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The impact of song-specific age and affective qualities of popular songs on music-evoked autobiographical memories (MEAMs)

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Abstract

Songs heard between the ages of 15 and 24 should be remembered better and have a stronger relationship to autobiographical memories when compared with music from other phases of life ("reminiscence bump effect"). Additionally, the proportion of music-evoked autobiographical memories (MEAMs) is at a maximum in these years of early adolescence and then declines up to the age of 60. In our study we tried both to replicate these important findings based on a German sample and to further investigate the influence of the affective characteristics of the songs on the frequency of participants' autobiographical memories. In Experiment 1 a group of adults ($N = 48$, $M_{age} = 67.1$ years) listened to excerpts from 80, number-one, popular music hits from 1930 to 2010 and gave written self-reports on MEAMs. In Experiment 2 the affective characteristics were rated by another group of adults ($N = 22$, $M_{age} = 66$ years) and were used to predict the frequency of MEAMs. As a main result of Experiment 1, we confirmed the reminiscence bump and decline effect with a small effect size for the ratings of feelings evoked by the song and with a medium effect size for the song recognition performance of those songs released during the participants' age range of 15 to 24 years. The total number of MEAMs was only marginally influenced by a memory bump and decline effect, and participants showed a significant proportion of MEAMs up to the fifth decade. Experiment 2 revealed that the affective ratings of the songs were unequally distributed over the two-dimensional emotion space unlike the average rate of MEAMs which was nearly equally distributed. In contrast to previous research, we therefore conclude that

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popular songs can be associated with autobiographical memory over five decades of life – independent of the affective character of the music.

Keywords
arousal, music-evoked autobiographical memory, popular music, reminiscence bumb effect, song-specific age, valence

Since the pioneering study on very long-term memory for popular songs by Bartlett and Snelus (1980), there has been extensive research on the relationship between autobiographical memory and popular music (e.g., Barrett et al., 2010; Basso, Basso, & Olivetti Belardinelli, 2004; Cady, Harris, & Knappenberger, 2008; Hyman & Rubin, 1990; Janata, Tomic, & Rakowski, 2007; Krumhansl & Zupnick, 2013; Vuoskoski & Eerola, 2012). Although music is not the only content that is related to autobiographical events (Janssen, Chessa, & Murre, 2007; Larsson & Willander, 2009; Willander & Larsson, 2006), repeated listening to music differs from the use of other cultural products, such as reading books or viewing movies only a limited number of times. As Janssen et al. (2007) suggested, music-evoked autobiographical memories (hereafter referred to as MEAMs, as suggested by Janata et al., 2007) begin at the listener's first encounter with a particular record or song (differential encoding) and are increased by repeated listening (re-sampling). Additionally, music is particularly suitable for associations with autobiographical life events because it conveys emotional content and features repeating elements, such as the chorus and lyrics (Cady et al., 2008). In our study, the construct of autobiographical memory is regarded as the product of a phenomenally experienced single episode (Brewer, 1996, p. 19) and understood as the "memory of information related to the self", which is in accord with Brewer's (1986, p. 26) definition.

Although autobiographical memories are acquired over the entire lifespan, the prevalence of memories differs between age phases. As described by Rubin, Wetzler, and Nebes (1986), autobiographical memories are not constantly accessible but are influenced by two main age-related effects: namely, reminiscence and infantile amnesia. Reminiscence effects influence the retention rate of events during adolescence and early adulthood (between 10 and 30 years) and are stronger for positive memories than for neutral or negative ones (Baddeley, Eysenck, & Anderson, 2009, p. 142; Rubin et al., 1986). The second age-related effect that influences the retention of autobiographical events is infantile amnesia, which is the lack of memories of the first years of life (Baddeley et al., 2009). Wetzler and Sweeney (1986) and Nelson (1993) argued that people have only limited or unreliable access to memories of events that occurred prior to their fifth birthdays.

But why is the relationship between music and autobiographical memories of interest for empirical music research? From a modern perspective of social psychology of music, one important function of music in everyday life is the management of self-identity (Hargreaves & North, 1999). Along these lines, one of the primary reasons that people engage with music (e.g., by collecting music) is memory retrieval: for example, to relive an event or an emotionally critical moment from the past (DeNora, 2000; Dibben, 2002). Based on data from an experience sampling study with 346 participants, North, Hargreaves, and Hargreaves (2004) found that 10.1% of all listening episodes were related to the category of "bringing back certain memories" when participants deliberately chose to hear music. This result is in line with the study by Schäfer and Sedlmeier (2010) on the reasons for liking music: the authors found that an important cognitive function of preferred music is its potential for self-reflection – for example, when used to reminisce. In another study on the fundamental functions of music listening, Schäfer, Sedlmeier, Städtler, and Huron (2013) could confirm "self-awareness" (e.g., represented by items such as "because it helps me reminisce") as the most important one of three main motivational factors for listening to music. Vuoskoski and Eerola (2012) observed that there was a relationship between sad music and sad autobiographical memories, which was stronger for self-selected music (reports by 47% of participants) compared to researcher-selected music (reports by 3% of participants). Finally, research on MEAMs revealed the emotional quality of the evoked memories, which can best be described by nostalgia in terms of a mixed, bittersweet emotion characterized by concurrent elements of happiness and sadness (Barrett et al., 2010). Such nostalgic memories seem to be an important emotional byproduct of an experience with music (Zentner, Grandjean, & Scherer, 2008); these memories are mostly related to persons and periods and stronger for familiar than for unfamiliar music (Janata et al., 2007).

In their groundbreaking study on MEAMs, Schulkind, Hennis, and Rubin (1999) compared younger adults' ($n = 18$, $M_{age} = 19.0$ years) memories for recent music with older adults' ($n = 18$, $M_{age} = 67.5$ years) memories of the music of their own generation to determine whether memory for popular music remains relatively intact across the lifespan. Schulkind et al. (1999) revealed that (a) emotionality ratings reached their maximum for songs heard during adolescence and early adulthood (between the song-specific age [SSA] of 15–24 years)[1] and showed a significant decline only over the subsequent five decades; (b) songs from this period (15–24 years) were more familiar; (c) memories of specific events were at a maximum for this period; (d) memories from a general period in life were at a maximum for the SSA of 5–14 years; (e) mean differences between the actual year of popularity and participants' ratings were smallest for this period; (f) for the period of childhood and youth (the SSA of 5–14 years), more song details were remembered correctly; (g) there was an overall significant positive relationship between emotional evaluation and MEAMs (general period: $r = .74$; specific event: $r = .54$).

Two more recent studies have given detailed insight into the relationship between memory for popular songs, autobiographical memories and age: Krumhansl and Zupnick (2013) investigated the reminiscence bump for autobiographical memories, quality judgements and emotional reactions in 20-year-olds compared with the music experiences of their parents. According to the authors, the young participants showed a typical increase for music ratings and MEAMs for songs released during their parents' first two decades of life. Thus, music experiences in the home environment seem to function in terms of a musical cultural transmission over generations in terms of "cascading reminiscence bumps". In a study by Zimprich and Wolf (2015), the authors wanted to replicate the finding of a better song recognition performance for those songs (31 Top 3 songs of the German charts between 1954 and 1997) listened to between the age of 10 and 30 (memory bump effect) based on a sample in the age range between 58 and 86 years. They found a high degree of individual variability in the location of the reminiscence bump for song recognition with an average peak around the age of 29 years. However, this finding cannot be interpreted in terms of a deterministic memory model; the authors emphasized by means of a linear mixed model approach that the location and variance of the bump's position is modulated by the participants' preferences for rock and pop music during their youth.

