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Recognizing images: The role of motivational significance, complexity, social content, age, and gender

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ABSTRACT

Memory for affective events plays an important role in determining people's behavior and well-being. Its determinants are far from being completely understood. We investigated how recognition memory for affective pictures depends on pictures' motivational significance (valence and arousal), complexity (figure-ground compositions vs. scenes), and social content (pictures with people vs. without people) and on observers' age and gender. Younger, middle-aged, and older adults viewed 84 pictures depicting real-life situations. After a break, the participants viewed 72 pictures, half of which had been viewed previously and half of which were novel, and were asked to endorse whether each picture was novel or had been presented previously. Hits, false alarms, and overall performance (discrimination accuracy) were our dependent variables.

The main findings were that, across participants, recognition memory was better for unpleasant than pleasant pictures and for pictures depicting people than pictures without people. Low-arousal pictures were more accurately recognized than high-arousal pictures, and this effect was significantly larger among middle-aged and older adults than younger adults. Recognition memory worsened across adulthood, and this decline was steeper among men than women. Middle-aged and older women outperformed their male counterparts.

The present study suggests that how well we are able to successfully discriminate previously seen pictorial stimuli from novel stimuli depends on several pictures' properties related to their motivational significance and content, and on observer's age and gender.

Keywords: Affective pictures; Age differences; Arousal; Gender differences; Recognition memory; Valence

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INTRODUCTION

Recognition memory can be defined as the ability to recognize previously encountered items such as events, objects, and people (Fraundorf, Hourihan, Peters & Benjamin, 2019). Much research has focused on recognition memory for emotional events, given its potential implications for understanding people's well-being and behavior (e.g., Charles, Mather & Carstesen, 2003; Grühn, Scheibe & Baltes, 2007; Reed & Carstensen, 2012). The determinants of recognition memory for emotional events are far from being totally understood (Fraundorf et al., 2019). The aim of the present study was to determine to what extent recognition memory for affective pictures depends on their motivational significance, complexity, and social content, and on the age and gender of the observer.

Motivational significance: valence and arousal

Motivational significance can be conceived in terms of information that is processed and appraised as bearing relevance to the individual's goals. One model to understand motivational significance of stimuli is provided by Lang and Bradley (2010). According to their model, emotional stimuli activate two phylogenetically old motivational systems, defensive and appetitive. The defensive system is activated primarily by cues signaling threat (e.g., attacking humans) and is associated with negative valence (unpleasantness) and aversive motivation. The appetitive system is activated primarily by cues signaling reward (e.g., appetizing food) and is associated with positive valence (pleasantness) and approach motivation. The vigor of activation within each of these systems is reflected by arousal, which ranges from low to high. From an evolutionary perspective, better recognition memory for relevant information in the environment should facilitate the survival of individuals by increasing their chances of successful behavioral responses to both aversive and appetitive cues. Thus, we would predict that more salient stimuli (i.e., more relevant to the survival of the individuals) would be better recognized than less salient ones. Because higher arousal is supposed to index enhanced defensive and appetitive motivation, a plausible hypothesis is that higher arousal is significantly related to better recognition memory performance.

The principle of negativity bias refers to the observation that across a broad range of psychological phenomena bad is stronger than good (Baumeister, Bratslavsky, Finkenauer & Vohs, 2001) and negative entities are given greater weight than positive ones (Rozin & Royzman, 2001). For instance, different lines of research have shown that negative as opposed to positive information has privileged access to attentional resources (e.g., Carretie, Mercado, Tapia & Hinojosa, 2001; Gomez, Shafy & Danuser, 2008; Pratto & John, 1991; Smith, Cacioppo, Larsen & Chartrand, 2003; Rozin & Royzman, 2001). Based on the principle of negativity bias, we would predict that compared to pleasant contents of similar arousal, unpleasant contents are better recognized.

Support for the arousal hypothesis is strong for free recall of affective material (e.g., Bradley, Greenwald, Petry & Lang, 1992; Bradley & Lang, 2000; Dolcos, LaBar & Cabeza, 2004 a,b; Palomba, Angrilli & Mini, 1997) but mixed for recognition memory (Ohira, Winton and Oyama, 1998; Versace, Bradley and Lang, 2010). The valence hypothesis has received support from studies reporting that negative words are recognized more successfully than positive words (Ohira et al., 1998; Robinson-Riegler & Winton, 1996) and studies finding that the proportion of correctly recognized unpleasant pictures is greater than pleasant pictures of similar arousal (Charles et al., 2003; Grühn et al., 2007; Hämmerer, Hopkins, Betts, Maass, Dolan & Duzel, 2017). To the best of our knowledge, there are no studies that have tested simultaneously the contributions of valence and arousal to recognition memory for affective pictures.

Affective pictures' complexity and social content

In addition to the motivational significance of the pictures, we were interested in determining the potential effects of pictures' complexity (figure-ground compositions vs. scenes) and social content (presence of people or not) on recognition memory. Segmentation of a picture into object(s) and background is an important stage in perceptual processing (Palmer, 1999). We can classify pictures as either figure-ground compositions or scenes (Bradley, Hamby, Löw & Lang, 2007). Figure-ground compositions have a focal figure with a rather uniform/constant background and are thus considered perceptually simpler, whereas scenes lack a clear central figure or constant background and are thus perceptually more complex (Bradley et al., 2007). The specific early event-related potential (ERP) components that distinguish figure–ground compositions from scenes have been interpreted as indicating easier mapping of sensory information onto memory for figure-ground compositions than scenes (Bradley et al., 2007; Löw, Bradley & Lang, 2013). If more complex scenes are more difficult to perceptually process and map onto mental representations, it may be hypothesized that they are also less well recognized.

