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A Cross-Sectional Study of Reminiscence Bumps for Music-Related Memories in Adulthood

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Author Contributions: BT, FP, and LH designed and collected the data for the original study. KJ and LH generated the initial idea for the present study, and KJ and TE led the analysis for the current paper, with input from all authors. KJ wrote the initial draft, and all authors contributed to writing and approval of the final manuscript.

Abstract

Music is often intimately linked to identity, as evidenced by the high value many people place on musical activities and the way in which music can become seemingly effortlessly coupled to important memories from throughout one's lifespan. Previous research has revealed a consistent reminiscence bump in autobiographical memory—the disproportionate recall of memories from between ages 10 to 30 years in comparison to other lifetime periods—which also appears to extend to music-related memories. The present study represents one of the largest explorations of the musical reminiscence bump across adulthood to date. Participants ($N = 470$; ages 18 to 82 years) were shown the titles and artists of 111 popular songs that had featured in the charts between 1950 and 2015 and rated the degree to which they had autobiographical memories associated with each song, as well as the degree to which they were familiar with and liked the song. We found a reminiscence bump in adolescence (peaking around age 14) for both ratings of the autobiographical salience of songs featured in the charts during that period and the familiarity of these songs. Liking ratings showed more divergent results depending on a participant's current age, including evidence for a cascading reminiscence bump, in which liking ratings from young adults increased for music from their parents' adolescent years. We also revealed new evidence that music-related autobiographical memories appear to invoke similar retrieval processes to the common methodology of eliciting autobiographical memories via word cues. We contextualise these results in relation to general theoretical accounts of the reminiscence bump, and age-related differences in the bump are discussed in relation to various sociocultural and technological changes in music listening habits.

Keywords: musical memory, autobiographical memory, music-evoked autobiographical memory, reminiscence bump, aging

A Cross-Sectional Study of Reminiscence Bumps for Music-Related Memories in Adulthood

Autobiographical memory processes play a key role in the construction of a sense of self throughout the course of one's lifespan (Conway, 2005). Music can be a highly effective cue for autobiographical memories—in particular, positive emotional memories comprising social themes (Jakubowski & Ghosh, 2019; Janata, 2009; Janata, Tomic, & Rakowski, 2007), which may be more vivid and embodied than memories triggered by other perceptual cues, such as famous faces or verbal prompts (Belfi, Karlan, & Tranel, 2016, 2018; Zator & Katz, 2017). Music may even retain its efficacy as a retrieval cue in cases in which autobiographical recall has otherwise been impaired as a result of brain damage or disease (e.g., Baird & Samson, 2014; El Haj, Postal, & Allain, 2012; Irish et al., 2006). For instance, self-selected music has been shown to elicit a comparable number of 'self-defining' memories in people with mild Alzheimer's disease in comparison to healthy controls (El Haj, Antoine, Nandrino, Gély-Nargeot, & Raffard, 2015). This suggests that memories that are central to one's sense of identity are often inextricably associated with music. This may be related, amongst other explanations, to the common tradition of coupling music with significant life events and the increased consumption and value placed on music during key periods of identity formation in adolescence (North, Hargreaves, & O'Neill, 2000).

One robust and central concept within autobiographical memory research is the 'remembrance bump'. The remembrance bump refers to the observation that older people (typically those aged over 40 years) tend to disproportionately recall memories from the period between ages 10 to 30 years in comparison to memories from other lifetime periods (Rubin, Wetzler, & Nebes, 1986). Memories from the remembrance bump period also tend to be recalled more accurately, more vividly, and rated as more important (Rubin, Rahhal, & Poon, 1998; Rubin et al., 1986). This life period is characterised by many 'self-defining' experiences; their central role to one's self-concept might thus help to explain the increased

accessibility of these memories (Conway, 2005). Other explanations that have been posited to explain the reminiscence bump include that this is a life period containing many memories of novel experiences, which may be encoded more deeply and rehearsed more frequently, and that biological and hormonal changes during this period may result in better encoding (Gidron & Alon, 2007; Robinson, 1992; Rubin et al., 1998).

In terms of musical memory specifically, older adults prefer, remember more about, and report stronger emotional responses to popular (pop) music released during their reminiscence bump period in comparison to pop music from other eras (Holbrook & Schindler, 1989; Janssen, Chessa, & Murre, 2007; Krumhansl, 2017; Schulkind, Hennis, & Rubin, 1999; Zimprich & Wolf, 2016). A related but distinct question is the extent to which music from the reminiscence bump period demonstrates an enhanced ability to cue autobiographical memories. In a large online study of participants born between 1940 and 1999, Krumhansl (2017) provided some evidence in this regard, revealing that personal memories related to pop songs were most strongly correlated with music released when participants were between 13 to 29 years of age. However, the amount of listening to music from *all* periods of participants' lives correlated significantly with the proportion of people reporting personal memories. Rathbone, O'Connor, and Moulin (2017) asked participants aged 40 years or older to nominate five personally significant songs and revealed a predominance of songs that were released when the participants were aged 10 to 19 years. These personally-significant songs were also more often reported to be associated with episodic memories than other familiar songs that were not chosen as personally significant. Finally, in a study of 48 healthy older adults, Platz, Kopiez, Hasselhorn, and Wolf (2015) found that music released during the participants' reminiscence bump period was remembered better, and this music showed a small increase in terms of its ability to cue autobiographical memories.

Krumhansl and Zupnick (2013) approached this topic from a somewhat different angle by examining the autobiographical relevance of music for *young* adults ($M_{\text{age}} = 20$ years). This approach represents a departure from the traditional reminiscence bump literature, which typically focuses on memories recalled by older adults (aged at least 40 years). Krumhansl and Zupnick (2013) played their participants short clips of pop songs released every year between 1955 (well before the participants were born) and 2009. In addition to the expected increase in personal memories associated with recently released pop music, these young adult participants also reported a greater number of personal memories for music released during their *parents'* reminiscence bump period (around 1980 to 1984). The authors term this previously unreported phenomenon a 'cascading reminiscence bump', and suggest that music is an ideal stimulus not only for investigating reminiscence bumps that emerge for songs released during a person's lifetime, but also for exploring the transmission of a cultural product across different generations.

Finally, although the reminiscence bump is a robust and well-replicated phenomenon, recent work has challenged the notion of whether the bump can be defined as a unitary concept across different memory retrieval tasks. Koppel and Berntsen (2015) reviewed the findings of all previous reminiscence bump studies that have used two common autobiographical memory retrieval tasks: the 'cue word' method (i.e., participants report memories prompted by cue words such as 'doctor' or 'anger') and the 'important memories' method (i.e., participants are asked to report particularly notable or important memories). They found that the cue word method elicited a reminiscence bump that peaked at a significantly earlier age ($M = 15.5$ years) in comparison to the important memories method ($M = 21.5$ years). The authors proposed that word-cued memories are retrieved via an associative, bottom-up search process whereas the important memory method represents a more strategic, top-down process, and that theoretical accounts need to be revised to account

for these retrieval-related differences in the temporal location of the bump. Specifically, although Koppel and Berntsen (2015) provide evidence that the important memories bump may be explained by existing theories, such as the life script account (the higher preponderance of culturally normative and important events that occur during the bump period), the word-cued memories bump is less well accounted for. This leaves open the question as to whether other cues that may trigger memories via associative processes, such as music, produce a bump in a similar temporal location to word cues (Janssen, 2015; Rubin, 2015).

In sum, previous research has revealed that music released during one's reminiscence bump period is associated with increased familiarity and preference ratings, with some initial evidence that this music may be more strongly associated with autobiographical memories. One study has reported the existence of a cascading reminiscence bump in young adults for music from one's parents' reminiscence bump period, which merits further exploration and replication. In addition, there is evidence that the temporal location of the reminiscence bump varies systematically as a function of the retrieval method that is utilised, but no previous study has compared the location of the reminiscence bump for music-related memories to other common autobiographical memory cueing methods.