Motivation for the current study

An important motivation for our study was to test for the validity of previous findings on memory for popular music, which was heard during the decades of adolescence and early adulthood. Second, significant changes in the media and society from 1999 to 2013 make it plausible that the increasing availability of music on the Internet and via mobile devices over the last two decades could have had a significant influence on the relationship between musical events and autobiographical memory. Third, in light of Zimprich's and Wolf's (2015) general critique on the methodological approaches of earlier studies, we aimed to increase the internal validity of responses by use of an open-answer format for MEAMs with subsequent coding (controlled for inter-rater reliability). Moreover, from our point of view, another critical point raised in previous studies concerns the chronological age related to MEAMs. Despite the possibility that parents' memory-evoking music might elicit MEAMs in their offspring (Krumhansl & Zupnick, 2013), we consider infantile memories unreliable because they seem to differ individually by a high degree. As reported by Baddeley et al. (2009, pp. 281), 2-year-olds might have autobiographical memory for events occuring several months earlier (e.g., injury), but these memories depend on the child's language skills to talk about the event at the time it happened. Thus, "children under the age of 3 typically have much poorer verbal recall of even significant events" (p. 283). Autobiographical memories from the early years of life are also fostered by parents who have an elaborative reminiscing style (Baddeley et al., 2009, p. 285). These high degrees of unreliability and intraindividual variability prompted our decision to exclude MEAMs from a song-specific age of less than 5 years. In other words, due to the unpredictable effects of so-called "infantile amnesia" (see Baddeley et al., 2009, p. 142; Baddeley & Wilson, 1986), we decided that participants should have been at least 5 years old at the time of song release (see Bartlett & Snelus, 1980). Fourth, it remains open whether results reported in earlier studies (e.g., Schulkind et al., 1999) can be transferred under culturally different conditions (e.g., USA vs. Germany; for a general discussion, see Henrich, Heine, & Norenzayan, 2010). Fifth, to avoid the Type II error (false negative error, see Ellis, 2010, p. 50) for rare events, such as specific autobiographical memories, the number of participants and test power were increased. Finally, previous studies did not consider the emotional features of the musical stimuli, although more recent research has shown that there is a relationship between the emotions triggered by music and episodic long-term memory (see, e.g., Bower, 1981; Eschrich, Münte, & Altenmüller, 2008; Holland & Kensinger, 2010; Jäncke, 2008; Tesoriero & Rickard, 2012; Vuoskoski & Eerola, 2012).

Rationale of the study

The main aim of the study was two-fold: first, the results from previous studies on bump and decline effect of MEAMs (Experiment 1) were to be validated; second, we wanted to go beyond previous studies by investigating the influence of the emotional characteristics of the music samples (valence and arousal) on the frequency of reported MEAMs (Experiment 2).

Experiment 1

Study design

The study was conceived as a laboratory survey, with written responses in a standardized, open-answer format. Sociodemographic variables (age, sex, level of education) were recorded as control variables as well as self-reports on the current state of health and auditory functions (1 = very poor, 4 = very good). In line with Schulkind et al.'s (1999) methodological approach, the following dependent variables were measured by means of dichotomous or Likert scales: *familiarity of the piece* (Have you ever heard the song before? [yes/no]); *liking* (How much do you like the song? [1 = not at all, 5 = very much]); *emotionality* (How do you feel when listening to the song? [1 = very unhappy, 5 = very happy]); *year of popularity* (What year was the song popular? [exact year]). Additionally, for measurement of the variable *combined recall*, participants had to provide the title of the song, the name of the performer/band, and four words in a lyric completion task (see Table S1 in Supplemental Material Online for song details). For the recording of MEAMs, participants gave written responses to the question: "Does this song remind you of anything from your life? If yes, please write down your reminiscence".

Some differences between our design and previous studies should also be emphasized: first, to avoid the rating of songs released before the subject was born (the so-called negative song-specific age values: see Results section and Hemming, 2013; Holbrook & Schindler, 1989) and because of our interest in older adults' memories for songs from their entire lifespan, we did not consider a group of younger participants. Second, the songs in our study covered a larger age range of 80 years. Third, to increase the internal validity of responses, we tried to increase the demands for a valid response and thus decided to use an open-answer format for the detailed recording of MEAMs. Fourth, due to the excessive time needed for the complete presentation of all songs (80 song examples [each of 30 s duration] × 3 minutes response time [plus time for writing of the memories] = about 280 minutes), we used instead an incomplete blockwise randomized design based on four randomized song selections of 20 songs from 10 equal-spaced periods presented in forward/backward sequence, thus giving us a design of 4 (sequences A to D) × 2 (forward/backward) × 10 (songs). Each participant listened to a random selection of 20 songs from eight decades (see flowchart in Figure 1). As a result, each participant listened to a total selection of 20 musical samples comprised of different songs. For the evoking of memories, we used a cued-recall paradigm (Baddeley et al., 2009, p. 141) with music excerpts of 20 s duration as memory probes. In this line of research, music is regarded as "a very powerful cue for retrieving autobiographical memories" (Krumhansl & Zupnick, 2013, p. 2059).

Method

Participants. Participants were recruited by a call for participation published in a local newspaper in the region of Hanover, Germany, with the title "Songs from your Life". A minimum age of 50 years was required. The sample was comprised of $N = 48$ valid cases (equal proportions of male and female participants), with an average age of 67.1 years ($SD = 6.8$, range = 52–82 years; for age distribution see Figure S1 in Supplemental Material Online). Subjects gave written self-reports on their general state of health and auditory functions (see Table 1). Reports did not show any abnormalities. None of the participants had received formal instrumental training for more than three years ($M = 2.1$, $SD = 2.9$ years). As a supplement to demographic standards, information on the level of education was requested by means of the "International Standard Classification of Education" (ISCED, 1997). As Table 1 shows, the majority of participants had completed apprenticeships, vocational training, or university degree programmes (ISCED97 level 4 to 5).

Materials. Based on the anthology of German number-one chart hits by Ehnet (2002),[2] we selected 80 songs (released between 1930 and 2010) along the following criteria: songs had to have the highest chart position in a specific year, but they were not to be released again in the same version or as a cover version in the Top 10 of a subsequent year. Additionally, all songs had to have a sufficient amount of lyrics so that the participants could complete the lyric continuation task. No performer/band was to appear multiple times in different songs. No song was selected for 1946 because the only title available in the original version, Ferdl Weiß – *Ein Wagen von der Linie 8*, is mostly in parlando style with no melody of sufficient length, and the alternative two most successful songs of the same year, Peter Igelhoff, *Skandal im Harem*, and Günther Schulze, *Es war einmal eine Liebe*, were available only as cover versions. The excerpts from the