Taking a functionalistic view, conspecifics should be given processing priority as the perception of other individuals is of great social significance (Adolphs, 1999). Accordingly, there is evidence that both faces and bodies are processed with higher priority than other objects, with distinct cortical areas specialized for processing faces and human bodies (e.g., Löw et al., 2013; Stein, Sterzer & Peelen, 2012). Consequently, we would predict that pictures showing people would be better recognized than pictures without people. To the best of our knowledge, this remains to be tested.

Age and gender differences

Long-held views on old age as a time of emotional deterioration and losses have been challenged by more recent investigations showing that aging up to the seventh decade is associated with greater emotional stability and enhanced positive overall emotional well-being (Carstensen et al., 2011; Charles & Carstensen, 2010). According to the socioemotional selectivity theory, older individuals tend to prioritize emotional goals – feeling good, avoiding negative feelings (Carstensen, 2006). One mechanism thought to contribute to better emotional well-being in late adulthood is the age-related positivity effect in attention and memory, i.e., the preferential processing of positive over negative information observed in older adults compared to younger adults (Reed & Carstensen, 2012; Reed, Chan & Mikels, 2014). With regard to memory for emotional materials, this age-related positivity effect has been observed in studies of working memory (e.g., Mikels, Larkin, Reuter-Lorenz & Carstensen, 2005), autobiographical memory (e.g., Kennedy, Mather & Carstensen, 2004; Schlagman, Schulz & Kvavilashvili, 2006), and both recall and recognition memory for pictorial stimuli (e.g., Charles et al., 2003; Grühn et al., 2007).

The influence of gender on memory for emotional events has attracted much attention because of the potential ramifications on our understanding of gender differences in disorders involving emotion dysregulation (e.g., Bloise & Johnson, 2007; Hyde, Mezulis & Abramson, 2008). Several laboratory studies have found gender differences favoring women in episodic memory tasks, typically using emotionally neutral materials (Herlitz & Rehnman, 2008). It has been suggested that a small but significant advantage for women over men may exist for general episodic memory (Andreano & Cahill, 2009). Whereas some studies suggest that women outperform men in recalling life events independently of their affective tone (Fujita, Diener & Sandvik, 1991; Seidlitz & Diener, 1998), other authors have suggested that women show advantage for emotional information but not for neutral information (Bloise & Johnson, 2007; Davis, 1999). Moreover, whether gender differences in recall are paralleled by gender differences in recognition memory is unclear. Whereas Naveh-Benjamin, Maddox, Jones, Old & Kilb (2012) found that women performed better than men in an emotional verbal recognition memory task, Bloise and Johnson (2007) found no gender effects on recognition memory for emotional statements.

From the theoretical and empirical evidence just introduced, we derived the following hypotheses to guide our research. With regard to pictures' properties, we predicted recognition memory performance to improve with increasing unpleasantness and increasing arousal of the pictures and to be better for simple than complex pictures and for pictures with people than without people. With regard to observers' age, the main hypothesis was that age group and pictures' valence would significantly interact with each other in line with the age-related positivity effect in memory. Finally, with regard to observers' gender, the main prediction was that women would outperform men. Other effects involving age group and gender were treated as exploratory issues.

METHODS

Data presented here were collected as part of a larger study on psychophysiological responses to affective pictures that included cardiovascular, respiratory, electrodermal, pupillary, and eye-gaze variables. The results for these measures are reported in "references XYZ".

Participants

Participants were 76 men and 103 women belonging to three age groups: younger (ages 20-34 years), middle-aged (ages 40-54 years), and older (ages 60-74 years). Studies of aging and recognition memory often compare young adults with an older sample (Fraundorf et al., 2019). With the inclusion of a middle-aged sample, nonlinear age effects can be explored. Participants were recruited from the XYZ area through advertisements placed in different public places, in newspapers, and on websites. The study was approved by the ethics committee of XYZ.

Prospective volunteers completed a screening questionnaire. We included respondents who had scores lower than 11 on both the anxiety and depression scales of the Hospital Anxiety

Depression Scale (HADS; Zigmond & Snaith, 1983, scale range: 0-21). This was done to avoid the experience of excessive emotional distress among vulnerable people. Furthermore, participants had to be proficient in XYZ, report at least "satisfactory" current general health on a 5-point scale ranging from "very good" to "very bad", not be pregnant or breastfeeding, not use recreational/illicit drugs, have normal or corrected-to-normal vision, not suffer from color blindness, not have a cardiac pacemaker, and not be currently under medical treatment for any psychiatric disorder.

Table 1 shows that participants were relatively healthy individuals. Anxiety and depression scores were low. Mental health, physical functioning, and general health perception were better than average scores of the general local population (XYZ). Mean scores of verbal fluency were above average compared to normative data (Tombaugh, Kozak & Rees, 1999).

Stimuli

Stimuli were 120 pictures selected from the International Affective Picture System (Lang, Bradley & Cuthbert, 2005; see the supplementary material for the library number of the pictures). Eighty-four of these 120 pictures were first presented in the emotion task. The 84 pictures were arranged into 14 series, each consisting of 6 different pictures. Each series represented a different thematic content. Six series were expected to be pleasant, six unpleasant, and two neutral. Moreover, the six pleasant and the six unpleasant series were expected to vary in arousal from low to high. The six pleasant contents were appetizing food, erotic heterosexual couples, pleasant family scenes, pleasant nature, romantic heterosexual couples, and sport scenes. The unpleasant contents included environmental contamination, human loss, mutilated/burned bodies, physical violence, sick/injured human beings, and suffering/dead animals. The two neutral series showed household objects and neutral human activities. Categorization was performed by the first author and two research assistants and was based on

Lang et al. (2005), Bradley, Codispoti, Cuthbert and Lang (2001), and Gomez and Danuser (2010).

