



# UNIVERSITÀ DI PARMA

## ARCHIVIO DELLA RICERCA

University of Parma Research Repository

Evaluative ratings and attention across the life span: emotional arousal and gender

This is the peer reviewed version of the following article:

*Original*

Evaluative ratings and attention across the life span: emotional arousal and gender / Ferrari, Vera; Bruno, Nicola; Chattat, Rabih; Codispoti, Maurizio. - In: COGNITION & EMOTION. - ISSN 0269-9931. - 31:3(2017), pp. 552-563. [10.1080/02699931.2016.1140020]

*Availability:*

This version is available at: 11381/2813812 since: 2016-09-21T12:51:25Z

*Publisher:*

Routledge

*Published*

DOI:10.1080/02699931.2016.1140020

*Terms of use:*

Anyone can freely access the full text of works made available as "Open Access". Works made available

*Publisher copyright*

note finali coverpage

(Article begins on next page)

23 July 2025

Evaluative ratings and attention across the life span:

Emotional arousal and gender

Vera Ferrari, Nicola Bruno, Rabih Chattat, Maurizio Codispoti

\*Corresponding Author: Vera Ferrari, University of Parma, Department of Neuroscience,  
Via Volturmo, 39, 43125 Parma, ITALY, vera.ferrari@unipr.it

Bruno Nicola, University of Parma, Department of Neuroscience, Via Volturmo, 39, 43125  
Parma, ITALY, nicola.bruno@unipr.it

Rabih Chattat, University of Bologna, Department of Psychology, Via Berti Pichat, 5,  
40127, Bologna, ITALY, rabih.chattat@unibo.it

Maurizio Codispoti, University of Bologna, Department of Psychology, Via Berti Pichat, 5,  
40127, Bologna, ITALY, maurizio.codispoti@unibo.it

*Running header: Aging and gender in emotion perception*

Abstract

This study was designed to investigate the evolution of emotional processing over the whole adult life span as a function of stimulus arousal and participants' gender. To this end, self-reported affective evaluation and attentional capture prompted by pleasant and unpleasant pictures varying in arousal were measured in a large sample of participants (n=211) balanced by gender and equally spread across seven decades from 20 to 90. Results showed age differences only for affective evaluation of pleasant stimuli, with opposite patterns depending on stimulus arousal. As age increased, low-arousing pleasant cues (e.g. images of babies) were experienced as more pleasant and arousing by both males and females, whereas high-arousing stimuli (e.g. erotic images) were experienced as less pleasant only by females. In contrast, emotional pictures (both pleasant and unpleasant) were effective at capturing attention in a similar way across participants, regardless of age and gender. Taken together, these findings suggest that specific emotional cues prompt different subjective responses across different age groups, while basic mechanisms involved in attentional engagement towards both pleasant and unpleasant stimuli are preserved in healthy aging.

*Keywords:* aging, gender, evaluative ratings, natural scenes, emotion

## Introduction

A range of studies outline the fact that cognitive, affective and social aspects of human life have different trajectories across the life span (Baltes, Staudinger, & Lindenberger, 1999; Kensinger, 2009). Indeed, one relevant issue that has prompted intensive research in recent years concerns whether and to what extent aging affects emotional processing (Ebner & Fischer, 2014; Isaacowitz & Blanchard-Fields, 2012; Scheibe & Carstensen, 2010).

Emotion has been widely investigated via the presentation of affective pictures that are effective cues in evoking a broad range of emotional reactions, and that involve both pleasant and unpleasant affects (Bradley, 2000; Lang, Greenwald, Bradley, & Hamm, 1993). Several studies have shown that valence and arousal are the most important dimensions of emotional reactivity, and that they control most of the variance of subjective reports (Bradley, Codispoti, Cuthbert, & Lang, 2001; Osgood, 1969; Russell & Barrett, 1999).

To date, many studies have focused on the subjective impact of emotional stimuli (i.e. affective evaluation) across age groups, but findings are not consistent across studies. Several studies failed to find any age effect (e.g. Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005; Neiss, Leigland, Carlson, & Janowsky, 2009; Ritchey, Bessette-Symons, Hayes, & Cabeza, 2011; Smith, Hillman, & Duley, 2005; Söderholm, Häyry, Laine, & Karrasch, 2013; Tsai, Levenson, & Carstensen, 2000; Wieser, Muhlberger, Kenntner-Mabiala, & Pauli, 2006; Wurm et al, 2004), while others found a general decline of the appetitive system activation with increasing age, as all (both high and low in arousal) pleasant stimuli were rated as less arousing and less pleasant in older compared to younger participants (Keil & Freund, 2009). On the contrary, other studies reported higher

### *Aging and gender in emotion perception*

pleasantness ratings for low-arousing pleasant and/or neutral cues in older compared to younger adults (Backs, da Silva, & Han, 2004; Gruhn & Scheibe, 2008; Keil & Freund, 2009; Mather & Knight, 2005; Neiss et al., 2009; Streubel & Kunzmann, 2011). In terms of unpleasant emotions, several studies did not observe relevant age-related changes in reported feelings prompted by unpleasant stimuli (e.g. Dolcos, Katsumi, Dixon, 2014; Mather & Knight, 2005; Keil & Freund, 2009; Wisner et al., 2006) but others found enhanced subjective reactivity to stimuli inducing negative emotions in older compared to younger adults (Beaudreau, MacKay, & Storandt, 2009; Fajula, Bonin-Guillaume, Jouve, & Blin, 2013; Gruhn & Scheibe, 2008; Kunzmann & Grün, 2005; Kunzman & Richter, 2009; Streubel & Kunzmann, 2011), despite the lack of age differences in terms of autonomic reactivity (Gavazzeni, Wiens, & Fischer, 2008; Kunzmann & Grün, 2005; Kunzman & Richter, 2009).

One explanation for these inconsistencies may have to do with differences or weaknesses in the sampling criteria across studies. The large majority of cross-sectional studies in aging and emotion consists of comparisons of samples of young and old adults (i.e. extreme-groups design), however, this type of experimental design can be problematic for several reasons. First, two groups that differ in age are also likely to differ in other respects, hence, it is always possible that the observed results are attributable to some variable other than age. If data are available from adults across the complete age range (i.e. *continuous*-groups design, Salthouse, 1999), then we are in a better position to separate the effects of other confounding variables that are unlikely to covary with age, or might partly covary within certain age ranges. Second, a continuous group design allows us to assess whether changes in emotional reactivity occur linearly during the aging process, or whether

### *Aging and gender in emotion perception*

they are more abrupt (nonlinear patterns), as they may coincide with significant biological, psychological or sociocultural changes. Third, in many previous studies, the “older group” comprised participants with a wide range of ages (60-80+), and the mean age varied across studies, making it difficult to evaluate the findings. Considering that people experience very different conditions (e.g. the degree of mental and physical decline) as they grow older (e.g. Hof & Mobbs, 2009; Baltes et., 1999), a more accurate portrayal of significant life changes could be provided by subdividing the elderly population into separate decades, rather than grouping together all people over 60.

Some of the previous studies did not compare gender-balanced groups; indeed, differences between sexes have rarely been analyzed (Gomez, Von Gunten, & Danuser, 2013; Keil & Freund, 2009). One might hypothesize that gender may mediate differential responses to specific emotional cues across the life span and may thus contribute to the variety of findings across studies. Sex differences in emotional response are well documented in young adult populations (Bradley, Codispoti, Sabatinelli, & Lang, 2001; Murnen & Stockton, 1997), indicating that women are generally more defensively reactive, whereas men are specifically more aroused by erotic cues. Whether these affective preferences in men and women remain stable or change over the aging process has yet to be clarified. Thus, in the present study, we used a picture-viewing paradigm to assess emotional reactivity in participants covering a large segment of the adult life span (age 20-80+), grouped into seven age decades in which males and females were equally represented.