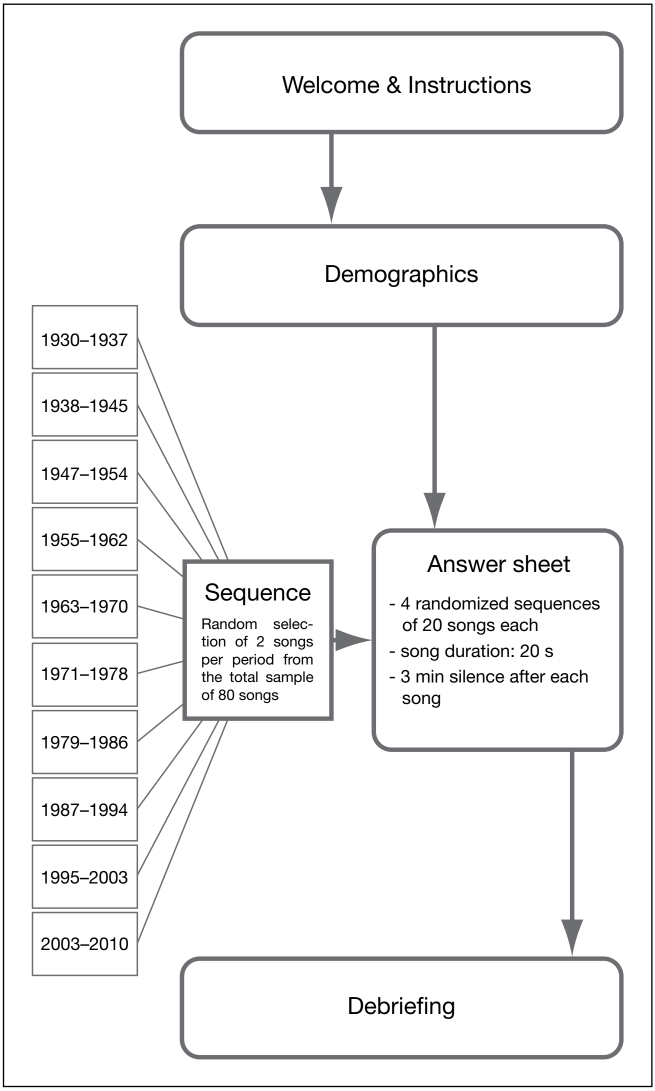

Figure 1. Flowchart of the study on music-evoked autobiographical memories (Experiment 1).

songs had a length of 20 s, ranging 10 s before and after the beginning of the chorus and including 1 s for fade-in and fade-out (Kopiez, Platz, Müller, & Wolf, 2015). The length of 20 s for musical examples is within the range of previous studies (see Altenmüller, Siggel, Mohammadi, Samii, & Münte, 2014; Basso et al., 2004; Bigand, Vieillard, Madurell, Marozeau, & Dacquet, 2005; Cady et al., 2008; Janata, 2009).

Procedure. The survey was conducted in the years 2011 and 2012 in small groups with no more than five participants, who sat at separate desks. First, a short introduction to the task was given in written form. Participants filled in the sociodemographic questionnaire and gave written informed consent. The written instructions were as follows:

Table 1. Descriptive data of sample in Experiment 1 (N = 48).

	M	Range	*SD*	*N* (%)
General state of health	3.2	2–4	0.5	–
Auditory functions	3.1	2–4	0.5	–
Age				
Male	68.6	53–78	6.2	24 (50.0)
Female	65.6	52–82	7.0	24 (50.0)
Total	67.1	52–82	6.8	48 (100.0)
Level of education (ISCED97)				
Level 3				8 (16.7)
Level 4				12 (25.0)
Level 5				26 (54.0)
Level 6				2 (4.2)

Note. Self-rating of general state of health and auditory functions: 1 = very poor, 4 = very good; level of education according to the International Standard Classification of Education (ISCED, 1997).

> In this study on the relationship between autobiographical memory and music, you will listen to 20 short musical examples of 20 seconds each. Examples will be played only once. Each example is followed by a three-minute break. During this break, your task is to write down all personal memories – if any – this song reminds you of. The end of the break will be announced by a signal.

Talking was not permitted during the entire survey. The data collection procedure started with an example as a warm up (Hans Albers, *La Paloma*, 1944). The entire duration was about 90 minutes, and participants were debriefed. No reimbursement was paid.

Results

Data analysis. All responses from Experiment 1 are shown in Table 2. Although a total of 960 responses (20 songs × 48 participants) would be expected in the column "Total", the number of valid responses was smaller due to (a) the exclusion of responses for those subjects who were younger than 5 years when the song was released (SSA < 5 years) and (b) a certain number of missing responses. For example, for the category of familiarity, we received n = 947 responses with n = 608 in the category of positive familiarity with the particular song and n = 102 negative (unfamiliar) responses, resulting in n = 710 valid responses. In a first step of data preparation, self-reported written MEAMs had to be transcribed and coded into the categories of *specific* and *general* memories. A specific autobiographical memory was defined as a "type of episodic memory comprising vivid personal recalling the time and place of events", whereas a general autobiographical memory was defined as a written music-evoked response which gives "narrative, factual knowledge about oneself" (VandenBos, 2007, p. 90), but with no detailed information on place *and* time of the event. For example, comments such as "New Year's Eve at home in 1954" or "my honeymoon in Greece in 1962" represent specific memories; in contrast, comments such as "childhood in Berlin" and "dance parties" were coded as general memories. Other missing or unrelated utterances (e.g., "corny music") were coded into the category of "no memory". Written records on MEAMs were coded into the two categories by three trained raters. The reliability of coding was tested with a selection of 20 written comments to be coded independently by three trained coders. Inter-rater reliability was calculated by means of the

Table 2. Descriptive data for dependent variables in Experiment 1.

	Song-specific age (decades)									
	5–14	15–24	25–34	35–44	45–54	55–64	65–74	>74		
Category	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	*N°/M/SD*	Total *N°*	Missing
Liking	114/3.2/1.0	117/3.6/1.1	105/3.3/1.0	112/3.6/1.0	108/3.5/1.1	95/2.8/1.2	43/3.0/1.1	4/2.8/1.5	698	30
Emotionality	114/3.4/0.7	117/3.6/0.7	105/3.4/0.7	112/3.5/0.8	108/3.4/0.8	95/3.0/0.9	43/3.1/0.8	4/2.5/1.0	698	30
Combined recall	114/0.3/0.3	117/0.4/0.3	105/0.3/0.3	112/0.2/0.2	108/0.1/0.2	95/0.1/0.2	43/0.1/0.2	4/0.0/0.0	698	30
Years away	101/1.6/10.5	105/2.7/17.0	85/3.0/9.3	89/–0.5/13.3	81/-4.3/12.4	48/-5.7/12.3	19/–5.6/13.6	1/n.d./n.d.	529	199
	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	N^+/N^{+-}/%	Total N^+/N^{+-}/All	
Familiarity	114/115/99.1	117/119/98.3	101/104/97.1	100/112/89.3	89/113/78.8	58/97/59.8	28/46/60.9	1/4/25.0	608/710/947	
General memories	74/118/62.7	82/121/67.8	66/106/62.3	70/116/60.3	68/118/57.6	49/98/50.0	24/47/51.1	1/4/25.0	434/728/947	
Specific memories	10/118/8.5	9/121/7.4	2/106/1.9	1/116/0.9	4/118/3.4	2/98/2.0	1/47/2.1	0/4/0.0	29/728/947	
Total memories	84/118/71.2	91/121/75.2	68/106/64.2	71/116/61.2	72/118/61.0	51/98/52.0	25/47/53.2	1/4/25.0	463/728/947	

