

PHENOMENOLOGICAL DIFFERENCES IN MUSIC- AND TELEVISION-EVOKED AUTOBIOGRAPHICAL MEMORIES

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MUSIC CAN BE A POTENT CUE FOR AUTOBIOGRAPHICAL memories in both everyday and clinical settings. Understanding the extent to which music may have privileged access to aspects of our personal histories requires critical comparisons to other types of memories and exploration of how music-evoked autobiographical memories (MEAMs) vary across individuals. We compared the retrieval characteristics, content, and emotions of MEAMs to television-evoked autobiographical memories (TEAMs) in an online sample of 657 participants who were representative of the British adult population on age, gender, income, and education. Each participant reported details of a recent MEAM and a recent TEAM experience. MEAMs exhibited significantly greater episodic reliving, personal significance, and social content than TEAMs, and elicited more positive and intense emotions. The majority of these differences between MEAMs and TEAMs persisted in an analysis of a subset of responses in which the music and television cues were matched on familiarity. Age and gender effects were smaller, and consistent across both MEAMs and TEAMs. These results indicate phenomenological differences in naturally occurring memories cued by music as compared to television that are maintained across adulthood. Findings are discussed in the context of theoretical accounts of autobiographical memory, functions of music, and healthy aging.

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THE IDEA THAT MUSIC HAS A POTENT ABILITY to transport us back to significant moments from our past is pervasive in popular culture. The BBC radio program *Desert Island Discs* uses pieces of music as a means of delving into the personal autobiographies of celebrities, while the viral spread of a clip from a documentary (*Alive Inside*, 2014)¹ featuring a patient with Alzheimer's disease instantly recognizing the music of his youth indicates the widespread appreciation of the clinical implications of this phenomenon. Empirical research on such experiences has established that music-evoked autobiographical memories (MEAMs) are a prevalent consequence of music listening, and are often associated with highly positive emotional responses and vivid recall of past events (Belfi, Karlan, & Tranel, 2016; Jakubowski & Ghosh, 2019; Janata, Tomic, & Rakowski, 2007). MEAMs frequently comprise social themes related to friends, family, and significant others (Janata et al., 2007; Michels-Ratliff & Ennis, 2016), and are typically retrieved involuntarily, rather than via strategic, goal-directed memory search processes (El Haj, Fasotti, & Allain, 2012; Jakubowski & Ghosh, 2019).

Further research on the contents and retrieval characteristics of MEAMs is essential for providing critical insights on the extent to which music may have privileged access to certain aspects of our personal histories in comparison to other memory retrieval cues. In addition, little is known about how the properties of MEAMs vary across the human population as a function of individual differences such as age and gender. As music is a widespread, cheap, and easily accessible commodity in our society, research in this area has significant implications for understanding the extent to which music can be effectively utilized in everyday listening settings for the purposes of shaping and maintaining one's sense of self and regulating emotions via these personal associations (Schäfer, Sedlmeier, Städtler, & Huron, 2013), as well as informing therapeutic practices that aim to harness these properties of music in clinical populations (e.g., Baird & Thompson, 2018).

¹ <https://www.youtube.com/watch?v=fyZQf0p73QM&t=3s>

Previous Comparisons of MEAMs to Other Autobiographical Memories

A handful of previous studies have compared MEAMs to autobiographical memories evoked by other cues. Belfi et al. (2016) found that popular music evoked memories with a greater proportion of episodic and perceptual details than photographs of famous faces, indicating that MEAMs were more vividly relived. However, the face cues evoked significantly more memories than the music; the authors suggested that this difference may have been caused by greater familiarity with the face cues in comparison to the music cues, although familiarity was not explicitly measured. In a subsequent study using data collected via the same paradigm, Belfi, Bai, and Stroud (2020) were able to classify (with over 80% accuracy) music- versus face-evoked memory descriptions on the basis of their thematic content, as categorized using Linguistic Inquiry and Word Count (LIWC; Pennebaker, Boyd, Jordan, & Blackburn, 2015), an automated text classification software. They found that memories evoked by music had greater authenticity (descriptions predicted to be more truthful) and more auditory and physical perceptual details, while face-evoked memory descriptions contained more visual perceptual details. Zator and Katz (2017) compared memories evoked via popular music to memories evoked via two types of matched word cues—life period word cues (e.g., “5 years old”) and event-specific word cues (e.g., “Hurricane Katrina”). Using LIWC, they found that descriptions of the memories cued by music made use of more motion-related and spatial terms, suggesting a more embodied experience within MEAMs. Conversely, memories evoked by event-specific word cues contained more words related to higher-order cognitive processes than MEAMs, which can be suggestive of a reappraisal of events. Finally, Rathbone, O’Connor, and Moulin (2017) compared popular songs and films selected as personally significant by older adults.² Personally significant songs were more likely to be from the reminiscence bump period than personally significant films, in terms of both the participant’s age when the song/film was released and the age at which it was rated to be most personally significant. The reminiscence bump is a well-established phenomenon in which older adults disproportionately

recall memories from adolescence/early adulthood (typically ages 10 to 30 years) in comparison to other life periods (Rubin, Rahhal, & Poon, 1998). The increased accessibility of memories from this age range may relate, at least in part, to the fact that this is a key period in identity formation (Conway & Pleydell-Pearce, 2000).

A related body of research has compared MEAMs to other autobiographical memories in populations in which memory function has been impaired due to brain damage or disease. In people with Alzheimer’s disease (AD), MEAMs may be preserved in comparison to autobiographical memories cued by photographs of famous events (Baird, Brancatisano, Gelding, & Thompson, 2018) or autobiographical memories generated in silence (El Haj, Postal, & Allain, 2012; Irish et al., 2006), while one study found that MEAMs exhibited similar properties to odor-evoked memories in AD (El Haj, Gandolphe, Gallouj, Kapogiannis, & Antoine, 2018). MEAMs in AD have also been found to be more positive, self-defining, and involuntarily retrieved than memories evoked in a silent control condition, in which no retrieval cue was presented (El Haj, Antoine, Nandrino, Gély-Nargeot, & Raffard, 2015; El Haj, Fasotti, & Allain, 2012; El Haj, Postal, & Allain, 2012), and show a reminiscence bump that was not found for photograph-evoked memories (Baird, Brancatisano, Gelding, & Thompson, 2018). However, the mechanisms underlying this potential sparing of MEAMs are still not well understood, as explicit memory for (even familiar) music has been shown to be impaired in several case studies of AD (Baird & Samson, 2009). This suggests that autobiographical retrieval may instead be facilitated by implicit memory or the emotional qualities of the music, for instance. Extending beyond research on AD, music has been shown to be a more effective memory cue than verbal prompts from the Autobiographical Memory Interview in three patients with acquired brain injury (Baird & Samson, 2014), and recent work indicates that both music and photographs may be effective cues for autobiographical memories in people with behavioral variant fronto-temporal dementia (Baird, Gelding, Brancatisano, & Thompson, 2020). In contrast, Belfi, Karlan, and Tranel (2018) found evidence of impairment in the episodic richness of MEAMs in patients with damage to the ventromedial prefrontal cortex, despite episodic richness measures that did not differ from matched controls for memories evoked by photographs of famous faces, suggesting a critical role of this brain region in associating music with autobiographical memories. This result aligns with previous neuroimaging research, in which activation of the medial prefrontal cortex has been consistently found

² A methodological difference should be noted here, as this study did not specifically investigate whether these “personally significant” songs/films evoked autobiographical memories; however, Study 2 of their paper indicates that there is a significant relationship between personal significance and the evocation of episodic memories.

during MEAM experiences (Ford, Addis, & Giovanello, 2011; Janata, 2009).

To summarize, previous research has revealed several points of divergence between MEAMs and memories evoked via various other cues, including differences in the number of memories evoked, memory content, episodic details, and their connection to the reminiscence bump. Several of these differences appear to persist even in the presence of certain memory impairments, although the paucity of clinical research utilizing comparable control conditions to music (rather than silence) limits the extent to which such findings may be considered conclusive (see Halpern, Talarico, Gouda, & Williamson, 2018, for a related “cautionary tale” on the necessity of comparing music to appropriate control conditions). In the present work we further compared MEAMs to other autobiographical memories, aiming to both replicate previous findings on the episodic vividness and reminiscence bump in MEAMs, and introduce novel comparisons of characteristics such as emotional responses, personal significance, and the involuntary nature of the memories. All of these factors are important for building a more complete understanding of the extent to which music may have privileged access to certain types of memory experiences, and if so, why.

Effects of Age and Gender on MEAMs

The secondary focus of the present study was to investigate the extent to which properties of MEAMs vary according to demographic factors. Such research is important for understanding whether the potentially beneficial effects of MEAMs (e.g., emotion regulation, clinical uses) might be more pronounced in certain individuals than others. Here we focus on effects of age and gender.

