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We presented older and younger nonmusician adult listeners with (mostly) unfamiliar excerpts of film music. All listeners rated their emotional reaction using the Geneva Emotional Music Scale 9 (GEMS-9; Zentner, Grandjean, & Scherer, 2008), and also rated familiarity and liking. The GEMS-9 was factor-analyzed into 3 factors of Animacy, Valence, and Arousal. Although the 2 age groups liked the music equally well, and showed roughly the same pattern of responses to the different emotion categories, the younger group showed a wider range of emotional reactivity on all the factors. We found support for a type of positivity effect, in that older people found Happy music somewhat less happy than did younger people, but found Sad music much less sad than did younger people. Older people also rated Fearful music more positively than did younger people. We propose that the GEMS-9 scale is an efficient and effective device to collect evoked emotion data for a wide age range of listeners.

Keywords: aging, evoked emotion, GEMS, music

Older adults are well represented in musical audiences and as performers. They constitute a significant proportion of concert audiences, including particularly classical and jazz. In the United States, a survey of National Public Radio listeners revealed that the median age of listeners to jazz programs in 2009 was 55 (up from 48 in 1999); classical music listeners had a median age of 65 (up from 58; Stimson, 2009). A study in Australia noted that in 2005 through 2006, 11.8% of people aged 65 to 74 attended classical concerts in the past year. By 2009 through 2010, this had increased to 13.6% ("Musical Briefing: Ageing Audiences," 2012). And older adults are found in significant numbers among professional musicians: According to statistics from the U.S. Bureau of Labor Statistics, the proportion of employed musicians in the United States aged 55 and over is 30%, far higher than actors and other entertainers; 8% of musicians are above age 70 (National Endowment for the Arts, n.d.).

Despite the robust participation of older adults in music, this age group is poorly represented in the psychological literature on cognitive and emotional aspects of music understanding. Our interest here was in age differences in emotional reactions to music. We had three primary goals in this experiment.

First, we wanted to add to the very small literature on age differences in actual affective reactions to music—most studies investigate the ability to decode emotions from music (detecting emotion the music is conveying). In particular, we were interested in assessing the robustness of a "positivity effect" that has been reported across a number of studies: the tendency of older adults to show preserved processing of happy emotions or positive attributes, compared with sad emotions or negative attributes. For instance, older adults are more accurate in decoding happy compared with other emotions expressed by music (Vieillard, Didierjean, & Maquestiaux, 2012; Lima & Castro, 2011) as well as in speech prosody (Laukka & Juslin, 2007; Mitchell, Kingston, & Barbosa Bouças, 2011 – although the effect was marginal in that study). Vieillard and Gilet (2013) studied age differences in emotional reactions to music. Their participants were asked to rate the degree of happiness, peacefulness, sadness, and fear they felt when listening to short composed piano excerpts designed to elicit each of these emotions. The older and younger adults did not differ in accurately categorizing happy excerpts, but older adults reported lower levels of sadness when listening to sad excerpts.

Using the same type of excerpts, Vieillard and Bigand (2014) asked older and younger adults to rate emotional activation, hedonic feeling, and liking, during an auditory target detection task. Older adults liked the happy music more than younger and overall felt more positive valence to all music; they showed less activation to threatening music compared to younger and detected targets more slowly in that type of music. Both sets of results were interpreted as support for a socioemotional selectivity theory (Reed & Carstensen, 2012), wherein older adults adopt a positive focus to increase affect.

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An alternative cognitive aging theory would, however, predict a different pattern of results. Park and Reuter-Lorenz (2009) noted that a normally aging brain shows increasing *dedifferentiation*, wherein previously lateralized functions become more bilateral. This pattern is shown only among highly performing seniors, suggesting that the dedifferentiation is a successful compensation mechanism. According to their Scaffolding Theory of Aging and Cognition (STAC), this dedifferentiation represents the recruitment of additional (if less honed) neural resources to support the decline in primary networks for an assortment of tasks. Although the authors cite primarily cognitive and perceptual evidence for their theory, we propose that a decrease in selectivity of emotional reactivity across several emotions would be consistent with STAC.