The present study aimed to systematically probe the emergence and evolution of both the reminiscence bump and cascading reminiscence bump across the course of adulthood, particularly in relation to the degree to which popular music is associated with autobiographical memories. We asked healthy participants ($N = 470$) from across the full range of adulthood (ages 18-82 years) to rate the autobiographical salience of songs featured in the charts between 1950 and 2015. To probe the extent to which the autobiographical salience of a song is related to previous exposure and affective responses, participant ratings of familiarity and liking of each song were also analysed. In addition, we compared the

temporal location of the reminiscence bump for ratings of the autobiographical salience of songs to the reminiscence bump data reported in Koppel and Berntsen (2015) for word-cued and personally important memories. Given previous evidence that music tends to cue autobiographical memories in an associative and involuntary manner (El Haj, Fasotti, & Allain, 2012; Jakubowski & Ghosh, 2019; Zator & Katz, 2017), we predicted that music-related memories would show a similar reminiscence bump to word-cued memories, due to similarities in underlying retrieval processes.

Our study comprises an analysis of data from an online questionnaire used to study the general musical preferences of the French population. This list of music used in this questionnaire was originally created to assist families of non-communicating patients in choosing personally relevant stimuli for assessment of consciousness (Castro et al., 2015; Perrin, Castro, Tillmann, & Luauté, 2015). To our knowledge, the present study represents one of the largest datasets investigating musical reminiscence bumps to date, and the first focussing on the French population. The results provide insights on the extent to which music from across one's lifespan is associated with personal memories, including how these associations might evolve throughout the course of one's life. We also make a novel comparison of the musical reminiscence bump to reminiscence bumps generated by other commonly-employed autobiographical memory retrieval methods, and thereby contribute to ongoing theoretical debates on the degree to which the retrieval process influences the temporal location of the bump.

Method

Design

An online questionnaire was used to investigate participants' ratings of 118 pieces of music. Specifically, we examined the effects of the year a song was featured in the charts and

each participant's current age on 1) ratings of the extent to which the song evoked memories from a participant's past (hereafter referred to as autobiographical salience ratings), 2) ratings of familiarity with the song, and 3) ratings of liking for each song.

Participants

A total of 1,576 people completed (at least part of) the original questionnaire, which was available online between February and July of 2017. For the present work, we used data from participants who had completed the full questionnaire ($N = 995$) and had continuously lived in France (participants who had been absent from France for more than 5 years were excluded; $N = 962$). As the age distribution of respondents was highly skewed toward young adulthood, we also selected only the first 10 respondents from each birth year, which gives a total of 472 participants with a more uniform age distribution. One of these participants was excluded as they never responded to the question on autobiographical salience of the songs throughout the entire survey, and another was excluded for being under the age of 18. The age range of the remaining 470 participants was 18 to 82 years ($M = 43$, $SD = 16$; see Figure 1), and 98% spoke French as their native language. The included respondents consisted mainly of people working in higher education (37%), salaried employees (18%), or students (20%). Education levels were negatively skewed in comparison to the general population, with 79% of respondents having completed a higher education degree. 54% of respondents reported current or previous experience in performing music, either by playing a musical instrument and/or via singing lessons/singing in a choir, and 80% reported listening to music at least once per day. No question on gender was asked to increase anonymity of the questionnaire. The study was performed in accordance with the Declaration of Helsinki, and no personally identifiable information was recorded.

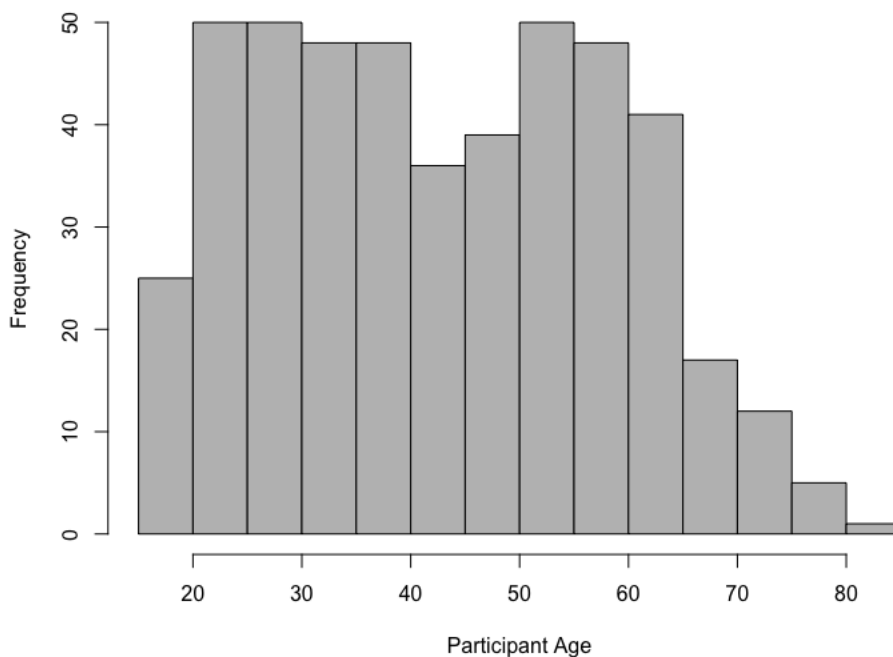


Figure 1. Age distribution of the 470 participants included in the present study.

Materials

The questionnaire comprised the titles and artists of 118 pieces of music (see Figure 2). 91 of these were best-selling pop songs between 1963 and 2015, based on information taken from the website infodisc.fr. For each five-year period the ten longest first-place, best-selling songs were chosen. The remaining songs were 20 “intergenerational” pop songs that were selected via an initial pilot study, and 7 classical pieces that had been selected in a previous published study (Plailly et al., 2007). In the pilot study, 384 participants from different generations (born between 1940 and 1997¹) were questioned on their preference for 90 well-known songs released between 1950 and 1991 that had not necessarily reached long-lasting positions in the charts but were suggested to be culturally significant by a range of different media sources (music magazines, online charts, etc.). Responses to the 7 classical

¹ Specifically, the sample comprised 88 people born between 1940-1959, 92 people born between 1960-1975, 146 people born between 1978-1989, and 58 people born between 1990-1997.

pieces will not be examined in the present paper, as our primary aim is to investigate ratings of pop songs in relation to the year they featured in the charts.

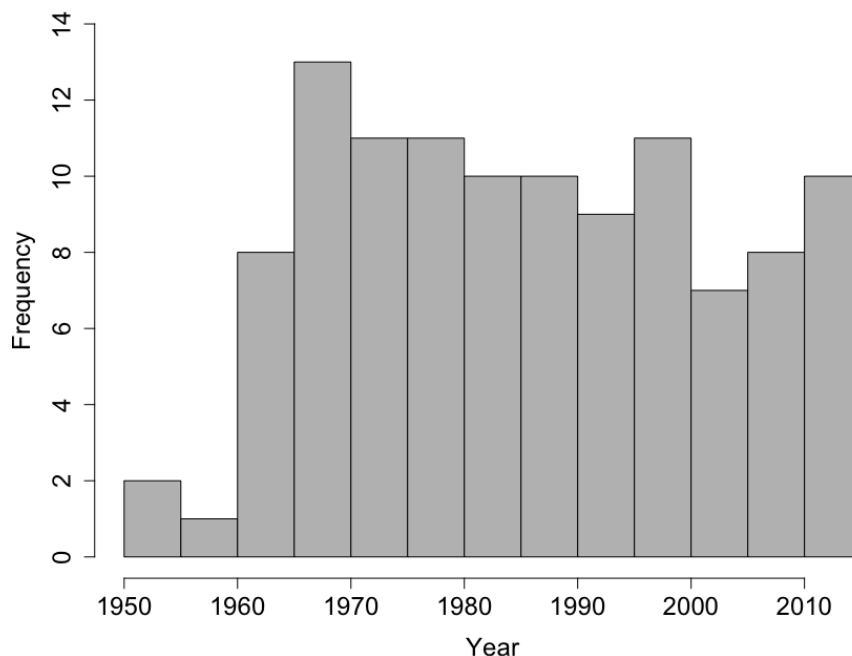


Figure 2. Year featured in the charts for the 111 pop songs included in the present study.