Comparisons of the properties of MEAMs on the basis of age have been relatively rare, as most studies of healthy participants' MEAMs have focused predominantly on reports from either young adults/undergraduate students (Janata, 2009; Janata et al., 2007; Kristen-Antonow, 2019; Zator & Katz, 2017) or older adults (typically with a focus on the reminiscence bump; Platz, Kopiez, Hasselhorn, & Wolf, 2015; Rathbone et al., 2017). Schulkind, Hennis, and Rubin (1999) compared groups of younger versus older adults in their responses to popular songs from across a 60-year period. Older participants remembered more about and showed heightened emotional responses to music from their youth, while younger participants responded more strongly to recently released music, but overall the music cued more specific autobiographical memories

in the younger group. Ford, Rubin, and Giovanello (2016) compared the phenomenological and neural profiles of MEAMs in younger and older adults and found that more familiar music increased the specificity of memories in young adults and the positivity of memories in older adults. In a diary study of MEAMs in everyday life, Jakubowski and Ghosh (2019) found significant positive correlations between participant age and both self-reported emotional positivity and vividness of MEAMs.

Two studies have made comparisons between MEAMs in groups of younger versus older adults with a primary focus on comparing these two groups to older adults with AD (Cuddy, Sikka, Silveira, Bai, & Vanstone, 2017; El Haj, Fasotti, & Allain, 2012). Cuddy et al. (2017) reported evidence of a positivity effect for older adults (both with and without AD) as compared to younger adults; specifically, older adults rated their MEAMs as more positive and less negative than younger adults. In addition, older adults rated their MEAMs as more vivid but less specific than younger adults. El Haj, Fasotti, and Allain (2012) also found evidence for a positivity effect in MEAMs of healthy older adults (though not in the AD group) as compared to younger adults, but did not find evidence that the healthy older adults' MEAMs were less specific (although AD participants showed significantly lower memory specificity, which was comparatively alleviated for MEAMs versus memories generated in silence).

In sum, previous research has revealed that MEAMs in older adults tend to be experienced as more emotionally positive and more vivid than MEAMs in younger adults, with mixed results regarding age-related changes in specificity. These results on MEAMs all have parallels in the literature on autobiographical memories more generally. The age-related positivity effect has been demonstrated in a variety of behavioral tasks and settings (Reed, Chan, & Mikels, 2014), and is often considered to be an indicator of healthy aging. The socioemotional selectivity theory explains this bias for positive memories as a motivational shift toward emotional meaning and satisfaction in line with coming to terms with the finite nature of life (Carstensen, Isaacowitz, & Charles, 1999; Mather & Carstensen, 2005). In addition, a number of previous studies have found age-related increases in self-report ratings of vividness of autobiographical memories (Luchetti & Sutin, 2018; Rubin & Schulkind, 1997; Rubin & Berntsen, 2009). This finding is not well understood to date in terms of whether these increased ratings represent an actual phenomenological change in memory experience with age. It may be, for instance, that some of the types of

memories sampled in previous studies (e.g., most important or happiest memories) were highly accessible and therefore older adults rated these as particularly vivid when considering them in relation to the memories they typically recall in everyday life; conversely, younger adults may show less differentiation between how vividly they are able to recall highly accessible versus more mundane memories (Janssen, Rubin, & St. Jacques, 2011). In terms of specificity, several previous studies have shown that older adults retrieve less specific autobiographical memories than young adults (Anderson, Cohen, & Taylor, 2000; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Piolino, Desgranges, Benali, & Eustache, 2002; Piolino et al., 2006). However, Schlagman and colleagues (Schlagman, Kvavilashvili, & Schulz, 2007; Schlagman, Kliegel, Schulz, & Kvavilashvili, 2009) found no difference in the specificity of *involuntary* autobiographical memories between young and older adults, which is in line with the relative preservation of automatic recall processes in old age (e.g., implicit memory, priming; Grady & Craik, 2000; Light, Prull, La Voie, & Healy, 2000). Therefore, the mixed findings in previous MEAMs research may be due, at least in part, to differences in the degree to which the memories were voluntarily or involuntarily retrieved.

Effects of gender on MEAMs have been even less frequently explored. Cady, Harris, and Knappenberger (2008) found that women used more words to describe their MEAMs, and Herz (1998) found in one of two experiments that both music and odor cues elicited more autobiographical memories in women. Belfi et al. (2016) revealed that women's memory descriptions contained more episodic details than men; this was the case not only for MEAMs but also for autobiographical memories evoked via famous faces. On the other hand, Jakubowski and Ghosh (2019) found no gender differences in MEAM frequency, ratings of vividness, retrieval intentionality, and emotions in reports of naturally occurring MEAMs from 31 participants.

Despite the dearth of evidence on MEAMs specifically, research from across the autobiographical memory literature more broadly has revealed gender effects; in particular suggesting that women give more elaborate accounts of their autobiographical memories, with more specific details, more emotional information, and more references to interpersonal relationships than men (e.g., Baron & Bluck, 2009; Bohanek & Fivush, 2010; Hayne & MacDonald, 2003; Walls, Sperling, & Weber, 2001). Such findings have been connected to evidence of gender differences in how children are taught to talk about their memories and the types of activities they

engage in during key periods of development in autobiographical memory processes and one's sense of self (see Grysman & Hudson, 2013, for a review). However, it should be noted that many autobiographical memory studies have also reported inconsistencies or a lack of gender differences altogether (e.g., Bauer, McAdams, & Sakaeda, 2005; McLean, 2005), while other work has suggested that these effects vary according to the methodology used—with gender differences more often appearing in narrative measures in comparison to studies using rating scales (Grysman & Hudson, 2013). It is therefore important to further investigate the extent to which gender-related effects are exhibited in studies of autobiographical memory, to provide a more complete understanding of the situations under which such differences emerge.

The Present Study

For the purposes of the present study we administered an online survey, which allowed us to access a larger and more representative sample of participants than has been attained in any previous MEAMs research. Specifically, we used quota sampling to reach a sample of over 800 participants who were representative of the UK adult population in terms of age, gender, and household income. We asked participants to report details of the most recent experience they could recall when they were listening to a piece of music and it brought back an autobiographical memory. We chose this naturalistic method over presenting pre-selected musical cues, as even studies that have focused on a much narrower demographic (undergraduate students aged 18 to 29 years) have only succeeded in eliciting MEAMs on 30% of trials (Janata et al., 2007); given the much more varied background of our participants, such an approach thus seemed unsuitable for capturing the likely wide range of musical preferences exhibited in the present sample. This method also allowed us to probe a single MEAM experience in more detail than previous studies, while the wider and more personalized range of musical retrieval cues captured via this method may also provide access to a wider range of memories.

For comparison to the recent MEAM data, participants were asked to report analogous details from their most recent experience of an autobiographical memory being evoked by watching television (TV). TV-evoked autobiographical memories (hereafter TEAMs) were chosen as a comparison condition as TV watching is an activity that occurs with a similar daily frequency to music listening in the UK (Ofcom Media Nations

UK Report, 2018³), and is therefore a more suitable comparator to music than broader cue categories traditionally used in autobiographical memory research, such as word cues or pictorial cues. TV shows also unfold over time, can express and evoke a wide range of emotions (Dorr, Doubleday, & Kovaric, 1983), convey the zeitgeist of a time or culture (Gerbner, Gross, Morgan, & Signorielli, 1986), and can serve as a “social surrogate” (or temporary substitute for social interaction; Schäfer & Eerola, 2018) similarly to music. We of course acknowledge certain inherent differences between music and TV, such as their typical duration, modality (TV viewing tends to be multimodal, while music can be unimodal or multimodal, as in the case of live performances or music videos), and the degree of attention they require (both can be focused on attentively *or* put on in the background to accompany another task, but the latter may be more common with music). However, we argue that no comparison stimulus is truly analogous to music on all possible dimensions, and advocate that future work should seek to utilize comparison stimuli that are matched to music on other dimensions than the present work. We also included questions on the recency of the memory experience, familiarity and liking of the music/TV show, and daily frequency of music listening/TV viewing in order to develop an initial understanding of how MEAMs and TEAMs might differ on the basis of these broader, descriptive features.

The primary aim of the present study was to compare MEAMs and TEAMs in terms of retrieval characteristics, content, and emotional responses. We measured several retrieval characteristics of these memories, in particular self-report ratings of vividness, reliving, significance of the memory, the extent to which emotions at recall matched the originally experienced emotions, and retrieval intentionality (the degree to which recall was involuntary/voluntary when the memory was evoked). Some of these measures relate to the episodic nature of the memories (vividness, reliving, presence of the original emotions); therefore, we predicted that MEAMs would display higher ratings than TEAMs on these properties, in line with the findings of Belfi et al. (2016, 2018) on the greater episodic richness of MEAMs as compared to memories evoked by famous faces. We also made novel comparisons of ratings of retrieval intentionality and personal significance, predicting that MEAMs would be rated lower in retrieval intentionality and higher in personal significance than TEAMs, given

preliminary evidence that MEAMs exhibit many of the features of involuntary memories (El Haj, Fasotti, & Allain, 2012) and may be connected to key periods in identity formation (Rathbone et al., 2017).

In addition to these self-report measures of memory features, we analyzed the content of participants’ written descriptions of their memories, with a particular focus on words that conveyed perceptual and social content. We predicted that MEAMs would be characterized by higher percentages of perceptual words as compared to TEAMs, in line with the highly episodic nature of MEAMs (Belfi et al., 2016, 2018). It has been observed in multiple studies that MEAMs often comprise a high proportion of social themes (Jakubowski & Ghosh, 2019; Janata et al., 2007), although Belfi et al. (2020) did not find social content to be a significant factor in discriminating MEAMs from face-evoked memories. We therefore aimed to further explore this question by comparing the social content of MEAMs and TEAMs.