Thirty-six of these 84 pictures were presented a second time in the recognition task ("old pictures"). These were two pictures for each of the six pleasant and six unpleasant series and six pictures for each of the two neutral series. We presented all 12 neutral pictures to have a well-balanced number of pleasant, neutral, and unpleasant pictures. Each of these 36 pictures had a novel partner similar in thematic content and affective tone that was presented in the recognition task ("new pictures"). Specifically, there were two pictures for each of the six pleasant and six unpleasant series and six pictures for each of the two neutral series. All pictures were landscape in orientation.

The pictures were characterized in terms of brightness, contrast, complexity, and social content. Brightness was defined as the mean RGB (red green blue) value for each pixel, averaged across all pixels (Bradley, Houbova, Miccoli, Costa & Lang, 2011). Values can range from 0 (black) to 255 (white) for each of the RGB components in a color picture. Mean brightness of nine pictures was modified using Adobe Photoshop to make mean brightness across picture series very similar. The standard deviation of the mean RGB scores computed across pixels was used as an index of contrast (Bradley et al., 2011). Following previous work, we operationalized picture complexity as figure-ground compositions vs. scenes (Bradley et al., 2007, 2011; Löw et al., 2013). Social content of the pictures was defined in terms of whether the pictures included people or not.

For the 36 old pictures, mean (*SD*) brightness was 108 (30) and mean (*SD*) contrast was 69 (13). For the 36 new pictures, mean (*SD*) brightness was 110 (34) and mean (*SD*) contrast was 63 (14). We classified 32 pictures as either figure-ground composition or scene using classification by Bradley and colleagues (Bradley et al., 2007, 2011; Löw et al., 2013). The first authors and two research assistants classified the remaining 40 pictures applying Bradley and colleagues' definition and examples. We classified 18 old pictures and 18 new pictures as figure-ground compositions. Twenty-three old pictures and 23 new pictures included people.

Measures

Hits, false alarms, and overall recognition memory performance. A response to an old picture that has been guessed correctly as "old" produces a hit. A response to a new picture that has been guessed incorrectly as "old" produces a false alarm (Fraundorf et al., 2019). For each of the 72 pictures, we scored "yes" answers as 0 and "no" answers as 1 and considered the dependent variables hits, false alarms, and overall recognition memory performance. Overall performance can be understood as discrimination accuracy, i.e., how well participants can discriminate old stimuli from new stimuli (Fraundorf et al., 2019), in line with threshold and signal detection theory models (Wixted, 2007).

Valence and arousal ratings. Valence and arousal were collected with the pencil-and-paper version of the 9-point Self-Assessment Manikin (Lang et al., 2005, scale range: 1-9). We scored valence and arousal ratings so that higher values indicated more pleasant and more aroused, respectively.

Self-rated health. A few days before the experimental session, participants completed the Medical Outcomes Study 36-Item Short Form (SF-36; Ware & Sherbourne, 1992), which we used to determine mental health, physical functioning, and general health perception.

Educational level. Educational level was divided into three categories: level I = no vocational training with or without practical on-the-job training; level II: completed vocational training equivalent to apprenticeship or a degree judged equivalent; level III: baccalaureate with or without later academic studies. For the analyses, we combined participants belonging to level I and participants belonging to level II because only 7% of the participants belonged to level I.

Verbal fluency. Verbal fluency was assessed with the Animal Naming Task (1 minute, Kertesz, 1982).

Procedure

Participants were tested individually in a windowless room with the same lighting conditions during the entire session for all participants. First, the experimenter provided the participants with an outline of the experimental procedure and an explanation of the measurements. The experimenter explained that 14 series, consisting of 6 pictures each, would be displayed on the screen in front of them and that the pictures would depict life events, objects, and persons that could evoke positive and negative emotions. The themes of the pictures (e.g., physical violence) were not mentioned. The experimenter also explained that after the removal of the sensors at the end of the emotion task, there would be a 10-min break followed by different tasks. The exact nature of these tasks was not revealed. Then, participants signed an informed consent form.

After attaching the physiological sensors, the rating procedure was explained to the participants. It was emphasized that the ratings should be performed quickly and spontaneously and reflect the emotions felt during picture viewing. Subsequently, the emotion task began. The participants were shown an exemplary series of mushroom images followed by the 14 series, each lasting 1 min (10 s per picture), with 75-s pauses between series. The pictures were displayed full-screen using Experiment Center Software (SensoMotoric Instruments, Teltow, Germany) on a 19-in. computer screen placed at a viewing distance of about 70 cm. A gray screen was shown between series. Participants gave one valence and one arousal rating after each series and then relaxed until the next series. We instructed participants to look at the monitor at all times except when rating the series. The 14 series were shown in six different presentation orders, which were counterbalanced across genders and age groups (see "reference" for details).

Upon completing the emotion task, the physiological sensors were removed. After a 10-min break, the participants sat in front of the computer screen and viewed 72 pictures, half of which had been shown previously and half of which were novel. These pictures were presented in random order, and participants were asked to endorse whether the picture presented was novel or had been shown previously during the emotion task. Each picture was shown for 2 s. Before each picture, a gray screen appeared with a number between 1 and 72. Using a paper sheet with a list of numbers from 1 to 72, the participants encircled next to the corresponding number the word "Yes" if they thought they had seen the picture before or the word "No" if they thought the picture was novel. Responses were self-paced. After making the decision, participants pressed the space bar to view the next picture. The recognition task was followed by the animal naming task. Finally, the participants were debriefed, paid XYZ, and thanked.

Statistical analyses

All analyses were performed using SPSS Statistics version 25 (IBM Corp., Armonk, NY, USA). An alpha level of .05 was used for all tests.

