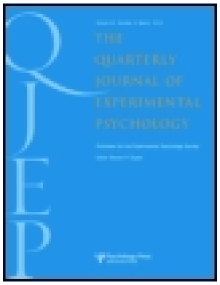

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Distinct effects of positive and negative music on older adults' auditory target identification performances

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Older adults, compared to younger adults, are more likely to attend to pleasant situations and avoid unpleasant ones. Yet, it is unclear whether such a phenomenon may be generalized to musical emotions. In this study, we investigated whether there is an age-related difference in how musical emotions are experienced and how positive and negative music influences attention performances in a target identification task. Thirty-one young and twenty-eight older adults were presented with 40 musical excerpts conveying happiness, peacefulness, sadness, and threat. While listening to music, participants were asked to rate their feelings and monitor each excerpt for the occurrence of an auditory target. Compared to younger adults, older adults reported experiencing weaker emotional activation when listening to threatening music and showed higher level of liking for happy music. Correct reaction times (RTs) for target identification were longer for threatening than for happy music in older adults but not in younger adults. This suggests that older adults benefit from a positive musical context and can regulate emotion elicited by negative music by decreasing attention towards it (and therefore towards the auditory target).

Keywords: Ageing; Musical emotions; Target identification task; Positivity effect; Emotional dedifferentiation.

Numerous studies examining age-related differences in attention processing of emotional information have shown that older adults selectively attend to positive rather than negative stimuli (Isaacowitz, Toner, & Neupert, 2009; Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b; Knight et al., 2007; Mather & Carstensen, 2003, 2005; Rösler et al., 2005). This emotional bias towards positive information and/or against negative information, called the positivity effect, has been described within the socioemotional selectivity theory (SST) model (Carstensen, 1992; Carstensen, Isaacowitz, & Charles, 1999) as a motivational shift towards emotionally meaningful goals due to a limited perspective of time. There is a large agreement that the positivity effect may represent a potential strategy for emotion regulation in older adults. Faced with physical and cognitive declines, and with a limited amount of time, older adults may attempt to maintain a positive affect by prioritizing the processing of positive stimuli over negative stimuli (Carstensen & Mikels, 2005).

Empirical studies on the positivity effect in attention in the elderly have mainly focused on visual stimuli such as emotional pictures (e.g.,

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Knight et al., 2007; Rösler et al., 2005), faces (e.g., Isaacowitz et al., 2009; Isaacowitz et al., 2006a, 2006b; Mather & Carstensen, 2003), or words (Langley et al., 2008). Recording eye movements while displaying pairs of happy and angry faces, Isaacowitz et al. (2006a) showed that, compared to younger adults, older adults preferentially shift their attention away from negative stimuli and towards positive stimuli. Other recent findings have demonstrated that attention deployment strategies play an important role in emotion regulation in the elderly (Opitz, Rauch, Terry, & Urry, 2012): During a cognitive reappraisal activity in an emotion regulation task, when controlling for visual attention deployment, older adults were less successful than younger adults at using cognitive reappraisal to decrease unpleasant emotion. This corroborates the view that, in order to reduce the occurrence of stressors and maintain their well-being, older adults seem to use an emotional coping skill aimed to avoid unpleasant situations by averting their gaze. In this respect, an interesting question arises: How efficient could emotion control be when older adults are faced with an emotional auditory stimulus such as music for which there is no possibility to redirect auditory perception? Indeed, by contrast with visual stimuli, auditory perception cannot be averted to achieve an avoidance goal, notably when presented by headphones.

The literature on ageing and emotion has also indicated that older adults show a less pronounced differentiation between valence and arousal, which has been interpreted as a possible decline in emotional functioning with age. To date, this phenomenon has been demonstrated in both the visual (Grühn & Scheibe, 2008) and the auditory (Vieillard, Didierjean, & Maquestiaux, 2012) domains but has been limited to perceived emotions. This leaves open the question of whether emotional dedifferentiation exists when emotions are experienced. Young listeners who focused on their emotional experience may give a significantly higher rating of recognition than those who paid attention to what they perceived, suggesting that being personally engaged in musical listening may increase emotion processing (Vieillard et al., 2008). Given that previous findings have indicated that emphasizing on emotion rather than on knowledge may be more meaningful to older adults than younger adults (e.g., Mikels et al., 2010), we stated that the assessment of the emotional experience would be particularly appropriate to track down age-related differences.

Until now, both emotional dedifferentiation and positivity effect have been addressed separately but the possibility that they may represent the two faces of the same coin cannot be ruled out. Even if the positivity effect was initially associated to a motivated cognition and to controlled processes postulated by the socioemotional theory, the recent development of the dynamic integration theory (DIT) of Labouvie-Vief (2008) also predicted an emotional bias for positivity with ageing. The DIT model postulates that when older adults are faced with cognitive decline, their homeostasis would become more vulnerable to tension and to negativity, resulting in a diminished cognitive performance. Older adults' attempt to avoid tension and negativity would result in a tendency to maximize positive affects and minimize negative affects. Given the age-related cognitive decline, this attempt would in turn cause a reduction in complex emotional processing (e.g., emotional dedifferentiation). To summarize, the DIT model assumes that the decrease in emotional complexity is the cognitive counterpart of the attempt to preserve well-being. In the current research, we conceptualized the reduction of emotional complexity in terms of a reduction in the differentiation between arousal and valence, two main dimensions of emotions that we labelled emotional activation (from "weak" to "strong") and hedonic feeling (form "negative" to "positive"), respectively. We also anticipated that in older adults the positivity effect would be susceptible to co-occur with the reduction of emotional complexity.