Next, we compared the emotional responses to the memories, with the prediction that MEAMs would evoke more positive and fewer negative emotions, greater nostalgia, and greater intensity of emotions than TEAMs. Although emotional responses to MEAMs have not been systematically compared to other autobiographical memories in healthy adults, this prediction was based on research indicating that MEAMs are typically characterized by highly positive and nostalgic emotional responses (Jakubowski & Ghosh, 2019; Janata et al., 2007). Finally, we predicted that music would cue more memories from the reminiscence bump period than TV shows, similar to the results of Rathbone et al. (2017).

The secondary aim of the present work was to investigate effects of age and gender on the aforementioned retrieval characteristics, content, and emotional responses of both MEAMs and TEAMs. In line with previous research from the wider autobiographical memory literature, we predicted that both MEAMs and TEAMs would exhibit a positivity effect (increase in positive emotions and decrease in negative emotions) and increase in vividness ratings with increasing age (e.g., Cuddy et al., 2017; Janssen et al., 2011; Reed et al., 2014), and that women would report more vivid and emotional MEAMs and TEAMs with more social details (e.g., Baron & Bluck, 2009; Belfi et al., 2016; Bohanek & Fivush, 2010; Hayne & MacDonald, 2003; Walls et al., 2001). The other aspects of these analyses were more exploratory. In particular, very few previous studies (with the exception of the gender comparisons in Belfi et al., 2016, and Herz, 1998) have compared the

³ https://www.ofcom.org.uk/__data/assets/pdf_file/0014/116006/media-nations-2018-uk.pdf

effects of individual differences on MEAMs versus autobiographical memories evoked via other cues in healthy adults. However, such an investigation is important for understanding whether musical cues might exhibit differential access to certain types of memories across adulthood. For instance, research on older adults with AD suggests that music can be a means for spared access to personally significant memories in comparison to other retrieval cues (Baird et al., 2018), which provides impetus for investigating whether similar results might emerge in healthy older adults, despite the decrements in various aspects of memory function that accompany normal aging.

Method

DESIGN

An online survey was used to probe properties of a recent MEAM and TEAM experience in a repeated-measures design. An additional section of the survey included questions on properties of a frequent MEAM; these data will be reported elsewhere and are outside the scope of this paper.

PARTICIPANTS

Participants were recruited using Qualtrics' Online Sample service. Quota sampling was enforced based on figures from the UK's Office for National Statistics (2017, accessible at ons.gov.uk) for age, gender, and annual household income after taxes (see Table 1). In total, 819 participants completed the survey. All participants were UK residents and 94% were born in the UK.

In this paper we considered only the data from 659 participants (80%) who gave responses indicating that an autobiographical memory was retrieved to both open-ended questions in which they were asked to describe their recent MEAM and TEAM. Participants who gave a response such as "None," or "I don't remember" or gave a response that did not contain any autobiographical content to at least one of these open questions were excluded from consideration in the present study. Two additional participants were excluded who used only one response option on the 5-point scale throughout the entire survey. The final subset of 657 participants (321 men, 336 women) was still representative of the UK population on age, gender, and household income (see Table 1). The age distribution of the sample is presented in Figure 1 ($M = 45.6$ years, $SD = 16.7$, range = 18–85) and the education levels of the participants are presented in Table 2. In our sample, 44% of participants held or were currently undertaking a university degree. This aligns very well with statistics

TABLE 1. Quota categories for participant sampling in initial survey ($N = 819$) and final sample ($N = 657$)

Variable	Categories	Initial Target (%)	Final Sample (%)
Age	18-24 years	15	16
	25-34 years	17	15
	35-44 years	15	15
	45-54 years	17	18
	55+ years	36	36
Gender	Male	50	49
	Female	50	51
Income	less than £15,700	20	18
	£15,700-£24,000	20	21
	£24,001-£34,300	20	20
	£34,301-£50,400	20	20
	greater than £50,400	20	21

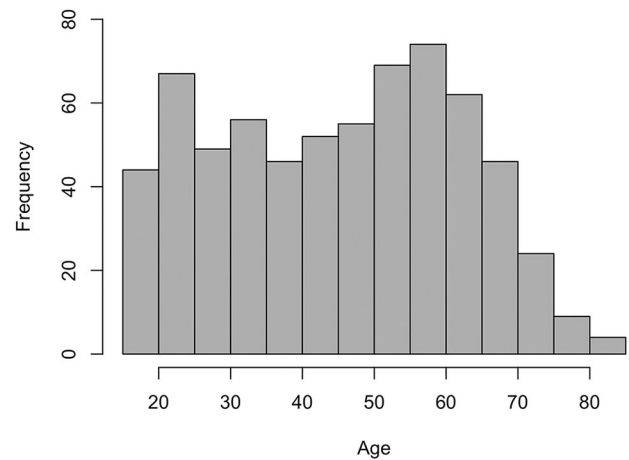


FIGURE 1. Current age of included participants ($N = 657$).

TABLE 2. Education levels of included participants (highest qualification attained)

Qualification	Participants (%)
Primary school	1
High school/ GCSE	27
A-Levels	28
Currently pursuing undergraduate degree	6
Undergraduate degree completed	27
Currently pursuing postgraduate degree	1
Postgraduate degree completed	10

from the UK Department of Education stating that 44% of working-age adults held a higher education qualification in 2017.⁴

⁴ <https://www.gov.uk/government/statistics/education-and-training-statistics-for-the-uk-2018>

At the end of the survey, participants were asked about the number of years they had engaged in formal instrumental/vocal music lessons (using a question from the Goldsmiths Musical Sophistication Index; Müllensiefen, Gingras, Musil, & Stewart, 2014) and classified their musicianship status (using a question from the Ollen Musical Sophistication Index; Ollen, 2006). In total, 83% of participants had two or fewer years of formal music training and 82% classified themselves as nonmusicians (with 18% self-identifying as amateur or professional musicians). This result shows good agreement with the “Taking Part” national survey (2017–18)⁵ by the Department for Digital, Culture, Media and Sport on leisure activities in a representative sample of 7,715 adults in the UK. In their sample, 16% of participants answered “yes” to at least one question about whether they had sung or played an instrument (either for performance or pleasure) in the past 12 months.

MATERIALS

The survey was presented in Qualtrics online survey software. Participants were asked a series of essentially identical questions about the most recent experience of a MEAM and a TEAM they could recall. The following definition of autobiographical memory was provided throughout the survey:

An **autobiographical memory** occurs when you remember personal experiences from your past. These memories may contain details about events, people, places, and time periods from your life. Such a memory could be of a unique event, such as a memory of your 10th birthday party, or a recurring event, such as a memory of walking your dog.

Once participants had a particular MEAM or TEAM in mind, they answered a series of questions including the title of the piece of music or TV show that cued the memory, the recency of the experience, whether they were listening to music/watching TV alone or in a group, and liking and familiarity ratings of the music/TV show. In regard to the contents of the memories, they were asked to tick from a list any particular people and places involved, describe the memory content in detail in an open text box, and provide an estimate of their age during the remembered event. Likert scales (5-point) were provided to rate the degree of retrieval intentionality, vividness, reliving, extent to which they felt the same emotions they felt at the time of the event, significance, and emotional intensity of the memory. These questions were based on relevant questions from the

Autobiographical Memory Questionnaire (Rubin, Schrauf, & Greenberg, 2003) and memory characteristics studied in previous MEAMs research (Belfi et al., 2016; Janata et al., 2007). Participants also rated their emotional responses to the memory on 12 emotion pairs from previous research on music and emotions (Juslin, Barradas, & Eerola, 2015). See Appendix 1 for a full list of survey and demographic questions.

PROCEDURE

Participants provided informed consent and then completed the demographic questions; if they met the quota sampling requirements they moved on to the main survey. They were asked two general questions about the frequency with which listening to music and watching TV brings back autobiographical memories. They then completed the questions on a recent MEAM experience and a recent TEAM experience in a counterbalanced order. At the end of the survey they completed questions about the amount of time they spent listening to music and watching TV each day, as well as the two questions about their musical background. The median time taken to complete the survey was 11.9 minutes.

Results

Below, we first give an overview of the general frequency and contexts of MEAM and TEAM experiences. We then investigate the main research questions related to how the properties of each memory varied as a function of cue type (music vs. TV) and each participant's age and gender.

FREQUENCY AND CONTEXTS OF MEAMS AND TEAMS

The survey began with two questions on how often listening to music and watching TV brought back autobiographical memories in general. Music was reported to trigger memories more often than TV shows (modal response for music = “25–50% of the time,” modal response for TV = “less than 25% of the time”) according to a Wilcoxon signed-ranks test, $Z = -12.45$, $p < .001$. This was despite the fact that participants reported spending significantly more time watching TV on a daily basis (median response = “2 hours”) than listening to music (median response = “30–60 minutes”; $Z = -15.06$, $p < .001$).