It is well established that arousal is a critical factor in emotional reactivity at the level of both self-report affective evaluations, as well as physiological (cortical, subcortical,

### *Aging and gender in emotion perception*

and peripheral) changes (Bradley et al., 2001; Codispoti, Ferrari, De Cesarei & Cardinale, 2006; Lang & Bradley, 2010; Kensinger, 2008; Streubel & Kunzmann, 2011). Moreover, several recent findings suggest that aging affects emotional reactivity differently as a function of the level of stimulus arousal (Bucks et al., 2004; Streubel & Kunzmann, 2011). Therefore, we assessed aging effects here by examining emotional reactivity to high- and low-arousing pictures within each valence category.

High-arousing emotional pictures are also known to engage attentional resources naturally and reflexively (Bradley, 2009; Ferrari, Codispoti, Cardinale & Bradley, 2008; Lang, Bradley & Cuthbert, 1997). A number of studies are consistent in showing greater attention allocation to pleasant and unpleasant pictures compared with neutral contents. For example, interference effects caused by task-unrelated emotional pictures have been observed during a variety of visual and acoustic tasks, suggesting that motivationally relevant (pleasant and unpleasant) stimuli draw more on attentional resources, leaving them less available for task processing (Bradley, Cuthbert & Lang, 1999; Calvo & Nummenmaa, 2007; De Cesarei & Codispoti, 2008; Mitchell et al., 2008; Okon- Singer, Tzelgov, & Henik, 2007; Weinberg & Hajcak, 2011). In addition to self-reports of affective experience, in the present study we examined attentional capture by the same emotional pictures in the same participants, to better clarify the relationship between the two components (self-report and attention) of affective processing over the entire adult life span. Assuming that self-reports and attention to emotional cues reflect different facets of emotional processing, with the former being more vulnerable to sociocultural factors as well as to subjective control, we might expect different age-related effects across these two measures of emotional processing.

## Methods

### *Participants*

A total of 211 adults (108 female) participated in this study. Participants were distributed among seven different age decades (from age 20 through 90), with a balanced number of males and females in each age group. Most of the young adults (20-29 yrs old) were undergraduate psychology students from the University of Bologna; middle-aged and older adults were recruited through voluntary organizations and social centers for elderly people. Prior to participating, all subjects were informed concerning the potentially disturbing content of some stimuli and signed a written informed consent in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and with the recommendations of the local ethical committee of the Department of Psychology of University of Bologna.

All participants had normal or corrected-to-normal visual acuity and were screened using a standardized health interview prior to inclusion in the study. All participants scored 27 or higher on the Mini-Mental State Examination (MMSE, Folstein, Folstein, & McHugh, 1975), consistent with normal cognitive functioning. Education was lower with increasing age  $F(6,197)=35.8, p<.0001, \eta_p^2=.5$ , in line with the normative increase in formal education over the last century in Italy, older participants. This pattern was not modulated by participant's gender (age x gender,  $F<1$ ). Table 1 presents participants' demographic and affective well-being information in each group.

### *Materials and Procedure*

The study consisted of two sessions. During the first session, participants completed several questionnaires assessing demographic and affective well-being characteristics (see

### *Aging and gender in emotion perception*

Table 1). The second session (held about one week later) required participants to sit comfortably in front of a laptop and perform two tasks: The emotional interference task, followed, after a short break, by the affective rating task.

*Affective well-being measures:* The questionnaire packet included: 1) The Positive and Negative Affect Schedule (PANAS); 2) The Affect Intensity Measure (AIM); 3) The Emotion Regulation Questionnaire (ERQ); 4) The Beck Depression Inventory-II (BDI-II); 5) The State-Trait Anxiety Inventory (STAI).

The PANAS is a 20-item self-report measure of positive and negative affect developed by Watson, Clark, and Tellegen (1988). Positive Affect (PA) reflects the extent to which a person feels enthusiastic, active, and alert. Negative Affect (NA) reflects the extent to which a person feels negative affective states, such as being nervous and upset. Participants were asked to rate how they felt in general (general instruction; see Watson et al., 1988). The AIM (Larsen et al., 1986) is a 40-item questionnaire that measures trait levels of affective intensity. A sample item from the AIM is the following: “My emotions tend to be more intense than those of most people.” The AIM has been shown to have good internal consistency, test-retest reliability, and good discriminant validity (Larsen et al., 1986). The ERQ (Gross & John, 2003) consists of 10 items covering two factors: Cognitive Reappraisal (six items) and Expressive Suppression (four items). The six-item reappraisal subscale assesses the frequency with which individuals regulate their emotions through the use of thought-change strategies. The four-item suppression subscale measures the extent to which individuals regulate their emotions through the use of suppression strategies. The ERQ has been shown to have excellent psychometric properties. The BDI II (Beck, Steer & Brown, 1996) consists of 21 items to assess the intensity of depression in clinical and

### *Aging and gender in emotion perception*

normal patients. Each item has a list of four or more statements, arranged according to increasing severity, about a particular symptom of depression. The STAI (Spielberger et al., 1983) is a self-report assessment device that includes separate measures of state and trait anxiety. We report only the trait form, composed of 20 items. Trait anxiety denotes a general tendency to respond with anxiety to perceived threats in the environment.

*Experimental stimuli:* The stimuli were 72 colored pictures (800x600 pixel resolution) selected from the International Affective Picture System (IAPS, Lang, Bradley, & Cuthbert, 2008), consisting of 24 pleasant, 24 unpleasant, and 24 neutral pictures. Based on normative ratings acquired from college students (Lang et al, 2008), both pleasant and unpleasant pictures were selected in such a way that half were typically rated as high-arousing—pictures of erotic couples and pictures of injured bodies and the other half as low-arousing stimuli –pictures of babies/families and pictures of accidents, contamination, illness, and loss. Neutral pictures depicted non-arousing scenes, such as people and objects. Therefore, picture stimuli were arranged as a function of standardized pleasantness (p) and arousal (a) ratings (Lang et al., 2008) in five picture content categories: high-arousing pleasant (p=6.5; a=6.4) and unpleasant pictures (p=1.9; a=6.3), low-arousing pleasant (p=6.6; a=4.5) and unpleasant pictures (p=2.8; a=5.1), and neutral pictures (p=5.3; a=3.4).

In the *emotional interference task* (Mitchell et al., 2008; Weinberg & Hajcak, 2011), participants were instructed to respond with their left and right index fingers in a simple discrimination task (circle/square stimuli, 3°x 3°of visual angle, white filled on a black background). The display showing the target stimulus (circle/square) was always preceded by the presentation of an IAPS picture (either emotional or neutral), which was irrelevant for the task. The components of each trial were presented serially. First a fixation cross was

### *Aging and gender in emotion perception*

shown (1 sec), then an IAPS picture (2 sec), which was immediately followed (no blank in between) by the onset of the target (2 sec). Subjects were required to respond as fast and accurately as possible as to whether they saw a square or circle by pressing one of two digits on the keyboard (“x” or “m”). For half of the participants, the probe-digit mapping was reversed. Participant response was allowed during the target presentation, as well as during the inter-trial interval (for a total of 6 sec). Two presentation orders were constructed that varied, across participants, the order of picture presentation, as well as the association of a specific picture with the target (square or circle). In this task, there was a total of 72 trials, corresponding to the 72 pictures originally selected for the study, so that each picture exemplar was presented only once throughout the task.

In the *affective rating*, the same 72 pictures used in the interference task were then presented again and subjects viewed each picture for as long as they liked, terminating exposure with a key press. After termination, the subjects were required to rate first the pleasantness (i.e. valence) and then the intensity (i.e. arousal) of the experienced emotional state on a 9-point scale using the Self-Assessment Manikin (SAM; Lang, 1980). A computer version of the SAM scales was displayed and remained on the screen until participants provided their ratings using the 1-9 keys on the laptop keyboard.