The few studies that have explored emotion and ageing using auditory stimuli such as music (Hailstone et al., 2009; Laukka, 2007; Laukka & Juslin, 2007; Lima & Castro, 2011; Vieillard, Didierjean, et al., 2012) have focused on the purpose music serves in everyday life as well as on older adult's abilities to recognize or categorize emotions in music. These studies have shown that older adults (a) reported feeling mostly positive emotions while listening to music (Laukka, 2007), and (b) succeeded in discriminating some emotion categories in music but performed significantly poorer in recognizing negative emotions such as fear and sadness among other categories (Laukka & Juslin, 2007; Lima & Castro, 2011). More recent findings revealed that older listeners succeeded in discriminating different emotion categories in music (i.e., happiness, peacefulness, sadness, and threat) but showed an increased focus on happy music and a stronger covariation between the judgements of valence and arousal in comparison with their younger counterparts (Vieillard, Didierjean, et al., 2012). This has been interpreted as being in line with the theoretical model of Labouvie-Vief (2008), according to which older adults' attempt to attain affect optimization would result in a less complex emotional reasoning so that emotion representations are simplified. Taken together, the studies reviewed above support the argument of an age-related emotional bias towards positive music and/or against negative music (but see Ruffman, Henry, Livingstone, & Phillips, 2008, for inconsistent findings showing that older adults display decline in the recognition of vocal expression of happiness). However, no prior studies have examined the effect of age on the way positive and negative musical emotions may modulate auditory attention, nor the possibility that the dedifferentiation phenomenon may be found in a condition where participants are instructed to focus on their emotion experience, not simply on emotion recognition.

In the present research, participants were asked to listen to musical excerpts while reporting their emotional experience on three rating scales—namely, Emotional Activation, Hedonic Feeling, and Liking. In addition, a concomitant auditory identification task was used as an index of attention processing while participants were listening to happy, peaceful, sad, or threatening music. As in visual attention studies, emotional auditory stimuli typically draw larger amounts of attention than neutral stimuli (Vieillard, Roy, & Peretz, 2012). In line with the positivity effect hypothesis of a difference between older and younger adults in their attention to positive as opposed to negative material (Reed & Carstensen, 2012), we inserted one of two distinct auditory targets into the positive or negative musical stimuli. Our hypothesis was that the positive or negative emotion elicited by music would differentially modulate the attention to music, then influencing the time required to correctly identify the auditory target. For instance, being strongly engaged with a positive music would lead to increase attention to auditory stimulation, thus leading to faster correct reaction times (RTs). Participants were instructed to carefully monitor each musical excerpt for the identification of an auditory target (beep signal *or* white noise). The rationale for using a decision-making task (identification) rather than a more simple detection task was to make it more resource demanding since it has been suggested that the emotional bias may be linked to tasks requiring consciously controlled processing rather than those relying on automatic processes (Leclerc & Kensinger, 2008; Mather & Knight, 2005). As a result, we selected two easily distinguishable sounds—that is, a beep signal and a white noise of neutral emotional value.

Based on previous findings (Grühn & Scheibe, 2008; Keil & Freund, 2009; Mather et al., 2004; Vieillard, Didierjean, et al., 2012), and in line with the hypothesis that a reduction of emotional complexity (e.g., emotional dedifferentiation) may emerge as a cognitive counterpart of older adults' attempt to reduce negativity and maximize positivity, we expected that older adults would show a stronger association between the Emotional Activation and Hedonic Feeling ratings than their younger counterparts. Regarding the target identification task, the motivational perspective of SST postulates that older adults should preferentially direct attention towards positive stimuli and away from negative stimuli. In the music context, this means that older adults would be more strongly engaged with positive musical excerpts (i.e., peaceful and happy music) than with negative musical excerpts (i.e., sad and threatening music). As a result, older adults should pay greater attention to the auditory targets inserted into positive music, which in turn would result in faster target identification for positive musical excerpts than negative musical excerpts. In contrast, such an effect should not be expected in younger adults.

Although there is general agreement on arousal being another important modulating factor in attention processing, no clear prediction has yet been made about the arousal by valence interaction in age-related changes in emotion processing. Therefore, in order to provide more understanding about the potential role of the emotional arousal dimension on positivity effect, we used both positive and negative musical excerpts equated on the arousal dimension (see Vieillard et al., 2008, for the validation study) with the aim to examine whether highly arousing music would lead to a greater variation of attention.

Method

Participants

Fifty-nine nonmusician and native French speakers volunteered to participate in the study. No medical or psychiatric antecedent was reported. Two participants (1 younger adult and 1 older adult) were excluded from the correct RTs analysis because of technical problems or because they exceeded the mean RT by 3 or more standard deviations. As a result, the data of 30 younger adults (19–25 years, $M = 21$; 67% females) and 27 older adults (62–91 years, $M = 71$; 56% females) were analysed. Groups of age were matched on education years, $t(55) = -0.95$, $p = .35$, corresponding to a high-school diploma. The younger and older adults were recruited without financial compensation at the psychology department of the University of Franche-Comté and through senior social programmes in Besançon, respectively. For each participant, potential hearing loss was examined using an online audio test (Crotal, n.d.). To this end, the lowest decibel hearing level (dBHL) at which each frequency was detected was retained and entered in a nonparametric Mann–Whitney test (independent samples) as ordinal data. As shown in Table 1, and as expected, dBHL varied as a function of age. However, the Mann–Whitney test did not show a statistically significant difference between younger and older adults ($U = 50$, $Z = -0.50$, $p = .62$ for 500 Hz; $U = 60$, $Z = -0.15$, $p = .88$ for 1000 Hz; $U = 39$, $Z = 0.71$, $p = .48$ for 2000 Hz; $U = 67$, $Z = -0.66$, $p = .51$ for 4000 Hz; $U = 36$, $Z = 0.27$, $p = .79$, for 8000 Hz). This lack of difference probably stemmed from the variability observed within the groups, in particular in older adults.[1] As expected, performances on fluid intelligence (measured by Raven's Progressive Matrices, Set I, Raven, Raven, & Court, 2003) and working memory (measured by Digit Span from the Wechsler Adult Intelligence Scale–Third Edition, WAIS–III, Wechsler, 2000) were higher in younger than in older adults [$t(55) = -4.42$, $p = .00$; $t(55) = -2.58$, $p = .01$, respectively]. Depression (Beck Depression Inventory–II, BDI–II; Beck, Steer, & Brown, 1998) and state–trait anxiety (State–Trait Anxiety Inventory Form Y, STAI–Y; Spielberger, 1993) measures were significantly different between age groups [$t(55) = -2.28$, $p = .03$ for depression; $t(55) = -2.32$, $p = .02$ for state anxiety; $t(55) = -2.65$, $p = .01$ for trait anxiety)]. Despite these significant differences, we found a minimum level of depression ($M = 9$ in younger adults; $M = 6$ in older adults) as well as a very low state–anxiety ($M = 32$ in younger adults; $M = 27$ in older adults) and low trait–anxiety ($M = 32$ in younger adults; $M = 27$ in older adults) for both age groups. Younger adults did not report a better state of health than older adults, $t(55) = -0.74$, $p = .46$. The Mini Mental State Examination (MMSE; Petit et al., 1998) scores for older adults ranged from 25 to 30, with a mean score of 29, suggesting no cognitive impairment.