We had some additional goals for this study. In most extant studies on emotional reactivity and aging, reactions have been assessed based on a categorical model, wherein listeners are asked to assess their emotion category (and intensity) with the same four adjectives as the pieces putatively express. However, as Table 3 from the paper by Vieillard and Gilet (2013) shows, a significant proportion of pieces elicited what they called "ambivalent" responses: For instance, if a putatively sad piece elicited equal numbers of "sad" and "peaceful" ratings, it was considered ambivalent and not included in the main analyses of accurate categorization. Vieillard and Bigand (2014) used one scale item to measure arousal and valence, respectively. We chose to analyze emotional responses via a more fine-grained instrument, the Geneva Emotional Music Scale 9 (GEMS-9; Zentner et al., 2008). The rating scales are the nine primary factors that emerged from a 45-item checklist derived from both semantic analyses of music emotion terms and data from music experiments. The GEMS-9 consists of the following scales: tenderness, nostalgia, peacefulness, tension, wonder, transcendence, power, joy, and sadness. By this means, we hoped to capture a more differentiated emotional reaction to the music.

Finally, we chose to test emotional reactivity to more naturalistic and longer-duration music than the 10 s excerpts used by Vieillard and Gilet (2013). We used the 16 film music excerpts selected and analyzed by Vuoskoski and Eerola (2011) in their comparison of several emotion models. Film music has several appealing features: it is nonverbal, fully orchestrated, and most importantly, designed to elicit emotions. The pieces used by Vuoskoski and Eerola were validated in their study as conveying primarily one of four different emotions: happiness, sadness, fear, or tenderness.

To summarize, we presented young and older adults with film music, and asked the participants how the music made them feel. These feelings were expressed as ratings on each of the dimensions of the GEMS-9 scale. We also asked how much each excerpt was liked, in case that was mediating the emotional reactivity. We then factor analyzed the nine items to reduce the dimensionality, anticipating that two dimensions would correspond to Valence and Arousal, as is often found in emotion research (Russell, 1980; Vuoskoski & Eerola, 2011). We predicted that older adults would feel less sadness to sad pieces and possibly more happiness to happy pieces, than younger adults. However, an alternative dedifferentiation hypothesis would predict overall less distinction among the four types of music, on the GEMS-9 scales, or the reduced dimensions derived therefrom.

Method

Participants

Participants comprised two groups: first, 22 younger adults aged 18 to 35 ($M = 19.95$; $SD = 2.63$; 18 female); second, 15 older adults aged 60 to 80 ($M = 67.6$; $SD = 5.21$; 12 female). The younger group had a mean of 15.47 years of education ($SD = 3.72$), whereas the older group had an average of 15.00 years of education ($SD = 1.72$). All participants were selected so as to represent nonmusicians: median years of musical training was three in the older and one in the younger group. On a self-report scale of 1 = *musician* and 7 = *nonmusician*, both groups rated themselves on average as being fairly non–musician-like: $M = 5.47$, $SD = 2.03$ for older $M = 5.20$, $SD = 1.86$ for younger.

Stimuli

The stimuli were 16 excerpts of film music, each approximately 60 s long. The stimuli were those used by Vuoskoski and Eerola (2011), who categorized them into four types on the basis of their listener responses: scary, happy, sad, and tender (four in each category), each type occupying a different quadrant of a 2-D Valence-Arousal emotion space (Russell, 1980). Details relating to the stimuli can be found in Appendix A of Vuoskoski and Eerola (2011) and online at https://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/emotion/soundtracks-1min (mean ratings and audio examples).