For all participants, the interference task always went first, so that the amount of attentional capture was not affected by picture repetition (Ferrari, Bradley, Codispoti, Lang, 2011). Stimulus presentation and response recording were controlled by E-Prime (Version 1.2) experimental software. Both tasks were presented on a PC laptop, situated approximately 0.5 m from the participant. For both tasks, instructions were given both orally by the experimenter and visually on the laptop screen, and before beginning the

## *Aging and gender in emotion perception*

actual task, participants performed several practice trials to ensure compliance with task instructions. Each task consisted of a total of 72 trials. Each session took about 1 hour.

In accordance with the guidelines of the journal, we reported how we determined our sample size, all data exclusions, all manipulations, and all measures in the study.

### Data analysis

A multivariate repeated measure ANOVA, with factors age Group (7: Age 20-29, 30-39, 40-49, 50-59, 60-60, 70-79, Over 80) x Gender (2) x picture Content (5: Pleasant High-Arousing, Pleasant Low-Arousing; Neutral, Unpleasant High-Arousing, Unpleasant Low-Arousing) was conducted on pleasantness and arousal ratings as well as on reaction times in the emotional interference task<sup>1</sup>. All post-hoc tests were corrected for multiple comparisons with the Bonferroni procedure. The partial eta squared statistic ( $\eta_p^2$ ), indicating the proportion of the variance explained by one experimental factor and the total variance, was calculated and is reported.

Analysis of reaction times (RTs) was performed only for accurate response trials. In addition, response latencies that were shorter or longer than the mean (within each subject and condition)  $\pm 3$  times the standard deviation of the mean were not included in the analysis.

A statistical power analysis was performed for sample size estimation (G\*Power 3; Faul, Erdfelder, Lang, & Buchner, 2007). Assuming a medium effect size (Cohen's  $f=0.25$ ) at 95% power, the current sample ( $n=211$ ) was considered reasonable to detect a statistically significant interaction between our factors (age group, gender and picture content) as well as the mean comparisons of interest.

### Results

## *Aging and gender in emotion perception*

### *Affective space*

Figure 1 presents each of the 72 pictures used in this study (solid symbols) in the two dimensional space formed by plotting each picture by its mean pleasantness (i.e. valence) and arousal rating separately for women (upper panel) and men (lower panel) in each age group.

*Pleasantness rating.* A significant age Group x Gender x picture Content interaction,  $F(24, 677)=2.3$ ,  $p<.0001$ ,  $\eta_p^2=.1$ , indicated that changes in pleasantness rating of specific picture contents were different for men and women across age groups. This three-way interaction was primarily due to high-arousing pleasant pictures, mostly depicting erotic contents (see figure 1, lower-left panel): whereas men rated high-arousing pleasant pictures as highly pleasant, compared to neutral contents,  $F(1,96)=392$ ,  $p<.0001$ ,  $\eta_p^2=.78$ , and this pattern remained stable across the whole life span (main effect of age group for high-arousing pictures in men,  $F<1$ ), women rated this picture content as less pleasant with advancing age,  $F(6,101)=8.5$ ,  $p<.0001$ ,  $\eta_p^2=.33$ ; linear trend  $p<.0001$ . More specifically, women in young and middle-aged adulthood (age group 1 to 4; age < 60) rated high-arousing pleasant pictures as more pleasant than neutral pictures ( $F_s>9$ ,  $\eta^2>4$ ) with no difference across groups; the pattern was then reversed in older women (age > 60), who rated this picture content as less pleasant than younger women ( $p_s<.05$ ), and even significantly less pleasant than neutral pictures [age group 60-69,  $F(1,13)=9.8$ ;  $p<.01$ ,  $\eta_p^2=.4$ ; 70-79,  $F(1,12)=7.7$ ;  $p<.05$ ,  $\eta_p^2=.5$ ; 80-89,  $F(1,16)=37$ ;  $p<.0001$ ,  $\eta_p^2=.7$ ].

On the other hand, both low-arousing pleasant and neutral pictures were rated as more pleasant with increasing age [main effect of group,  $F_s(6,204)>12.4$ ,  $p_s<.0001$ ,  $\eta_p^2>.3$ ; linear trend  $p_s<.0001$ ], with a slight but significant steeper increase for low-arousing

### *Aging and gender in emotion perception*

pleasant, compared to neutral, pictures [linear trend,  $F(6,197)=2.8$ ,  $p<.05$ ,  $\eta_p^2>.08$ ]. This increase in pleasantness for low-arousing pleasant and neutral pictures with increasing age was similar in men,  $F_s(6,101)>5.7$ ,  $ps<.0001$ ,  $\eta_p^2>.25$ , linear trend,  $ps>.0001$ , and women,  $F_s(6,96)>4.5$ ,  $ps<.0001$ ,  $\eta_p^2>.22$ ; linear trend,  $ps>.0001$ . Therefore, whereas young and middle-aged men generally rated low-arousing pleasant pictures as less pleasant than high-arousing pleasant pictures (group 20-29; 30-39; 40-49  $F_s>52$ , 20, 9, respectively), in older men (>50 yrs old), pleasant low- and high-arousing pictures did not differ in pleasantness ratings.

It is worth noting that pleasantness ratings of unpleasant pictures, either high or low in arousal, did not change across the life span ( $F_s<1$ ). High-arousing unpleasant pictures were rated as more unpleasant than low-arousing pictures in all age groups ( $F_s>314$ ), and compared to men, women rated both low- and high-arousing unpleasant pictures as generally more unpleasant,  $F_s(1,197)>21$ ,  $ps<.0001$ ,  $\eta_p^2>.1$ .

*Arousal rating.* A significant interaction of picture Content x age Group,  $F(24,678)=6.9$ ,  $p<.0001$ ,  $\eta_p^2=.17$ , indicated that an age effect for arousal ratings was evident only for low-arousing pleasant pictures, main effect of Group,  $F(6,197)=18$ ,  $p<.0001$ ,  $\eta_p^2=.35$ , which were rated as increasingly more arousing with advancing age (linear trend,  $p<.0001$ ). More specifically (see Figure 1, lower-right panel), young adults (20-29) rated these pictures as less arousing than did older people starting from 40 yrs of age (all comparisons,  $ps<.005$ ). Also, arousal ratings of middle-aged adults (40-49; 50-59 yrs) were significantly lower compared to older people (from 60 to over 80 yrs;  $ps<.05$ ). No further differences were found between older age groups (60-69 vs. 70-79 vs. 80-89,  $F_s<1$ ). Moreover, this linear increase in arousal ratings for low-arousing pleasant pictures was

### *Aging and gender in emotion perception*

similar in men,  $F(6,96)=11$ ,  $p<.0001$ ,  $\eta_p^2=.41$  linear trend,  $p<.0001$ , and women,

$F(6,101)=7$ ,  $p<.0001$ ,  $\eta_p^2=.29$  linear trend,  $p<.0001$ .

As expected, men and women differed in arousal ratings in all picture contents except for neutral images, gender x content  $F(4,194)=19$ ,  $p<.0001$ ,  $\eta_p^2=.28$ . Compared to men, women rated unpleasant pictures, both high and low in arousal, as more arousing,  $F_s(1,197)>11$ ,  $ps<.005$ ,  $\eta_p^2>.1$ ; conversely, men rated high-arousing pleasant pictures as more arousing,  $F(1,197)=26$ ,  $p<.0001$ ,  $\eta_p^2=.16$ , and low-arousing pleasant pictures as less arousing  $F(1,197)=8$ ,  $p<.01$ ,  $\eta_p^2=.05$ , than women. These gender effects were consistent across age group.