Materials

Forty short musical excerpts, computer generated in a piano timbre and taken from Vieillard et al.'s

[1]An additional correlation analysis was conducted to test whether older adults' dBHL values were linked to their correct RTs in the auditory target identification task. Results indicated that correlation values obtained for each frequency and emotion category were low (ranged from −.20 to .24) and not significant, showing that target identification performances and hearing loss in older participants were independent from each other.

Table 1. *Participant characteristics*

	Younger listeners (n = *16)*	*Older listeners* (n = *16)*
Demographic characteristics		
Age (years)	21 (1.70)	72 (7.94)
Education (years)[a]	13 (0.54)	12 (2.84)
Sex (% female)	60	50
Marital status (%)	100 singles	13 singles, 69 married, 18 widowed
Questionnaire data		
Classical music listening	7	2
Self-reported health (max. 5)	4.50 (0.52)	4.25 (0.45)
Mean lower decibel hearing level[b]		
500 Hz	28 (10–40)	33 (20–60)
1000 Hz	13 (10–20)	23 (10–50)
2000 Hz	29 (20–40)	43 (20–70)
4000 Hz	33 (20–50)	56 (30–100)
8000 Hz	20 (10–40)	51 (20–80)
Cognitive performances		
Raven's Matrices (max. 12)	10.38 (1.31)**	8.63 (1.26)**
Digit span (max. 30)	13.81 (3.23)*	11.75 (2.27)*
MMSE	—	29 (1.34)
Affective state		
BDI-II (max. 63)	7.74 (4.07)	5 (3.71)
STAI-Y Trait (max. 80)	35.31 (5.45)	33.86 (6.11)
STAI-Y State (max. 80)	30.19 (6.76)	26.94 (4.43)

Note: MMSE = Mini-Mental State Examination; BDI–II = Beck Depression Inventory–II; STAI–Y = State–Trait Anxiety Inventory Form Y. Standard deviations are listed in parentheses.

[a]Number of years of education has been calculated from 6 years old (age at which school is compulsory in France). [b]Range in parentheses.

*Significant difference at $p < .05$. **Significant difference at $p < .001$.

(2008) set of unfamiliar musical stimuli, were selected for their power to convey four distinct emotions (i.e., happiness, peacefulness, sadness, and threat). Musical excerpts were controlled for their valence (unpleasant versus pleasant) and arousal (low versus high). More especially, the sad excerpts were written in a minor mode at an average slow tempo of 46 Maelzel's metronome (range: 40–60), with the pedal. The peaceful excerpts were composed in a major mode, had an intermediate tempo (mean: 74, range: 54–100), and were played with pedal and arpeggio accompaniment. The scary excerpts were composed with minor chords on the third and sixth degree, hence implying the use of many out-of-key notes. Each emotion category included 10 musical excerpts of about 13 seconds ($SD = 2$ s) duration. Examples can be found in Peretz (2008). A previous study in younger adults demonstrated that the current threatening and happy musical excerpts elicited a higher magnitude in skin conductance response (SCR) than sad and peaceful musical excerpts (Khalfa, Peretz, Blondin, & Robert, 2002), suggesting that the present threatening and happy stimuli were arousing enough to induce event-related responses of the sympathetic nervous system. Another study using the same musical excerpts to examine the effect of age on emotion perception in music indicated that older listeners easily succeeded in distinguishing happiness, peacefulness, sadness, and threat in music (Vieillard, Didierjean, et al., 2012).

Procedure

The experiment was divided into two sessions separated by an interval of approximately one week. During the first session, the participants completed a consent form and were asked about their age, musical listening preferences, education level, self-reported health, visual and auditory acuity, and medical history. Auditory perception was controlled using a free online audio test (Crotal, n.d.), which provided an approximate estimation of hearing loss. In order to measure a potential hearing loss as reliably as possible, pure tones at intervals between 500 Hz and 8000 Hz were presented to both ears through high-quality professional 240 Sennheiser headphones in a quiet room in a test–retest procedure. For each participant and frequency, the lowest decibel hearing level (dBHL) detected was retained. Participants also carried out two cognitive tasks: a fluid intelligence task (Raven's Progressive Matrices, Set I) and a working memory task (Digit Span from the WAIS–III). The participants were then asked to complete depression and anxiety inventories (i.e., BDI–II and STAI–Y). The older participants were asked to complete the Mini Mental State Examination. This session lasted about an hour.

During the second session, the participants were individually tested in a quiet room with the presence of the experimenter. They were first asked to perform emotional ratings followed by a target identification task.

In the emotional ratings, participants were seated in front of a computer screen and were instructed to listen attentively to the 40 musical excerpts that were presented binaurally and pseudorandomly in two counterbalanced orders. The loudness of four new musical excerpts (which were taken from the four emotion categories of the same musical battery but not included in the emotional ratings) was adjusted subjectively so that it was comfortable for each participant during the experiment. Participants began each trial by pressing the space bar. For each trial, they listened to the full musical excerpt and were asked to indicate what they *experienced* in terms of emotional activation (from 0 "weak" to 9 "strong") and hedonic feeling (from 0 "negative" to 9 "positive"). They also rated how much they liked each musical excerpt on a scale ranging from 0 "not at all" to 9 "very much". The presentation order of these three rating scales was counterbalanced across participants.