When reporting on a recent experience of a MEAM and TEAM, importantly these two memories did not differ in terms of how recently the MEAM or TEAM had been recalled in a paired-samples t test, $t(656) = 1.33$, $p = .18$; MEAMs: $M = 2.70$, $SD = 1.41$; TEAMs: $M = 2.61$, $SD = 1.37$, on a 5-point scale where

⁵ <https://www.gov.uk/government/collections/sat-2>

TABLE 3. Descriptive and inferential statistics for ratings of retrieval characteristics of MEAMs and TEAMs

Retrieval Characteristic	MEAM Mean Rating (SD) [95% CI]	TEAM Mean Rating (SD) [95% CI]	Univariate Comparison
Vividness	4.13 (0.99) [4.06, 4.21]	3.87 (1.02) [3.80, 3.96]	$F(1, 651) = 34.90, p < .001, \eta^2_p = .051^*$
Reliving	3.63 (1.21) [3.54, 3.73]	3.41 (1.17) [3.33, 3.51]	$F(1, 651) = 19.89, p < .001, \eta^2_p = .030^*$
Significance	3.61 (1.12) [3.52, 3.69]	3.36 (1.16) [3.28, 3.46]	$F(1, 651) = 20.42, p < .001, \eta^2_p = .030^*$
Same Emotions	3.65 (1.13) [3.57, 3.74]	3.42 (1.12) [3.33, 3.51]	$F(1, 651) = 22.24, p < .001, \eta^2_p = .033^*$
Retrieval Intentionality	2.04 (1.18) [1.96, 2.15]	2.04 (1.08) [1.96, 2.13]	$F(1, 651) = 0.05, p = .83, \eta^2_p < .001$

* significant at the Dunn-Bonferroni-corrected level of $p < .01$

“5” = *most recent*. The music and TV shows that elicited memories also did not differ in terms of liking ratings in a Wilcoxon signed-ranks test ($Z = -1.21, p = .22$), with both being generally highly liked (music: $M = 4.59, Mdn = 5$; TV: $M = 4.55, Mdn = 5$). Both cue types were rated relatively highly on the familiarity scale (music: $M = 4.60, Mdn = 5$; TV: $M = 4.47, Mdn = 5$), which is supported by the fact that only 15 participants (2%) did not know the name of the piece of music that cued their memory and, similarly, 15 participants could not recall the name of the TV show. However, the music cues were rated as more familiar overall than the TV show cues across the sample ($Z = -2.83, p = .005$). MEAMs were more likely to be experienced alone (69%), while TEAMs were more equally distributed between being experienced alone (53%) or with other people (47%); this distribution was significantly different in a McNemar chi-squared test, $\chi^2(1) = 39.29, p < .001$.

EFFECTS OF CUE TYPE, AGE, AND GENDER ON MEMORY PROPERTIES
We next investigated how the retrieval characteristics, contents, and emotions of each memory varied as a function of cue type (music/TV) and the participant's current age and gender. For consideration of age-related effects, the participants were categorized into 3 age groups (ages 18–35 years: $N = 216, 141$ women; ages 36–55 years: $N = 222, 94$ women; ages 56–85 years: $N = 219, 101$ women), hereafter referred to as the young, middle-aged, and older adults. These categories were primarily defined in order to split the sample into age groups that were as equal in size as possible. Our category boundaries are well aligned with age categories from a previous study using three age groups to investigate music, emotion, and aging (Lima & Castro, 2011). Gender was categorized as a binary variable (male/female participants).

EFFECTS OF CUE TYPE, AGE, AND GENDER ON RETRIEVAL CHARACTERISTICS

In this section we consider the effects of cue type, age group, and gender on the ratings of retrieval characteristics of the memories, specifically vividness, reliving, significance of the memory, the extent to which emotions at recall matched the original emotions, and retrieval intentionality. A $2 \times 3 \times 2$ mixed MANOVA revealed a significant effect of cue type on the retrieval characteristics of the memories, $F(5, 647) = 10.18, p < .001, \eta^2_p = .073$, as well as a significant effect of age group, $F(10, 1294) = 3.81, p < .001, \eta^2_p = .029$, but no significant interaction between cue type and age group, $F(10, 1294) = 0.96, p = .48, \eta^2_p = .007$. To further investigate the main effect of cue type, post hoc univariate tests were run, which revealed a significant effect of cue type on vividness, reliving, significance, and presence of the original emotions, with MEAMs being rated higher on all these features than TEAMs (see Table 3). MEAMs and TEAMs did not differ significantly in terms of retrieval intentionality, with both types of memories being rated as typically more involuntarily than voluntarily recalled. (Retrieval intentionality was rated on a 5-point scale, where “1” = *completely spontaneous recall* and “5” = *completely deliberate recall*.) The only statistically significant post hoc univariate test for the effect of age group was on ratings of vividness, $F(2, 651) = 5.95, p = .015$ (following Dunn-Bonferroni correction for five post hoc tests, $\eta^2_p = .018$), with memory vividness ratings increasing with age (young group: $M = 3.86, 95\% \text{ CI } [3.73, 3.97]$; middle-aged group: $M = 4.00, 95\% \text{ CI } [3.93, 4.16]$; older group: $M = 4.13, 95\% \text{ CI } [4.02, 4.24]$).

Gender did not exhibit a significant main effect on retrieval characteristics of the memories, $F(5, 647) = 1.39, p = .23, \eta^2_p = .011$, and did not significantly

interact with cue type, $F(5, 647) = 0.38, p = .86, \eta^2_p = .003$, or age group, $F(10, 1294) = 1.67, p = .08, \eta^2_p = .013$. The three-way interaction between cue type, age group, and gender was also not statistically significant, $F(10, 1294) = 0.90, p = .53, \eta^2_p = .007$.

In order to further probe how participants' typical engagement with the two cue types might affect the recall of vivid autobiographical memories, we fit a linear mixed effects model with cue type (music/TV), self-reported amount of average daily exposure to each cue type, ratings of how often each cue type brings back autobiographical memories in general, and their interactions as predictors of memory vividness ratings. Individual participants were included in the model as random effects. We found significant main effects of all three predictors, with no significant two- or three-way interactions ($ps > .074$). As before, music cued more vivid memories than TV, $F(1, 1052.4) = 7.15, p = .008$. The vividness of memories increased both as the frequency of daily exposure to a cue increased ($B = 0.013, SE = 0.05$), $F(1, 1193.7) = 6.67, p = .010$, and as the ratings of how often a cue brought back an autobiographical memory increased ($B = 0.086, SE = 0.08$), $F(1, 1190.6) = 4.27, p = .039$.

EFFECTS OF CUE TYPE, AGE, AND GENDER ON MEMORY DESCRIPTIONS

Next, we considered how the content of participants' written memory descriptions varied in relation to cue type, age group, and gender. We used Linguistic Inquiry and Word Count (LIWC; Pennebaker, Boyd, Jordan, & Blackburn, 2015), a software that automatically classifies individual words into themes using large dictionaries of conceptually related words. LIWC has been used successfully in several previous studies of MEAMs (Cuddy et al., 2017; Jakubowski & Ghosh, 2019; Janata et al., 2007; Zator & Katz, 2017), which also allowed for comparisons between our results and relevant previous findings. In this study, we focused on measures from the "Percept" and "Social" themes, in order to test the extent to which memory descriptions comprised perceptual details (including words such as "hear," "see," "feel," names of colors, etc.) and social elements (including words such as "family," "friend," "classmate," etc.) respectively. LIWC was used to compute the percentage of total words falling into each of these two themes for each memory description. We also included the total word count of each memory description as an additional independent variable in this analysis. Before subjecting the textual data to LIWC analysis and subsequent content analysis, we removed any text from the memory description responses that clearly referred

to the context of the situation in which the MEAM/TEAM was recalled, rather than describing the remembered event itself. For instance, one participant wrote "Was driving when the song came on and it reminded me of my partner singing it at karaoke at a party" and for this analysis we retained "it reminded me of my partner singing it at karaoke at a party." See Appendix 2 for examples of typical MEAM and TEAM descriptions.

In a $2 \times 3 \times 2$ mixed MANOVA, a significant effect of cue type on memory description content was found, $F(3, 649) = 15.16, p < .001, \eta^2_p = .066$, as well as a significant effect of gender, $F(3, 649) = 5.97, p = .001, \eta^2_p = .027$. There was no significant main effect of age group, $F(6, 1300) = 1.16, p = .33, \eta^2_p = .005$, and none of the two- or three-way interactions between independent variables were statistically significant; cue type and age group: $F(6, 1300) = 1.78, p = .10, \eta^2_p = .008$; cue type and gender: $F(3, 649) = 1.32, p = .27, \eta^2_p = .006$; age group and gender: $F(6, 1300) = 0.42, p = .86, \eta^2_p = .002$; cue type, age group, and gender: $F(6, 1300) = 1.75, p = .11, \eta^2_p = .008$.