Note. Although the theoretical number of responses should be 960 [20 songs × 48 participants], the number of valid responses (*N°*) is always smaller due to exclusion of responses within song-specific age category < 5 years. Ratings of liking ("How much do you like this song?"): 1 = not at all, 5 = very good; ratings of emotionality ("How do you feel when listening to this song?"): 1 = very unhappy, 5 = very happy; combined recall: average of correct identification of song title, performer and song lyrics (max. score = 1); years away: average difference between estimated year and actual year of song release. For "years away", positive values indicate that the estimated year of song release was later than the actual year and vice versa. *N°* = number of valid responses (participants × songs) within each SSA categoy; N^+/N^{+-}/% = values indicate number of valid "yes" responses (N^+)/number of total valid responses (N^{+-}) /proportion of "yes" responses in relation to all valid responses (N^{+-}) within SSA categories (familiarity: *N* = 710 valid responses; general, specific and total memories: *N* = 728 valid responses). Total *N* = sum of valid "yes" responses (N^+), valid "no" responses (N^-), and missing responses after exclusion due to a song-specific age of < 5 years. Repeated measures analyses for liking, emotionality, combined recall, and year of song release are available from Table S2 (see Supplemental Material Online). Analyses of effect sizes for all dependent variables showed the following results: liking: $\eta^2 = 0.05$ (small effect), emotionality: $\eta^2 = 0.05$ (small effect), combined recall: $\eta^2 = 0.12$ (medium effect), years away: $\eta^2 = 0.06$ (medium effect). Familiarity as a function of song-specific age categories: $X^2(6, N = 608) = 127.3$, $p < .001$, $\omega = 0.46$ (medium effect); general memories: $X^2(6, N = 434) = 9.5$, $p = .15$, $\omega = 0.15$ (small effect); specific memories: $X^2(6, N = 29) = 15.6$, $p = .02$, $\omega = 0.73$ (large effect); total memories: $X^2(6, N = 463) = 18.5$, $p = .005$, $\omega = 0.20$ (small effect). Due to the very low number of frequencies, the category of SSA > 74 was excluded from X^2 analyses. For benchmarks of effect sizes, see Ellis (2010, p. 41). Effects size calculation:

$$\eta^2 = \frac{SS_{treatment[SSA\ decade]}}{SS_{total}}, \quad \omega = \sqrt{\frac{X^2}{N}}.$$

intraclass correlation coefficient (ICC). The ICC is used to express how observations in the same category are related or how they tend to be more alike on average than observations in different categories. It indicates how the values of an individual rater are correlated with the values of other raters (Hays, 1994, p. 535). The inter-rater reliability was ICC (2, 1) = .81, which can be interpreted as an "almost perfect" (Landis & Koch, 1977) strength of agreement beween coders.

In a second step of data preparation, songs had to be categorized by the same system of description. As already suggested by Rubin et al. (1986, p. 213), "reminiscence can best be described in terms of the age of the subject at the time of the memory". Thus, to represent the relationship between the year of song release and the participant's age in one value, we decided to define the song-specific age (SSA) as the difference between a song's year of release and the listener's year of birth, as suggested by Holbrook and Schindler (1989). For example, if a song released in 1960 was evaluated by a listener born in 1940, that would result in an SSA of 20 years. In other words, the SSA identifies a person's age when listening to a freshly released song, independent of the person's absolute year of birth. This transformation made findings much easier to interpret in terms of comparing lifetime experiences of participants of different ages.

In a third step of data preparation, we filtered the responses further. First, we did not consider responses to songs that were released before the participant was born because that would have resulted in a song categorization with a negative SSA. In the case of a song being older than the subject, we would not have been able to control for the exact time of the participant's exposure to or familiarity with the particular song. Second, due to the unreliability of autobiographical memory in the early ages (so-called "infantile amnesia", see Baddeley et al., 2009, p. 142; Baddeley & Wilson, 1986), all responses with SSAs before the age of 5 were excluded. Finally, we aggregated all data into decades.

Distribution of responses across the lifespan. As shown in Figures 2A–D and Table 2, differences in ratings for dependent variables between SSA decades were found as follows: for "liking" (Figure 2A), two maxima were observed (SSAs 15–24 and 35–44 years) as well as an overall decline of liking with an increasing SSA, $F(7, 47) = 6.21$, $p < .001$ (for detailed statistical information on the repeated measures analysis, see Table S2 in Supplemental Material Online). However, values varied across decades only within about one scale step, and small differences between decades were also reflected in the small overall effect size of $\eta^2 = 0.05$. For the dependent variable "emotionality" (Figure 2B), participants felt better when listening to music released when they were between the ages of 15 and 24, $F(7, 47) = 7.01$, $p < .001$; $\eta^2 = 0.05$, with an increase during the SSA of 15–24 years and a decline with an increasing SSA. Again, the variation across decades remained within one scale step. The combined "recall" score (average value for correct song title, performer, and lyrics completion task; Figure 2C) showed a better performance with a global maximum at an SSA of 15–24 years and an overall decline with an increasing SSA, $F(7, 47) = 23.23$, $p < .001$. Differences between SSA groups were characterized by a medium effect size of $\eta^2 = 0.12$. We think that this "recall bump" might be regarded as the strongest evidence for a "bump effect" for popular songs released between subjects' adolescence and early adulthood. Our argument for the strength of this dependent variable in the search for an age-related memory maximum is its derivation from a performance task on song recall. In contrast to the self-report ratings for "liking" and "emotionality", the data from a performance task might have resulted in a better discrimination between decades. Finally, the difference between the estimated year of song release and the actual year (Figure 2D) showed an interesting picture: the highest precision could be found for an SSA of 35–44 years. Before

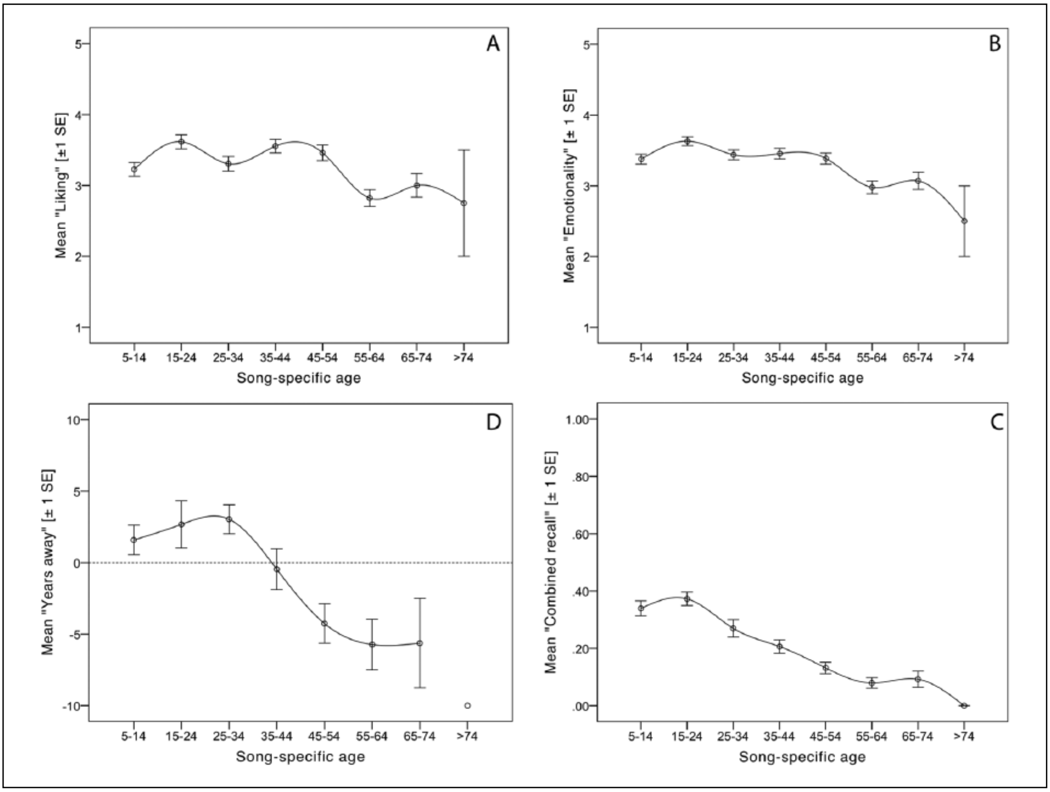

Figure 2A–D. Ratings of *liking* (A), *emotionality* (B), *combined song recall* (C), and difference between actual year of popularity and the participants' estimation of song release (*years away*, D) as a function of song-specific age. Interpolation lines are based on spline curves. For details see Table 2.

this point, the year of song release was estimated as being later than the actual year and after this point, earlier, $F(7, 45) = 5.19$, $p < .001$, $\eta^2 = 0.06$.