After that, the participants were asked to perform the auditory target identification task with the same excerpts as those used in the emotional rating task. In this task, a beep signal and a white noise with 25 ms duration were used as two brief and easily distinguishable targets inserted into musical excerpts. In each of the 40 musical excerpts, one target, either the beep signal or the white noise, was inserted at either 5000 or 8000 ms after the beginning of the excerpt. The nature (beep signal versus white noise) and the location (5000 versus 8000 ms) of the target were counterbalanced across participants. To match the 40 trials comprising an auditory target, the 40 original excerpts were presented once each without a target and were mixed with those with a target. In order to facilitate emotion elicitation, the musical excerpts were presented in four blocks of 20 stimuli from the same emotion category. The presentation order of the blocks was counterbalanced across participants. Stimulus order within each block was randomized. In this two-choice discrimination task, participants were informed that the musical excerpts may contain a target (either a beep signal or a white noise) that they had to identify as quickly as possible by pressing one of the two keys labelled "beep" or "noise" with the index and middle fingers of their dominant hand. Key assignments were counterbalanced across participants. Two examples of each target and four practice trials (the same four musical excerpts used for loudness adjustment in the emotional ratings) were presented before the beginning of the task. Each trial began with a "Ready?" warning so that participants initiated each trial by pressing a start button. Then, a musical excerpt was presented with the screen "listen attentively" and stopped immediately when the participants pressed one of the two key responses. No feedback was delivered after the response. This session lasted about one hour, after which the participants were fully debriefed.

For both emotional ratings and target identification task, response recordings were carried out using E-prime Software (Schneider, Eschmann, & Zuccolotto, 2002).

Results

Mixed-model analyses of variance were conducted separately on each dependent variable (i.e., mean scores of rating for emotional activation, mean score of rating for hedonic feeling, mean score of rating for liking, target identification task accuracy, and target identification task latency) with age group as the between-subjects factor and emotion category (i.e., happiness, peacefulness, sadness, and threat) as the within-subjects factor. Following on from these analyses, a set of repeated measures analyses of covariance (ANCOVAs) was performed to explore whether differences in emotional responses to music (i.e., ratings and target identification performances) existed between younger and older adults having controlled the affective factors (i.e., depression and anxiety). To this end, a set of ANCOVAs was conducted to investigate the role of differences in affective functioning in age effects, with emotion category as a within-subject factor, age group as a between-subject factor, and affective factors as covariates (i.e., depression and anxiety scores).

Emotional activation

A significant main effect of emotion category, $F(3, 165) = 135.54$, $p = .000$, $\eta_p^2 = .71$, as well as a significant Age Group × Emotion Category interaction, $F(3, 165) = 10.77$, $p = .000$, $\eta_p^2 = .16$, was found. The interaction indicated that the age groups did not show the same pattern of emotional activation across the four emotion categories. To understand this interaction more fully, we performed post hoc pairwise comparisons (Bonferroni's correction) between age groups within each emotion category and separately for each age group between emotion categories. As shown in Figure 1 and confirmed by post hoc comparisons, compared to their younger counterparts, older adults reported experiencing lower emotional activation when listening to threatening music ($p = .002$). No age difference was found for any of the three other emotion categories (with $p = 1.000$ for happy music, $p = .221$ for peaceful music, and $p = 1.000$ for sad music). Moreover, post hoc comparisons between emotion categories conducted separately for each age group indicated

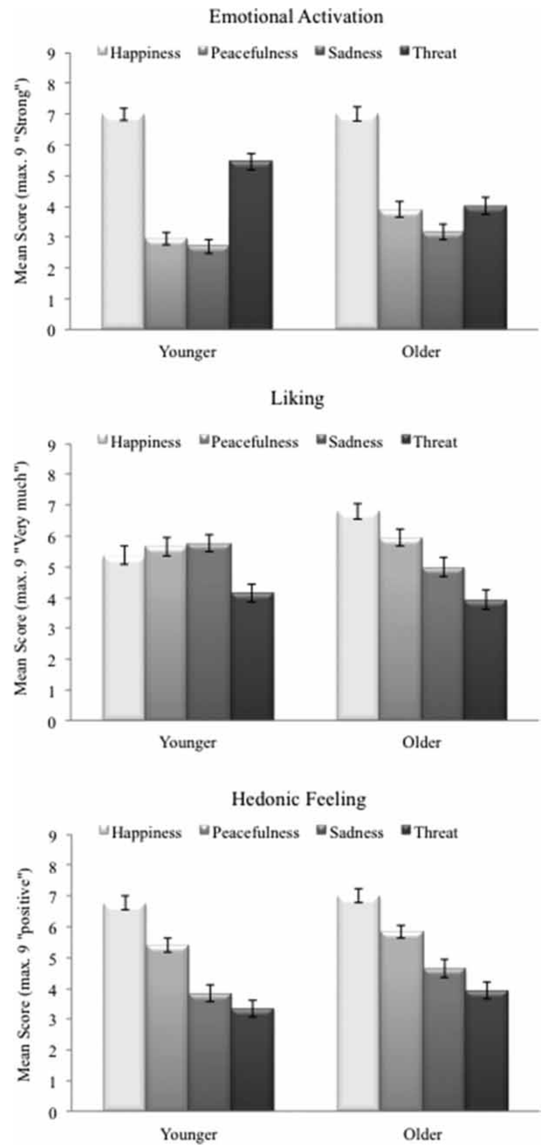

Figure 1. *Mean and standard error for emotional activation, liking, and hedonic feeling ratings as a function of emotion category (happiness, peacefulness, sadness, and threat) and age group (younger, older).*

that happy music was associated to the highest emotional activation in comparison with the three other emotion categories (ps = .000). They also revealed that younger adults reported experiencing higher emotional activation when listening to threatening music than when listening to sad ($p = .000$) and peaceful music, ($p = .000$) while older listeners did not, ($p = 1.00$). An ANCOVA with affective factors (i.e., depression and anxiety scores) as covariate did not substantially reduce the Age Group × Emotion Category interaction, $F(3, 156) = 10.68$, $p = .000$, $\eta_p^2 = .17$.