Procedure

Participants listened to the excerpts in one of two randomized presentation orders. After having listened to each excerpt, participants rated how the music made them feel, on nine 5-point Likert scales (1: *not at all*; 2: *somewhat*; 3: *moderately*; 4: *quite a lot*; 5: *very much*) corresponding to the GEMS-9 scale (Zentner et al., 2008): wonder, transcendence, power, tenderness, nostalgia, peacefulness, joyful activation, sadness, and tension. The scale and instructions for administering it are available at http://www.psychinstruments.com/cms/uploads/GEMS-9.pdf. After rating emotional reaction, participants were then asked whether or not they recognized the excerpt and how much they liked it on a 7-point Likert scale (1: *not at all*; 7: *very much*).

Following the main experimental block, participants completed the Ten-item Personality-inventory (TIPI) of the '"Big Five' (see Gosling, Rentfrow, & Swann Jr, 2003), which is not analyzed further in this report. They also received a vocabulary test (the second half of the WAIS vocabulary subscale), two musical training questions referred to above, and a working memory test. The working memory test was an operations span, in which the participant was presented with a series of sentences; the semantic plausibility had to be judged for each. At the end of each set of sentences, the last word of the sentences had to be recalled. The sentence set size began at two, and was increased by one until the participant failed to recall all the words in the set correctly.

Working memory span was designated as the largest sentence set recalled perfectly.

Results

Memory and Vocabulary

As is typical, the older group scored higher on the vocabulary test ($M = 23$, $SD = 7.2$) than the younger group ($M = 17$, $SD = 7.5$; $t(35) = 2.32$, $p = .03$), but the groups were equivalent on the working memory task, all groups finding it to be a difficult task (Ms = 1.40 and 1.91; SDs = .51 and 1.19, for older and younger respectively; $t(35) = -1.56$, NS).

Liking and Recognition

The liking and recognition ratings were subjected to ANOVAs using a within-subject factor of *emotional category* (four levels: happy, sad, fearful, tender) and a between-subjects factor of *age group* (two levels: younger, older).

For recognition, we found a significant effect of age group, $F(1, 34) = 8.43$, $p < .01$ but no other main or interaction effect. The younger adults ($M = .20$, $SD = 27$) found significantly more of the stimuli familiar than did the older adults ($M = .05$, $SD = .13$).

For liking, we found a main effect of emotional category, $F(3, 105) = 15.21$, $p < .001$, and an interaction between emotional category and age, $F(3, 105) = 4.82$, $p < .001$, but no main effect of age. The participants liked the positive valenced (happy and tender) excerpts more than the negative valenced (sad and fearful) ones; this preference was stronger among the younger people.

GEMS-9 Ratings

Nine separate 2 × 2 ANOVAs were performed using each of the nine GEMS ratings as a dependent variable and a within-subject factor of *emotional category* (four levels: happy, sad, fearful, tender) and a between-subjects factor of *age group* (two levels: younger, older). We use the Bonferroni method to correct for the fact that we are performing nine statistical tests on the data. As expected, the analyses produced significant main effects of emotion ($p < .01$) for all GEMS factors, with the exception of Transcendence which did not differ among the 4 emotions. There were no significant main effects of age. However, there were significant interactions between age and emotion for Peacefulness, $F(3, 105) = 4.58$, $p < .05$, Sadness, $F(3, 105) = 6.67$, $p < .05$ and Tension, $F(3, 105) = 14.69$, $p < .01$. Comparison of the mean ratings from each group for each of these scales suggests that the two groups differentiate the stimulus categories in the same way but the younger adults have more extreme responses than the older adults (see Figure 1).