Preliminary analyses. We tested the effects of gender and age group on anxiety, depression, physical functioning, mental health, general health, and verbal fluency with ANOVA, and on educational level with logistic regression. Variables with significant effects were included in the main analyses to control for their potential confounding effect.

Main analyses. Multilevel mixed-effects binary logistic regression with the logit link function and the residual method for degrees of freedom was fitted for hits, false alarms, and overall performance (Stroup, 2012). Random intercepts for participants and for pictures were included to take into account the multi-level structure of the data. For the fixed effects, we report the coefficients as odds ratios (exp(β)) with the 95% confidence interval. This analytical approach is different from that used in previous studies in this domain (e.g., Charles et al., 2003) as it models recognition memory performance by taking into account the responses to each single stimulus by each participant and the properties of each single stimulus and participant without averaging across predefined categories (e.g., pleasant, neutral, unpleasant pictures). A main advantage of this approach is that the effects of multiple factors can be simultaneously estimated.

In model 1, we tested fixed main effects of the six variables of main interest gender, age group (younger vs. middle-aged vs. older), valence, arousal, complexity (figure-ground compositions vs. scenes), and social content (people vs. no people). We treated valence and arousal as continuous variables and gender, age group, complexity, and social content as categorical variables. Valence and arousal are the subjective valence and arousal judgments given by the participants averaged across genders and age groups. Mean affective ratings by gender and age groups are provided as supplementary material. Effects of valence/arousal in model 1 with an odd ratio higher than one indicate that hits/false alarms/overall performance significantly increased with increasing pleasantness/arousal.

In model 2, we added to model 1 eight two-way interactions to test whether the effects of valence, arousal, complexity, and social content were significantly different as a function of gender and age group. The interaction gender x age group was also tested. Testing main effects and interaction effects in two separate models is required because in multilevel mixed-effects binary logistic regression analyses the effects of lower-order factors (e.g., main effects of valence and age group) cannot be readily interpreted when higher-order factors (e.g., valence x age group interaction) are also included. Control variables entered in all models were educational level, verbal fluency score, depression, physical functioning, picture brightness, and picture contrast.

RESULTS

Control variables

Younger adults were significantly better educated than middle-aged and older adults (*p*s < .001). Younger adults reported less depressive symptoms than older adults ($p = .019$). Older adults reported worse physical functioning than younger and middle-aged adults (*p*s < .003). Men reported better physical functioning than women ($F(1, 174) = 4.95$, $p = .027$). There was a significant gender x age group interaction for verbal fluency ($F(2, 172) = 3.14$, $p = .046$). Middle-aged women had better scores than middle-aged men, whereas older women had worse scores than older men.

Hits, false alarms, and overall performance

Estimates of fixed effects for hits, false alarms and overall performance are presented in Table 2.

Hits. Women had significantly more hits than men. Unpleasant pictures, figure-ground compositions, and pictures with people were more correctly identified than pleasant pictures, scenes, and pictures without people. The interaction age group x valence was significant (see Fig. 1). Older adults' relationship between valence and hits differed significantly from younger ($p = .048$) and middle-aged ($p = .010$) adults' relationships. Whereas the valence effect approached significance for younger adults (OR = 0.80, CI = 0.62-1.03, $p = .080$) and was significant for middle-aged adults (OR = 0.71, CI = 0.55-0.90, $p = .005$), it was not significant for older adults (OR = 0.92, CI = 0.71-1.20, $p = .55$). The age group by social content interaction was significant. Younger adults recognized pictures depicting people better than older adults (OR = 3.17, CI = 1.64-6.13, $p = .001$). For pictures without people, all pairwise comparisons between age groups were not significant (*p*s > .52).

False alarms. Younger adults had fewer false alarms than both middle-aged (OR = 0.50, CI = 0.28-0.92, $p = .025$) and older adults (OR = 0.22, CI = 0.12-0.39, $p < .001$). Middle-aged adults had fewer false alarms than older adults (OR = 0.44, CI = 0.26-0.74, $p = .002$). Increasing arousal was associated with more false alarms. Gender interacted significantly with social content. Women had significantly more false alarms for pictures without people than with people (OR = 4.17, CI = 1.14-15.30, $p = .031$), whereas men had no significant difference ($p = .54$). Age group interacted significantly with both valence and arousal (see Figs. 1 and 2). Older adults' relationship between valence and false alarms differed significantly from younger adults' relationship ($p = .003$). The three age groups differed significantly from each other in their relationships between arousal and false alarms (ps < .045). The valence and arousal effects were not significant for younger (OR = 1.02, CI = 0.63-1.66, $p = .92$ and OR = 1.27, CI = 0.64-2.51, $p = .49$, respectively) and middle-aged (OR = 1.14, CI = 0.73-1.78, $p = .56$ and OR = 1.59, CI = 0.82-3.08, $p = .17$, respectively) participants. In contrast, for the older adults the valence effect approached significance (OR = 1.39, CI = 1.00-1.94, $p = .052$) and the arousal effect was significant (OR = 2.26, CI = 1.39-3.69, $p = .001$).