Procedure

Participants were recruited via email through the University of [REMOVED FOR PEER-REVIEW] database, personal and professional contacts, and mailing lists. Participants were also asked to distribute the email to their contacts or on social media. The questionnaire was described as part of a new study into the effects of musical preference on cerebral capacity of coma patients, for which the researchers were investigating the general musical preferences of the French population. Participants were furthermore informed that the questionnaire consisted of ratings of familiarity, appreciation, and associated memories to songs for which the title and artist were named. Participants were asked to make their ratings on the basis of the title and artist name, without listening to the indicated song. We acknowledge that such a procedure may result in some underestimations of familiarity, that

is, a participant may be familiar with a song upon hearing it but not be able to name the title/artist. However, previous research in this domain has indicated that memory for a song title/artist name is positively associated with familiarity with the actual song (e.g., Schulkind, Hennis, & Rubin, 1999). In addition, results from Cady, Harris, and Knappenberger (2008) indicate that song titles are comparable cues to playing the actual music for eliciting associated autobiographical memories. Specifically, Cady et al. (2008) found that autobiographical memories evoked by song titles versus hearing the songs did not significantly differ on any of the measures they examined, which included emotionality, vividness, specificity, and feelings of being ‘brought back’ to the remembered time period, amongst others.

The first part of the questionnaire consisted of questions on demographics and musical involvement. The second part of the questionnaire consisted of written song titles and artists, for which the participant was asked to rate their familiarity, liking, and amount of autobiographical memories related to the song on 10-point rating scales (with 10 as the highest rating for each). Participants were asked to respond with “NA” for the liking and memory questions if their initial familiarity rating was “not at all familiar” (i.e., 1). The song titles were presented in a semi-randomized order (pages of questions were randomized, but not the titles on a single page). The questionnaire took on average 29 minutes to complete (median = 24 min, $SD = 17$ min; ranging between 10 and 150 min), and participants were not compensated for their participation.

Data Analysis

Analysis of the relationship between song-specific age, current age, and song ratings (autobiographical salience, familiarity, and liking)

Our first strand of analyses focused on examining the relationship between participant age, the date a song was featured in the charts, and ratings of autobiographical salience, familiarity, and liking of the song. In order to determine each participant's age when a song was featured in the charts, we subtracted each participant's birth year from the year each song was featured in the charts; this measure will be referred to as song-specific age (SSA), in line with previous literature using the same approach (e.g., Hemming, 2013; Holbrook & Schindler, 1989; Platz et al., 2015). Negative SSA values thereby correspond to songs featured in the charts before a participant was born.

We also placed the participants into four age groups based on their current age (ages 18-29 years: $N = 115$, ages 30-41 years: $N = 111$, ages 42-55 years: $N = 120$, ages 56-82 years: $N = 124$). The boundaries for these four groups were set so as to create four groups as equal in size as possible. The main motivation for splitting the participants into groups on the basis of current age was to investigate whether the peak or shape of the musical reminiscence bump varies in different age cohorts, which could be due to changes in listening habits or technologies across generations. The two oldest age groups represent the demographic most commonly explored in the general reminiscence bump literature (most previous studies have tested participants aged 40 and older; Rathbone et al., 2017, Rubin et al., 1998), while inclusion of the younger groups allowed us to test for a cascading reminiscence bump for songs released *before* a participant was born.

Rating data were aggregated into SSA bins of 5 years in width (e.g., SSA of 0 to 4 years, 5 to 9 years, etc.). In order to ensure each SSA bin comprised a comparable amount of data that was representative of the responses of each age group as a whole, we excluded some SSA bins on the basis of two steps. First, for each of the four age groups of participants, we excluded SSA bins in which fewer than 90% of the participants in that age group contributed responses. Second, from the remaining SSA bins, within each age group we excluded bins in

which each participant contributed on average fewer than 5 song ratings (to ensure data in each SSA bin represented responses to a range of different songs). For example, the age bin representing an SSA of 79-84 years was excluded from consideration in this paper as there were only two observations in the entire dataset that fell into this bin (see Hemming, 2013, for an exploration of the potential detrimental effects of such outliers). Following this exclusion procedure, there were 10 usable SSA bins (spanning 50 years in duration) for each age group.

For entirely unfamiliar songs (those rated '1' on familiarity), we assigned an autobiographical salience rating of 1, as it was presumed that songs to which a participant had never previously been exposed would not be associated with autobiographical memories. Liking ratings were only usable for familiar songs (those rated '2' and above), as participants could not determine how much they liked a song that they had never heard before on the basis of only the song title and artist.

We then statistically tested for evidence of a reminiscence bump for each of the song rating variables (autobiographical salience, familiarity, liking). For instance, for autobiographical salience ratings, we tested whether the mean autobiographical salience rating for each SSA bin for each age group was significantly higher than the 'expected' rating (the mean rating of autobiographical salience for that age group across *all* SSAs). One-sample t-tests were run to compare the autobiographical salience rating data for each age group at each SSA bin to the overall age-group mean. Bonferroni corrections were applied across the 40 tests (4 age groups \times 10 SSA bins), such that a t-test was determined to be significant if the p-value was less than .00125. An identical analysis procedure was applied to test for a reminiscence bump in the familiarity and liking ratings.

Comparison of the music-related reminiscence bump to reminiscence bumps in word-cued and important memories

Our second strand of analysis explored the degree to which the reminiscence bump for the autobiographical salience of music is similar to reminiscence bumps for 1) autobiographical memories evoked by word cues and 2) retrieval of important autobiographical memories (i.e., studies in which participants were asked to retrieve particularly notable or important memories). Specifically, we compared the distribution of our autobiographical salience rating data for songs to that of the word-cued and important autobiographical memories summarised in the review by Koppel and Berntsen (2015), using data reported in Tables 1 and 2 of their paper.

For this analysis, we used only songs that were rated high (ratings of 8 or higher) in autobiographical salience, thereby making this approach more comparable to the other retrieval methods, where participants typically select a salient or highly accessible memory in response to each cue. We also only used data from participants who were currently aged at least 40 years and ratings of songs featured in the charts after the period of ‘childhood amnesia’ (song-specific ages of 4 years or greater; Nelson & Fivush, 2004), to make our data comparable to the participant samples and age range for autobiographical memories typically utilised in studies using word cues or important memories. This left 4,434 unique ratings of the autobiographical salience of songs for the analysis, whereas word-cued and important memories were represented by the means of the individual studies reviewed by Berntsen and Koppel (2015), rendering these smaller in size ($N = 21$ and $N = 32$, respectively). Two studies from the ‘important memories’ dataset were excluded from consideration, as their mean ages (5 and 8 years) were significantly outside the distribution (3.47 SD and 2.84 SD from the mean of 21.52; $p < .001$ and $p = .002$, respectively), leaving $N = 30$ for the important memories dataset. We compensated for the difference in the sample sizes between our dataset