Univariate tests revealed that, on average, MEAM descriptions exhibited a significantly higher percentage of "Percept" words, $M_{\text{MEAMs}} = 7.24, 95\% \text{ CI } [6.34, 7.85]$, $M_{\text{TEAMs}} = 5.15, 95\% \text{ CI } [4.59, 5.81]$; $F(1, 651) = 15.02, p < .001, \eta^2_p = .023$, and "Social" words, $M_{\text{MEAMs}} = 13.75, 95\% \text{ CI } [12.55, 14.91]$, $M_{\text{TEAMs}} = 11.27, 95\% \text{ CI } [10.33, 12.06]$; $F(1, 651) = 12.75, p < .001, \eta^2_p = .019$, than TEAM descriptions. On average, TEAM descriptions contained more total words than MEAM descriptions, $M_{\text{MEAMs}} = 15.46, 95\% \text{ CI } [14.18, 16.79]$, $M_{\text{TEAMs}} = 18.00, 95\% \text{ CI } [16.71, 19.30]$; $F(1, 651) = 18.92, p < .001, \eta^2_p = .028$. Only the "Social" category showed a significant gender effect, such that women used a significantly greater percentage of social words in their memory descriptions than men, $M_{\text{women}} = 13.80, 95\% \text{ CI } [12.68, 14.81]$, $M_{\text{men}} = 11.15, 95\% \text{ CI } [10.08, 12.27]$; $F(1, 651) = 10.96, p = .003$ following Dunn-Bonferroni correction for three post hoc tests, $\eta^2_p = .017$.

A full thematic analysis of the written memory descriptions is beyond the scope of this paper. However, to give a general overview of the topics depicted in these memories, the most frequent nouns and descriptive verbs used in the memory descriptions were tabulated, excluding stop words and words referring to the music/TV show rather than the memory (e.g., "this song reminds me of..."). For MEAMs the most frequent words were as follows (counts listed in brackets): play(s/ed/ing) [90], time(s) [83], friend(s) [73], danc(e/ed/es/ing) [56], lov(e/ed/es/ing) [55], home(s)/

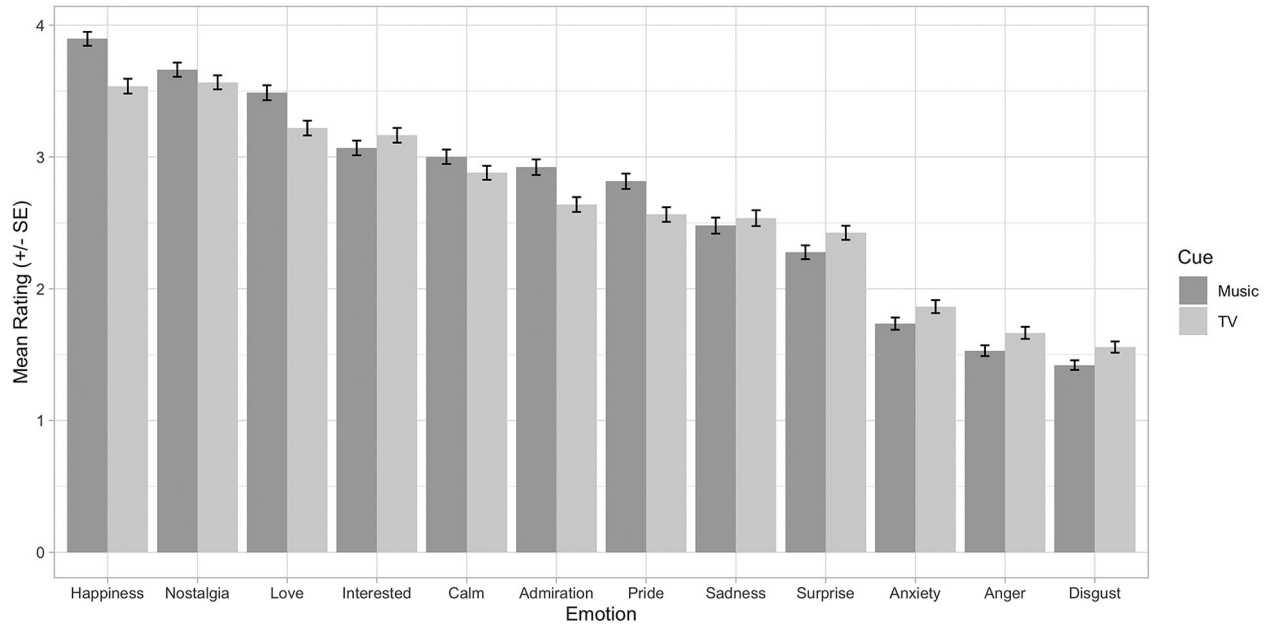


FIGURE 2. Mean ratings of emotional responses to memories by cue type.

house [46], car(s)/driv(e/es/ing) [45], sing(ing) [42], day(s) [35], mum/mom/mother(s) [33], favo(u)rite(s) [31], school [31], concert [30], and happ(y/ier/iness/iest) [30]. The most frequent words used in TEAM descriptions were: time(s) [96], friend(s) [75], home/house [63], year(s) [59], mum/mom/mother(s) [47], famil(y/ies) [44], dad(s)/father [42], school [42], young(er) [41], child(s)/ren [33], and together [33]. In response to the fixed-choice question on which people were present in the remembered event, the most frequently reported category was “spouse/partner” for both MEAMs ($N = 217$) and TEAMs ($N = 183$). For MEAMs, the next most frequent categories of people reported were “friend(s)” ($N = 190$), “none” ($N = 101$), and “parent” ($N = 82$). For TEAMs, these were “parent” ($N = 150$), “friend(s)” ($N = 148$), and “sibling (brother/sister)” ($N = 97$).

As a final means of probing the written memory descriptions, we coded each memory description in terms of whether the particular music/TV cue was mentioned as being present during the remembered event (e.g., “Just dancing with friends in the pub to this song,” “It reminded me of when I was in a GCSE Business lesson, and we were watching Dragons Den, and I was chilling with my classmates”). This allowed us some initial insight into the frequency with which exposure to a cue (listening to music/watching TV) brought back memories of a previous event during which that same cue was present. In total, 41.2% of MEAM descriptions

and 23.1% of TEAM descriptions referred to the cue being present during the original event, and this difference was statistically significant in a McNemar chi-squared test, $\chi^2(1) = 69.96$, $p < .001$.

EFFECTS OF CUE TYPE, AGE, AND GENDER ON EMOTIONAL RESPONSES

Finally, we considered participants’ emotional responses to the memories (regardless of the emotions present at encoding) as a function of cue type, age group, and gender. Ratings of the individual emotions felt in response to each memory were averaged across two categories: positive emotions (*Happiness/elation*, *Calm/contentment*, *Interested/captivated*, *Pride/confidence*, *Love/tenderness*, *Admiration/awe*) and negative emotions (*Sadness/melancholy*, *Anxiety/nervousness*, *Anger/irritation*, *Disgust/contempt*). *Surprise/astonishment* ratings were excluded from consideration on account of their ambiguous emotional valence, but *Nostalgia/longing* ratings were retained as a separate variable due to previous findings on nostalgia as a prominent emotion experienced during MEAMs (Janata et al., 2007; Michels-Ratliff & Ennis, 2016). It should be noted that, overall, positive emotions were more frequently elicited than negative emotions for both cue types (see Figure 2). In addition, we included participant ratings of overall intensity of their emotional responses (regardless of valence) as a final dependent variable of interest.

TABLE 4. Descriptive and inferential statistics for emotion ratings of MEAMs and TEAMs

Emotion Measure	MEAM Mean Rating (SD) [95% CI]	TEAM Mean Rating (SD) [95% CI]	Univariate Comparison
Positive Emotions	3.20 (1.07) [3.13, 3.29]	3.00 (1.10) [2.92, 3.09]	$F(1, 651) = 25.42, p < .001, \eta^2_p = .038^*$
Negative Emotions	1.79 (0.91) [1.71, 1.85]	1.91 (1.00) [1.84, 1.99]	$F(1, 651) = 11.39, p = .001, \eta^2_p = .017^*$
Nostalgia	3.66 (1.38) [3.56, 3.77]	3.57 (1.37) [3.46, 3.67]	$F(1, 651) = 2.53, p = .11, \eta^2_p = .004$
Emotional Intensity	3.77 (1.07) [3.69, 3.85]	3.46 (1.15) [3.39, 3.57]	$F(1, 651) = 34.86, p < .001, \eta^2_p = .051^*$

* significant at the Dunn-Bonferroni-corrected level of $p < .0125$

A 2 x 3 x 2 mixed MANOVA revealed significant effects of cue type, $F(4, 648) = 15.52, p < .001, \eta^2_p = .087$, age group, $F(8, 1296) = 4.22, p < .001, \eta^2_p = .025$, and gender, $F(4, 648) = 2.62, p = .034, \eta^2_p = .016$, on emotional responses. No significant two- or three-way interactions were found; cue type and age group: $F(8, 1296) = 1.54, p = .14, \eta^2_p = .009$; cue type and gender: $F(4, 648) = 1.54, p = .19, \eta^2_p = .009$; age group and gender: $F(8, 1296) = 0.49, p = .87, \eta^2_p = .003$; cue type, age group, and gender: $F(8, 1296) = 1.64, p = .11, \eta^2_p = .010$.