### *Emotional interference task*

Response times (RTs) to the visual target (either the square or the circle) were significantly modulated by picture content,  $F(4,792)=25$ ,  $p<.0001$ ,  $\eta_p^2=.11$ ; quadratic trend,  $F(1,198)=68$ ,  $p<.0001$ ;  $\eta_p^2=.26$ , see Figure 2: high-arousing pictures, both pleasant and unpleasant, prompted longer RTs, compared to neutral,  $F_s(1,197)>51$ ,  $ps<.0001$ ,  $\eta_p^2>.21$ , and low-arousing pictures, pleasant low,  $F_s>38$ ,  $ps<.0001$ ,  $\eta_p^2>.16$ ; unpleasant low,  $F_s>9$ ,  $ps<.005$ ,  $\eta_p^2>.04$ . High-arousing pleasant and unpleasant pictures did not differ from each another. RTs after viewing of low-arousing unpleasant pictures were also slower compared to neutral and low-arousing pleasant pictures,  $F(1,197)=28$ ,  $p<.0001$ ,  $\eta_p^2=.13$ ;  $F(1,197)=16$ ,  $p<.0001$ ,  $\eta_p^2=.08$ , respectively, whereas low-arousing pleasant and neutral pictures prompted similar RT responses.

More interestingly, despite a general RT slowdown with aging,  $F(6,197)=20$ ,  $p<.0001$ ,  $\eta_p^2=.38$ , picture content similarly modulated reaction times in all age groups, [age Group x picture Content,  $F(24,678)=1$ ,  $p=.4$ ; quadratic trends in each age group,  $F_s >6$ ,  $ps<.05$ ,

### *Aging and gender in emotion perception*

$\eta_p^2 > .17$ , see Table 2). Aside from a small Gender effect,  $F(1,197)=6.5$ ,  $p < .05$ ,  $\eta_p^2 = .03$ , due to slower RTs in women compared to men, no other significant effect involving Gender was found.

Discrimination accuracy was overall good ( $> 97\%$ ) across participants, and was not affected by picture content. Women were slightly less accurate than men,  $F(1,6)=6.13$ ,  $p < .05$ ,  $\eta_p^2 = .03$ , means=97, 98%, respectively, and the oldest participants (over 80 years old, mean= 95%) performed significantly worse than all the other age groups,  $F(6,197)=7.1$ ,  $p < .0001$ ,  $\eta_p^2 = .18$ .

### *Individual differences and aging*

A multivariate ANOVA, with factors age Group (7: Age 20-29, 30-39, 40-49, 50-59, 60-60, 70-79, Over 80) x Gender was conducted on all questionnaire scores. All post-hoc tests were corrected for multiple comparisons with the Bonferroni procedure. Table 1 reports mean scores ( $\pm$ SEM) in each age group, separately for males and females.

Age effects were found for the Beck Depression Inventory (BDI),  $F(6,197)=7.4$ ,  $p < .0001$ ,  $\eta_p^2 = .18$ , as well as for the Emotion Regulation Questionnaire (ERQ), both in the reappraisal,  $F(6,197)=3$ ,  $p < .001$ ,  $\eta_p^2 = .08$ , and suppression scale,  $F(6,197)=7.7$ ,  $p < .0001$ ,  $\eta_p^2 = .19$ . The highest BDI scores were observed in the age group 70-79, being significantly higher compared to the groups ranging from 20 to 60 years old,  $F_s > .005$ . The oldest group ( $>80$ ) only differed from age decade 30-39,  $F(1,56)=10$ ,  $p < .005$ ,  $\eta_p^2 = .16$ , and the group 60-69 was similar to all age groups. For the ERQ-reappraisal scale, post-hoc comparisons revealed that only the oldest group ( $>80$ ) scored higher compared to the two youngest groups,  $p_s < .05$ . Similar age effects were found for the ERQ-suppression scale, where the highest scores were found again in the age group  $>80$ , that differed from the younger

### *Aging and gender in emotion perception*

groups 20-59,  $p < .05$ . The group 70-79 scored higher compared to the first two young decades (20-29, 30-39,  $p < .0001$ ;  $p < .05$ , respectively) and the group 60-69 only differed from the very young group (20-29,  $p < .01$ ). The three old groups did not significantly differ from each other.

An overall significant Gender effect was found for negative affectivity (NA), AIM, STAI and BDI, with females showing higher scores compared to males,  $F(1,197)=4.7$ ,  $p < .05$ ,  $\eta_p^2=.02$ ;  $F(1,197)=10$ ,  $p < .005$ ,  $\eta_p^2=.05$ ;  $F(1,197)=8.4$ ,  $p < .005$ ,  $\eta_p^2=.04$ ;  $F(1,197)=4.4$ ,  $p < .05$ ,  $\eta_p^2=.02$ , respectively. No significant age Group x Gender interaction was found in any of the questionnaires.

This pattern of results was confirmed by a multiple linear regression analysis, in which participant's age was treated as continuous variable. The BDI and both the ERQ subscales (suppression and reappraisal) showed significant regression coefficients,  $F_s(2,209) > 9$ ,  $p < .0001$ ,  $R^2_s > .08$ , where age was the only significant predictor ( $\beta_s > -.27$ ,  $p_s < .0001$ ). A significant regression equation was found,  $F_s(2,209) > 4$ ,  $p < .05$ ,  $R^2_s > .03$ , for the STAI, NA and AIM, where only gender was a significant predictor,  $\beta_s > -.19$ ,  $p_s < .01$ , suggesting that females, compared to men, showed higher scores in all these questionnaires. Positive affectivity (PA) scores did not show any significant relationship with age or gender.

### Discussion

The present study provides clear evidence for age-related changes of subjective emotional experience to specific pleasant cues, whereas unpleasant cues seem to prompt emotional feelings that remain stable across the life span. Moreover, aging affected emotional reactivity differently as a function of the arousal level of the stimuli. Low-arousing pleasant pictures, which mostly included pictures of families and babies, prompted

### *Aging and gender in emotion perception*

reports of more pleasant and arousing affective experiences in elderly people, and this was found for all participants regardless of gender. An opposite pattern, that is, a decrease in pleasantness, was found, however, for high-arousing pleasant pictures, which seem to vary in affective meaning and prompt differential responding in women, but not in men, over the aging process.

Several theories on emotional aging (for a review see Scheibe & Carstensen, 2010) hold that the aging process may prompt changes in emotional preferences and strategies, enhancing emotionally gratifying experiences and minimizing negative ones. Consistent with these theories, in the present study, pleasant emotions prompted by low-arousing pleasant cues are reported to be more pleasant and more intense with increasing age. Interestingly, this age effect specific for pictures of babies and smiling families seems to develop linearly over age decades, starting from middle adulthood (> 40 yrs old) and becoming even more evident across old age; moreover, it applies equally to men and women, suggesting that it does not necessarily depend on motherhood or gender roles, but rather reflects a general drive toward these affective cues. One possible speculation could be that the increased affective engagement for these specific contents reflects the need to somehow deal with the limited future time perspective in older people, for example providing cues to retrieve autobiographical past memories related to relatively happy times, when they were younger and actively engaged in childrearing (Charles, Mather & Carstensen, 2003). Whether this selective difference in emotional preferences reflects an explicit and conscious strategy, or rather, a more inherent biological need is hard to establish here, but either way it might reflect an adaptive behavior for the benefit of

### *Aging and gender in emotion perception*

momentary mood and presumably long term well-being (Scheibe, & Carstensen, 2010; Freund & Baltes, 2007).

A different age-related effect mediated by gender differences was found in the subjective ratings of high-arousing pleasant pictures, mostly depicting erotic couples. Sexual cues represent primary reinforcers that directly engage the appetitive system, and several studies have demonstrated that, within pleasant picture categories, sexual cues are the most effective in eliciting autonomic, cortical and subcortical changes (Bradley et al 2001; Codispoti & De Cesarei, 2007; Sabatinelli et al 2007; Schupp, Junghöfer, Weike, & Hamm, 2004). Consistent with this, the present study showed that young and middle-aged adults, both men and women, reported pleasant and intense subjective reactions after viewing pictures depicting sexual contents, and consistent with previous studies, ratings were less extreme in women (Bradley et al., 2001; Codispoti, Surcinelli & Baldaro, 2008; Murnen & Stockton, 1997). With increased age, men continued to evaluate erotic scenes as highly pleasant and arousing; women, instead, rated this picture content as unpleasant as they grew older (60+). A decrease in pleasantness ratings with aging was previously observed (Backs et al., 2005; Keil & Freund, 2009), with pleasant pictures prompting lower pleasantness in older, compared to younger, adults, but no sex modulatory effects emerged in these studies, probably because of the relative low number of males in the sample group or the specific picture contents used in the high-arousing condition. Thus, the present findings indicate that the age-related appetitive impairment for high-arousing contents depicting sexual cues more likely affects the female population, rather than being a general effect of aging.