Liking

There was a significant main effect of emotion category, $F(3, 165) = 28.82$, $p = .000$, $\eta_p^2 = .34$, as well as a significant Age Group × Emotion Category interaction, $F(3, 165) = 7.74$, $p = .000$, $\eta_p^2 = .12$. As shown in Figure 1 and confirmed by post hoc pairwise comparisons (Bonferroni's correction), older adults reported a significantly higher level of liking for happy music ($p = .014$) than their younger counterparts. No other significant effect was found (with $p = 1.000$ respectively for peaceful, sad, and threatening music). Further pairwise comparisons computed separately for each age group within emotion categories indicated that older adults reported a significantly higher level of liking for happy music than for sad music ($p = .000$), as well as a significantly higher level of liking for peaceful music than for threatening music ($p = .000$). Such differences were not found in younger adults, except between peaceful and threatening music, ($p = .000$). The Age Group × Emotion Category interaction was still significant after including affective factors (i.e., depression and anxiety scores), $F(3, 156) = 4.54$, $p = .004$, $\eta_p^2 = .08$.

Hedonic feeling

There were significant main effects of age group, $F(1, 55) = 4.89$, $p = .031$, $\eta_p^2 = .08$, and emotion category, $F(3, 165) = 90.07$, $p = .000$, $\eta_p^2 = .62$. No significant interaction between these two factors was found, $F(3, 165) = 0.65$, $p = .584$, $\eta_p^2 = .01$. The main effect of age group showed that, whatever the emotion category, older adults generally reported more positive feeling ($M = 5.35$, $SE = 0.17$) than their younger counterparts ($M = 4.84$, $SE = 0.16$).

Pearson correlation analyses were conducted to assess associations between the mean ratings of emotional activation, hedonic feeling, and liking through the four emotion categories in younger and older adults, respectively. Results indicated that younger adults showed a negative and no significant correlation between emotion activation and liking, $r(118) = -.12$, $p = .183$, while older adults associated a positive and stronger relationship between these two factors, $r(106) = .60$, $p = .000$ ($Z = -6.53$, $p = .000$). Older adults also showed a stronger association between liking and hedonic feeling, $r(106) = .94$, $p = .000$, than younger adults did, $r(118) = .33$, $p = .000$ ($Z = -10.38$, $p = .000$), indicating that the more they rated music as positive, the higher their preference for it. Moreover, and as expected, older adults showed a stronger association between emotional activation and hedonic feeling, $r(106) = .66$, $p = .000$, than younger adults did, $r(118) = .37$, $p = .000$ ($Z = -3.01$, $p = .000$). This stronger association for older adults indicated that they rated musical excerpts inducing negative feeling as conveying the lowest emotional activation (i.e., threatening excerpts) and rated those inducing positive feeling as conveying the highest emotional activation (i.e., happy excerpts). To test whether the higher correlation between emotional activation and hedonic feeling observed in older adults reflected a general dedifferentiation between these two emotional dimensions or rather a threat-specific effect, we ran an additional correlation analysis separately for each age group, leaving out the threatening musical excerpts. In accordance with the type of emotions included in the additional analysis, results showed a significant and positive association between emotional activation and hedonic feeling both in younger, $r(88) = .65$, $p = .000$, and older, $r(79) = .68$, $p = .000$, adults, indicating that the stronger the emotional activation, the more positive the emotion felt.

Auditory target identification performances

Raw correct RT artefacts were identified and discarded from the sample. These corresponded to

0.5% of all correct RTs. Moreover, 0.9% of the mean values lying 3 standard deviations over the group average were considered as out values and were excluded from the analyses. The mean percentage of missed identification was around 0.3%. The mean wrong identification reached around 7.1%, with 7.4% for beep signal and 6.8% for white noise signal, respectively.

Accuracy. The analysis of accuracy was based on the mean percentage of wrong identification. Neither main effect of any factor [$F(3, 55) = 0.06$, $p = .804$, $\eta_p^2 = .00$ for age group; $F(3, 165) = 1.896$, $p = .132$, $\eta_p^2 = .03$ for emotion category] nor significant interaction between these factors, $F(3, 165) = 2.324$, $p = .077$, $\eta_p^2 = .04$, was found.

Correct RTs. The analysis of the RTs for the subsequent correct responses in the target identification task showed significant main effects of age group, $F(1, 55) = 34.62$, $p = .000$, $\eta_p^2 = .39$, and emotion category, $F(3, 165) = 5.37$, $p = .002$, $\eta_p^2 = .09$, as well as a significant Age Group × Emotion Category interaction, $F(3, 165) = 2.97$, $p = .034$, $\eta_p^2 = .05$. Follow-up analyses showed a significant main effect of emotion category in older adults, $F(3, 78) = 6.04$, $p = .000$, $\eta_p^2 = .19$, but not in their younger counterparts, $F(3, 87) = 0.79$, $p = .79$, $\eta_p^2 = .01$. Consistent with the hypothesis of age-related differences in emotional processing as a function of valence and (possibly) arousal, and as shown in Figure 2, linear trend comparisons conducted across emotion categories separately for each age group indicated that older adults took longer to correctly identify the auditory targets located in threatening music than in happy music, $F(1, 26) = 11.86$, $p = .002$, $\eta_p^2 = .31$. This linear trend was not found in younger adults, $F(1, 29) = 0.94$, $p = .34$, $\eta_p^2 = .03$. An ANCOVA including affective factors (i.e., depression and anxiety scores) as covariates did not eliminate the Age Group × Emotion Category interaction, $F(3, 156) = 3.39$, $p = .020$, $\eta_p^2 = .06$.