As shown in Table 1, liking shows a moderately strong negative correlation with Tension and moderately strong positive correlations with Wonder, Tenderness, Peacefulness, and Joyfulness. Table 1 also shows that there are strong correlations between many of the GEMS rating scales. Vuoskoski and Eerola (2011) conducted principal components analysis on the GEMS ratings they obtained from young adults and recovered a two-dimensional solution (interpreted as representing Valence and Energy respectively), which accounted for 89.9% of the variance in their data

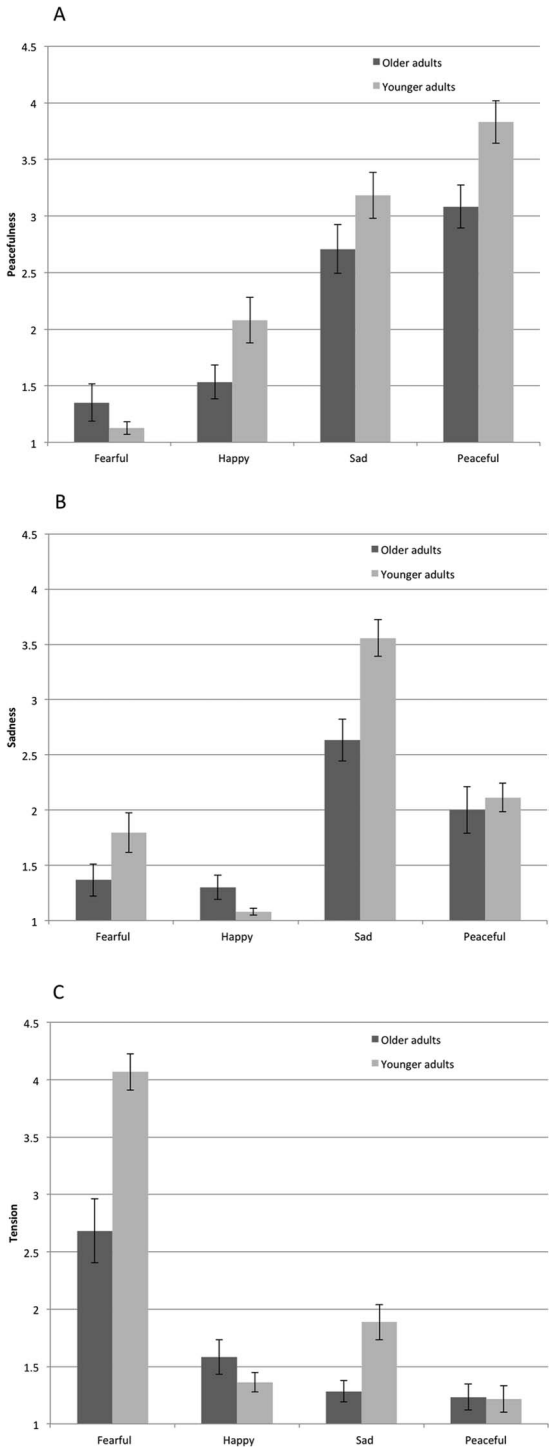

Figure 1. Mean ratings for older and younger adults for each emotional stimulus category for Peacefulness (A), Sadness (B) and Tension (C). Error bars show standard error.

(although Transcendence and Wonder were not well distinguished). Using factor analysis, Zentner et al. (2008) also found that correlations between the 9 GEMS factors could be accounted for in terms of three higher-order factors, which they labeled sublimity

Table 1
Correlations Across All Stimuli and Participants Between the 9 GEMS Ratings and Liking Ratings

Rating	Wonder	Transcendence	Power	Tenderness	Nostalgia	Peacefulness	Joyful A.	Sadness	Tension	Liking
Wonder	1.0	**0.81**	0.28	0.28	0.27	0.31	0.36	−0.14	−0.18	**0.63**
Transcendence		1.0	**0.59**	−0.17	−0.15	−0.15	0.32	−0.26	0.23	0.24
Power			1.0	**−0.74**	**−0.77**	**−0.76**	**0.62**	**−0.71**	0.45	−0.05
Tenderness				1.0	**0.93**	**0.95**	−0.23	0.46	**−0.72**	**0.57**
Nostalgia					1.0	**0.96**	−0.37	**0.65**	**−0.61**	0.46
Peacefulness						1.0	−0.29	**0.55**	**−0.72**	**0.54**
Joyful A.							1.0	**−0.71**	−0.24	**0.51**
Sadness								1.0	−0.11	−0.03
Tension									1.0	**−0.66**
Liking										1.0

Note. Correlations with absolute coefficients above 0.5 have been highlighted in bold.