Overall recognition memory performance. Women performed better than men. Younger adults outperformed middle-aged (OR = 2.59, CI = 1.53-4.38, $p < .001$) and older (OR = 7.31, CI = 4.41-12.11, $p < .001$) adults, and middle-aged participants outperformed older participants (OR = 2.83, CI = 1.83-4.36, $p < .001$). Performance was better for unpleasant than pleasant pictures, for low-arousal pictures than high-arousal pictures, and for pictures with people than pictures without people. The gender and age group effects depended significantly on each other (see Fig. 3). Women outperformed men among middle-aged (OR = 2.68, CI = 1.29-5.57, $p = .008$) and older (OR = 3.96, CI = 2.20-7.15, $p < .001$) participants but not among younger participants (OR = 0.98, CI = 0.43-2.24, $p = .97$). The age group effect was larger among male than female participants ($F(2, 5374) = 21.69$, $p < .001$ and $F(2, 7314) = 5.63$, $p = .004$, respectively). The age group x arousal interaction was significant (see Fig. 2). The younger group's relationship between arousal and overall memory performance was different from the middle-aged ($p = .013$) and older ($p = .005$) adults' relationships. The effect of arousal was significant for middle-aged (OR = 0.43, CI = 0.21-0.86, *p* = .018) and older (OR = 0.36, CI = 0.19-0.66, *p* = .001) participants but not for younger participants (OR = 0.66, CI = 0.31-1.40, *p* = .27).

DISCUSSION

Recognition memory is affected by many factors (Fraundorf et al., 2019). A strength of the present study is that we investigated the effects of stimulus- and person-related characteristics on recognition memory simultaneously.

Pictures' valence and arousal influence recognition memory depending on observer's age

As hypothesized, we found a significant main effect of pictures' valence indicating that memory performance improved with increasing unpleasantness (hits and overall performance). This finding is in line with and extends the results of studies using different paradigms and stimuli (Bless, Hamilton & Mackie, 1992; Charles et al., 2003; Dreben, Fiske & Hastle, 1979; Grady, Hongwanishkul, Keightley, Lee & Hasher, 2007; Grühn et al., 2007; Hämmerer et al., 2017; Ohira et al., 1998; Pratt & John, 1991; Robinson-Riegler & Winton, 1996; Skowronski & Carlston, 1987; but see Chainay, Michael, Vert-pré, Landré & Plasson, 2012). One way to interpret these findings is through the principle of negativity bias according to which "bad is stronger than good" across a broad range of psychological phenomena (Baumeister et al., 2001; Rozin & Royzman, 2001; see Introduction).

The main valence effect was significantly modulated by age for hits and false alarms. Whereas younger and middle-aged adults recognized old unpleasant pictures better than pleasant ones, their false alarms were not significantly modulated by pictures' valence. In contrast, older adults recognized pleasant and unpleasant old pictures equally well but tended to commit more false alarms for new pleasant pictures than unpleasant ones. As a result of these opposite age-dependent modulations of the effect of valence on hits and false alarms, the three age groups did not significantly differ as to the effect of pictures' valence on overall performance. Thus, our hypothesis of an age-related positivity effect in recognition memory was only partially supported. Although some studies have found strong support for the age-related positivity effect in recognition memory (e.g., Charles et al., 2003; Grühn et al., 2007), others have not (see Reed et al., 2014). In their meta-analysis, Fraundorf and colleagues (2019) concluded that support for the age-related positivity effect in recognition memory is mixed. It is possible that age differences are less pronounced in recognition memory tasks than free-recall tasks because the former demand less self-directed processing that is less likely to be affected by motivational goals (Charles et al., 2003).

Arousal significantly predicted recognition memory, but the direction of its effect was contrary to our expectations. Participants tended to report more often as new previously seen high-arousal pictures than low-arousal ones and committed significantly more false alarms for novel high-arousal pictures than low-arousal ones. Consequently, overall performance was significantly worse for high-arousal than low-arousal images. Our initial hypothesis regarding the effect of arousal was derived from studies using free-recall paradigms that had consistently found memory to be better for high-arousal than low-arousal materials (Bradley et al., 1992; Bradley & Lang, 2000; Dolcos et al., 2004a,b; Palomba et al., 1997). These opposite findings may be reconciled by considering differences in how low- and high-arousal stimuli are processed. Research suggests that for stimuli that elicit strong emotional arousal, memory for their gist (central details) is relatively good, whereas memory for their contextual and peripheral details is relatively poor (Christianson, 1992; Heuer & Reisberg, 1992). Adolphs, Denburg, and Tranel (2001) have shown that the amygdala may enhance memory for the overall gist of highly emotional pictures while suppressing memory for the visual details of such stimuli. Affective low-arousal stimuli may automatically attract attention to the perceptual and contextual details, thereby enhancing memory for this information (D'Argembeau and Van der Linden, 2004). In recognition memory tasks like ours, old and new pictures are typically very similar in their gist. Thus, memory performance in recognition tasks strongly depends on attentively processing and remembering details of the stimuli. This contrasts with the typical free-recall task where stimuli are quite different, and participants are required to give simple descriptions without dwelling on details (Charles et al., 2003). In line with this reasoning, emotional arousal had opposite effects in a free-recall task and a forced-choice recognition task. In the former, emotional arousal enhanced memory for gist, whereas in the latter it reduced memory for visual details (Denburg, Buchanan, Tranel & Adolphs, 2003).

Age significantly modulated the effect of arousal on false alarms and overall performance. The effect of pictures' arousal was smallest and non-significant for younger adults and largest for older adults, with middle-aged adults falling in between. These findings are consistent with the enhanced subjective experience of illusory recollection of emotionally arousing events among older adults compared to younger adults (Gallo, Foster & Johnson, 2009) and with results by Grühn and Scheibe (2008) showing that after partialing out valence, memorability by young adults for over 500 pictures was unrelated to arousal, whereas memorability by older adults was negatively related to arousal. The present study extends this work by suggesting that the arousal effect becomes progressively larger across adulthood. More broadly, our findings fit with the general idea that arousal has different effects on young and older adults' memory, with high arousal becoming increasingly "problematic" and potentially disrupting information processing as we age (Labouvie-Vief, 2015).