The analysis of the MEAMs is shown in Figure 3A–D and Table 2 (lower part). The variable song familiarity (Figure 3A) shows an unequal distribution ($X^2[6, N = 608] = 127.3$, $p < .001$, $\omega = 0.46$ [medium effect size]) which remains constant until an SSA of 25–34 years, followed by a decrease (due to the low number of frequencies, the SSA category >74 years was excluded in all X^2 analyses). No overall bump effect for song familiarity could be found. The distribution of music-evoked general memories (Figure 3B) was nearly equal across decades ($X^2[6, N = 434] = 9.5$, $p = .15$, $\omega = 0.15$ [small effect size]), with a nearly constant proportion of memories until an SSA of 45–54 years, followed by a slight decline. For this dependent variable, the overall memory bump effect at an SSA of 15–24 years, as found for the dependent variable of song recall, could be confirmed with a small effect size. Unfortunately, the distribution of specific memories (Figure 3C) could not be statistically analysed due to the extremely low overall frequency of memory responses ($N = 29$) and to the fact that five out of seven SSA categories showed frequencies smaller than five MEAMs, leading to an invalid, underpowered statistical analysis. Against the background of the overall low number of cases for general and specific memories, we decided to collapse those subcategories of memories into the higher-level category of total memories. The distribution of the total number of

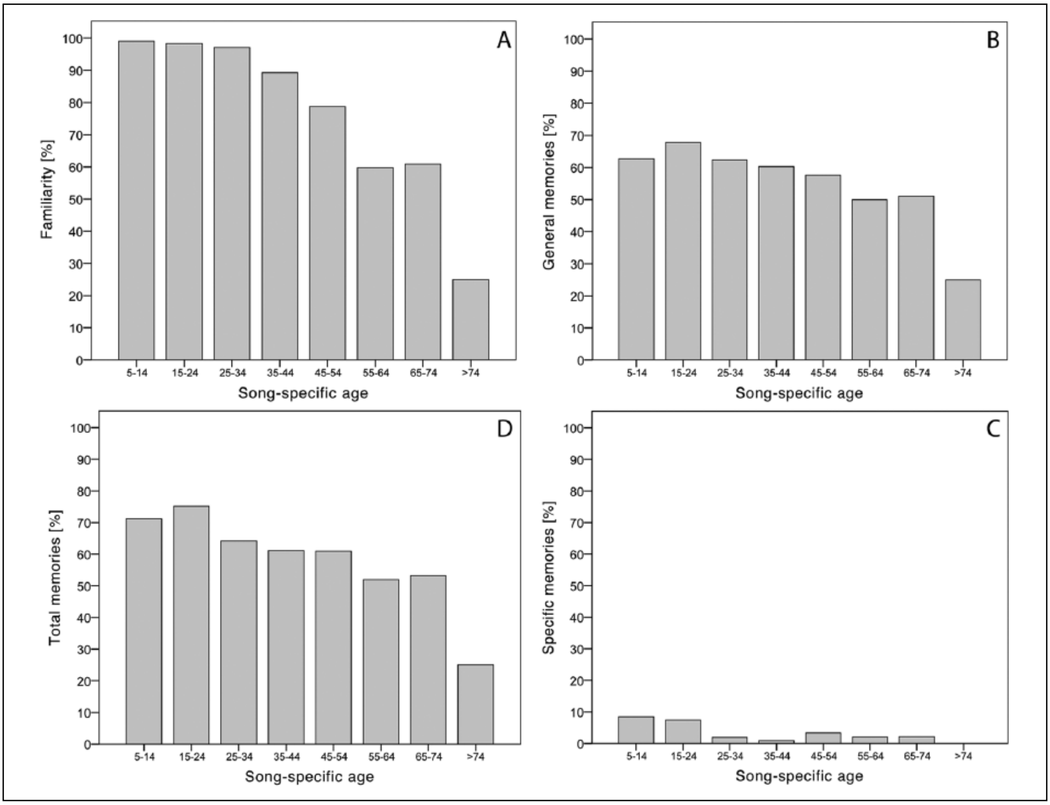

Figure 3A–D. Results for self-reported *song familiarity* (A), *general memories* (B), *specific memories* (C), and aggregated *total memories* (D). For details, see Table 2.

memories (Figure 3D) showed a significant deviation from equal distribution to an extent of a small effect size ($X^2[6, N = 463] = 18.5$, $p = .005$, $\omega = 0.20$), confirming the expected memory bump at an SSA of 15–24 years. However, the proportion of MEAMs showed only a slight decrease in the SSA of 25–34 years, followed by a nearly constant proportion up to the seventh decade (this very slow decrease of MEAMs over age is also reflected in the quadratic regression analysis shown in Figure S3; see the Supplemental Material Online section). The average number of total MEAMs was $M = 7.8$ ($SD = 2.5$) per song (the overall distribution of response frequencies is shown in Figure S2 in Supplemental Material Online). Specifically, a song from our collection of samples evoked on average 0.5 to 0.9 autobiographical memories per listener, while 8 to 15 listeners evaluated each song. In other words, at least every second song could stimulate a MEAM, which points to a strong relationship between popular songs from the charts and autobiographical events. However, the proportion of MEAMs was strongest for the age range of 15 to 24 years.

Correlations between variables. Finally, we conducted a correlation analysis between dependent variables (see Table 3). Against the background of effect sizes as an additional indicator for relevance next to significance (Ellis, 2010), the correlations between song familiarity and various types of MEAMs did not exceed a small effect size. In contrast, the correlation between song familiarity and combined recall performance reached a medium effect size of $r = .36$, whereas

Table 3. Correlation matrix for dependent variables in Experiment 1.

	Familiarity	Combined recall	Emotionality	Liking	Years away	General memories	Specific memories
Combined recall	.36*** 923						
Emotionality	.29*** 905	.20*** 909					
Liking	.30*** 905	.15*** 909	.78*** 906				
Years away	.08* 708	.11** 710	.05 707	.03 706			
General memories	.13*** 923	.22*** 928	.17*** 909	.15*** 909	−.05 710		
Specific memories	.10*** 923	.11** 928	.07* 909	.04 909	.05 710	−.31*** 947	
Total memories	.19*** 923	.28*** 928	.21*** 909	.17*** 909	−.02 710	.87*** 947	.19*** 947

Note. Second line indicates number of cases. Spearman correlations (two-tailed).
$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

songs that made the listeners feel happy (emotionality ratings) were strongly associated with a higher rating for liking ($r = .78$) but showed only a weak relationship with the total number of MEAMs ($r = 21$). Weak correlations were also observed between the ratings for the liking of the song and the number of total memories ($r = .17$).

To summarize, the correlations we observed were characterized by mostly tiny to small effect sizes. Even correlations between the total number of MEAMs and the predictor variables familiarity, combined recall, emotionality and liking were only in the range of $r = .17$ and $r = .28$ (see Table 3, lowest line).

Discussion

In Experiment 1, age-evoked differences could only be confirmed for changes in emotionality ratings ("this song makes me feel very unhappy [...] very happy"), song recall, and estimation of year of song release. However, differences between SSA categories were characterized by small effect sizes (for the dependent variables liking and emotionality) or medium effect sizes (for the dependent variables combined recall and estimated year). The global maxima (so-called bump effect) showed only slight differences in the overall development, and the average ratings for liking and emotionality differed by less than one scale degree. This small variance was not a surprise, as we selected the music examples from the corpus of mainstream popular music, which is highly compatible with the masses' preference and usage (Schramm, 2005).