To examine the role of cognitive factors (i.e., fluid intelligence, working memory) on the correct RTs, a set of correlation analyses was computed between the correct RTs measures and the cognitive performances (i.e., Raven's Matrices scores, Digit Span scores) for each emotion category. As shown in Table 2, the Raven's Matrices and the Digit Span performances both correlated negatively and significantly with correct RTs for sad music [$r(55) = -.41$, $p = .001$; $r(55) = -.30$, $p = .026$], and for threatening music [$r(55) = -.35$, $p = .008$; $r(55) = -.26$, $p = .047$]. These relationships indicated that the lower the cognitive performances, the higher the RTs for target identification in a context of negative music. We computed a multiple regression analysis to specify to what extent cognitive factors (i.e., working memory and fluid intelligence) may

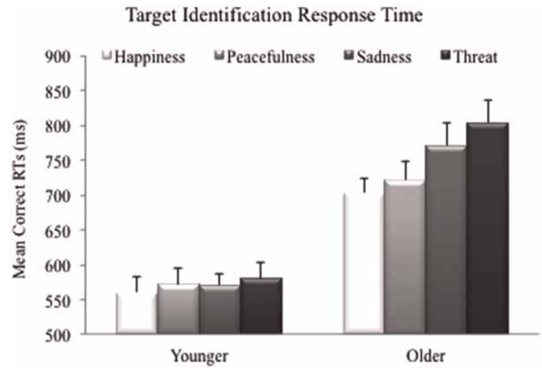

Figure 2. *Mean and standard error for correct response times (ms) as a function of emotion category (happiness, peacefulness, sadness, and threat) and age group (younger, older).*

Table 2. *Correlations and results of multiple regression analysis predicting the correct RTs for each emotion category from working memory and fluid intelligence performances.*

	Coefficients				
Behavioral measures	*Raven's Matrices*	*Digit Span*	R	F(df)	p
Mean correct RTs					
Happiness	−.23	−.10	.23	1.55 (2, 54)	.22
Peacefulness	−.11	−.04	.11	0.33 (2, 54)	.72
Sadness	**−.41***	**−.30***	.44	6.54 (2, 54)	**.00**
Threat	**−.35***	**−.26***	.38	4.51 (2, 54)	**.02**

Note: RT = reaction time. Emotion categories: happiness, peacefulness, sadness, and threat. Working memory: Digit Span subtest. Fluid intelligence: Raven's Matrices.

predict correct RTs. As shown in Table 2, the multiple R indicated that these two factors accounted for 14% and 20% of the variance in the correct RTs for sad and threatening music, respectively.

Another set of correlations between the mean scores on emotional ratings (i.e., emotional activation, liking, and hedonic feeling) and the mean correct RTs was performed separately for younger and older adults, indicating no significant relationship between emotional ratings and correct RTs, neither in younger [$r(118) = -.06$, $p = .485$ for emotional activation; $r(118) = -.10$, $p = .289$ for liking; $r(118) = -.07$, $p = .466$ for hedonic feeling] nor in older adults [$r(106) = -.04$, $p = .656$ for emotional activation; $r(106) = -.07$, $p = .471$ for liking; $r(106) = -.07$, $p = .492$ for hedonic feeling].

Discussion

In this study, we used emotional ratings and an auditory target identification task as tools to investigate age-related differences in emotional response and attention processing for emotions in music. We explored an emotional dedifferentiation phenomenon in emotional feeling and investigated how positive and negative music affect attention performances in a target identification task.

The current findings indicated that older adults showed a stronger linear relationship between their hedonic feeling and emotional activation than their younger counterparts. However, when removing threatening musical stimuli from the correlation analysis, the age group difference no longer appeared, suggesting that both age groups were quite similar across emotions, except for threatening condition in which older adults reported lower emotional activation than their younger counterparts. This age difference might reflect a tendency to pay less attention to negative stimuli, which appears to be a possible outcome of a positivity effect. A main question is whether this reduction of emotional processing for negative stimuli occurs automatically or whether it requires more control processes (Reed & Carstensen, 2012). According to previous findings (e.g., Mather & Knight, 2005) the positivity effect would require cognitive control abilities. Therefore the more cognitive resources older adults possess, the better they should be at selectively attending to positive stimuli and avoiding negative ones. An alternative explanation coming from the affective neurosciences postulated that positivity effect would arise from automatic processes associated to impairments in amygdala function that would in turn lead to a reduction in the emotional arousal of negative but not positive stimuli (aging brain model by Cacioppo, Berntson, Bechara, Tranel, & Hawkley, 2011). The diminution of emotional arousal associated to a decrease of the amygdala activation in response to negative stimuli would help older adults maintain their level of subjective well-being.

The current study also reveals that compared to their younger counterparts, older adults gave less differentiated judgements between hedonic feeling and liking, indicating that the more they rated music as positive, the higher their preference for it. This relationship between hedonic feeling and preference suggests that accumulated life experiences allow older adults to get a better match between what they like and how they feel it. Taken together with our findings indicating that older adults reported a higher level of liking for happy music than younger adults, the current result suggests that the way the music is subjectively perceived by older adults reflects a positivity effect.

When considering attention processing, our findings indicated that older adults took longer to identify the target in a context of sad and threatening music than in a context of peaceful and happy music, whereas younger adults did not show such an effect. In accordance with the definition of the positivity effect (Reed & Carstensen, 2012), our results provide evidence of a relative difference among older and younger people when processing positive as opposed to negative stimuli. This suggests that older adults' auditory probe identification was impaired in the condition of negative music because they were better at reducing their attention to such an unpleasant stimulus. Indeed, being less attentive to the music (and therefore to the auditory target) would represent a helpful strategy to better regulate negative emotion elicited by music. We could assume that older adults were able to suppress emotion by reducing attention, but this does not explain how this process occurs in a context in which the possibility to redirect attention away from auditory streaming is precluded. One possible explanation is that *attention reduction* and *attention redirection* are two distinct processes. In the visual domain, previous findings have demonstrated the existence of a decrease of the visual processing during emotional perception in the elderly and found that this phenomenon was linked to a reduced functional connectivity between amygdala and posterior brain regions (St. Jacques, Dolcos, & Cabeza, 2010). These data have been interpreted as fitting the hypothesis that ageing would be associated with a greater motivation to increase attention to positive stimuli and a diminished response to negative ones. Although additional neuroimaging research is needed to test whether such a phenomenon may be extended to auditory processing, it might be that in the current research, older adults may have paid less attention to threatening music because of the voluntary reduction in perceptual processing for negative stimuli.