Gender and age are important determinants of recognition memory

In line with our predictions, women outperform men (hits and overall performance). This finding converges with previous studies that have shown better performance for females in episodic memory tasks and supports the idea that there is a general female advantage in memory for previously processed stimuli (Herlitz & Rehnman, 2008; Naveh-Benjamin et al., 2012). Women's better recognition memory performance may rely on more effective use of verbal labelling strategies (Andreano & Cahill, 2009). This mechanism seems unlikely to explain the present findings because we statistically accounted for the influence of verbal fluency. An alternative explanation for the observed gender effect is that women exhibit more explorative eye-gaze behavior than men (Coutrot, Binetti, Harrison, Mareschal & Johnston, 2016; Mercer Moss, Baddeley & Canagarajah, 2012; Rennels & Cummings, 2013; Shen & Itti, 2012). Relatedly, according to the selectivity hypothesis of information processing females are comprehensive processors engaging in more detailed elaboration of the available information in apprehending environmental stimuli as basis for judgement, whereas males are selective processors considering only a subset of the available information (Darley & Smith, 1995; Meyers-Levy, 1989). In line with this view, gender differences in the detail of encoding were significantly related to the female advantage for recalling autobiographical emotional and neutral everyday events (Seidlitz & Diener, 1998).

This line of reasoning to explain the observed gender effect is challenged by the fact that middle-aged and older adults but not younger adults exhibited a significant gender effect. It might be that the observed gender differences are actually a by-product of an age-related decline in memory performance that is steeper among men than women. We turn to this issue in the following.

Older adults' overall memory performance was poorer than younger adults' performance, with middle-aged adults falling in between. These findings are in line with the conclusion of a meta-analysis that older adults are consistently less effective than younger adults at discriminating new and old items (Fraundorf et al., 2019). The present study extends this by showing that this decline in recognition accuracy is already present in middle-aged adults. Furthermore, this age effect was driven primarily by an age effect for false alarms. This accords with the meta-analysis by Fraundorf et al. (2019) and with the observation that older adults are particularly vulnerable to making high-confidence false recollection of recently learned events (Dodson, Bawa, & Krueger, 2007).

Men showed a larger age-related decline in performance than did women. This finding is similar to results from studies showing a steeper age-related decline in recognition memory in men than in women (Graves et al., 2017; Gualtieri, 2014; Maylor, Reimers, Choi, Collaer, Peters & Silverman, 2007; Naveh-Benjamin et al., 2012). Because the hippocampus plays a central role in recognition memory (Huijgen & Samson, 2015), one might speculate that the hippocampus undergoes larger age-dependent alterations in males than in females (Lacreuse et al., 2005). Some reports in humans are consistent with this hypothesis (e.g., Nobis et al., 2019; Pruessner, Collins, Pruessner & Evans, 2001; Raz, Gunning-Dixon, Head, Rodrigue, Williamson & Acker, 2004).

Recognition memory depends on pictures' social content and to a lesser degree on pictures' complexity

As anticipated, pictures depicting people were better recognized than pictures without people (hits and overall performance). Compared to pictures without people, processing of pictures depicting people is associated with enhanced early occipital ERP negativity, a neural signature interpreted as indicating facilitated identification and recognition of pictures depicting people (Löw et al., 2013) and associated with better recognition memory (Versace et al., 2010). Our finding is in line with the idea that for a highly social species as humans, other people's features (e.g., identity, age, gender) are possibly the most important class of environmental information to promote the survival of the individual (Stein et al., 2012).

In line with our predictions, previously seen figure-ground compositions were better recognized than scenes. However, when taking into account the effect of picture complexity on novel pictures, overall memory performance was no longer significantly predicted by complexity. Previous theorizing and empirical research on the role of stimulus complexity on memory for affective material has been scant and contradictory (Madigan, 1974; Nguyen & McDaniel, 2015; Snodgrass & Vanderwart, 1980). Contrasting findings may partly be explained by the type of stimuli (natural scenes vs. line drawings) and how perceptual complexity is defined (Marin & Leder, 2013).

Limitations and outlook

First, although the pictures covered a broad range of real-life themes, and we considered a large number of picture properties in our analyses, we cannot exclude that the observed effects are due to aspects of the selected pictures that we did not account for. For instance, Fraundorf et al. (2019)'s meta-analysis showed that increasing resemblance of the new items to the old items magnifies age differences in recognition memory. Second, the to-be-recognized pictures were embedded in thematically and affectively homogenous series of pictures. This design was dictated by other research goals concerning psychophysiological responding ("reference"). Recognition memory performance varies depending on whether the to-be-recognized pictures are presented in emotion-homogeneous (i.e., single valence category) or emotion-heterogeneous contexts (i.e., different valence categories; Grühn et al., 2007). Future studies may test whether the present findings are reproduced when pictures are embedded in emotion-heterogeneous contexts or shown separately. Third, investigating the effect of emotion regulation on recognition memory is an important area to pursue given that strategies such as distraction and suppression impair memory for emotional contents (Richards & Gross, 2006; Sheppes & Meiran, 2008) and that their use varies as a function of gender and age (Scheibe, Sheppes & Staudinger, 2015; Zimmermann & Iwanski, 2014). Fourth, researchers may also want to investigate the role of thematic content (erotica, physical violence, etc.) on recognition memory and how its effect may depend on gender and age (Bernat, Patrick, Benning & Tellegen, 2006). Fifth, in future studies it would appear important to control in the analyses for potential differences in time spent on the self-paced recognition task. Sixth, the role of physiological responses at stimulus encoding and recognition for memory performance would be another issue to investigate (Gavazzeni, Anderson, Bäckman, Wiens & Fischer, 2012; Hämmerer et al., 2017). Finally, interpretation of the results regarding age-related vs. cohort effects requires caution because of the cross-sectional study design.