Table 4 displays the univariate comparisons for the four emotion rating variables by cue type. MEAMs were accompanied by significantly higher ratings of positive emotions and emotional intensity and lower ratings of negative emotions than TEAMs, with no significant difference in nostalgia ratings. None of the post hoc tests for gender were statistically significant ($ps > .25$ following Dunn-Bonferroni correction). Age group had a significant effect on negative emotion ratings, $F(2, 651) = 7.08, p = .001, \eta^2_p = .021$, and a marginally significant effect on nostalgia ratings, $F(2, 651) = 4.11, p = .068$ following Dunn-Bonferroni correction, $\eta^2_p = .012$, with no significant effect on positive emotions or emotional intensity ($ps > .37$). Specifically, negative emotion ratings decreased with age (young group: $M = 1.99$, 95% CI [1.88, 2.11]; middle-aged group: $M = 1.86$, 95% CI [1.75, 1.97]; older group: $M = 1.70$, 95% CI [1.59, 1.80]) and nostalgia ratings increased with age (young group: $M = 3.42$, 95% CI [3.28, 3.59]; middle-aged group: $M = 3.69$, 95% CI [3.53, 3.82]; older group: $M = 3.74$, 95% CI [3.59, 3.88]).

COMPARING MEAMs AND TEAMs MATCHED ON CUE FAMILIARITY

Given that, across the sample as a whole, participants rated the music that cued their memories to be significantly more familiar than the TV cues, we conducted one additional set of analyses, to test whether the effects reported above could be attributed to cue familiarity. That is, we aimed to investigate whether some of the

phenomenological differences between MEAMs and TEAMs might disappear when the two cue types were matched on familiarity. For these supplementary analyses, we extracted a subset of 382 participants who gave the exact same familiarity rating (on a 5-point scale) for both the music and TV show that cued their reported memories. This sample comprised 123 young adults, 131 middle-aged adults, and 128 older adults, of whom 198 were women and 184 were men. We re-ran the three MANOVAs reported above on this subset of participants.

Full results of these analyses are reported in the Supplementary Materials (see mp.ucpress.edu). To summarize, the analysis of retrieval characteristics of the memories (vividness, reliving, etc.) revealed the same pattern of results to the full dataset, with the exception that the effect of age group on memory vividness ratings was no longer statistically significant. This MANOVA also produced a significant interaction between age group and gender that was not present in the analysis of the full dataset, but none of the post hoc univariate tests for this interaction effect were statistically significant. The analysis of the content of the memory descriptions also yielded very similar results to our initial analysis, with the exception that there was no longer a significant difference between MEAMs and TEAMs in terms of the percentage of words used from the "Percept" category. Finally, the analysis of the emotional responses revealed that MEAMs were still rated higher on positive emotions and emotional intensity than TEAMs, but this time with no significant difference in negative emotion ratings. The age-related decrease in negative emotions that was seen in the analysis of the full dataset was no longer present. However, the cue type by age group interaction found in this follow-up analysis indicated that MEAMs elicited more positive emotions than TEAMs in the two older age groups in particular. In addition, the analysis on this familiarity-matched subset of data revealed that men gave higher

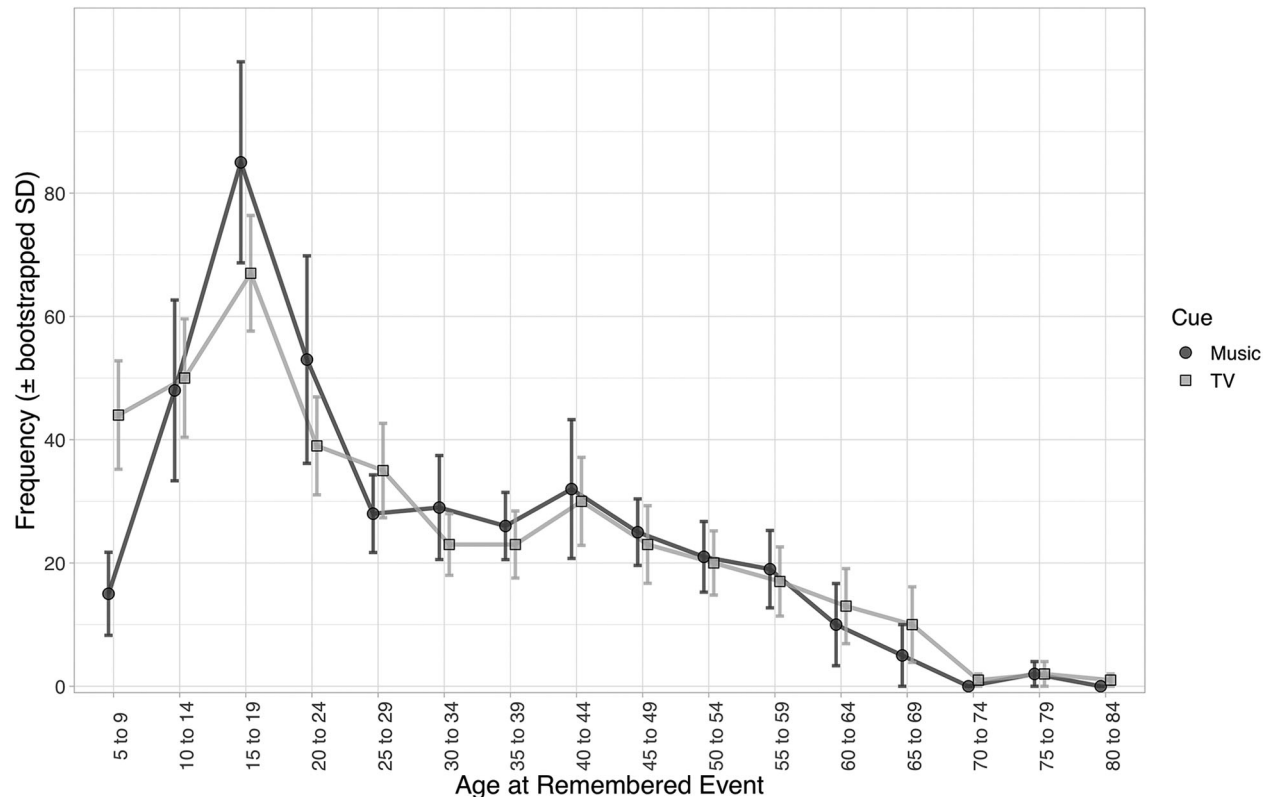


FIGURE 3. Number of memories for events across 5-year age bins, by cue type (music/TV), reported by participants currently aged 40 years or older ($N = 398$). Standard deviations have been estimated with maximum entropy bootstrapping for timeseries (Vinod & López-de-Lacalle, 2009) with 1,000 replicates.

positive emotion ratings than women, an effect that did not emerge in the analysis of the full dataset.

REMINISCENCE BUMP MEMORIES BY CUE TYPE

The final research question of interest in the present study was to compare the distribution of MEAMs and TEAMs from the reminiscence bump period. For this analysis, we included only the memories from the 401 participants aged 40 years or older (following Rathbone et al., 2017). We excluded three participants who reported memories that were dated to have occurred before the age of four years, given the unlikelihood that participants were actually able to remember such events from this period of “childhood amnesia” (Nelson & Fivush, 2004). Figure 3 shows the number of memories reported across 5-year age bins for each cue type. Although both cue types show a peak for memories from when participants were 15 to 19 years old, MEAMs exhibit a higher, more pronounced peak from ages 15 to 24 years. For subsequent analysis, memories were categorized as being from the reminiscence bump

period if the participant was aged 10 to 30 years when the remembered event first occurred (Rubin, Rahhal, & Poon, 1998). Note that this reminiscence bump categorization therefore includes the memories from age bins 10–14, 15–19, 20–24, and 25–29 years in Figure 3, in addition to some memories from the 30–34 age bin (events that occurred when participants were aged 30 years). The distribution of memories by cue type in accordance with their reminiscence bump status is presented in Table 5. Although music evoked more memories from the reminiscence bump period than TV, this distribution was not significantly different in a McNemar chi-squared test, $\chi^2(1) = 1.97$, $p = .16$.

Discussion

The present study investigated differences in the properties of autobiographical memories evoked by music and TV shows, and explored how such properties vary as a function of age and gender. The online survey method adopted here allowed us to collect a large

TABLE 5. Frequency (and percentage) of memories by cue type and whether they were from the reminiscence bump period (ages 10-30 years). McNemar $\chi^2(1) = 1.97, p = .16$.

Cue Type	Reminiscence Bump Memory	Non-Reminiscence Bump Memory
Music	228 (57.3%)	170 (42.7%)
TV	200 (50.3%)	198 (49.7%)

sample of naturally occurring memories from a more representative range of participants than has been possible in any previous MEAMs research to date. Despite the potential limitations of this naturalistic and retrospective reporting method, the present work has supported and extended previous findings to highlight several potentially distinctive features of MEAMs.

When comparing the properties of autobiographical memories as a function of cue type (music/TV), the majority of our hypotheses were supported. MEAMs exhibited several features indicating that these memories were richer in episodic detail than TEAMs, including greater self-report ratings of memory vividness, reliving, and reactivation of the same emotions as at encoding, as well as increased usage of perception-related words in written descriptions of the memories. This was the case despite the fact that TEAM descriptions contained more words, on average, overall. These results support those of Belfi et al. (2016, 2018) on MEAMs as compared to memories evoked by famous faces, and extend these findings to naturally occurring MEAMs in a more representative participant sample.