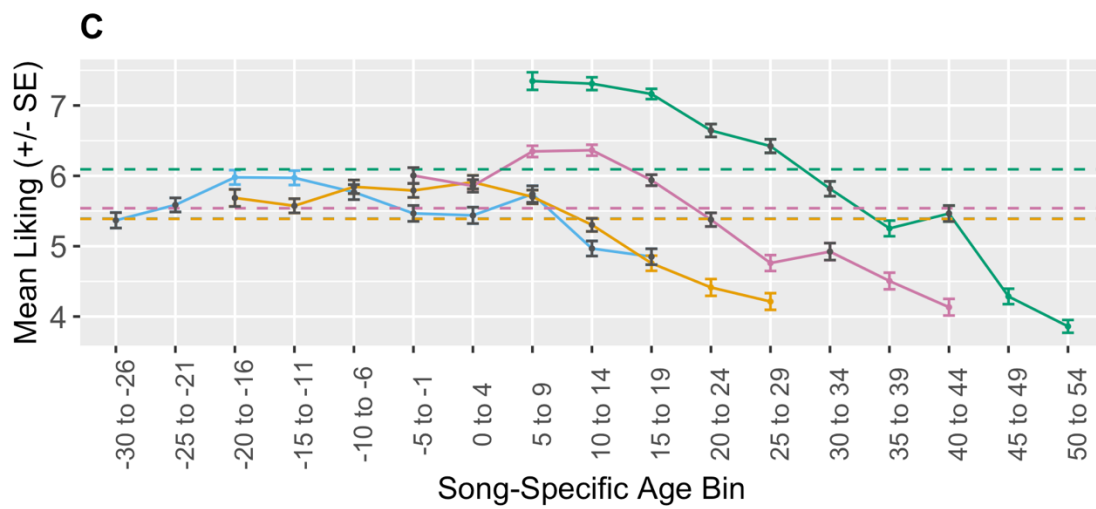
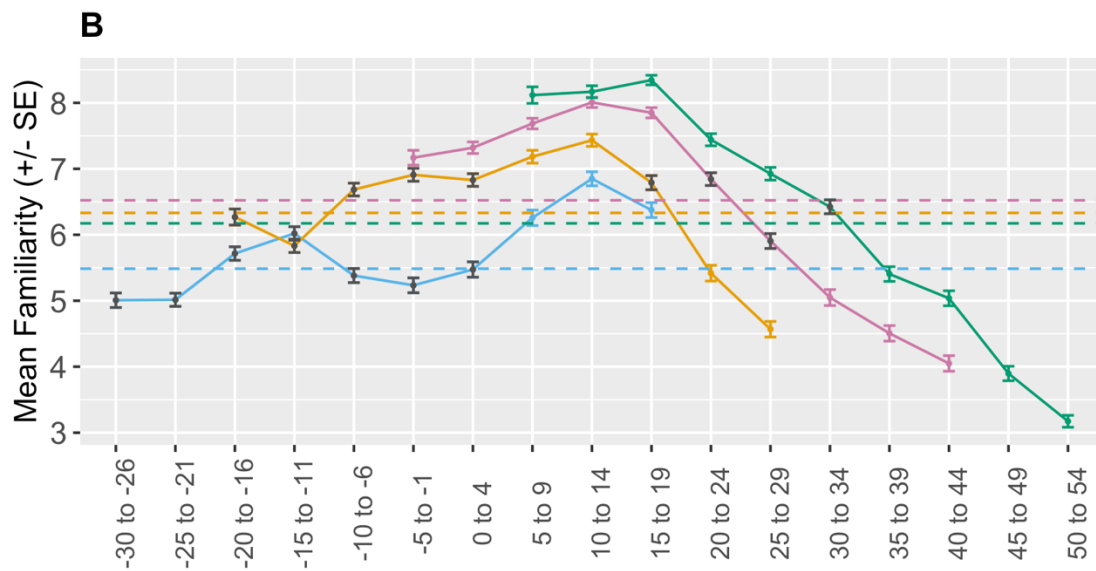
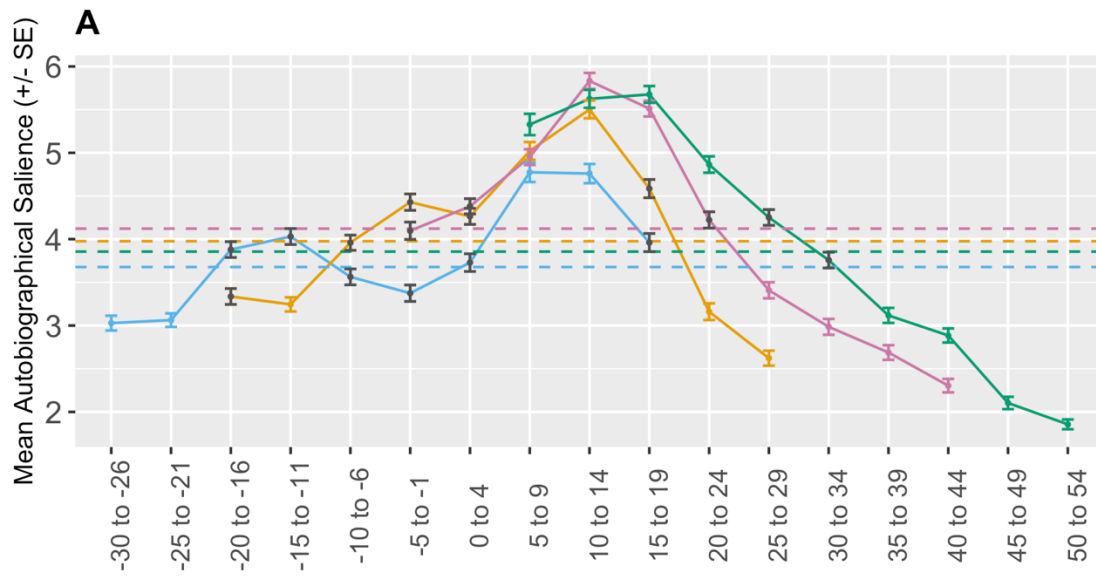
and the summary data from previous studies by utilising bootstrapping (1,000 iterations), where we sampled an equal number of music-related memories to the word-cued memories or important memories in each draw ($N = 21$). The bootstrapped distributions of the music-related, word-cued, and important memories were statistically compared using chi-squared tests.

Results

Descriptive statistics for the full dataset can be found in the online Supplementary Materials; these have been calculated at the level of individual songs to facilitate future research and clinical usages in which data on the musical tastes of the French population across different age groups may be of use.

Relationship between song-specific age and ratings of autobiographical salience

Our primary research question was to investigate whether reminiscence bumps could be detected for participant ratings of the autobiographical salience of songs. Figure 3A shows the mean autobiographical salience ratings for the four age groups across 5-year SSA bins (see also Figure S1 for mean ratings aggregated across all age groups). The dashed horizontal lines in Figure 3A show the mean autobiographical salience rating for each of the four age groups across the full dataset (regardless of SSA). If SSA does *not* impact autobiographical salience ratings, we would expect autobiographical salience ratings to cluster around these dashed lines across all SSA bins. In one-sample t-tests, we compared the data represented by the solid line to the dashed line in Figure 3A for each age group for each SSA bin. Coloured points on the figure represent statistically significant results, whereas grey points represent mean autobiographical salience ratings that are not significantly different from the overall age-group mean (see Appendix for individual t-test results).



AgeGroup 18-29 30-41 42-55 56+

Figure 3. A) Mean autobiographical salience ratings (+/-standard error), B) mean familiarity ratings (+/-standard error), and C) mean liking ratings (+/-standard error) for each age group across 5-year song-specific age (SSA) bins. Dashed horizontal lines represent mean ratings across all SSAs for each age group. Coloured points represent mean ratings that are significantly different from the age-group mean ($p < .00125$, Bonferroni corrected for 40 tests), whereas grey points represent non-significant differences. See Appendix for statistical results, and Figure S1 for a supplemental visualisation of these results aggregated across all age groups.

The results in Figure 3A provide evidence for reminiscence bumps in autobiographical salience ratings in all age groups. All four groups show evidence for a reminiscence bump for songs featured in the charts when participants were 5 to 14 years old, with this period extending to age 19 for the second oldest group (participants currently aged 42-55 years) and age 24 for the oldest group (currently aged 56+). The peak (highest point) of the bump period in the oldest group is also later (SSA of 15 to 19 years) in comparison to the other three age groups, which show a peak at an SSA of 10 to 14 years. The bump in the youngest age group (currently aged 18-29) is lower and shows a less defined peak. A cascading reminiscence bump is also visually evident in the youngest group around an SSA of -20 to -6 years. If their parents were 25 years old when these participants were born, this would represent the period when their parents were 5 to 19 years old. However, the autobiographical salience ratings from this cascading reminiscence bump period were not significantly different from the age-group mean in the one-sample t-test analysis.

Relationship between song-specific age and ratings of familiarity and liking

As a secondary point of interest, we investigated how ratings of familiarity (Figure 3B) and liking (Figure 3C) varied with SSA across the four age groups. A main point to note regarding the song familiarity ratings is the high degree of similarity to the results for the autobiographical salience ratings. The location and shape of the reminiscence bump for familiarity ratings (Figure 3B) is highly similar across all age groups when compared to the results in Figure 3A, indicating that two common methods for probing the reminiscence bump for music—1) rating the extent to which songs evoke autobiographical memories, and 2) recognition of/familiarity with the songs themselves —produce generally complementary results when interrogated across the same group of participants. A primary point of divergence between these two sets of ratings is that one of the age groups (participants currently aged 42-55 years) showed significantly increased familiarity ratings in comparison to the age-group mean for music featured in the charts up to 5 years *before* they were born.

In contrast, liking ratings (Figure 3C) did not show such a pronounced or consistent reminiscence bump across the age groups. Although the two oldest groups showed a pattern of liking ratings that was broadly similar to their ratings of autobiographical salience and familiarity, the two youngest groups showed less defined preferences, with mean liking ratings even exhibiting a small decrease over the reminiscence bump period from an SSA of 5 to 19 (and extending to an SSA of 29 in the 30-41 age group). The youngest group did, however, show statistically significant evidence for a cascading reminiscence bump from SSAs of -20 to -11, which broadly corresponds to the non-significant trends seen in the plots for autobiographical salience and familiarity ratings. This indicates that these young adults like the music from their parents' reminiscence bump period more than music from the surrounding periods and, interestingly, more than the music from their own reminiscence bump period.

