosis memories reported here were on average more than a decade old, and those of 9/11 reported by Talarico and Rubin were only one year old. Together, our findings from these measures demonstrate that memories for a medical diagnosis are recalled with the same vivid detail, emotional intensity, and robust confidence as FBMs for public events.

Critically, our data suggest that the flashbulb nature of personal diagnosis memories endures over time. Time since diagnosis was not associated with decreased FBMC scores or decreased AMQ ratings for those scales associated with memory richness. Further, although negative emotion declined over time, subjective AMQ ratings for participants who received their child's diagnosis 20 years ago or more were all reliably higher than ratings for everyday memories from prior studies (Talarico & Rubin, 2007). Our findings join with others (e.g., Berntsen & Thomsen, 2005; Hirst et al., 2015; Luminet & Spijkerman, 2017; Tekcan & Peynircioglu, 2002) in demonstrating the long-lasting nature of FBMs. Their endurance over time reinforces the need to understand the factors that contribute to their development.

FBMs are generally thought to be vivid, consequential, and emotionally intense because of *what happened* (i.e., the event itself was surprising, impactful), but our study demonstrates that *how the information is received* plays a significant role in the formation and duration of FBMs. Mothers who perceived greater support and received positive information about Down syndrome from medical staff experienced less negative emotion as they recalled their diagnosis experience. This decrease was not necessarily associated with the event becoming *positive*, as a child's medical diagnosis is unlikely to be experienced as a positive event, but it helps reduce negative affect so that it is more subjectively neutral. These mothers were also more likely to distance themselves from the memory, as indicated by the shift from field to observer perspective, showing decreased tendency to experience the event through their own eyes.

Finally, positive medical support when delivering news of the diagnosis was associated with a waning of the intense, aversive details of FBMs over time: Mothers who received positive support from medical staff at diagnosis were more likely to experience an attenuation of the flashbulb nature of their memories with increased time since diagnosis, but mothers who did not receive positive support failed to show these decreases. Interestingly, these effects were not driven by the association between medical support and reduced negative emotion, suggesting that the delivery of impactful news can have an effect on how that memory is retained, above and beyond the emotional effect the news has at the time. Notably, the timing of the diagnosis (prenatal vs. postnatal) was not associated with the likelihood of having a FBM for the diagnosis, nor did it predict whether the flashbulb nature of the memories faded over time, suggesting that these medical interactions are related to hearing the news of the diagnosis rather than support provided at the time of a child's birth.

To our knowledge, our findings are the first to show convergence in FBM classification across FBMC and AMQ measures. Our data also demonstrate a significant association between FBMC scores and AMQ variables within the structural equation model. It is important to note, however, that the interaction between medical staff support and time since diagnosis emerged for FBMC scores *only*, and not for AMQ variables. Specifically, when looking at individuals who report higher levels of support from medical staff, FBMC scores were lower for mothers with more remote diagnoses compared to mothers with more recent diagnoses. This same pattern was not present for memory richness ratings from the AMQ. These findings are consistent with research showing that participant- and researcher-provided measures may diverge in their estimates of how age influences memory vividness, with some studies showing age-related decreases in memory detail but not in vividness ratings (e.g., Addis, Musicaro, Pan, & Schacter, 2010; Cole, Morrison, & Conway, 2013). Such differences may be driven by differences in how researchers and participants judge detail richness: Detail in the FBMC largely reflects the *quantity* of details, whereas the subjective richness of participants' AMQ ratings may instead be driven by the *quality* of particular details. In other words, a participant may rate a memory as being highly vivid if only a small subset of details is recalled, as long as they are recalled in sufficient detail. This subjective vividness may be more resistant to decay over time compared to objective measures of detail quantity. Together, our comparison of FBMC and AMQ measures suggest that they may be comparable in their classification of personal FBMs, but they may diverge when considering individual difference factors that influence these memories.

4.1 | Limitations and future work

The current study serves as an important first step in understanding the formation and duration of personal FBMs. Additional work is needed to understand how the nature of these memories might influence future behaviors and emotional experiences of the parents as well as their children. FBMs influence social bonds, self-continuity, social identity, and future decisions (Berntsen, 2009; Demiray & Freund, 2015; Neisser, 1982; Pillemer, 1992) and have been shown to guide behavior after an event (Bluck, Alea, Habermas, & Rubin, 2005; Ford et al., 2017; Greenberg, Dyen, & Elliott, 2013). FBMs may be unique among autobiographical memories in their increased service of social rather than directive or self-functions (Rasmussen & Berntsen, 2009); people may be particularly inclined to retrieve a FBM to share and connect with other individuals with similar experiences. Indeed, it has been suggested that FBM formation may occur, in part, due to activation of one's social identity surrounding an event (Berntsen, 2009; Talarico, Bohn, & Wessel, 2019).