We also found novel evidence that MEAMs contained significantly more social content than TEAMs. Although previous research has indicated that MEAMs often comprise social themes (Jakubowski & Ghosh, 2019, Janata et al., 2007), other work has found no difference between the social content of music- and face-evoked memories (Belfi et al., 2020). The increased social content of MEAMs found in the current study conflicts somewhat with the often solitary nature of music listening that is prevalent in modern society; in the present study this was demonstrated by the fact that MEAMs were more likely to be experienced alone (69% of the time) than TEAMs (53% of the time). However, it appears that music can be a particularly effective means for allowing us to relive social encounters even in situations in which we are currently alone. This result aligns very well with recent findings by Schäfer and Eerola (2018), who studied how listening to music, watching TV, and reading fiction may be used as substitutes for social interaction. They found that reminiscing about people and events was rated as one of the most

important usages for music but was a less essential motivation for engaging with the other two media forms.

The responses to the fixed-choice question probing which people were present in the remembered event revealed that MEAMs contained more reports of significant others and friends, whereas TEAMs involved more family members, such as parents and siblings. This suggests that music- versus TV-cued memories may not only vary in terms of the *amount* of social content, but also *type of people* typically involved in the recalled events. This may be related to the frequency with which people engage with each cue type in the presence of different types of acquaintances; that is, it may be more common to listen to music with one's friends and watch TV with one's family (e.g., Larson, Kubey, & Colletti, 1989). Music also evoked many memories involving previous performances, with words such as "played" and "concert" appearing frequently in MEAM descriptions, as well as memories of activities that are often accompanied by music such as "dancing" and "driving." TEAM descriptions contained more references to the place in which TV is often watched—"home/house"—than MEAMs, and also contained more family-related words, similar to the fixed-choice response results.

MEAMs were rated significantly higher in personal significance than TEAMs. Adults aged 40 years and older also reported more MEAMs from the reminiscence bump period than TEAMs, although this difference was not statistically significant. Taken together, these results provide preliminary evidence that MEAMs might exhibit a privileged status in terms of their link to identity formation. During adolescence, people often engage with music as a means of connecting to their peers and forming in-groups on the basis of musical taste as well as other shared values (Laiho, 2004). Thus, music can become intimately linked to this period when an individual is exploring and developing his/her beliefs, ideals, and social identity. In addition, music is often present (and may play a prominent role) during other highly significant personal life events and turning points, such as initiations, weddings, and funerals, and may subsequently become an effective cue for these autobiographical milestones.

Finally, our study provides new insights on emotional responses to MEAMs. Specifically, MEAMs were rated higher in positive emotions and emotional intensity and lower in negative emotions than TEAMs, with no difference in nostalgia ratings. These results have potential implications for the use of music for positive emotion regulation and therapeutic purposes. In particular, these positive features of MEAMs persisted into older age,

and the analysis of the subset of data in which the two cue types were matched on familiarity revealed that older participants reported more positive emotions in response to MEAMs than TEAMs, while the youngest group gave similar ratings of positive emotions across both cue types. This indicates that music can be an effective vehicle for achieving motivational aims favoring positive emotional memory experiences in line with the socioemotional selectivity theory, in particular in older adults (Carstensen et al., 1999; Mather & Carstensen, 2005).

Contrary to our predictions, no difference in retrieval intentionality was found between MEAMs and TEAMs, despite previous indications that MEAMs are typically evoked highly involuntarily (El Haj, Fasotti, & Allain, 2012). However, MEAMs have not previously been compared to memories evoked via other sensory cues in terms of retrieval intentionality, and the present study revealed that *both* music- and TV-evoked memories tended to be rated as more involuntarily than voluntarily retrieved (mean ratings of 2.04 on a 5-point scale, where “5” = *completely deliberate recall*). The fact that we asked participants to assess retrieval intentionality retrospectively, some time after the MEAM/TEAM actually occurred, limits the extent to which we can be confident in participants’ ratings of this aspect of their memories. Future studies that capture measures of retrieval intentionality as a memory is being recalled should be conducted as a matter of priority, to further clarify this finding in terms of whether music and TV indeed exhibit comparable levels of direct access to autobiographical memories. In addition, research is needed that compares different methodological paradigms, including those where music/TV stimuli are presented to participants as memory cues (such as in the MEAM studies of Belfi et al., 2016, and Janata et al., 2007), naturalistic sampling of MEAMs/TEAMs during everyday life (e.g., Jakubowski & Ghosh, 2019), and the retrospective memory sampling method utilized here, in order to test whether retrieval intentionality varies in relation to cuing method. Such research is of particular importance given that voluntary/involuntary retrieval can impact on phenomenological qualities of the evoked memories (Berntsen & Hall, 2004; Schlagman & Kvavilashvili, 2008).

Overall, fewer age- and gender-related effects on the memory properties were found in comparison to cue type effects; these also exhibited smaller effect sizes than the cue type effects. The general lack of significant interactions (with the exception of the cue type by age group interaction effect on positive emotions found in the familiarity-matched data analysis) indicated that, for

the most part, effects of age and gender did not vary systematically in relation to whether the memory was cued by music or TV. This suggests that, in general, music may not exhibit differential access to certain types of memories in different periods of adulthood or as a function of gender. Instead, it appears that differences in properties of MEAMs in comparison to TEAMs are relatively stable across the adult population, whereas individual differences in age and gender exhibit (comparatively smaller) effects on properties of autobiographical memories as a whole.

Similar to previous research (Cuddy et al., 2017; Luchetti & Sutin, 2018; Rubin & Berntsen, 2009; Rubin & Schulkind, 1997), ratings of memory vividness increased with age for both MEAMs and TEAMs. Some evidence for an age-related positivity effect was found, as older adults gave lower ratings of negative emotions for both memory types. However, no significant increase in positive emotions was found with age, suggesting the positive emotions that are evoked by these memories, such as happiness and love, instead remain relatively stable across the lifespan. Interestingly, both of these age-related effects (on memory vividness and negative emotions) were no longer present when we conducted the same analysis on a subset of data matched on cue familiarity. This could be due in part to the relatively small effect sizes of these results in the initial analysis, but may also suggest that familiarity differences between cues elicit differential effects on aspects of memory depending on the participant’s current age (cf., Ford et al., 2016, who reported different effects of familiarity on memory specificity and positive affect in younger versus older adults). It should be noted, however, that the three age groups did not differ in their familiarity ratings of the cues overall ($ps > .17$ in Mann-Whitney tests for independent groups), which precludes the explanation that the older adults were simply more familiar with the cues than the younger adults.

The memory properties measured here were relatively unaffected by gender differences. One small effect was found in which women reported a greater percentage of social details in their memory descriptions. This aligns with previous research indicating that women tend to include more details of interpersonal relationships in autobiographical memory narratives than men (e.g., McAdams et al., 2006; Walls et al., 2001). In a comprehensive review of gender differences in autobiographical memory, Grysman and Hudson (2013) highlighted that gender differences are rare in studies using ratings scales, as opposed to narrative measures. They emphasize that these two methodologies tap into somewhat different dimensions of the memory experience, with

rating scales assessing participants' opinions and memories for events and narrative accounts reflecting how participants conceptualize and interpret these experiences. This assessment aligns very well with the present results, in which the only robust gender difference we found was derived from participants' written accounts of their memories, with no differences for any of the rating scale measures. One additional gender effect surfaced in the familiarity-matched cues analysis, in which men gave higher ratings of positive emotions than women. This effect was not present in the main analysis of the full dataset and does not appear to have a precedent in previous literature, but merits further investigation to test whether it can be replicated in future work.

An important question that emerges from the overall results of this study is *why* music is able to cue more episodically rich, personally significant, and emotional memories than TV shows. Although the music cues in our study were not rated as more liked than the TV cues and music was actually listened to *less* frequently than TV was watched, the music cues were rated as significantly more *familiar* than the TV shows. However, the majority of the significant effects of cue type were still present in a follow-up analysis of a subset of data in which the music and TV show cues were given identical familiarity ratings (with the exception of the cue type effects on the percentage of "Percept" words used in memory descriptions and the negative emotion ratings). One potential explanation for these remaining differences between MEAMs and TEAMs could be that, although self-reported familiarity (as rated on a 5-point scale) did not substantially explain these differences, this familiarity measure may not be nuanced enough to capture the number of total exposures to a particular cue over one's lifetime. Favorite pieces of music are often listened to over and over for many years (Janssen, Chessa, & Murre, 2007), whereas TV shows may not be re-watched as frequently. Therefore, MEAMs may be more frequently rehearsed than the TEAMs evoked in our study; specifically, listening to a particular piece of music may have evoked that same memory many times before. Our analysis of the memory descriptions also indicated that music may provide a closer cue-target match than TV shows; that is, music more often brought back memories of instances of listening to the same piece of music, whereas TV tended to cue memories in a more diverse range of ways (e.g., seeing a place that one had previously visited on TV, seeing characters involved in a situation that paralleled a situation from one's own life, etc.). This suggests that music may serve more frequently as a direct retrieval cue than TV, and thereby access more specific episodic details.