Liking ratings by year song featured in the charts

As the liking ratings showed a somewhat divergent response pattern to the autobiographical salience and familiarity ratings, we conducted one additional analysis to explore whether these results might be at least partially explained by aspects of the song stimuli themselves. It is plausible that the differing effects of SSA on liking for the different age groups may be related to music from certain time periods being considered ‘better’ or more preferred regardless of a participant’s current age. To examine this possibility, we plotted mean liking ratings for the four age groups as a function of the year each song was featured in the charts, in 5-year bins (see Figure 4), and compared these mean liking ratings for each 5-year bin for each age group against the age-group mean liking rating across all songs in one-sample t-tests (see Table S4 in Appendix). Here we considered only songs featured in the charts from 1960 onwards, due to the relatively low number of songs from the 1950s ($N=3$) that had been used in the questionnaire (see Figure 2).

In the oldest age group, liking ratings for the music decreased fairly steadily over time (see Figure 4). The most liked music for the oldest group was that released between 1961-1965, which corresponds to the period when participants across this age group were 0 to 30 years old and thereby mirrors the analyses on the autobiographical salience and familiarity of these songs. However, the three youngest groups showed more similarities in their liking ratings to one another. Specifically, liking ratings for music from the late-1970s to early-1980s were significantly higher than the age-group mean in these three groups, indicating some shared preferences for particular music across generations regardless of SSA (SSAs across the three age groups during this decade spanned almost 50 years: from -23 to 23 years of age). It is also notable that all four groups displayed similarly low liking ratings for songs from the early 2000s, while an increase in liking for songs featured in the charts from 2011 to 2015 suggests a recency effect.

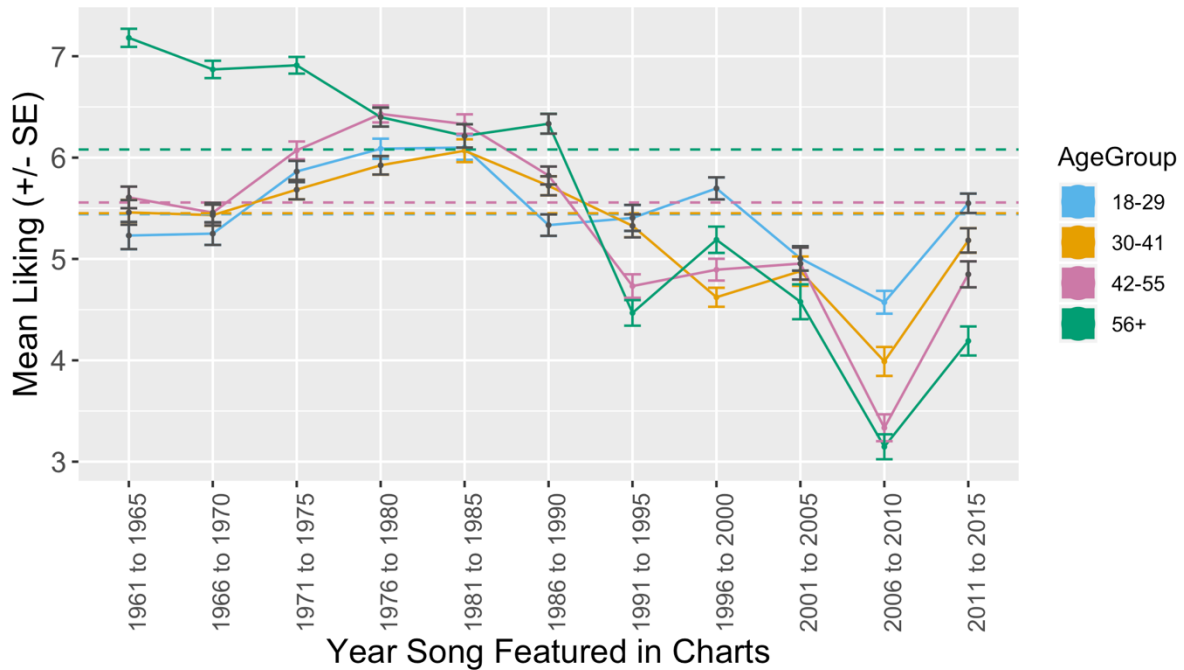


Figure 4. Mean liking ratings (+/-standard error) for each age group by year songs featured in the charts (in 5-year bins). Dashed horizontal lines represent mean liking ratings across songs from all years for each age group. Coloured points represent mean ratings that are significantly different from the age-group mean ($p < .00114$, Bonferroni corrected for 44 tests), whereas grey points represent non-significant differences. See Appendix for statistical results.

Relationships between autobiographical salience, familiarity, and liking

Correlations between the three dependent variables (autobiographical salience, familiarity, and liking ratings) were computed for each individual participant across all songs ($df = 109$). The mean of these participant-wise correlations was then computed, separately for each age group; these results are shown in Table 1. The three dependent variables tended to highly be correlated within all age groups. However, the oldest two groups show similar magnitudes of average correlation across all three dependent variables, whereas the two

younger groups show lower correlations for the pairings involving liking ratings, in comparison to the correlation of autobiographical salience with familiarity. This aligns well with the main results visualised in Figure 3. The semi-partial correlations presented in the two rightmost columns of Table 1 indicate that familiarity and liking both uniquely contribute to explaining some of the variance in autobiographical salience ratings. However, the strength of the relationship between autobiographical salience and familiarity is more dramatically reduced in the two older than the two younger groups when the effect of liking is partialled out. The opposite pattern of results is seen for the relationship between autobiographical salience and liking—that is, the relationship between autobiographical salience and liking is stronger in the older two than the younger two groups when the effect of familiarity is removed.

Table 1. Mean (and Standard Deviation) of Participant-wise Pearson Correlations of Autobiographical Salience, Familiarity, and Liking, by Age Group

Age Group (Current Age)	Autobiographical Salience & Familiarity	Autobiographical Salience & Liking	Familiarity & Liking	Semi-Partial Correlation of Autobiographical Salience & Familiarity, Controlling for Liking	Semi-Partial Correlation of Autobiographical Salience & Liking, Controlling for Familiarity
18-29 years	.73 (.16)	.62 (.19)	.63 (.20)	.32 (.18)	.16 (.19)
30-41 years	.67 (.18)	.56 (.20)	.58 (.20)	.31 (.18)	.15 (.20)
42-55 years	.66 (.20)	.66 (.20)	.66 (.20)	.21 (.16)	.26 (.21)
56+ years	.70 (.19)	.69 (.19)	.71 (.19)	.14 (.12)	.22 (.20)
All groups	.69 (.18)	.63 (.20)	.65 (.20)	.24 (.17)	.20 (.20)

Comparing the music-related reminiscence bump to word-cued and important memories

Our final analyses focused on comparing our data on the autobiographical salience of music to previous data on word-cued and important autobiographical memories (see *Data Analysis* section for details on data preparation for these analyses). First, the shape of the underlying distribution of the music-related reminiscence bump was established by assessing the fit of its distribution to normal and gamma distributions using bootstrapping (1,000 iterations) with 200 different random samples from the data. This analysis yielded an excellent fit with the gamma distribution ($X^2 = 12.6, p = .28$), whereas the normal distribution did not adequately capture the shape of the data ($X^2 = 35.4, p = .005$). For word-cued and important memories (bootstrapped 1,000 times with a random sample of 50% of the observations), both normal and gamma distributions provided a decent fit ($X^2 < 5, p > .14$ for word-cued memories, $X^2 < 3.31, p > .176$ for important memories). It is worth noting that the bumps for word-cued and important memories are smaller and estimated from means reported in the review paper (Koppel & Berntsen, 2015), not from the original data, which might explain their limited range and normality (see Figure 5). As we can see from Figure 5, the maxima of the music-related and word-cued reminiscence bumps are close to one another (14.0 and 14.7 years, respectively), despite the variations in the shape and ranges of the distributions. The bootstrapped comparison of these distributions indicates that these two phenomena might represent the same underlying distribution (mean $X^2 = 32.8, p = .158$). However, the important memories bump, with its considerably later peak (22.3 years) implies a rather different temporal distribution to the music-related memories (mean $X^2 = 49.9, p < .01$). Finally, comparison of the word-cued and important memories in this fashion revealed a significant difference (mean $X^2 = 33.6, p < .005$), showing that our method supports the conclusions of Koppel and Berntsen's (2015) analysis that these two types of autobiographical memories have distinct temporal distributions.