In conclusion, we have shown that recognition memory is better for unpleasant than pleasant pictures and for pictures depicting people than pictures without people. Recognition memory is worse for high- than low-arousal pictures, and this effect becomes larger across age. Recognition memory deteriorates across adulthood, and this decline is steeper among men than women. Middle-aged and older women outperform their male counterparts.

Appendix A. Supplementary data

Supplementary data to this article can be found online at….

Author note

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Table 1

Participants' characteristics by gender and age group

Variable	Men				Women			
	Younger	Middle-aged	Older	All	Younger	Middle-aged	Older	All
Sample size (n)	30	24	22	76	35	30	38	103
Age (years)	26.6 (0.9)	46.7 (0.8)	66.6 (1.0)	44.8 (2.0)	26.7 (0.8)	46.8 (0.8)	66.1 (0.6)	47.3 (1.7)
Educational level (#)[a]								
Level I	0	1	1	2	0	3	7	10
Level II	4	14	11	29	12	16	19	47
Level III	26	9	10	45	23	11	12	46
Self-reported health								
Anxiety[b]	5.0 (0.4)	4.5 (0.5)	5.2 (0.5)	4.9 (0.2)	5.4 (0.4)	5.3 (0.4)	5.0 (0.4)	5.2 (0.2)
Depression[b]	1.5 (0.2)	2.7 (0.4)	2.9 (0.5)	2.3 (0.2)	1.8 (0.3)	1.9 (0.4)	2.2 (0.3)	2.0 (0.2)
Mental health[c]	71 (3)	74 (3)	75 (3)	73 (2)	71 (3)	71 (3)	77 (3)	73 (2)
Physical functioning[c]	99 (0)	97 (1)	94 (1)	97 (1)	98 (1)	94 (2)	83 (4)	91 (2)
General health[c]	82 (2)	81 (3)	74 (3)	79 (2)	82 (2)	81 (3)	80 (3)	81 (2)
Verbal fluency								
Animal naming task[d]	23.8 (1.3)	21.4 (1.1)	23.4 (1.3)	22.9 (0.7)	23.7 (1.0)	24.7 (1.1)	20.9 (0.9)	22.9 (0.6)

Notes for Table 1

[a] Educational level: level I = no vocational training with or without practical on-the-job training; level II: completed vocational training equivalent to apprenticeship or a degree judged equivalent; level III: baccalaureate with or without later academic studies; values for age, self-reported health, and verbal fluency are means with *SE*s in brackets; [b] HADS (Zigmond & Snaith, 1983), scores between 0 and 21 with higher scores corresponding to more anxiety/depression; [c] SF-36 (Ware & Sherbourne, 1992), scores between 0 and 100 with higher scores corresponding to better health; [d] (Kertesz, 1982), number of animal names in 1 minute.

Table 2 Estimated multilevel mixed-effects binary logistic regression models for hits, false alarms and overall recognition memory performance

	Hits			False alarms			Overall performance		
	OR	95% CI	*p* value	OR	95% CI	*p* value	OR	95% CI	*p* value
Main effects									
Gender	1.87	1.29-2.71	**.001**	0.81	0.51-1.28	.35	2.83	1.93-4.14	**<.001**
Age group			.18			**<.001**			**<.001**
Younger adults	1.55	0.97-2.47		0.22	0.12-0.39		7.31	4.41-12.11	
Middle-aged adults	1.20	0.77-1.87		0.44	0.26-0.74		2.83	1.83-4.36	
Valence	0.81	0.67-0.99	**.039**	1.36	0.95-1.94	.092	0.62	0.43-0.90	**.011**
Arousal	0.74	0.54-1.01	.059	2.09	1.25-3.49	**.005**	0.38	0.22-0.67	**.001**
Complexity	3.76	1.85-7.63	**<.001**	1.80	0.63-5.14	.27	2.15	0.65-7.19	.21
Social content	3.61	1.66-7.84	**.001**	0.38	0.11-1.29	.12	8.50	2.17-33.34	**.002**
Educational level	0.92	0.63-1.36	.68	1.39	0.88-2.21	.16	0.69	0.46-1.01	.058
Depression	0.98	0.89-1.07	.62	1.00	0.89-1.13	.96	0.98	0.89-1.07	.66
Physical functioning	1.00	0.99-1.02	.52	0.99	0.98-1.01	.45	1.01	1.00-1.02	.074
Verbal fluency	1.03	1.00-1.06	.069	1.00	0.96-1.04	.93	1.02	0.99-1.05	.22
Picture brightness	1.00	0.99-1.02	.47	0.99	0.97-1.01	.15	1.02	0.99-1.04	.13
Picture contrast	0.97	0.94-1.00	.052	0.97	0.94-1.01	.17	0.99	0.95-1.04	.80
Interactions									
Gender x age group			.10			.076			**.001**
Younger female adults	0.66	0.27-1.64		3.40	1.07-10.79		0.15	0.06-0.41	
Middle-aged female adults	1.79	0.72-4.44		2.59	0.88-7.63		0.60	0.24-1.47	
Gender x valence	0.99	0.84-1.16	.90	1.00	0.86-1.17	.97	0.99	0.79-1.23	.91
Gender x arousal	0.93	0.71-1.21	.59	1.33	0.99-1.78	.056	0.70	0.48-1.03	.072
Gender x complexity	1.10	0.61-1.99	.74	0.91	0.52-1.59	.74	1.20	0.54-2.66	.64
Gender x social content	0.70	0.40-1.23	.21	0.36	0.17-0.74	**.005**	1.86	0.76-4.52	.17
Age group x valence			**.022**			**.007**			.37
Younger adults	0.81	0.66-1.00		0.69	0.54-0.88		1.16	0.84-1.58	
Middle-aged adults	0.78	0.65-0.94		0.85	0.71-1.02		0.91	0.71-1.17	
Age group x arousal			.17			**<.001**			**.013**
Younger adults	1.01	0.72-1.41		0.45	0.30-0.67		2.10	1.25-3.51	
Middle-aged adults	0.77	0.56-1.04		0.71	0.51-0.99		1.04	0.66-1.62	
Age group x complexity			.49			.73			.63
Younger adults	0.97	0.46-2.05		0.75	0.35-1.57		1.24	0.44-3.51	
Middle-aged adults	0.68	0.35-1.35		0.88	0.46-1.66		0.74	0.30-1.84	
Age group x social content			**.003**			.88			.16
Younger adults	3.35	1.66-6.75		1.18	0.45-3.11		3.06	0.95-9.81	
Middle-aged adults	1.90	0.98-3.70		1.21	0.53-2.73		1.65	0.59-4.60	