(Wonder, Transcendence, Tenderness, Nostalgia, Peacefulness), vitality (Joyful Activation and Power) and unease (Tension and Sadness). In the following section, therefore, we investigate whether the GEMS ratings can be projected to a lower-dimensional space using Factor Analysis.

Factor Analysis

The raw GEMS data were submitted to factor analysis using principal axis factoring, regression factor scores and Promax rotation ($\kappa = 4$), based on Eigenvalues greater than 1, without data suppression. Examination of the eigenvalues and percentage of variance explained suggested that the data could be accurately captured using three factors, with eigenvalues greater than 1.0 accounting cumulatively for 82% of the variance. Table 2 shows the factor loadings.

Examination of the factor loadings suggests the following interpretations of the factors. Factor 1 reflects the inverse of *Arousal* (loading positively on tenderness, peacefulness and joyful activation and negatively on tension). Factor 2 reflects positive high arousal emotions, which we term here *Animacy* (loading positively on wonder, transcendence and power). Factor 3 reflects (negative) *Valence* (loading positively on sadness and tension and negatively on joyful activation).

Analysis of Three Derived Factors

Figure 2 shows the three factor scores for each age group, separately for each of the four emotional categories. We here point out some overall patterns. Both age groups displayed the expected ordering of scores for the Arousal and Valence factors: Fearful music was by far the most arousing, followed by happy. Sad music elicited negative scores, and tender was the least arousing. For Valence, happy music elicited by far the highest positive scores, followed by fearful, then tender, with sad music eliciting the lowest valence. Both groups showed less differentiation among the music categories for the Animacy factor compared with the other two factors. However, the age groups diverged in that all scores for the older adults were negative and all but sad music were positive for the younger adults. Additional age differences are explored in the following analyses.

Table 2
Factor Loadings on Each of the GEMS Items for Each of the Three Factors

GEMS item	Factor 1	Factor 2	Factor 3
Wonder	.287	.816	−.115
Transcendence	.052	.859	−.051
Power	−.374	.618	−.352
Tenderness	.791	.200	.031
Nostalgia	.688	.235	.344
Peacefulness	.868	.103	.172
Joyful activation	.138	.363	−.697
Sadness	.175	−.025	.698
Tension	−.821	.362	.446

Note. Principal axis factoring; Promax rotation with Kaiser normalization converged in nine iterations.