Future experimental research should aim to more systematically measure, or even manipulate, participants' frequency of exposure to music and other cues (TV, photographs, etc.), in order to further probe the effects of cue exposure frequency/familiarity on associated memory properties. In addition, a measure of rehearsal frequency of the autobiographical memories that are evoked (i.e., how often they have been recalled before) would be of use, since some memories may come to mind in response to a variety of different cues. Thus, cue exposure frequency and memory rehearsal frequency should be measured as separate constructs. As noted above, the particular situations/contexts in which one is exposed to music may also differ in comparison to TV (or other cues): music is often a prominent feature during important life events and periods of identity formation. Although this is often seen as a formidable challenge to autobiographical memory research in general, studies that aim to capture features of the initial memory encoding stage can shed valuable light on this currently under-investigated aspect of MEAMs.

A few additional limitations of the current study should be noted. The survey utilized a retrospective method of collecting reports of MEAMs and TEAMs. Although we asked participants to report on their most *recent* MEAM and TEAM experience in order to minimize the length of time between the experience and the report, the responses are still subject to potential memory biases and forgetting. For example, many of the memories that were reported seemed to be regularly experienced (e.g., "I think of her [my daughter] every time I hear it," "Every time I watch, it reminds me of my youth watching with my mother and father"), indicating that well-rehearsed memories were potentially more accessible via this retrospective method, although this applied across both MEAMs and TEAMs. Forgetting was also evidenced in the responses of some participants, as 20% of the initial data were excluded due to participants not providing a memory description for either the MEAM or TEAM (with some participants explicitly writing comments such as "I don't remember"). However, importantly, the final sample still reflected the demographic characteristics of the initial target sample, indicating that factors such as age and gender did not play a role in how well participants were able to recall a MEAM and TEAM. Nevertheless, the results of this study should be replicated using a complementary methodology that captures such memory experiences directly as they happen (e.g., laboratory experiment or Experience Sampling of the memories as they occur in everyday life). In addition, several of the self-report measures used here could be further

supported by behavioral or physiological measures in future research in more controlled settings (e.g., reaction times to complement the retrieval intentionality ratings, measures of electrodermal activity to complement the emotion ratings).

In conclusion, this study has revealed several key phenomenological differences between naturally occurring autobiographical memories cued by music and TV. Autobiographical memories evoked by music were characterized by greater episodic detail, personal significance, social content, and positive, intense emotional responses. Although a handful of these phenomenological properties were affected by age and gender, these effects of individual differences were generally consistent across memories cued by music and TV. These findings provide new insights on the distinctive associations that are made in the general population between

pieces of music and vivid, personally valued memories, which appear to be accessible and relatively stable throughout the course of adulthood.

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Appendix 1

Survey Questions on Demographics, MEAMs/TEAMs, and Music/TV Engagement

Demographics (response options in italics):

Gender

Male; Female

Age (in years)

Dropdown menu ranging from 18 to 100

In which country do you currently live?

Dropdown menu

In which country were you born?

Dropdown menu

What is your annual household income? (taking into account all income, benefits and pension payments, and **after** taxes have been deducted)

Less than £15,700; £15,700 to £24,000; £24,001 to £34,300; £34,301 to £50,400; More than £50,400

What is the highest educational qualification you have attained?

Primary school; High school/GCSE; A-Levels; Currently pursuing undergraduate degree; Undergraduate degree completed; Currently pursuing postgraduate degree; Postgraduate degree completed

General MEAM/TEAM Frequency (response options in italics):

About how often does **listening to music** bring back autobiographical memories for you?

Less than 25% of the time that I listen to music; 25-50% of the time that I listen to music; 50-75% of the time that I listen to music; 75-100% of the time that I listen to music

About how often does **watching TV** bring back autobiographical memories for you?

Less than 25% of the time that I watch TV; 25-50% of the time that I watch TV; 50-75% of the time that I watch TV; 75-100% of the time that I watch TV

Recent MEAM/TEAM (response options in italics):

[Note that questions were identical for MEAMs and TEAMs, except where noted below. For TEAMs, all

instances of 'listening to music' were replaced with text referring to 'watching TV']

Please think of the most RECENT experience that you can when you were listening to music that brought back an autobiographical memory.

For example, hearing the song 'My Girl' might have reminded you of dancing with your first boy/girlfriend at a particular high school dance, bringing you back to the sights, sounds, and feelings of that event.

When you have a specific experience in mind, please answer the following questions.

How recently did this experience happen?

Today; Within the past week, but not today; 1 - 2 weeks ago; 2 weeks - 1 month ago; More than 1 month ago

Was the music you were listening to a live performance or a recording? [NOTE: this question was only present in the MEAMs but not the TEAMs condition]

Live performance; Recording; Other

Were you listening to the music alone or with other people?

Alone; With other person/people

What is the **name** of the song/piece of music?

Free response question

Who is the **performer** of the song/piece of music?

Free response question

Please include a **YouTube or internet link** to the version of the music you were listening to, if possible:

Free response question

How much do you **like** this particular music?

1 (dislike a lot); 2 (dislike a little); 3 (neither like nor dislike); 4 (like a little); 5 (like a lot)

How **familiar** are you with this music?

1 (not familiar); 2 (a little familiar); 3 (moderately familiar); 4 (quite familiar); 5 (very familiar)

Next, you will be asked to describe aspects of the **autobiographical memory** that you thought of in relation to this music.

Please tick below any particular **people** who were in the memory (you can tick as many choices as needed).

Friend(s); Spouse/Partner; Parent; Sibling (brother/sister); Child (son/daughter); Other relative (please specify); Other person (please specify); None

Please tick below any **places** involved in the memory (you can tick as many choices as needed).

School; University; Car; Concert/Gig; Restaurant; Bar/Pub; Club; Party; Church; Home; Work; Holiday/Vacation (please specify location); Other (please specify); None

Please **describe the autobiographical memory** as thoroughly as possible, including **details of the event/activity**.

Free response question

How old were you (**in years**) during the event that you recalled?

Dropdown menu from 1 to 100

Please rate the **degree of control** you had over bringing the memory to mind, in terms whether the memory came to you spontaneously or you tried deliberately to think of this memory.

Completely spontaneous recall/ Somewhat spontaneous recall/ Neither spontaneous nor deliberate recall/ Somewhat deliberate recall/ Completely deliberate recall

How **vivid** was the memory in your mind?

1 (not at all vivid); 2; 3; 4; 5 (very vivid)

When this memory came to mind, to what extent **did you feel you were reliving** the original event?

1 (not at all); 2; 3; 4; 5 (as clearly as if it were happening now)

When this memory came to mind, to what extent **did you feel the same particular emotions** you felt at the time of the event?

1 (completely different emotions); 2; 3; 4; 5 (identically the same emotions)

How significant is this memory to your life?

1 (not at all); 2; 3; 4; 5 (more than any other memory)

Please rate the **overall intensity of the emotions** that you felt when thinking about this memory.

1 (not intense); 2; 3; 4; 5 (very intense)

Please rate **how much you felt each of the following emotions** when thinking about this memory. (all presented with a 1-5 rating scale from 1 = not at all to 5 = a lot)

*Happiness/elation
Sadness/melancholy
Surprise/astonishment
Calm/contentment
Interested/captivated
Nostalgia/longing
Anxiety/nervousness
Pride/confidence
Anger/irritation
Love/tenderness
Disgust/contempt
Admiration/awe*

If there are any other emotions you felt that were NOT listed above, please list them here.

Free response question

Music and TV Engagement (response options in italics):

On average, I **listen attentively to music** for the following amount of time per day:

0-15 mins; 15-30 mins; 30-60 mins; 60-90 mins; 2 hours; 2-3 hours; 4 hours or more

On average, I **attentively watch TV** for the following amount of time per day:

0-15 mins; 15-30 mins; 30-60 mins; 60-90 mins; 2 hours; 2-3 hours; 4 hours or more

I have had ___ years of formal training on a musical instrument (including voice) during my lifetime.

0; 0.5; 1; 2; 3-5; 6-9; 10 or more

Which of the following best describes you?

Non-musician; Music-loving non-musician; Amateur musician; Serious amateur musician; Semi-professional musician; Professional musician

Appendix 2

Examples of Typical MEAM and TEAM Descriptions

Participant Age (Years)	Music Cue	MEAM Description	TV Cue	TEAM Description
20	<i>Rap God</i> (Eminem)	My cousins and siblings and I used to rave to Eminem when they would come to our house for Christmas break	<i>Suits</i>	My friend and I went for an evening meal which we planned out in school and got detention for talking about
41	<i>Bohemian Rhapsody</i> (Queen)	My Brother's 18th birthday on our first Family holiday abroad in Spain. My Brother and I went out for drinks. This song played at a bar/club. I remember that night everytime I hear the song.	<i>Friends</i>	First anniversary; I brought my Girlfriend roller boots and she not only loved them she was amazingly surprised
57	<i>We are the Champions</i> (Queen)	We wanted to go and see Queen in concert, but couldn't really afford it, so we didn't. Then Freddie Mercury died.	<i>The Good Life</i>	We used to watch this with a bottle of wine and a M&S recipe meal