### *Aging and gender in emotion perception*

We have to be cautious in interpreting these results, though, given the nature of the subjective ratings, which are clearly a type of measure of affective reactivity that can be highly vulnerable to sociocultural factors as well as to subjective control. In our study, thus, ratings of sexual contents could be biased by social desirability/appropriateness, in addition to (or instead of) subjective feelings about the stimulus. Due to possible cohort effects, the group of older women could be more sensitive, compared to older men or younger participants, to the social context of the experiment and feel uncomfortable watching pictures of erotica in such context, prompting therefore a negative judgment towards these specific picture content. Various sociocultural factors, such as culture and religion, have an influence on sexual attitudes and behavior (Rupp & Wallen, 2008), and we cannot exclude that our sample of older female participants had a high sense of religiosity. Thus, rather than reflecting a real age-related decline in appetitive engagement towards erotic cues, these findings may reflect group differences in a more general social desirability bias, triggered by erotic cues. Distinguishing between these alternatives relies on future research in which the relationship between age, gender and socio-cultural factors in affective ratings will be carefully assessed.

The present design allowed us to track age differences along a continuum, showing that the age effect specific for low arousing pleasant pictures appears gradually over age decades, already starting from middle (>40 years) adulthood, whereas the age effect for high arousing pleasant pictures only occurs in late (> 60 years) adulthood; both effects, however, are more evident starting from the group of sixty, possibly reflecting the impact of relevant events of social life (e.g., retirement, becoming grandparents) that somehow mark the official transition into the period of old age. Although future studies may consider

### *Aging and gender in emotion perception*

to increase the sample size ( $n > 20$ ) per group to ensure a more adequate statistical power, the fact that these effects of aging in emotional reactivity remain pretty much stable across the three groups of older people (60-69; 70-79;  $> 80$  years) makes our findings rather convincing<sup>1</sup>, as it avoids confounding issues that may arise when comparing two extreme groups (“extreme-groups design”, see introduction). When aging effects in emotional reactivity are observed, a critical question is whether the age group differences in emotional processing simply reflect socio-cultural or personality traits (e.g. positive and negative affectivity) that differ across groups. Data derived from the affective well-being questionnaires did not reveal any reliable difference between age groups, except for a slight increase of the BDI scores in the age decades ranging from 70-79 years, compared to younger participants. Consistent with recent findings that highlight the role of emotion regulation in successful aging (Suri & Gross, 2012), increasing age was associated with both types of emotion regulation strategies (ERQ-suppression and -reappraisal). However, these age differences in the questionnaire scores do not seem to help in explaining group differences observed in evaluative ratings. Future studies with a larger sample size are needed to explore more closely the role of socio-cultural (e.g. religiosity beliefs) factors as well as personality traits in age-related differences of emotional reactivity.

The perception of emotional cues is also associated with attentional engagement (i.e. natural selective attention, Bradley, 2009), here measured through an emotional interference paradigm. Overall, participants showed the typical reaction time slowdown to the target after viewing a high-arousing emotional (either pleasant or unpleasant) picture, compared to when the picture depicted a neutral content, consistent with previous findings with different variants of the paradigm (Bradley et al., 1999; De Cesarei & Codispoti, 2008;

### *Aging and gender in emotion perception*

Ferrari et al, 2008; Ferrari, Mastria, Bruno, 2014; Mitchell et al., 2008; Weinberg & Hajcak, 2011). Low-arousing unpleasant pictures were also effective in prompting a slight but significant RT slowdown relative to neutral and low-arousing pleasant pictures. It is more relevant to the current study to note that this RT affective modulation was similar across age groups: both high-arousing pleasant and unpleasant pictures were equally effective in capturing attention in younger as well as older people, suggesting that the basic mechanisms involved in attentional engagement prompted by motivationally-relevant cues, which is clearly driven by emotional arousal and not valence (Wangerlin, Bradley, Kastner, Lang, 2012) is preserved from aging (Leclerc & Kensinger, 2008; Murphy & Isaacowitz, 2008; Steinmetz, Muscatell, Kensinger, 2010; Knight et al., 2007).

### Summary and Conclusions

Evaluative ratings of pleasant emotions were clearly affected by the aging process, showing, on one hand, an enhanced affective engagement for low-arousing pleasant contents in older people, both men and women, and on the other hand, a polarity reversal of the ratings for high-arousing pleasant pictures (e.g. erotic cues) in older women only, who reported unpleasant affect during viewing of these stimuli that are typically associated with appetitive emotional experiences. Interestingly, subjective ratings of unpleasant stimuli, with either high or low arousal contents, did not show relevant changes across the lifespan.

Moreover, although specific affective cues were judged differently across age groups, the same stimuli were effective in capturing attention to the same extent in young and older people. The dissociation between subjective ratings and attentional capture in terms of aging effects is consistent with the idea that emotional stimuli prompt different processes that have evolved in order to assist the selection of appropriate survival behaviors

### *Aging and gender in emotion perception*

(Lang et al, 1997). According to this reasoning, it is not surprising that “natural selective attention” that is engaged by the presentation of motivationally significant (either pleasant or unpleasant) cues in the absence of overt tasks or specific instructions (Bradley, 2009; Ferrari et al., 2008) is preserved from aging. Conversely, affective evaluation of specific cues seems to vary as a function of age and gender, possibly reflecting the interaction of several factors (biological, psychological, sociocultural and other factors) that inevitably occur during the aging process. Using a multiple measurement approach may be considered for future studies; this would help to outline a more detailed picture of the specific effects of aging on the complex dynamic of the emotional response.

References

- Allard, E. S. & Kensinger, E. A. (2014). Age-related differences in neural recruitment during the use of cognitive reappraisal and selective attention as emotion regulation strategies. *Frontiers in Emotion Science, 5*, 296.
- Backs, R. W., da Silva, S. P., & Han, K. (2005). A comparison of younger and older adults' self-assessment manikin ratings of affective pictures. *Experimental Aging Research, 31*, 421–440.
- Baltes, P.B., Staudinger, U.M., & Lindenberger, U. (1999). Lifespan psychology: theory and application to intellectual functioning. *Annual Review of Psychology, 50*, 471-507.
- Beaudreau, S. A., MacKay, A., & Storandt, M. (2009). Older adults' responses to emotional stimuli: a cautionary note. *Experimental Aging Research, 35*, 235-249.
- Beck, A. T., Steer, R. A. & Brown, G. K. (1996) "*Manual for the Beck Depression Inventory-II*". San Antonio, TX: Psychological Corporation.
- Bradley, M. M. (2000). Emotion and motivation. In J. T. Cacioppo, L. G. Tassinary, & G. Berntson (Eds.), *Handbook of psychophysiology* (pp. 602–642). New York: Cambridge University Press.
- Bradley, M. M. (2009). Natural selective attention: Orienting and emotion. *Psychophysiology, 46*, 1–11.