Although observable changes were small, the distributions' maxima (bump effect) were found for the SSA of 15–24 years for liking, emotionality and combined recall. On the other hand, the phase after the SSA of 45–54 years marks a general decrease in preference ratings and emotionality ratings. In other words, popular music of adolescence and young adulthood was rated particularly more positively, and music listened to after the age of 55 only evoked limited emotional reactions in terms of "this song makes me feel very happy". However, ratings for liking and emotionality did not follow the inverted U-shape for the development of musical taste as suggested by Holbrook and Schindler (1989), who identified a peak for this development at about the 24th year and a significant slope before and after this phase of life. We also could not confirm Rubin et al.'s (1986) model of a general reminiscence bump for (non music-related) autobiographical events between the age of 10 and 30 years.

As a surprising outcome, only a very small memory bump effect for the SSA of 15–24 years was found for general, specific and total MEAMs in contrast to Schulkind et al.'s (1999) findings. Instead, the relationship between popular music and autobiographical memory seemed to be constant up until the mid-50s and then slightly decreased. The low number of specific memories remains a problem for the statistical analysis and might be the result of our separate coding of general and specific MEAMs. For future research we therefore suggest using only one category of MEAMs.

In total, the overall proportion of 0.5–0.9 MEAMs per participant and song can be interpreted as a strong association between popular songs from the charts and autobiographical events. In comparison, Janata et al. (2007) found that on average 30% of the number of songs drawn from a larger corpus of more than 1,500 songs elicited an autobiographical memory in some of the 18–29 year-old participants (only songs with an SSA between 7 and 19 years were considered). In other words, the use of music in general as a powerful cue for retrieving autobiographical memories could be confirmed (Janata et al., 2007, p. 846; Krumhansl & Zupnick, 2013, p. 2058). Finally, the relationship between the affective properties of the musical examples and the frequency of MEAMs remained an open question. This was the motivation for Experiment 2.

Table 4. Descriptive data of sample in Experiment 2 (*N* = 22).

	M	Range	*SD*	*N* (%)
General state of health	3.2	1–4	0.7	–
Auditory functions	3.3	2–4	0.6	–
Age	66.3	60–74	3.8	
Male	66.4	61–71	4.4	7 (31.8)
Female	66.2	60–74	3.7	15 (68.2)
Total	66.3	60–74	3.7	22 (100.0)
Level of education (ISCED97)				
Level 3				7 (31.8)
Level 4				2 (9.1)
Level 5				13 (59.1)
Level 6				0 (0.0)

Note. Self-rating of general state of health and auditory functions: 1 = very poor, 4 = very good; level of education according to theInternational Standard Classification of Education (1997).

Experiment 2

Method

Study design. In this experiment we used a survey study, with evaluations in a standardized rating format. Sociodemographic variables (age, sex, level of education) were recorded as control variables as well as self-reports on the current state of health and auditory functions (1 = very poor, 4 = very good). Based on the widely used two-dimensional emotion space (see, e.g., Nagel, Kopiez, Grewe, & Altenmüller, 2007; Russell, 1980; Schubert, 2001), the songs were evaluated on the two dimensions of valence and arousal by means of Likert scales: "This song is very unpleasant (= 1) / very pleasant (= 6) to me"; "This song affects me in a calming (= 1) / or arousing (= 6) way".

Participants. Participants of 50 years of age and over were recruited by a call for participation in a meeting place for senior citizens, resulting in a sample of *N* = 22 persons (*M* = 66.3 yrs., *SD* = 3.7, range = 60–74, see Table 4). Although the sample parameters were similar to those of Experiment 1, the proportion of females in this experiment was about twice as high as males. Despite subsequent adjustment, it was impossible to increase the number of males. However, based on a statistical control for the potential influence of sex bias on the evaluations of the songs (see the Results section), we registered only negligible effects on the valence and arousal ratings. Finally, none of the participants had received formal instrumental training for longer than three years (*M* = 2.5, *SD* = 3.6).

Materials. The same selection of music examples as in Experiment 1 was used. However, due to technical problems, the song for 1979 was excluded. In total, the sample comprised 79 songs.

Procedure. The survey was conducted at a meeting place for senior citizens in 2012. Participants sat at separate desks and were first requested to fill in the sociodemographic questionnaire after having given their written informed consent. Talking was not permitted during the entire survey, and no reimbursement was paid. To familiarize the subjects with the emotion space, we started the song evaluation with eight practice examples (two examples for each of

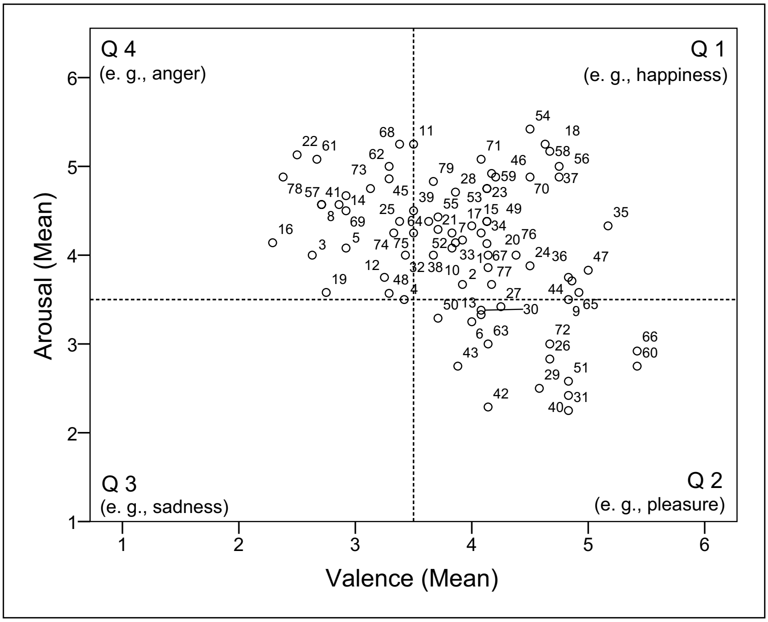

Figure 4. Projection of the popular songs onto the two-dimensional emotion space based on affective ratings (Experiment 2). Numbers indicate songs (for IDs see Table S4).

the four 2DES quadrants) from the International Affective Digitized Sounds collection (IADS-2, see Bradley & Lang, 2007). We used the following sounds for each of the four quadrants of the emotion space: for high valence/high arousal, ID 110 (Baby) and 311 (Crowd2); for high valence/low arousal, ID 151 (Robin) and 172 (Brook); for low valence/high arousal, ID 261 (Baby Cry) and 719 (Dentist Drill); for low valence/low arousal, ID 708 (Clock) and 728 (Paper 1). Each song was followed by a break of 20 s for evaluation and the transition to the next song. A standardized instruction was recorded and played to the participants (see Table S3 in Supplemental Material Online). The collection of 79 songs was presented to small groups of 3–5 participants in four randomized series. All songs were evaluated by all participants (complete design) during the procedure, which lasted a total of 60 minutes.

Results

In a first step, we controlled for potential effects of the unequal number of male and female participants (female: $N = 15$, male: $N = 7$) on the affective rating of the music examples. For the ratings of valence, no significant differences between the groups could be found, $t(803) = 0.96$, $p = .34$. For the dimension of arousal, the females' average ratings for all songs were higher ($M = 4.1$, $SD = 1.6$) than the the males' ($M = 3.8$, $SD = 1.3$) and reached statistical significance, $t(792) = 2.45$, $p = .02$, d = 0.20. However, on the basis of a post hoc power analysis ($\alpha = .10$, $d = 0.20$, $1\text{-}\beta = .36$), we argue that due to the limited test power and the small effect size, the difference between the two groups had only limited relevance for the evaluation of music examples in terms of arousal (for affective ratings of all songs, see Table S4 in Supplemental Material Online).