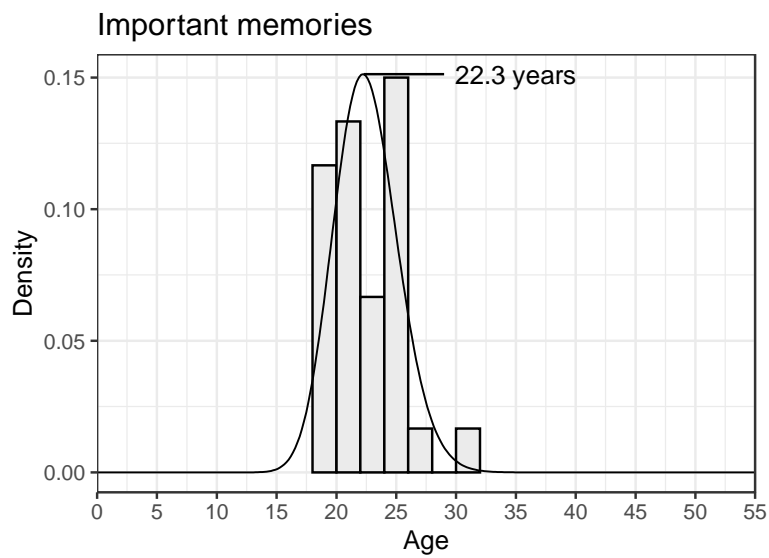
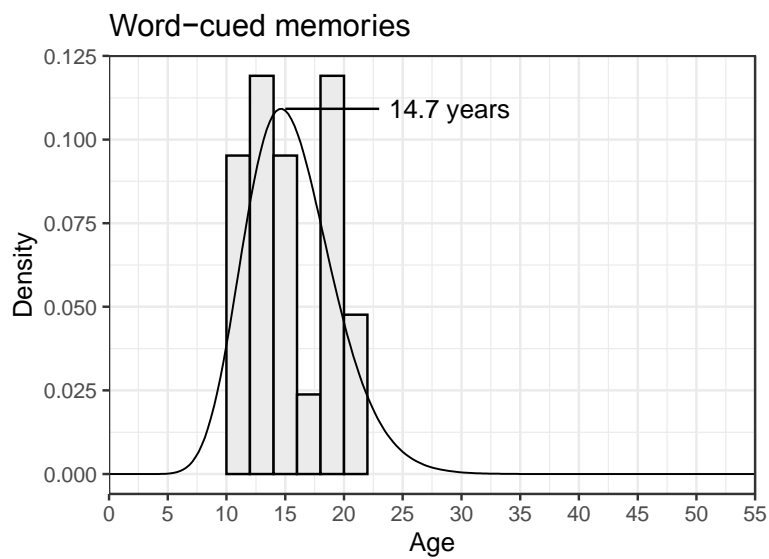
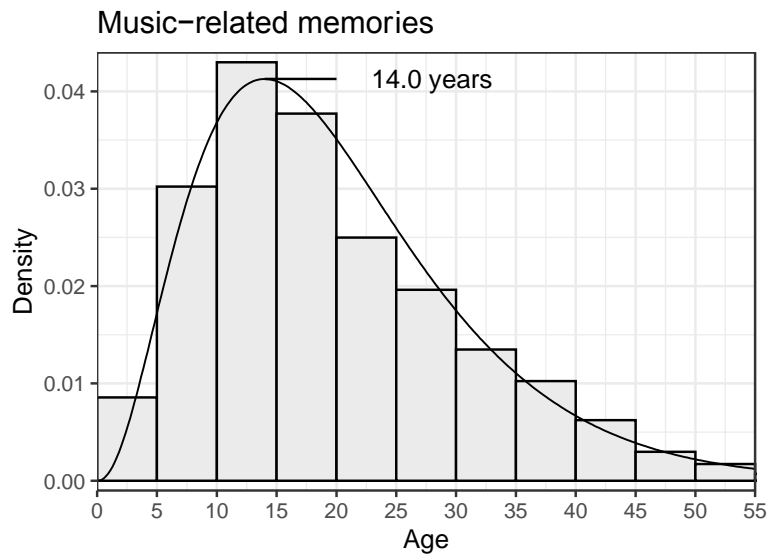


Figure 5. Actual and fitted gamma distributions of music-related, word-cued, and important memories. The y-axis shows the distribution probabilities from the actual data and the fitted distributions adjusted to the same scale.

Discussion

In this paper, we investigated the reminiscence bump for popular music from across a 65-year period (songs featured in the charts from 1950 to 2015) in participants across the full range of adulthood (ages 18 to 82 years). This represents one of the largest investigations of the musical reminiscence bump to date and, to our knowledge, the first extensive exploration of this phenomenon in the French population.

We found consistent evidence for a reminiscence bump for two aspects of the songs used here: ratings of the degree to which the songs evoke autobiographical memories, and familiarity ratings for the songs themselves. Reminiscence bumps for these two dependent variables were evidenced in all four age groups. The results for autobiographical salience ratings of the songs were broadly aligned with general theoretical conceptions of a reminiscence bump that occurs between ages 10 to 30 years (Rubin et al., 1998). The familiarity ratings exhibited largely the same response pattern as the autobiographical salience ratings, but the familiarity bump in the two middle age groups began somewhat earlier than expected (around 5 years before participants were born, although this result was statistically significant following correction for multiple comparisons only for the 42-55 age group). This suggests that songs that featured in the charts just before participants were born continued to be popular for some time beyond their initial release, and also demonstrates that the correspondence between the year a song is featured in the charts and the year at which a participant is first/most often exposed to it are not always equivalent. This result parallels the findings of Rathbone et al. (2017), who measured both age at release and age at which a pop

song was rated as most important, and found the average age at release to be approximately 5 to 6 years earlier than the average age at which songs were rated as most personally important to participants.

We also found some slight variations in the reminiscence bump between age groups. The peak (highest point) in the bump for the oldest age group for both autobiographical salience and familiarity ratings was 5 years later than the other age groups. It is possible that this represents a cohort effect; for instance, the oldest age group may have engaged with music in different ways during adolescence than the younger groups as a result of both sociocultural and technological factors, causing them to discover their most autobiographically salient music later in their teenage years. It could also be that the bump may shift its peak later in time as people age (and potentially reengage with the music of their youth in different ways across the lifespan), such that the three younger groups may eventually show a similar pattern when they reach the age of the oldest group. Another notable difference between the four age groups was that the youngest group showed a less pronounced reminiscence bump (lower peak) than the other three age groups. This aligns with previous literature showing a stronger reminiscence bump effect in older than younger adults (Janssen, Chessa, & Murre, 2005). This may be related to reengagement with favourite music over the course of a lifetime, which can strengthen the link between the music and associated memories via regular retrieval and rehearsal (see also the work of Janssen et al., 2007 on memory re-sampling effects, which are stronger for music than other cultural products, such as films and books).

The youngest group showed evidence of a cascading reminiscence bump for music released up to two decades before they were born. This bump we found here is similar, although slightly earlier in time, in comparison to the bump occurring 8 to 12 years before participants were born reported by Krumhansl and Zupnick (2013). This difference may be

partially attributed to the fact that the average maternal age is approximately 2 years older in France than the US², but could also reflect some cultural variations in music listening habits or sharing of music between generations. In our study, the cascading reminiscence bump was particularly evidenced in higher than average liking ratings for music from this period, which were even higher than for current music, i.e., music of the participants' own reminiscence bump period. It would be interesting to follow up this finding in longitudinal research, for instance, to test whether this cascading reminiscence bump is maintained throughout a participant's lifetime, or whether liking ratings for current pop music might increase as these young participants age and begin to look back on this period in a more nostalgic light. Future cross-sectional research could also compare how younger versus older adults respond to music released before they were born, as the present design primarily allowed for this particular factor to be investigated in the youngest two groups.