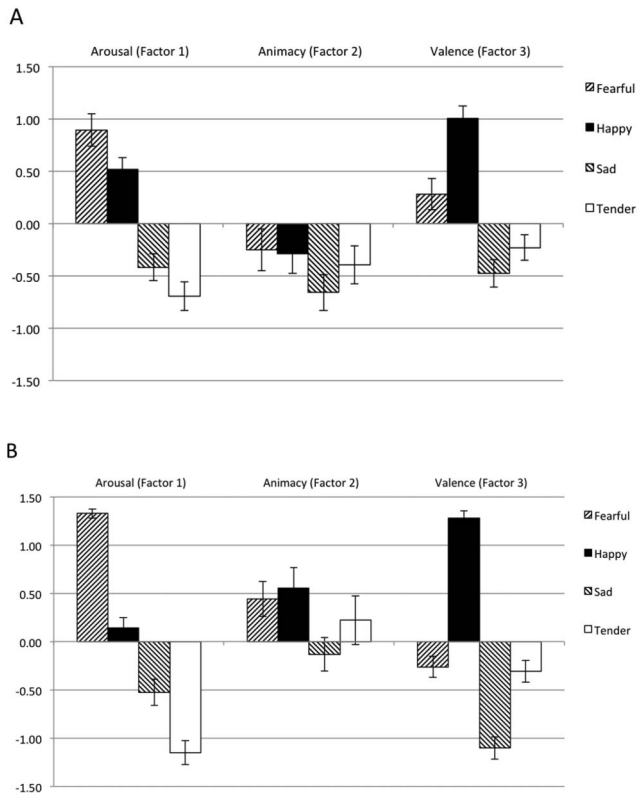

Figure 2. Mean factor loadings on each of the three GEMS factors for the older adults (A) and younger adults (B) to the stimuli in each emotional category. Error bars show standard error.

An analysis of variance was performed on the three factor scores for the stimuli using a between-subjects factor of *age group* (two levels: older, younger), a within-subject factor of *emotional category* (four levels: happy, sad, fearful, tender), and a within-subject factor of *GEMS factor* (three levels: Arousal, Animacy, Valence). The results indicate a significant effect of emotional category, $F(3, 33) = 44.33$, $p < .001$, and an interaction between emotion and age group, $F(3, 33) = 9.22$, $p < .001$. Furthermore, there were significant interactions between age and GEMS factor, $F(2, 34) = 6.15$, $p = .005$, GEMS factor and emotion, $F(6, 30) = 36.60$, $p < .001$, and a significant three-way interaction among all independent variables, $F(6, 30) = 7.21$, $p < .001$.

These interactions warranted follow-up 2 × 4 ANOVAs on the factor scores for each GEMS factor separately, with a between-subjects factor of *age group (*two levels: older, younger) and a within-subject factor of *emotional category* (four levels: happy, sad, fearful, tender). For Arousal (Factor 1), there was a significant effect of emotional category, $F(3, 33) = 120.04$, $p < .001$, and a significant interaction between emotional category and age group, $F(3, 33) = 11.28$, $p < .001$. For Animacy (Factor 2), there was a significant effect of emotional category, $F(3, 33) = 5.50$, $p = .004$, a significant difference between age groups $F(1, 35) = 7.08$, $p = .012$, but no significant interaction between emotional category and age group. For Valence (Factor 3), there was a significant effect of emotional category, $F(3, 33) = 142.08$, $p < .001$, and a significant interaction between emotional category and age group, $F(3, 33) = 7.75$, $p < .001$.

The effects of emotional category for all factors are not surprising, given how the factor analysis was derived. However, the results for Factor 2 suggest that younger participants experience greater animacy overall to music. The results for Factors 1 and 3 suggest that older listeners show a different pattern of emotional responses to music in terms of arousal (Factor 1) and valence (Factor 3). Specifically, the results suggest that older individuals have less extreme arousal response to fearful, happy and tender music. They also have more positively valenced experiences of fearful and sad music but also slightly less positive experiences of happy music.

Discussion

To recap our major results: older and younger listeners were both able to use the GEMS 9-item rating scale to capture their emotional responses to music. The analysis of the 9 GEMS scales indicated significant age-related effects between younger and older adults in peacefulness, sadness and tension. The two groups appear to experience these emotions in similar ways across the stimulus categories but the younger group show more extreme, differentiated responses. A similar pattern emerged from the analysis of the factor-analyzed data, which showed some notable differences in emotional experience between the groups: in particular, the older adults responded in a less differentiated manner than did young adults. This pattern supports a dedifferentiation pattern primarily, but we also found modest support for a positivity effect as discussed further below.

We would first like to comment on some aspects of the results that were age invariant. Both groups liked the excerpts to the same extent, even though the younger adults rated them as being more familiar. (Note, as we did not ask people to name the excerpts, we do not know whether this was the result of a true recollective memory difference, recognition based only on familiarity, or a bias). And both groups, not surprisingly, preferred positively valenced music more than negatively valenced, though this was more true for younger listeners: film music is *designed* to induce the appropriate emotions in the listeners, and overall, the composers succeeded here in inducing basic emotions even in the artificial laboratory listening environment.