*Aging and gender in emotion perception*

- Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion, 1*, 276–298.
- Bradley, M. M., Codispoti, M., Sabatinelli, D., & Lang, P. J. (2001). Emotion and motivation II: Sex differences in picture processing. *Emotion, 1*, 300–319.
- Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1999). Affect and the startle reflex. In M. E. Dawson, A. M. Schell, & A. H. Boehmelt (Eds.), *Startle modification: Implications for neuroscience, cognitive science, and clinical science* (pp. 157–183). New York: Cambridge University Press.
- Bradley, M. M., Houbova, P., Miccoli, L., Costa, V. D., & Lang, P. J. (2011). Scan patterns when viewing natural scenes: emotion, complexity, and repetition. *Psychophysiology, 48*, 1544-53.
- Calvo, M. G., & Nummenmaa, L. (2007). Processing of unattended emotional visual scenes. *Journal of Experimental Psychology General, 136*, 347-369.
- Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: the forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General, 132*, 310-24.
- Codispoti, M. & De Cesare, A. (2007). Arousal and attention: picture size and emotional reactions. *Psychophysiology, 44*, 680-686.

- Codispoti, M., De Cesarei, A., & Ferrari, V. (2012). The influence of color on emotional perception of natural scenes. *Psychophysiology*, *49*, 11-16.
- Codispoti, M., Ferrari, V., De Cesarei, A., & Cardinale, R. (2006). Implicit and explicit categorization of natural scenes. *Progress Brain Research*, *156*, 53-65.
- Codispoti, M., Surcinelli, P., & Baldaro, B. (2008). Watching emotional movies: affective reactions and gender differences. *International Journal of Psychophysiology*, *69*, 90-95.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- De Cesarei, A., & Codispoti, M. (2008). Fuzzy picture processing: effects of size reduction and blurring on emotional processing. *Emotion*, *8*, 352-363.
- Diener, E., Larsen, R. J., Levine, S., & Emmons, R. A. (1985). Intensity and frequency: Dimensions underlying positive and negative affect. *Journal of Personality and Social Psychology*, *48*, 1253-1265.
- Dolcos, S., Katsumi, Y., Dixon, R. A. (2014). The role of arousal in the spontaneous regulation of emotions in healthy aging: a fMRI investigation. *Frontiers in Psychology*, *5*, 681. doi: 10.3389/fpsyg.2014.00681.

*Aging and gender in emotion perception*

Ebner, N. C., & Fischer, H. (2014). Emotion and aging: evidence from brain and behavior.

*Frontiers in Psychology*, 5, 996. doi: 10.3389/fpsyg.2014.00996.

Fajula, C., Bonin-Guillaume, S., Jouve, E., & Blin, O. (2013). Emotional reactivity assessment of healthy elderly with an emotion-induction procedure. *Experimental Aging Research*, 39, 109-24.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39, 175–191. doi:10.3758/BF03193146.

Ferrari, V., Bradley, M. M., Codispoti, M., & Lang, P. J. (2011) Repetitive exposure: brain and reflex measures of emotion and attention. *Psychophysiology* 48, 515–22.

Ferrari, V., Codispoti, M., Cardinale, R., & Bradley, M. M. (2008) Directed and motivated attention during processing of natural scenes. *Journal of Cognitive Neuroscience*, 20, 1753–61.

Ferrari, V., De Cesarei, A., Mastria, S., Lugli, L., Baroni, G., Nicoletti, R., & Codispoti, M. (2016). Novelty and emotion: pupillary and cortical responses during viewing of natural scenes. *Biological Psychology*, 113, 75-82.

Ferrari, V., Mastria, S., & Bruno, N. (2014). Crossmodal interactions during affective picture processing. *PLoS One*, 9, e89858.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12,189-198.

Freund, A. M., & Baltes, P. B. (2007). Toward a theory of successful aging: Selection,

*Aging and gender in emotion perception*

optimization, and compensation. In R. Fernandez-Ballesteros (Ed.), *Geropsychology: European perspectives for an aging world* (pp. 239–254). Cambridge, MA: Hogrefe & Huber.

Gavazzeni, J., Wiens, S., & Fischer, H. (2008). Age effects to negative arousal differ for self-report and electrodermal activity. *Psychophysiology*, *45*, 148-151.

Gomez, P., von Gunten, A., & Danuser, B. (2013). Content-specific gender differences in emotion ratings from early to late adulthood. *Scandinavian Journal of Psychology*, *54*, 451-458.

Gross, J. J. (2001). Emotion regulation in adulthood: Timing is everything. *Current Directions in Psychological Science*, *10*, 214–219.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*, *85*, 348-362.

Gross, J. J., Carstensen, L. L., Pasupathi, M., Tsai, J., Skorpen, C. G., & Hsu, A. Y. (1997). Emotion and aging: experience, expression, and control. *Psychology and Aging*, *12*, 590-599.

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*, 512–521.

Hof, P. R., & Mobbs, C. V. (2009). *Handbook of the neuroscience of aging*. Academic

*Aging and gender in emotion perception*

Press, London, c2009.

Isaacowitz, D. M., & Blanchard-Fields, F.(2012). Linking Process and Outcome in the Study of Emotion and Aging. *Perspectives in Psychological Science*, 7, 3-17.

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

Kensinger, E. A. (2008). Age differences in memory for arousing and nonarousing emotional words. *Journal of Gerontology: Psychological Sciences*, 63, 13-18.

Kensinger, E. A. (2009). Cognition in aging and age related disease. In: Hof, P.R., Mobbs, C.V., editors. *Handbook of the Neuroscience of Aging*. London, UK: Elsevier Press.

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, 705-714.

Kunzmann, U., & Grühn, D. (2005). Age differences in emotional reactivity: The sample case of sadness. *Psychology and Aging*, 20, 47–59.

Kunzmann, U., & Richter, D. (2009). Emotional reactivity across the adult life span: the cognitive pragmatics make a difference. *Psychology and Aging*, 24, 879-89.

Lang, P. J. (1980). Behavioral treatment and bio-behavioral assessment: Computer applications. In .I. B. Sidowski, J. H. Johnson, & T. A. Williams (Eds.), *Technology in mental health care delivery* {pp. 119- 137}. Norwood, NJ: Ablex.

*Aging and gender in emotion perception*

- Lang, P. J., & Bradley, M. M. (2010) Emotion and the motivational brain. *Biological Psychology*, 84, 437–450.
- Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008): *International affective picture system (IAPS): Affective ratings of pictures and instruction manual*. Technical Report A-8. Gainesville, FL: University of Florida.
- Lang, P. J., Bradley, M. M., & Cuthbert, M. M. (1997) *Motivated attention: Affect, activation and action*. In PJ Lang, RF Simons, MT Balaban (Eds.), *Attention and Orienting: Sensory and Motivational Processes*. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Lang, P. J., Greenwald, M., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Evaluative, facial, visceral, and behavioral responses. *Psychophysiology*, 30, 261-273.
- Larsen, R.J. & Ketelaar, T. (1991). Personality and susceptibility to positive and negative emotional states. *Journal of Personality and Social Psychology*, 61, 132–140.
- Larsen, R.J., & Diener, E. (1987). Affect intensity as an individual difference characteristic: A review. *Journal of Research in Personality*, 21, 1-39.
- Lazarus, R. S., & Alfert, E. (1964). Short-circuiting of threat by experimentally altering cognitive appraisal. *Journal of Abnormal and Social Psychology*, 69, 195–205.
- Leclerc, C. M., & Kensinger, E. A. (2008). Effects of age on detection of emotional information. *Psychology and Aging*, 23, 209-215.
- Mather, M., & Knight, M. (2005). Goal-directed memory: the role of cognitive control in older adults' emotional memory. *Psychology and Aging*, 20, 554-70.