In general, liking ratings showed the least consistent evidence of a reminiscence bump. This was particularly due to differences between the two oldest and two youngest groups—the two oldest groups showed liking responses that were more consistent and more correlated with their autobiographical salience and familiarity ratings than the two youngest groups. These dissimilarities in liking ratings could be related to generational differences in the way people engage with music. For instance, younger adults tend to listen more to music via streaming and online services in comparison to older adults, which might allow for access to a wider range of music in terms of its release date, in comparison to older groups who more often make use of CD collections (Krumhansl, 2017). If young adults are listening to a broader array of music from across many decades³, this may increase their openness to music from different eras and result in less varied liking ratings across the songs used in this study.

² https://www.oecd.org/els/soc/SF_2_3_Age_mothers_childbirth.pdf

³ Although not all this music appears to be listened to exactly the same amount, as suggested by the familiarity ratings (see Figure 3B).

The effects of such shifts in listening methods and technologies on the formation and lifetime stability of the musical reminiscence bump have yet to be fully explored. The results presented in Figure 4 also show evidence of some intergenerational shared preferences, with the three youngest groups all giving their highest liking ratings for music from the late-1970s to early-1980s, indicating that particular stylistic conventions or features of the songs themselves may also play a notable role in shaping preferences for the pop songs presented in this study.

Finally, we found that the reminiscence bump for autobiographical salience ratings of the songs aligned relatively well with previous findings on the reminiscence bump for autobiographical memories evoked via word cues. The results of our analysis presented in Figure 5 indicate that songs featured in the charts during adolescence are more likely to elicit strong autobiographical associations in older adults, peaking around age 14. Adolescence is a key period in terms of identity development (e.g., Erikson, 1956; Meeus, 2011), and previous research also suggests that musical tastes are developed around this period (Holbrook & Schindler, 1989; North & Hargreaves, 2002). However, Holbrook and Schindler's (1989) findings indicate that musical preferences peak for music released around age 24, suggesting that the reminiscence bump in music-related autobiographical memories may not be entirely explained by the crystallisation of musical tastes. Our analysis also contributes the novel insight that the shape of the music-related reminiscence bump is well-characterised by a gamma distribution, which has implications for future research in terms of informing sampling decisions and making more precise assumptions about the predicted associations between age and music-related memories.

The comparatively earlier reminiscence bump evidenced for both music- and word-related memories indicates that the associative retrieval processes underlying these two tasks are accessing a somewhat different set of memories than the top-down retrieval method of

asking participants to recall particularly important memories. Such findings are important for informing the development of interventions that aim to elicit memories via specific types of retrieval cues. For instance, this finding suggests that using musical or word cues to elicit memories in people with Alzheimer's disease might be particularly effective for bringing back memories from adolescence. The 'important memories' method may be less effective in this population in general, due to the impairments in strategic retrieval that are common to this disease. Therefore, it is important to investigate whether other associative cue types, beyond music and word cues, may be found to be effective in eliciting memories from other lifetime periods (e.g., early adulthood), or whether, on the other hand, *all* associative retrieval tasks show a bump in the same temporal location. Studies that compare autobiographical memories evoked by different cue types across the same sample of participants using the same data collection protocol should be conducted as a matter of priority, in order to ensure the differences in the reminiscence bump location seen here cannot be attributed to methodological differences between studies.

In general, further research is needed to isolate the mechanisms underlying these different types of retrieval tasks, and theoretical accounts of the reminiscence bump require revision to incorporate explanations for these differences in temporal location of the bump. In particular, the majority of existing theories provide a more sufficient explanation for memories accessed via the 'important memories' method than via word cues or music (Koppel & Berntsen, 2015). It should also be noted that our analysis of the word-cued reminiscence bump gave some indication that there may actually be *two* bumps in the word-cued memories distribution (see Figure 5). An initial comparison of the studies producing earlier versus later word-cued bumps does not reveal any systematic difference in methodology; rather, it may be that the cue word method invokes several possible retrieval

strategies, including a combination of both top-down and associative processes that may vary from one participant or one cue to another.

Future research on this topic should further compare the methods of soliciting ratings of songs via visual presentation of the title to auditory presentation of the song. In particular, our method can be potentially useful in clinical settings in which family or carers may be asked to select personally-relevant music to be used with patients from a written song list; as such, it is of both theoretical and practical importance to fully explore any potential limitations of this method. Our study is based on the assumption that a song title can elicit phenomenologically similar autobiographical memories to hearing the song, following the results of Cady et al. (2008). An additional important finding from Cady et al. (2008) is that seeing the song title and hearing the music both elicited a high degree of mentally ‘hearing’ the song during the subsequent autobiographical recall task, which did not significantly differ between these two retrieval conditions. It is likely that the approach used in the present study also elicited a high degree of musical imagery for the songs whose titles were presented, although this factor was not explicitly measured. Subsequent research should investigate the degree to which musical imagery mediates the relationship between being presented information about a song (e.g., title, printed lyrics) and subsequent retrieval of autobiographical memories associated to that song. This is particularly important for understanding how different types of retrieval cues may affect the retrieved memory content and differentially impact the shape and temporal location of the reminiscence bump.

Our study has followed a similar approach to most previous research in this domain by focusing solely on popular music, which we acknowledge represents only one of many genres of music that may be autobiographically relevant to participants. In addition, technological advances such as music streaming services now offer researchers the opportunity to monitor and measure the listening histories of participants, which may be

utilised to map the relationship between date of first exposure, number of total exposures, and the autobiographical salience of a song in a more precise manner than ever before (see Stephens-Davidowitz, 2018, for an initial exploration of the popularity of songs on Spotify by age and gender of the listener). Online streaming frequency or number of radio plays of particular songs, for instance, may also be used as proxy measures for likelihood of familiarity with a song, although such figures may be more representative of certain demographic groups than others (e.g., Spotify usage in particular is still skewed toward younger adults)⁴.

In conclusion, the results of this study indicate the presence of a reminiscence bump in adolescence for both the familiarity of songs featured in the charts during that period and ratings of the autobiographical salience of these songs. Evidence for this bump was found consistently across participants currently aged 18 to 82 years. Liking ratings showed more divergent results depending on the participants' current age, with evidence for a cascading reminiscence bump, in which liking ratings from young adults increased for music of their parents' generation. We also revealed new evidence that music-related autobiographical memories appear to invoke similar retrieval processes to the common methodology of eliciting autobiographical memories via word cues. These findings contribute to both theoretical and practical discussions around the extent to which music is intrinsically linked to personal memories from throughout the lifespan, and provide further impetus for exploring the efficacy of music to cue vivid autobiographical memories in everyday and clinical settings.

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⁴ <https://www.businessofapps.com/data/spotify-statistics/#1>

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Appendix

Table S1. One-sample t-test results comparing autobiographical salience ratings for each age group at each song-specific age (SSA) bin to the age-group mean rating across all SSAs (see Figure 3A). * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Age Group	Song-Specific Age Bin	t-value	Degrees of freedom	Bonferroni-corrected p-value
18-29	-30 to -26	-3.62	112	.018 *
18-29	-25 to -21	-4.22	114	.002 **
18-29	-20 to -16	1.17	113	> .999
18-29	-15 to -11	2.08	114	> .999
18-29	-10 to -6	-0.66	113	> .999
18-29	-5 to -1	-1.70	113	> .999
18-29	0 to 4	0.29	113	> .999
18-29	5 to 9	5.85	113	< .001 ***
18-29	10 to 14	5.40	114	< .001 ***
18-29	15 to 19	1.45	114	> .999
30-41	-20 to -16	-2.84	107	.214
30-41	-15 to -11	-4.73	110	< .001 ***
30-41	-10 to -6	-0.11	110	> .999
30-41	-5 to -1	2.43	110	.675
30-41	0 to 4	1.74	110	> .999
30-41	5 to 9	5.31	110	< .001 ***
30-41	10 to 14	7.68	110	< .001 ***
30-41	15 to 19	3.00	110	.132
30-41	20 to 24	-4.43	110	< .001 ***
30-41	25 to 29	-8.45	109	< .001 ***
42-55	-5 to -1	-0.11	118	> .999
42-55	0 to 4	1.35	119	> .999
42-55	5 to 9	4.05	119	.004 **
42-55	10 to 14	8.36	119	< .001 ***
42-55	15 to 19	6.77	119	< .001 ***
42-55	20 to 24	0.51	119	> .999
42-55	25 to 29	-3.97	118	.005 **
42-55	30 to 34	-5.58	115	< .001 ***
42-55	35 to 39	-7.37	117	< .001 ***
42-55	40 to 44	-10.37	111	< .001 ***
56+	5 to 9	5.56	117	< .001 ***
56+	10 to 14	7.62	119	< .001 ***
56+	15 to 19	8.50	123	< .001 ***
56+	20 to 24	4.51	123	< .001 ***
56+	25 to 29	2.09	122	> .999
56+	30 to 34	-0.52	122	> .999
56+	35 to 39	-4.30	123	.001 **
56+	40 to 44	-6.01	122	< .001 ***
56+	45 to 49	-11.61	115	< .001 ***
56+	50 to 54	-14.12	115	< .001 ***

Table S2. One-sample t-test results comparing familiarity ratings for each age group at each song-specific age (SSA) bin to the age-group mean rating across all SSAs (see Figure 3B).
 $* = p < .05$, $** = p < .01$, $*** = p < .001$.