We performed our factor analysis on the GEMS-9 data from the groups combined. Although we did not have large enough samples to conduct the analysis separately for the age groups—a goal for the future—the qualitative similarity of the rating patterns for each group suggests that the GEMS-9 was appropriate for listeners of all ages. For Arousal (Factor 1), all listeners rated Fearful music as the most arousing, followed by Happy, Sad, and Tender in descending order. For Valence (Factor 3), all listeners rated Happy as most positive and Sad as least positive, with Fearful and Tender at intermediate values (interestingly, seniors rated Fearful music slightly positively, and young people rated Fearful music slightly negatively, contrary to the stereotype of horror movies appealing more to the younger set). Both groups regarded Tender music as slightly negative, which comports with reports of Nostalgia having a sad component to it (Barrett et al., 2010).

The main finding of age difference is that older adults showed less reactivity across the board. This was particularly true for Factor 2 (Animacy), where we did not see an Age × Emotion interaction. Although neither age group showed extreme loadings for any type of music on that dimension, the younger adults showed higher loadings generally. Our older listeners overall felt less of a sense of wonder, transcendence, and power while listening, at least for these pieces and in this listening situation.

We also saw a smaller range of reaction in the two age groups for the other two factors. In particular, older listeners found Fearful music less arousing (a result also found by Vieillard & Bigand, 2014) and Tender music less calming than younger; Happy music was less positively valenced and Sad music less negatively valenced for them compared to younger listeners. As noted in the Introduction, this pattern is consistent with the STAC model of Park and Reuter-Lorenz (2009), suggesting less specificity in processing at both cognitive and emotional levels. But further research should explore whether this result would generalize to other music and in other listening situations: it may be the case that our older listeners were less accustomed to "laboratory" -like listening conditions than were the younger people, inhibiting their emotional response. It is of note, however, that Mas-Herrero, Marco-Pallares, Lorenzo-Seva, Zatorre, and Rodriguez-Fornells (2013) found decreasing responses with age on several scales capturing musical reward experience as a trait. We should also recognize that all of these data were based on self-report, and we cannot exclude the possibility of more self-editing of responses among the seniors. Studies using EEG or other physiological measurements might be of help in this respect.

Against the backdrop of lower responsivity, we do however find some modest support for a Positivity Effect: the reduction of response in older people for Sad music was about twice the magnitude of their reduction of response for Happy music. In other words, older people found Happy music somewhat less happy than did younger people, but they found Sad music much less sad than did younger people. This pattern is similar to that found by

Vieillard and Gilet (2013) for accuracy of categorization of felt emotion in music (but Vieillard & Bigand, 2014, found no age differences in "hedonic feeling" in their four categories of music).

Finally we wish to comment on the three factors we saw emerge from our listening data. Interestingly, Zentner et al. (2008) also performed a higher-order factor analysis as they were developing the GEMS-9. Their data were not however actual listening responses, but an adjective checklist: how often the respondent reported feeling a particular emotion to various genres of music. And although they also reduced the GEMS to three factors, their pattern differed from ours. For instance, their Vitality dimension included Power and Joyful Activation, whereas we found Joyful Activation to load on our Arousal factor (negative loading) and Power to cluster with Wonder and Transcendence in our Animacy factor. Again, this may reflect the difference between actually listening versus a retrospective report, the type of music probed, and the listening situation. The important point is that the GEMS-9 scale is a useful tool to capture musical emotions among people of different ages and from different countries. The fact that the nine scales can be reduced to three factors can add convenience and statistical power to future analyses, and we would recommend that researchers conduct and report their own analyses to test the consistency of the higher-order factors over different samples of people and music.

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