Findings also showed that age differences in correct RTs were related to the decline in fluid and working memory abilities seen in normal ageing. If we assume that the positivity effect works in favour of emotion regulation, the emerging picture is consistent with the idea that when engaged in a voluntary emotion regulation (consisting in an attempt to decrease negative emotion through an attention reduction strategy), older adults become slower in tasks that tax their cognitive resources. In other words, emotion regulation would have a greater effect on older adults' auditory detection task performance because there are not enough cognitive resources available to be divided. This is relevant with theoretical frameworks positing that emotion regulation in ageing may have cognitive counterparts (Labouvie-Vief, 2008). At first sight, this may appear incongruent with recent findings indicating that emotion regulation was less effortful in older adults than in their younger counterparts (Scheibe & Blanchard-Fields, 2009). The reason of this apparent discrepancy is that in Scheibe and Blanchard-Fields's (2009) study, older and younger adults were both instructed to deliberately regulate their emotions, while in the present research, no such instruction was given. Consequently, younger adults had no reason to be engaged in any form of emotion regulation in our study. By contrast, if we consider that emotion regulation goals are chronically activated in older adults (e.g., Reed & Carstensen, 2012; Scheibe & Blanchard-Fields, 2009) even when the context does not demand it, we interpreted that older adults tried to modulate their inner experience of emotions in the current experiment and that it plausibly impacted their task performances. Our experiment was not designed to test whether emotion regulation process is more costly in task performance for older adults than for younger adults. Consequently, further researches are needed to know whether age-differences exist in a context in which emotion regulation and attention performances compete for the cognitive resources available.

Alternatively, it could be argued that older adults were slower for sadness and fear not because these musical stimuli were negative but because they were more difficult to process than happiness and peacefulness. In this case, we should have observed age differences, even if this is not significant, in identification accuracy for sad and threatening musical excerpts. However, our results showed that the ability to identify an auditory target in these stimuli was strictly similar across age groups. Furthermore, if age differences in correct RTs were essentially due to more complex musical features (e.g., dissonance, unexpectedness, irregularity) of the stimuli, no age-related increase in correct RTs should have been observed for regular and consonant negative musical excerpts in comparison with positive music. However, we did observe slower correct RTs in older adults for sad music than for happy music. Thus, it is unlikely that latencies for target identification may have been slower just because structural features made the task more cognitively demanding. Instead, it has been suggested that the negative experience per se (Labouvie-Vief, 2008) induced in the present research by threatening and sad music would be more cognitively demanding for older adults than for younger adults due to their vulnerability to stressors. Thus, an important question to address in the future is whether older adults were more disrupted to identify an auditory target only because they reduced their attention to negative stimuli to pursue emotion regulation goals or whether their limited cognitive resources along with emotion regulation processes both made them slower in the task. Such investigation should give more insight to the conditions in which cognitive losses implicated in emotion regulation may be or may not be transformed into adaptive behaviour.

Some limitations of the study need to be mentioned. Since our research is a cross-sectional study, we cannot draw definite conclusions about the age-related changes in emotion processing. Another limitation was that the sample size of older adults included a broad age range. This could result in a greater variability of older adults' performances which could lower the age-related differences in emotional modulation of attention. Further investigations are needed with a larger sample size. Despite these limitations, the current study suggests that older adults take advantage from positive musical context and may decrease their attention toward negative music to ensure regulation goals.

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REFERENCES

Beck, A. T., Steer, R. A., & Brown, G. K. (1998). *Beck depression inventory II*. Paris: Center of Applied Psychology.

Cacioppo, J. T., Berntson, G. G., Bechara, A., Tranel, D., & Hawkley, L. C. (2011). Could an aging brain contribute to subjective well being: The value added by a social neuroscience perspective. In A. Todorov, S. T. Fiske, & D. Prentice (Eds.), *Social neuroscience: Toward understanding the underpinnings of the social mind* (pp. 249–262). New York: Oxford University Press.

Carstensen, L. L. (1992). Social and emotional patterns in adulthood: Support for socioemotional selectivity theory. *Psychology and Aging*, *7*(3), 331–338. doi:10.1037/0882-7974.7.3.331

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist*, *54*(3), 165–181. doi:10.1037/0003-066X.54.3.165

Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science*, *14*, 117–121. doi:10.1111/j.0963-7214.2005.00348.x

Crotal (Producer). (n.d.). *Tester son audition*. Retrieved from http://www.cotral.com/fr/mediatheque/auditools-boite-a-outils/les-outils-de-sensibilisation/cotral-audiotest.html - .%20UoXp643VYZ0

Grühn, D., & Scheibe, S. (2008). Age-related differences in valence and arousal ratings of pictures from the International Affective Picture System (IAPS): Do ratings become more extreme with age? *Behavior Research Methods*, *40*(2), 512–521.

Hailstone, J. C., Omar, R., Henley, S. M., Frost, C., Kenward, M. G., & Warren, J. D. (2009). It's not what you play, it's how you play it: Timbre affects perception of emotion in music. *Quarterly Journal of Experimental Psychology*, *62*(11), 2141–2155. doi:10.1080/17470210902765957

Isaacowitz, D. M., Toner, K., & Neupert, S. D. (2009). Use of gaze for real-time mood regulation: Effects of age and attentional functioning. *Psychology and Aging*, *24*(4), 989–994. doi:10.1037/a0017706

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006a). Is there an age-related positivity effect in visual attention? A comparison of two methodologies. *Emotion*, *6*(3), 511–516.

Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006b). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging*, *21*(1), 40–48.