*Aging and gender in emotion perception*

- Mitchell, D., Luo, Q., Mondillo, K., Vythilingam, M., Finger, E., & Blair, R. (2008). The interference of operant task performance by emotional distracters: An antagonistic relationship between the amygdala and frontoparietal cortices. *Neuroimage*, 40, 859–868.
- Mikels, J. A., Larkin, G. R., Reuter-Lorenz, P. A., & Cartensen, L. L. (2005). Divergent trajectories in the aging mind: changes in working memory for affective versus visual information with age. *Psychology and Aging*, 20, 542-553.
- Murnen, S. K., & Stockton, M. (1997). Gender and self-reported arousal in response to sexual stimuli: A meta-analytic review. *Sex Roles*, 37, 135–153.
- Murphy, N.A., & Isaacowitz, D.M. (2008). Preferences for emotional information in older adults: A meta-analysis of memory and attention studies. *Psychology and Aging* 23. 263-286.
- Neiss, M. B., Leigland, L. A., Carlson, N. E. & Janowsky, J. S. (2009). Age differences in perception and awareness of emotion. *Neurobiology of aging*, 30, 1305–1313.
- Norris, C. J., Larsen, J. T., & Cacioppo, J. T. (2007). Neuroticism is associated with larger and more prolonged electrodermal responses to emotionally evocative pictures. *Psychophysiology*, 44, 823–826.
- Okon-Singer, H., Tzelgov, J., & Henik, A. (2007). Distinguishing between Automaticity and Attention in the Processing of Emotionally-Significant Stimuli. *Emotion*, 7, 147-157.

*Aging and gender in emotion perception*

- Osgood, C. E. (1969). On the whys and wherefores of E, P, and A. *Journal of Personality and Social Psychology, 12*, 194–199.
- Pedrabissi, L., & Santinello, M. (1989). Inventario per l'ansia di stato e di tratto (forma y). Firenze: Organizzazioni Speciali.
- Ritchey, M., Bessette-Symons, B., Hayes, S., & Cabeza, R. (2011). Emotion processing in the aging brain is modulated by semantic elaboration. *Neuropsychologia, 49*, 640–50.
- Rupp, H.A, Wallen, K. (2008). Sex Differences in Response to Visual Sexual Stimuli: A Review. *Archives of Sexual Behavior, 37*, 206–218.
- Russell, J. A., & Barrett, L. F. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology, 76*, 805–819.
- Sabatinelli, D., Bradley, M. M., Lang, P. J., Costa, V. D., Versace, F. (2007). Pleasure rather than salience activates human nucleus accumbens and medial prefrontal cortex. *Journal of Neurophysiology, 98*, 1374-9.
- Salthouse, T. A. (1999). Methodological assumptions in cognitive aging research. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of cognitive aging* (2nd ed., pp. 467–498). Mahwah, NJ: Erlbaum.
- Scheibe, S., & Carstensen, L. L. (2010). Emotional aging: recent findings and future trends. *Journal of Gerontology: Psychological Sciences, 65*, 135–144.
- Schupp, H. T., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2004). The selective processing of briefly presented affective pictures: an ERP analysis. *Psychophysiology, 41*, 441-449.
- Smith, D. P., Hillman, C. H., & Duley, A. R. (2005). Influences of age on emotional

*Aging and gender in emotion perception*

reactivity during picture processing. *Journals of Gerontology, Series B: Psychological Sciences and Social Sciences*, 60, 49–56.

Söderholm, C., Häyry, E., Laine, M., & Karrasch, M. (2013). Valence and arousal ratings for 420 Finnish nouns by age and gender. *PLoS One*, 8, e72859.  
doi:10.1371/journal.pone.0072859.

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Steinmetz, K. R., Muscatell, K. A., & Kensinger, E. A. (2010). The effect of valence on young and older adults' attention in a rapid serial visual presentation task. *Psychology and Aging*, 25, 239-245.

Streubel, B., & Kunzmann, U. (2011). Age differences in emotional reactions: arousal and age-relevance count. *Psychology and Aging*, 26, 966-978.

Suri, G., & Gross, J. J. (2012). Emotion regulation and successful aging. *Trends in Cognitive Science*, 16, 409-410.

Tsai, J. L., Levenson, R. W., & Carstensen, L. L. (2000). Autonomic, subjective, and expressive responses to emotional films in older and younger Chinese Americans and European Americans. *Psychology and Aging*, 15, 684-693.

Urry, H. L., & Gross, J. J. (2010). Emotion regulation in older age. *Current Direction in Psychological Science*, 19, 352–357.

*Aging and gender in emotion perception*

Wangelin, B. C., Bradley, M. M., Kastner, A., & Lang, P. J. (2012) Affective engagement for facial expressions and emotional scenes: the influence of social anxiety.

*Biological Psychology, 91*, 103–110.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.

Weinberg, A. & Hajcak, G. (2011). The late positive potential predicts subsequent interference with target processing. *Journal of Cognitive Neuroscience, 23*, 2994-

3007.

Wieser, M. J., Muhlberger, A., Kenntner-Mabiala, R., & Pauli, P. (2006). Is emotion processing affected by advancing age? An event-related brain potential study. *Brain Research, 1096*, 138–147.

Wurm, L. H., Labouvie-Vief, G., Aycock, J., Rebucal, K. A., & Koch, H. E. (2004).

Performance in auditory and visual emotional Stroop tasks: A comparison of older and younger adults. *Psychology and Aging, 19*, 523–535.

Acknowledgements

We are grateful to Dr Eric Vanman, and the two anonymous reviewers for their valuable comments on the earlier version of this article and to Giulia Sbaffi, Margherita Tosto, Alessandra Fantozzi and Romina Muratori for their kind help in data collection. The authors are also grateful to all participants who took part in the study.

Footnote

- <sup>1.</sup> In order to decrease chances of Type II error (false negative), we increased the sample size by collapsing more age decades, ending up with only two age groups—middle (30-59) and old (60-90), with an average of about 45 participants per cell. Participants in the very young age decade (20-29 years) were left out because of the even number of decades. The key findings were nearly the same as when we performed the statistical analysis with less observations per cell (see results by age decade).

Only for the ratings of unpleasant pictures, a slight but significant effect emerged with the two-group *vs.* the seven-group analysis: all unpleasant pictures (both low and high arousing) were rated as more unpleasant and more arousing in the old group (60-90), compared to the middle-age group (30-59),  $F_s(1,167) > 5$ ,  $p_s < .05$ ,  $\eta_{ps}^2 > .03$ . Again, reaction times in the emotional interference task did not show any significant age group x picture content interaction.

Table 1: Demographic and affective well-being information in male and female participants across different age groups.

Age group	N	Age (yr)	education (yr)	MMSE	AIM	STAI	PA	NA	BDI	ERQs	ERQr
20-29	F=20	25 (2.1)	12 (2.1)	30 (0.5)	166 (24)	43 (5.3)	31 (6.4)	24 (5.3)	8 (4.1)	11 (5.1)	30 (6.1)
	M=20	25 (2.5)	11 (2.3)	30 (0.6)	143 (18)	40 (8.7)	28 (4.6)	23 (4.3)	7 (4.6)	12 (3.7)	27 (6.9)
30-39	F=15	34 (2.8)	16 (3.5)	30 (0.2)	154 (25)	39 (8.3)	31 (4.8)	22 (4.9)	7 (5.6)	11 (5.0)	29 (7.7)
	M=15	34 (2.8)	15 (4.1)	30 (0.1)	144 (20)	35 (5.9)	33 (4.4)	21 (4.4)	5 (4.1)	14 (4.1)	28 (7.0)
40-49	F=15	44 (3.1)	14 (3.3)	30 (0.4)	154 (16)	38 (9.6)	30 (4.4)	22 (4.5)	6 (4.2)	13 (5.9)	30 (6.7)
	M=15	45 (2.9)	13 (4.3)	30 (0.1)	139 (23)	38 (7.6)	32 (4.3)	22 (5.4)	7 (6.2)	14 (5.3)	30 (5.3)
50-59	F=15	54 (2.7)	12 (2.7)	29 (0.5)	154 (15)	46 (7.4)	31 (4.1)	24 (6.2)	8 (5.6)	15 (4.4)	29 (5.5)
	M=14	54 (2.8)	11 (3.4)	30 (0.3)	142 (23)	36 (7.4)	32 (3.4)	22 (5.2)	5 (3.5)	13 (3.2)	31 (6.9)
60-69	F=14	65 (2.6)	8 (3.3)	30 (0.8)	157 (15)	38 (9.4)	32 (4.4)	25 (6.9)	10 (6.7)	15 (6.5)	32 (8.4)
	M=12	67 (2.2)	8 (3.3)	29 (0.8)	145 (24)	39 (9.2)	31 (5.6)	24 (5.6)	8 (5.1)	18 (4.8)	34 (5.4)
70-79	F=13	73 (2.8)	6 (1.5)	30 (1.0)	149 (23)	45 (6.3)	32 (5.3)	27 (4.6)	17 (9.2)	19 (7.4)	35 (6.6)
	M=14	74 (2.5)	7 (3.4)	28 (1.8)	153 (25)	38 (6.1)	30 (4.1)	24 (6.2)	11 (6.4)	16 (6.4)	29 (9.7)
> 90	F=17	83 (2.9)	6 (2.1)	28 (1.5)	153 (21)	39 (9.1)	32 (4.6)	25 (4.7)	10 (5.6)	19 (7.6)	35 (4.7)
	M=13	84 (2.7)	7 (2.9)	28 (1.7)	155 (21)	40 (7.7)	31 (4.4)	24 (4.9)	11 (7.6)	19 (5.9)	34 (6.4)