Finally, based on the affective ratings, all 79 songs were projected onto the two-dimensional emotion space (2DES). As Figure 4 shows, the overall distribution of songs in the 2DES was

Table 5. Distribution of number of memories in the two-dimensional emotion space (Experiment 2).

Quadrant of 2DES	Frequency of MEAMs	Frequency of songs	MEAMs per song (*M*/*SD*)	Range of memories per song
Q1 (V+ A+)	302	37	8.16 (0.41)	1–12
Q2 (V+ A–)	119	17	7.00 (0.70)	2–12
Q3 (V– A–)	9	1	9.00 (–)	–
Q4 (V– A+)	185	24	7.71 (0.46)	3–12
Total	615	79	7.78 (0.28)	1–12

Note. V = Valence, A = Arousal, + = high rating (> 3.5), – = low rating (⩽ 3.5; 6-point Likert scale).

unequal ($X^2[3, N = 615] = 293.47$, $p < .001$, $\omega = 0.69$, for details see Table 5), with the largest number of songs and memories within the first (upper right) quadrant. Considering that the songs we selected were from mainstream popular music, this finding was no surprise, as we could expect that this genre is mainly characterized by positive affect. High ratings for the positive affect "happiness" were obtained for songs such as Opus' *Live is Life* (1985, ID 54); for the affect "pleasure" for songs such as Miguel Rios' *Song of Joy* (1970, ID 40) and for the affect of "anger" for songs such as Lady Gaga's *Poker Face*, (2009, ID 78). The third quadrant of the 2DES ("sadness") is only represented by Max Hansen's song *Ach Luise* (1933, ID 4).

Unexpectedly, the average number of MEAMs (general and specific) per quadrant was in the range between $M = 7.0$ and 9.0, leading to a non-significant difference between all quadrants, $F(3, 75) = 0.92$; $p = .44$. In other words, regardless of the affective character of a song, *all* number-one chart songs in our study could be potentially associated with autobiographical memories – even if a song had a more neutral affective character as represented by songs located in the centre of the 2DES.

To control for the effects of changes in emotional quality of the music over time, we analysed the changes of valence and arousal ratings over time, following the suggestion by Schellenberg and von Scheve (2012). These authors observed an increase of the use of the minor mode and a decrease in the average tempo for Top 40 songs between 1965 and 2009. They interpreted their result as an increase in "sad-sounding over time". However, our time series analysis did not confirm this hypothesis. Instead, based on the psychological ratings of the affective quality of the songs, correlations revealed a (non-significant) increase for valence ($r = .11$, $p = .31$) and arousal ($r = .13$, $p = .26$), but not a decrease. Based on the psychological ratings by a group of elderly listeners, we could not confirm the hypothesis that the sad character of music increases over time.

Discussion

In contrast to Eschrich et al. (2008), who observed that high valence of music can be an important modulator of episodic long-term memory, in our study musical events with positive emotion (high valence) did not contribute to a higher number of MEAMs. However, the main difference between both studies is the considered time frame for the valence effect, which was only three days for the recall test in Eschrich et al. (2008). Additionally, Holland and Kensinger (2010) emphasized that valence is not the only factor which influences the way emotional memories are maintained, but other factors, such as personality traits, arousal or personal involvement of an experience, should also be taken into account. It also remains open whether MEAMs might differ by their affective quality – for example, by their degree of nostalgia (Barrett et al., 2010). However, as Barrett et al. (2010) emphasized, a nostalgia effect of MEAMs is only relevant for songs with autobiographical salience. We also cannot give an answer to the question of whether the frequency of MEAMs might have been influenced by a mood congruency effect (for a review, see Holland & Kensinger, 2010). As suggested by Bower (1981), experiences which have the same emotional content as the current mood people are in during recall are remembered better. For example, in our study participants in a music-induced, positive (happy) mood might have remembered more positive (happy) MEAMs than negative MEAMs. Unfortunately, due to the incomplete design of Experiment 1 (participants listened only to a random selection of 20 songs from eight decades), a control for this mood congruency effect was impossible. However, the average number of 7.0–9.0 MEAMs per quadrant of the 2DES does not support the assumption of a significant congruency effect (see Table 5). One explanation for our divergent results might be the different time frame: experimental mood congruency studies tend to use short-term intervals between emotional incidents and recall. For example, in the study by Bower (1981), participants recorded such emotional events in a daily diary for a week, and in Tesoriero and Rickard's (2012) study on a music-enhanced recall effect, the free recall of the narrative was tested five minutes after the end of the story. However, there is currently no research that supports the interpolation of these short-term congruency effects to events that occured decades ago, and other theories (e.g., theories of emotional arousal or function theories) on the relationship between mood and memory might be applicable for long-term recall (see Tesoriero & Rickard, 2012). Moreover, recent research has shown that the interactions between the emotional content of an autobiographical experience and the emotions at the time of autobiographical retrieval might influence the way in which an event is remembered (for an extensive review, see Holland & Kensinger, 2010). Finally, more recent neuroscientific studies have given support for the assumption that musical episodes and emotionally salient episodic autobiographical memories are integrated in the medial prefrontal cortex and can be activated spontaneously by familiar songs from our past (Janata, 2009).

Our findings also differ from those of Krumhansl and Zupnick (2013), who found that participants showed a higher number of personal memories when listening to music with high valence/high arousal ("happy" music) and to music that made them feel more energized. In their study, the association with nostalgia decreased from the first to the second decade of the subject's age. However, subjects in their sample were characterized by a very young age of about 20 years on average, which does not allow us to draw conclusions about lifespan effects of the music's emotional quality on MEAMs. Finally, our time-series analysis of the development of affective quality over time (see Figure 5) is also in contrast to previous findings by Schellenberg and von Scheve (2012) and their hypothesis that there is an increase effect of a "sad-sounding over time" in popular music, as indicated by the increasing use of the minor mode and slower absolute tempi over the last five decades. Differences between the studies might be explained by the methodological approaches: the measurement of structural features of music (tempo, mode) does not tell the same story as psychological ratings and should be handled with caution.

General discussion

The main findings of the whole study can be summarized as follows: the memory bump effect could clearly be confirmed for the dependent variable "combined recall". This variable has a special emphasis because it was based on a performance task (recall of song title, performer and lyrics completion task). This objective performance measurement resulted in more reliable data quality and better discrimination between SSA decades when compared to variables based on

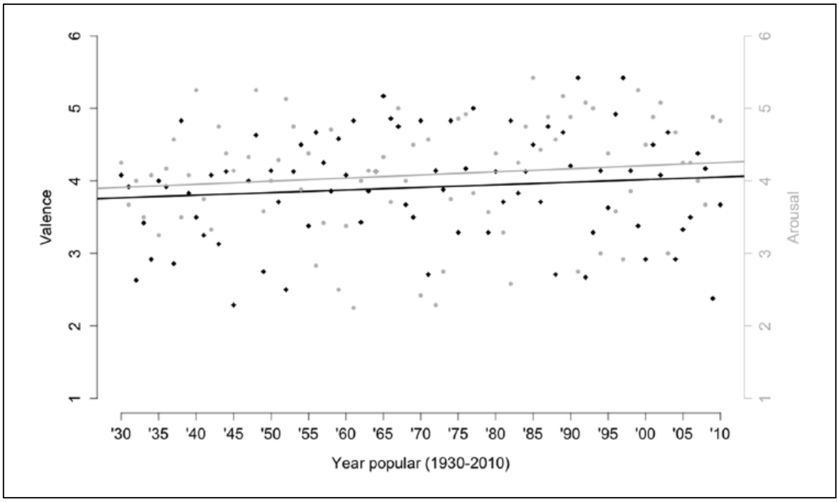

Figure 5. Changes in ratings of affective qualities (valence and arousal) of songs over time (cf. Schellenberg & von Scheve, 2012, Figure 1). (Correlations: $r_{valence}$ = .11, p = .31, $r_{arousal}$ = .13, p = .26).