Keil, A., & Freund, A. M. (2009). Changes in the sensitivity to appetitive and aversive arousal across adulthood. *Psychology and Aging*, *24*(3), 668–680. doi:10.1037/a0016969

Khalfa, S., Peretz, I., Blondin, J.-P., & Robert, M. (2002). Event-related skin conductance responses to musical emotions in humans. *Neuroscience Letters*, *328*(2), 145–149. doi:10.1016/S0304-3940(02)00462-7

Knight, M., Seymour, T. L., Gaunt, J. T., Baker, C., Nesmith, K., & Mather, M. (2007). Aging and goal-directed emotional attention: Distraction reverses emotional biases. *Emotion*, *7*(4), 705–714. doi:10.1037/1528-3542.7.4.705

Labouvie-Vief, G. (2008). Dynamic integration theory: Emotion, cognition, and equilibrium in later life. In V. Bengtson, M. Silverstein, N. Putney, & D. Gans (Eds.), *Handbook of theories of aging* (pp. 277–293). New York: Springer.

Langley, L. K., Rokke, P. D., Stark, A. C., Saville, A. L., Allen, J. L., & Bagne, A. G. (2008). The emotional blink: Adult age differences in visual attention to emotional information. *Psychology and Aging*, *23*(4), 873–885. doi:10.1037/a0013761

Laukka, P. (2007). Uses of music and psychological well-being among the elderly. *Journal of Happiness Studies*, *8*, 215–241.

Laukka, P., & Juslin, P. N. (2007). Similar patterns of age-related differences in emotion recognition from speech and music [Article]. *Motivation & Emotion*, *31*(3), 182–191. doi:10.1007/s11031-007-9063-z

Leclerc, C. M., & Kensinger, E. A. (2008). Effects of age on detection of emotional information. *Psychology and Aging*, *23*(1), 209–215. doi:10.1037/0882-7974.23.1.209

Lima, C. F., & Castro, S. L. (2011). Emotion recognition in music changes across the adult life span. *Cognition & Emotion*, *25*(4), 585–598. doi:10.1080/02699931.2010.502449

Mather, M., Canli, T., English, T., Whitfield, S., Wais, P., Ochsner, K., … Carstensen, L. L. (2004). Amygdala responses to emotionally valenced stimuli in older and younger adults. *Psychological Science*, *15*(4), 259–263. doi:10.1111/j.0956-7976.2004.00662.x

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological Science*, *14*(5), 409–415. doi:10.1111/1467-9280.01455

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*(10), 496–502. doi:10.1016/j.tics.2005.08.005

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging*, *20*(4), 554–570. doi:10.1037/0882-7974.20.4.554

Mikels, J. A., Lockenhoff, C. E., Maglio, S. J., Goldstein, M. K., Garber, A., & Carstensen, L. L. (2010). Following your heart or your head: Focusing on emotions versus information differentially influences the decisions of younger and older adults. *Journal of Experimental Psychology: Applied*, *16*(1), 87–95. doi:10.1037/a0018500

Opitz, P. C., Rauch, L. C., Terry, D. P., & Urry, H. L. (2012). Prefrontal mediation of age differences in cognitive reappraisal. *Neurobiology of Aging*, *33*(4), 645–655. doi:10.1016/j.neurobiolaging.2010.06.004

Peretz, I. (Producer). (2008). Happy, sad, scary and peaceful musical excerpts for research on emotions. Retrieved from http://www.brams.umontreal.ca/plab/publications/article/96

Petit, H., Bakchine, S., Dubois, B., Laurent, B., Montagne, B., Touchon, J., … Sorbé, G. (1998). Consensus statement of an interdisciplinary group of French experts on modalities of diagnosis and medical treatment of Alzheimer's disease at a treatable stage. *Revue Neurologique (Paris)*, *154*(5), 432–438.

Raven, J., Raven, J. C., & Court, J. H. (2003). *Manual for Raven's progressive matrices and vocabulary scales. Section 1: General overview*. San Antonio, TX: Harcourt Assessment.

Reed, A. E., & Carstensen, L. L. (2012). The theory behind the age-related positivity effect. *Frontiers in Psychology*, *3*, 339–348. doi:10.3389/fpsyg.2012.00339

Rösler, A., Ulrich, C., Billino, J., Sterzer, P., Weidauer, S., Bernhardt, T., … Kleinschmidt, A. (2005). Effects of arousing emotional scenes on the distribution of visuospatial attention: Changes with aging and early subcortical vascular dementia. *Journal of the Neurological Sciences*, *15*(229–230), 109–116.

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. *Neuroscience and Biobehavioral Reviews*, *32*(4), 863–881. doi:10.1016/j.neubiorev.2008.01.001

Scheibe, S., & Blanchard-Fields, F. (2009). Effects of regulating emotions on cognitive performances: What is cost for young adults is not so costly for older adults. *Psychology and Aging*, *24*(1), 217–223.

Schneider, W., Eschmann, A., & Zuccolotto, A. (2002). *E-Prime reference guide*. Pittsburgh, PA: Psychology Software Tools.

Spielberger, C. D. (1993). *State and trait anxiety inventory, form Y*. Paris: Center of Applied Psychology.

St. Jacques, P., Dolcos, F., & Cabeza, R. (2010). Effects of aging on functional connectivity of the amygdala during negative evaluation: A network analysis of fMRI data. *Neurobiology of Aging*, *31*(2), 315–327. doi:10.1016/j.neurobiolaging.2008.03.012

Vieillard, S., Didierjean, A., & Maquestiaux, F. (2012). Changes in the perception and the psychological structure of musical emotions with advancing age.

Experimental Aging Research, *38*(4), 422–441. doi:10.1080/0361073X.2012.699371

Vieillard, S., Peretz, I., Gosselin, N., Khalfa, S., Gagnon, L., & Bouchard, B. (2008). Happy, sad, scary and peaceful musical excerpts for research on emotions. *Cognition and Emotion*, *22*(4), 720–752.

Vieillard, S., Roy, M., & Peretz, I. (2012). Expressiveness in musical emotions. *Psychological Research*, *76*(5), 641–653. doi:10.1007/s00426-011-0361-4

Wechsler, D. (2000). *WAIS-III administration and scoring manual*. Paris: Center of Applied Psychology.