*Note.* MMSE: Mini Mental State examination (Folstein et al., 1975); AIM: Affective Intensity Measure (Larsen & Diener, 1987); STAI: State-Trait Anxiety Inventory (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983; Italian version: Pedrabissi & Santinello, 1989); POS AFF: Positive Affect Scale (PANAS, Watson, Clark, & Tellegen,

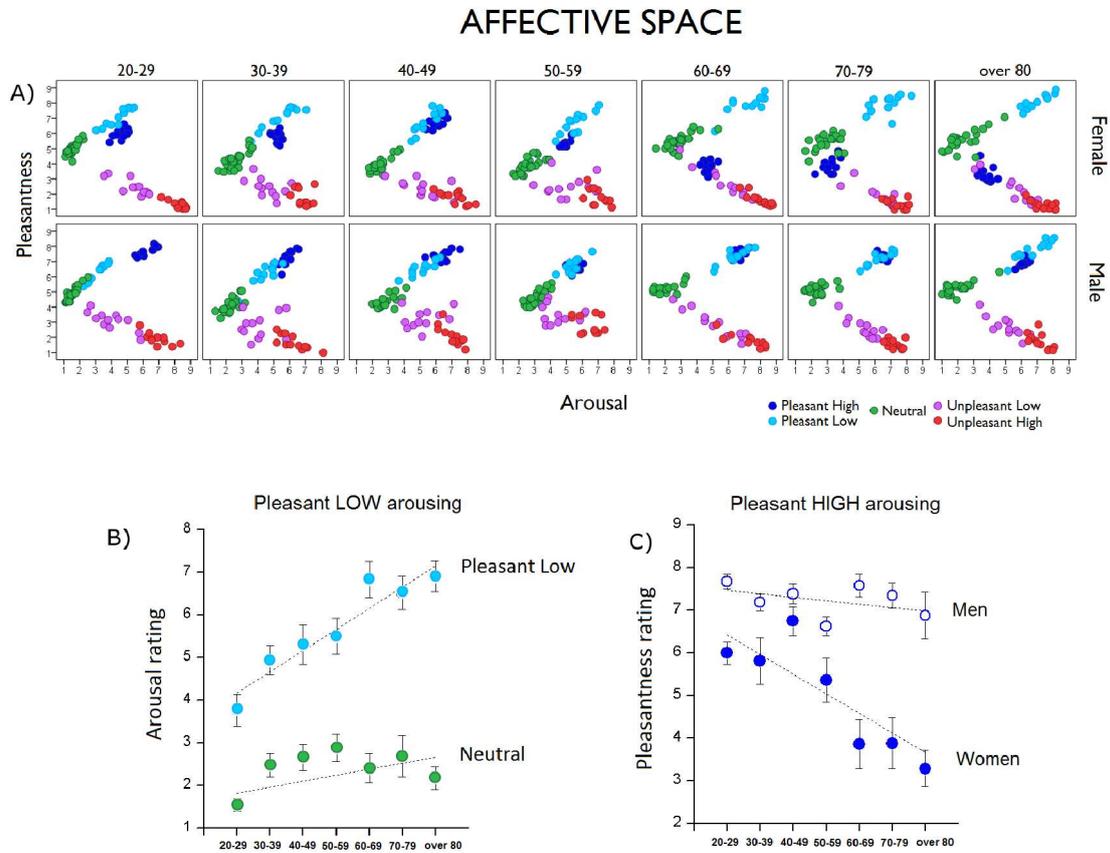
*Aging and gender in emotion perception*

1988); NEG AFF: Negative Affect Scale (PANAS, Watson, Clark, & Tellegen, 1988);  
BDI: Beck Depression Inventory-II (Beck & Steer, 1996); ERQ suppr: Emotion Regulation  
Questionnaire, suppression scale (Gross & John, 2003); ERQ reapp: Emotion Regulation  
Questionnaire, reappraisal scale (Gross & John, 2003). All values represent raw mean ( $\pm$   
SEM) scores.

Table 2: Raw means ( $\pm$  SEM) of Reaction Times (RTs, msec) to the visual target  
(circle/square) for each age group and picture content.

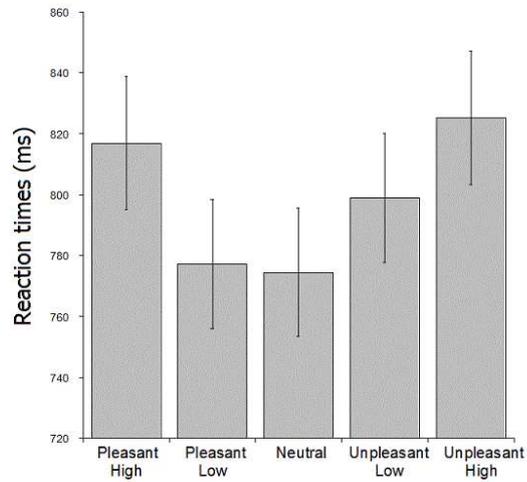
	20-29	30-39	40-49	50-59	60-69	70-79	> 80
Pleasant High	638 (26)	718 (25)	643 (30)	689 (42)	812 (57)	1045 (66)	1143 (57)
Pleasant low	607 (25)	676 (35)	611 (26)	664 (34)	750 (51)	979 (63)	1112 (68)
Neutral	615 (24)	677 (42)	609 (24)	672 (34)	731 (46)	967 (65)	1109 (64)
Unpleasant Low	639 (24)	705 (39)	637 (26)	690 (35)	772 (53)	1008 (64)	1123 (61)
Unpleasant High	670 (27)	747 (35)	684 (29)	697 (34)	803 (67)	1011 (66)	1142 (69)

Figures



**Figure 1.** (A) Each of the 72 pictures presented in this experiment is plotted in the affective space formed by its mean pleasure and arousal rating scale, averaged across participants separately for the seven age decades and for women (upper row) and men (lower row). Colors represent picture content (blue: pleasant high-arousing; light blue: pleasant low-arousing; green: neutral; purple: unpleasant low-arousing; red: unpleasant high-arousing). (B) Each circle represents the mean value ( $\pm$  SEM) of *arousal* ratings for neutral (green symbols) and low-arousing pleasant (light blue symbols) pictures in each age group. (C) Each circle represents the mean value ( $\pm$  SEM) of *pleasantness* ratings for high-arousing pleasant pictures in each age group, separately for women (solid symbols) and men (open symbols).

*Aging and gender in emotion perception*



**Figure 2.** Overall mean reaction times ( $\pm$  SEM) to a visual target discrimination (circle/square) after viewing of a pleasant, neutral or unpleasant picture. Pleasant and unpleasant pictures were further subdivided according to arousal intensity (high or low).