Future work should examine the functions of personal flashbulb memory retrieval in relation to their ability to support coping and well-being, focusing on how the nature of the *event* and the nature of the *delivery* alter these long-term consequences. Private FBMs have direct personal relevance, which could have the consequence of making these events more central to one's self-identity *and* more likely to have potent directive function on future behavior (Pillemer, 2009). Future work should examine how different features of personal FBMs influence how they serve each function relative to public FBMs. When considering the social function of personal FBMs, future work should be cautious regarding recruitment. A limitation in the current sample is that it included only biological mothers of children with Down syndrome who were recruited through support groups on social media. If social identify is central to the formation of FBMs, having a FBM for a child's diagnosis may be important to an individual's sense of membership in the Down syndrome community. Therefore, rates of FBMs may be higher among those in these online communities for whom these social connections are more important. Such a sample could bias FBM prevalence in the current study and would inflate estimates of social function in future studies.

A second potential confound of relying on samples from online social groups is that mothers with traumatic diagnosis experiences may be more likely to enroll in a support group, and to respond to a survey of this sort. Experience with Down syndrome support groups suggests that this is not the case, however, and given the lack of a national database of families who have children with Down syndrome, soliciting through support groups is an effective and accepted mechanism for recruiting participants. It should also be noted that a significant minority of our participants (32%) received their diagnosis prenatally, and it is possible that for those participants, decisions made at or around the time of diagnosis affected memory for the diagnosis itself.

The current study contained a geographically diverse sample of mothers—including mothers from 42 United States states plus Washington DC —whose diagnosis experience occurred from 0 to 52 years ago. However, the sample was fairly homogeneous along a number of other measures. The majority of participants were Caucasian (94%) and well-educated (71%), and all had the resources (internet access, time) necessary to partake in the survey. Furthermore, because we included only mothers in this study, it will be important to understand how a Down syndrome diagnosis affects fathers, and whether their memories for the diagnosis are also associated with interpersonal interactions with medical staff.

With respect to design, the present study utilized a cross-sectional rather than a longitudinal design; consequently, although our findings demonstrate that memories for diagnoses that occurred more than 20 years ago are still sufficiently vivid, intense, and richly detailed enough to qualify as FBMs, conclusions cannot be made about how diagnosis memories might change over time for a given individual. One alternate possibility is that diagnosis experiences have actually become less negative and salient in recent years due to medical and research gains related to Down syndrome (Patterson & Costa, 2005) and legislation focusing on effective communication from medical staff (Leach, 2016). If representations of more remote diagnosis memories *started* as more vivid, intense, and richly detailed than recent diagnosis memories, cross-sectional comparisons would not accurately represent change over time. However, time since diagnosis was not associated with less support from medical staff in the current sample, suggesting that such changes are unlikely to be the cause of the null effect.

An additional design consideration is that fact that memory narratives were collected only at a single time point and for only the diagnosis experience. Consequently, we were unable to evaluate memory consistency or to compare to a control memory directly. Future studies should collect narratives across multiple sessions to determine whether participants recall their child's diagnosis accurately and whether they differ from everyday memories from the same individuals. The current analysis utilized everyday memory ratings from a prior study (Talarico & Rubin, 2007) as a stand-in comparison, consistent with other recent studies (Kraha & Boals, 2014; Talarico, 2009), however, these across study analyses may be biased by different approaches to data collection and the older average age of participants in our study. Future work should make those comparisons between personal FBMs and everyday memory ratings more directly.

5 | CONCLUSIONS

The current study found that personal FBMs can be influenced both by differences in the perceived level of support provided by the person delivering the news, as well as individual differences related to the person hearing the news. These findings reveal important factors contributing to the formation and duration of personal FBMs beyond the content of the news itself. We surveyed mothers who received a diagnosis of Down syndrome for their child, and found that the vast majority of mothers experienced a FBM for their diagnosis experience. These memories remained vivid, emotionally intense, and unpleasant for years and even decades. Remembered support from medical personnel when delivering the news played a significant role in how people remembered their diagnosis experience, and in the endurance of memory detail over time. This study advances our understanding of the development of personal FBMs, paving the way for future work that can determine potential consequences of these memories.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data have not been made publicly available due to privacy or ethical restrictions. The scored data that support the findings of this study are available on request from the corresponding author. The raw data cannot be made available as they include personal and potentially identifiable information about participants.

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ENDNOTES

[1] This recruitment sample was selected as a convenience sample, as it was an easy way to recruit a number of mothers from somewhat diverse backgrounds. See Section 4.1 for potential limitations of this convenience sample.

[2] Participants were only required to complete 85% of the questions because the survey included optional demographic questions, along with questions that were conditional on the age of the child with Down syndrome.

[3] The only demographic variable from this list that was included in our analysis was mother's education. Mother's race, ethnicity, and gender identity had insufficient variability to be included as predictors; date of birth (age) was highly correlated with our measure of time since diagnosis; a large proportion of participants elected not to respond to religious affiliation and income questions; and, while many geographical regions were represented, the group sizes were imbalanced.

[4] Given the relation between medical support and emotional response, it is possible that this interaction was driven by the reduced negativity experienced by mothers who received more support. To control for this, an additional model was created that also examined how emotional response influenced the effect of time on FBMC scores. In this model, the time-by-support interaction was still significant ($z = -2.19$, $p = .03$) and the time-by-emotion interaction was not ($z = 0.14$, $p = .89$), suggesting that the time-by-support interaction was not being driven by the difference in initial emotional experience.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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