Age Group	Song-Specific Age Bin	t-value	Degrees of freedom	Bonferroni-corrected p-value
18-29	-30 to -26	-2.03	113	> .999
18-29	-25 to -21	-2.45	114	.633
18-29	-20 to -16	1.22	114	> .999
18-29	-15 to -11	2.80	114	.240
18-29	-10 to -6	-0.51	113	> .999
18-29	-5 to -1	-1.13	113	> .999
18-29	0 to 4	-0.06	113	> .999
18-29	5 to 9	3.87	113	.007 **
18-29	10 to 14	6.56	114	< .001 ***
18-29	15 to 19	4.13	114	.003 **
30-41	-20 to -16	-0.28	109	> .999
30-41	-15 to -11	-2.70	110	.322
30-41	-10 to -6	1.90	110	> .999
30-41	-5 to -1	2.97	110	.148
30-41	0 to 4	2.88	110	.190
30-41	5 to 9	4.85	110	< .001 ***
30-41	10 to 14	6.15	110	< .001 ***
30-41	15 to 19	2.17	110	> .999
30-41	20 to 24	-3.83	110	.008 **
30-41	25 to 29	-7.26	109	< .001 ***
42-55	-5 to -1	3.40	119	.037 *
42-55	0 to 4	5.01	119	< .001 ***
42-55	5 to 9	7.66	119	< .001 ***
42-55	10 to 14	9.48	119	< .001 ***
42-55	15 to 19	8.20	119	< .001 ***
42-55	20 to 24	1.60	119	> .999
42-55	25 to 29	-2.67	118	.345
42-55	30 to 34	-5.68	117	< .001 ***
42-55	35 to 39	-8.00	117	< .001 ***
42-55	40 to 44	-9.43	112	< .001 ***
56+	5 to 9	9.95	119	< .001 ***
56+	10 to 14	12.99	121	< .001 ***
56+	15 to 19	15.39	123	< .001 ***
56+	20 to 24	6.24	123	< .001 ***
56+	25 to 29	3.83	123	.008 **
56+	30 to 34	1.11	123	> .999
56+	35 to 39	-3.48	123	.028 *
56+	40 to 44	-5.09	123	< .001 ***
56+	45 to 49	-9.59	117	< .001 ***
56+	50 to 54	-12.43	115	< .001 ***

Table S3. One-sample t-test results comparing liking ratings for each age group at each song-specific age (SSA) bin to the age-group mean rating across all SSAs (see Figure 3C).

* = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Age Group	Song-Specific Age Bin	t-value	Degrees of freedom	Bonferroni-corrected p-value
18-29	-30 to -26	-0.13	111	> .999
18-29	-25 to -21	1.17	114	> .999
18-29	-20 to -16	3.66	114	.015 *
18-29	-15 to -11	3.70	114	.013 *
18-29	-10 to -6	2.05	112	> .999
18-29	-5 to -1	0.38	110	> .999
18-29	0 to 4	0.25	113	> .999
18-29	5 to 9	2.01	112	> .999
18-29	10 to 14	-2.57	113	.458
18-29	15 to 19	-3.26	114	.059
30-41	-20 to -16	1.38	109	> .999
30-41	-15 to -11	1.22	110	> .999
30-41	-10 to -6	2.98	110	.141
30-41	-5 to -1	2.50	110	.549
30-41	0 to 4	3.21	110	.069
30-41	5 to 9	1.75	110	> .999
30-41	10 to 14	-0.51	109	> .999
30-41	15 to 19	-3.62	110	.018 *
30-41	20 to 24	-5.35	109	< .001 ***
30-41	25 to 29	-6.51	102	< .001 ***
42-55	-5 to -1	2.33	119	.856
42-55	0 to 4	2.15	119	> .999
42-55	5 to 9	5.37	119	< .001 ***
42-55	10 to 14	5.32	119	< .001 ***
42-55	15 to 19	2.28	119	.979
42-55	20 to 24	-0.94	119	> .999
42-55	25 to 29	-4.58	118	< .001 ***
42-55	30 to 34	-2.92	113	.169
42-55	35 to 39	-4.53	108	.001 **
42-55	40 to 44	-5.63	95	< .001 ***
56+	5 to 9	6.20	119	< .001 ***
56+	10 to 14	7.49	121	< .001 ***
56+	15 to 19	6.38	123	< .001 ***
56+	20 to 24	2.99	123	.136
56+	25 to 29	1.97	123	> .999
56+	30 to 34	-1.43	123	> .999
56+	35 to 39	-4.21	119	.002 **
56+	40 to 44	-3.02	119	.123
56+	45 to 49	-8.04	102	< .001 ***
56+	50 to 54	-8.74	92	< .001 ***

Table S4. One-sample t-test results comparing liking ratings for each age group across 5-year bins for year song featured in the charts to the age-group mean rating across all song years (see Figure 4). * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Age Group	Year Songs Featured in Charts	t-value	Degrees of freedom	Bonferroni-corrected p-value
18-29	1961 to 1965	-1.13	111	> .999
18-29	1966 to 1970	-1.14	114	> .999
18-29	1971 to 1975	2.69	113	.362
18-29	1976 to 1980	3.96	114	.006 **
18-29	1981 to 1985	3.64	114	.018 *
18-29	1986 to 1990	-0.65	113	> .999
18-29	1991 to 1995	-0.22	114	> .999
18-29	1996 to 2000	1.42	113	> .999
18-29	2001 to 2005	-2.84	113	.236
18-29	2006 to 2010	-4.85	113	< .001 ***
18-29	2011 to 2015	0.63	114	> .999
30-41	1961 to 1965	0.05	110	> .999
30-41	1966 to 1970	-0.12	110	> .999
30-41	1971 to 1975	1.49	110	> .999
30-41	1976 to 1980	3.00	110	.148
30-41	1981 to 1985	3.62	110	.020 *
30-41	1986 to 1990	1.54	110	> .999
30-41	1991 to 1995	-0.82	110	> .999
30-41	1996 to 2000	-4.62	109	< .001 ***
30-41	2001 to 2005	-3.44	108	.036 *
30-41	2006 to 2010	-7.80	98	< .001 ***
30-41	2011 to 2015	-1.44	108	> .999
42-55	1961 to 1965	0.35	119	> .999
42-55	1966 to 1970	-0.63	119	> .999
42-55	1971 to 1975	3.43	119	.036 *
42-55	1976 to 1980	5.51	119	< .001 ***
42-55	1981 to 1985	4.76	119	< .001 ***
42-55	1986 to 1990	1.65	119	> .999
42-55	1991 to 1995	-5.17	118	< .001 ***
42-55	1996 to 2000	-3.50	116	.030 *
42-55	2001 to 2005	-2.46	109	.672
42-55	2006 to 2010	-10.26	91	< .001 ***
42-55	2011 to 2015	-3.30	110	.057
56+	1961 to 1965	7.36	123	< .001 ***
56+	1966 to 1970	5.19	123	< .001 ***
56+	1971 to 1975	5.70	123	< .001 ***
56+	1976 to 1980	1.77	123	> .999
56+	1981 to 1985	0.70	123	> .999
56+	1986 to 1990	1.59	123	> .999
56+	1991 to 1995	-9.32	119	< .001 ***
56+	1996 to 2000	-4.00	113	.005 **
56+	2001 to 2005	-5.74	92	< .001 ***
56+	2006 to 2010	-14.22	82	< .001 ***
56+	2011 to 2015	-7.34	88	< .001 ***