self-reports. For example, ratings of liking and emotionality did not show this clear maximum for one SSA decade. The number of MEAMs also did not show a significant inverted U-shaped pattern as expected from previous studies. Rather, MEAMs seemed to be constant up to the fifth decade of the lifespan. However, we have to bear in mind that the various studies used different methods for the measurement of MEAMs: Schulkind et al. (1999) asked whether the music examples evoked autobiographical memories (yes/no response) without asking for further details. In contrast, the restrictive methodological approach in our study with detailed written responses might have resulted in an underestimation of reported memories. Our method of measuring the MEAMs also differed from the procedure used by Krumhansl and Zupnick (2013) who asked their participants to indicate their personal memories associated with the music on a rating scale (0 = none to 10 = many). However, for future studies we see certain advantages for the validity of responses when using an open-answer format with detailed written responses and subsequent coding and control for inter-coder reliability. We assume that this procedure might result in a higher internal validity.

Accuracy of self-reports

According to the explanation of the reminiscence bump suggested by Janssen et al. (2007), media-evoked memories are based on two components: differential encoding (initial contact with media content in a life-situation) and re-sampling (repeated media exposition, such as the repeated listening to a record). Although this explanation seems to be plausible for the development of a reminiscence bump, the exact effects of repeated media exposure ultimately remain hard to control for. For example, cover versions of songs released years after the original song can result in an incorrect (time-shifted) allocation of autobiographic events to a song. As shown by Pendzich (2004), the increasing proportion of cover versions in chart music has been a phenomenon in German single charts since the 1980s. Thus, we cannot rule out that the observed, constant rate of autobiographical memories up to the fifth decade and the disappearance of a clear memory bump might also be influenced by the repeated exposure to cover versions. These unwanted re-sampling effects could only be controlled for with much effort, such as by the subject's allocation of his or her response to a particular song. This way, the reliability would be measured by the number of correct allocations of the memory to the song (e.g., by signal detection theory). As suggested by Brewer (1996, p. 46), internal validity can also be increased by the subjects' confidence ratings of their responses. Although research on autobiographical memory cannot get around the "memory-as-reconstruction rule" (Holland & Kensinger, 2010, p. 98) and memories are never perfect representations of the past, the limited overall accuracy of retrospective self-reports of autobiographical memories has to be accepted when using the paradigm of cued-recall. As emphasized by Zimprich and Wolf (2015), the measurement of memory performance for popular songs by means of cued-recall will always be characterized by the problem of little experimental control: in contrast to a typical laboratory task, we have nearly no control over the encoding phase between songs and life-events and, thus, cannot guarantee that all participants heard all the songs before and, if they did, with nearly the same frequency. Finally, our song selection criteria might have had an influence on participants' responses. We decided to use only number-one chart songs in order to guarantee a high probability for song familiarity. As there is no "gold standard" for the selection of songs in studies like this (which anthology should be used, which number-one songs should be included/excluded, if samples should be with/without a chorus, what to do with cover versions, etc.), we can only rely on the use of various selection strategies. For example, Krumhansl and Zupnick (2013) used the Top 1 or 2 singles from the Billboard charts and Zimprich and Wolf (2015) used song examples from the Top 3 songs of the German charts. Of course, our motivation to select number-one songs from the charts remains arbitrary but was guided by the assumption that our subjects would most likely be familiar with the songs. However, we cannot rule out that different selection criteria (e.g., Schulkind et al., 1999, who avoided the use of number-one or two songs) might have influenced the findings.

Limitations

One obvious limitation of our study was the use of researcher-selected chart music. This means that reports of MEAMs might have been influenced by the fact that the subjects could not bring their own music to the study. For example, Vuoskoski and Eerola (2012) could show that 47% of listeners reported sad memories when listening to self-selected sad music, but only 3% when listening to the sad music that the researcher had selected. Similarly, Grewe, Kopiez, and Altenmüller (2009) revealed a significant influence of familiarity with a particular music performance on the number of chills experienced. Thus, we cannot rule out that the use of chart music compared to participant-selected music may have resulted in an underestimation of the true relationship between music and autobiographical memory. Another limitation might result from the exclusive use of popular music as a stimulus: first, the exposure to popular music is hard to control for and might have contributed to the constant number of MEAMs up to the fifth decade; second, as Gabrielsson (2011) reported, classical and jazz music also can facilitate strong experiences with music and can thus contribute to MEAMs. Although MEAMs can be influenced by listener-selected music from various musical styles, our findings are in line with the distribution of strong experiences with music over the lifetime as reported by Gabrielsson (2011, S. 408, Table 30.2. See Figure S4 in the Supplemental Material Online section). Gabrielsson's distribution showed that the frequency of experiences remained nearly constant between the ages of 10 and 50, and many of these experiences had already taken place during the first five decades of life. The years from age 50 to 89 added only about 10% of strong experiences with music. Finally, we hope that our study can contribute to the important question of how music and autobiographical memory are intertwined. We are convinced that listening to music from earlier periods of life could be *one* road to gain access to entombed autobiographical memory (e.g., in the treatment of dementia patients) – but this is an option that is not limited to songs from only one particular decade of life.

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Notes

1. Schulkind et al. (1999) did not use the calculation of a person's "song-specific age" (SSA). However, our study follows the suggestion by Rubin et al. (1986) that "reminiscence can best be described in terms of the age of the subject at the time of the memory rather than in terms of the age of the memory itself" (p. 213). This concept of SSA was first introduced to research on the development of musical taste by Holbrook and Schindler (1989) and was validated by Hemming (2013). It is calculated as the difference value between the year of the song release minus a person's year of birth. The advantage of the SSA value is the representation of a listener's biological age and the particular song age in a single value. Negative SSA values indicate that a song was released before a person's birth. Thus, we decided to transform Schulkind et al.'s (1999) information on the year of song popularity and the participant's age into SSA categories based on the following assumptions: mean age of older participants = 67.5, year when study was conducted = 1997, mean participants' year of birth = 1930. Consequently, the first decade of the year of song popularity (1935–1945) corresponds to an SSA decade of 5–14 years, followed by SSA decades of 15–24, 25–34, 35–44, 45–54, and 55–64 years.
2. In his anthology, Ehnet (2002) based his selections on the following criteria: from 1930 to 1955 the three bestselling songs of a year were used, but no ranking information was available from the music industry; from 1956 to 2001 the German Top 30 sales chart rankings were included. From 1956 to 1989 the official sales charts were based on sales of singles, but the chart calculation in Germany was modified in the subsequent years. From 1989 to 2001 a combination of sales charts and airplay was used. For recent years, the following were considered in the rankings: since 2001 additional online sales (e.g., by Amazon), since 2002 sales of music videos, and since 2004 digital downloads (e.g., iTunes). For the period following 2001 we used additional sources on charts published by the official German chart provider Media Control (for 2002–2004:http://mix1.de/chartsarchiv/jahrescharts2002.htm; for 2005:http://viva.tv/charts/viva-single-jahrescharts[websites for 2002 to 2005 are no longer available]; for 2006–2010:http://musikindustrie.de/jahrescharts).

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