Notes for Table 2

Main effects are from Model 1; interactions are from Model 2. Reference categories for categorical predictors were as follows: gender: men; age group: older adults; complexity: scenes; social content: no people; educational level: level III. For continuous predictors, the ORs refer to a change of one unit on the corresponding scale. OR = odd ratio; CI = confidence interval. Significant effects are marked in bold.

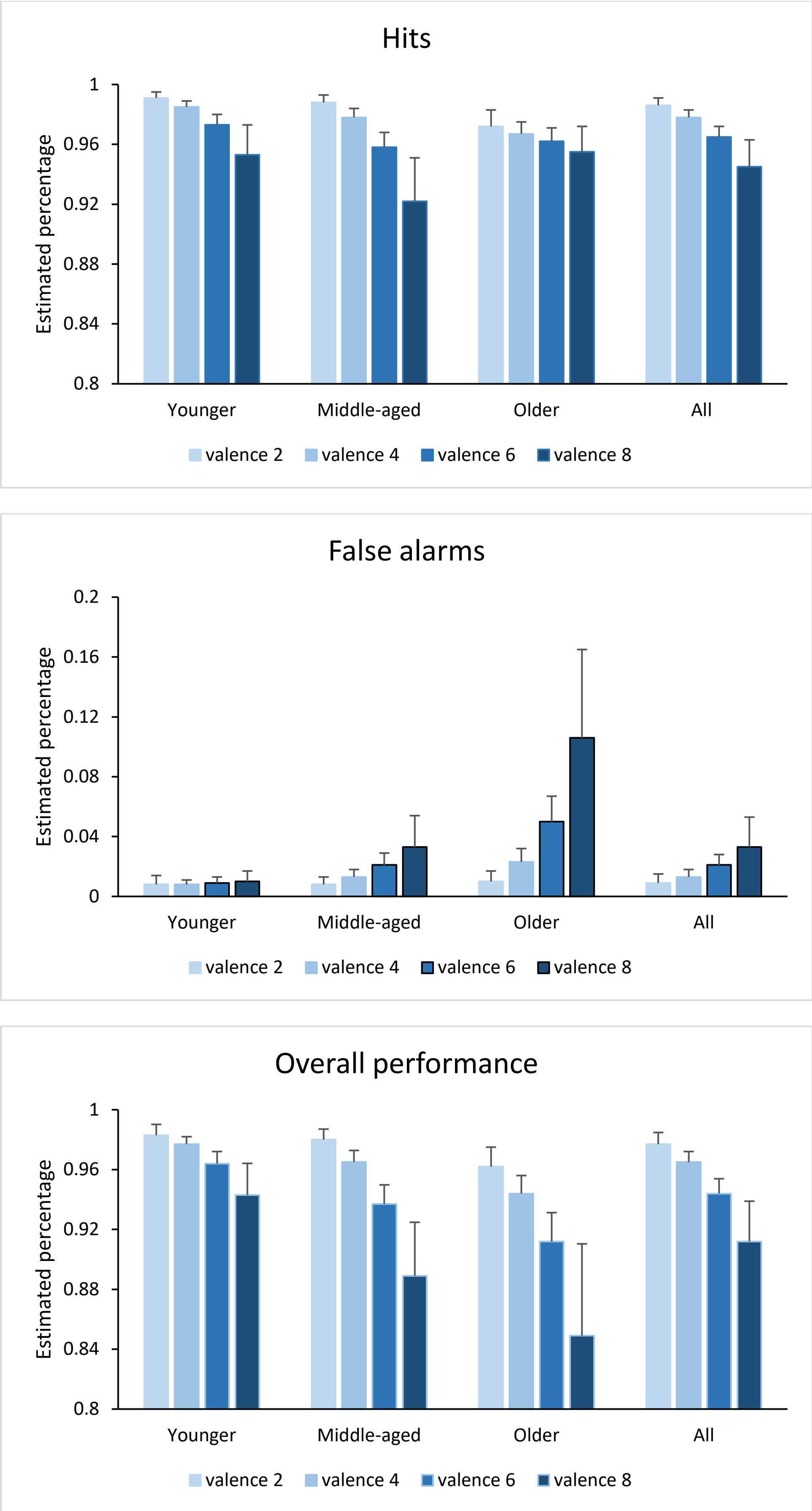

Hits
Estimated percentage
1
0.96
0.92
0.88
0.84
0.8
Younger
Middle-aged
Older
All
valence 2
valence 4
valence 6
valence 8
False alarms
Estimated percentage
0.2
0.16
0.12
0.08
0.04
0
Younger
Middle-aged
Older
All
valence 2
valence 4
valence 6
valence 8
Overall performance
Estimated percentage
1
0.96
0.92
0.88
0.84
0.8
Younger
Middle-aged
Older
All
valence 2
valence 4
valence 6
valence 8

Fig. 1

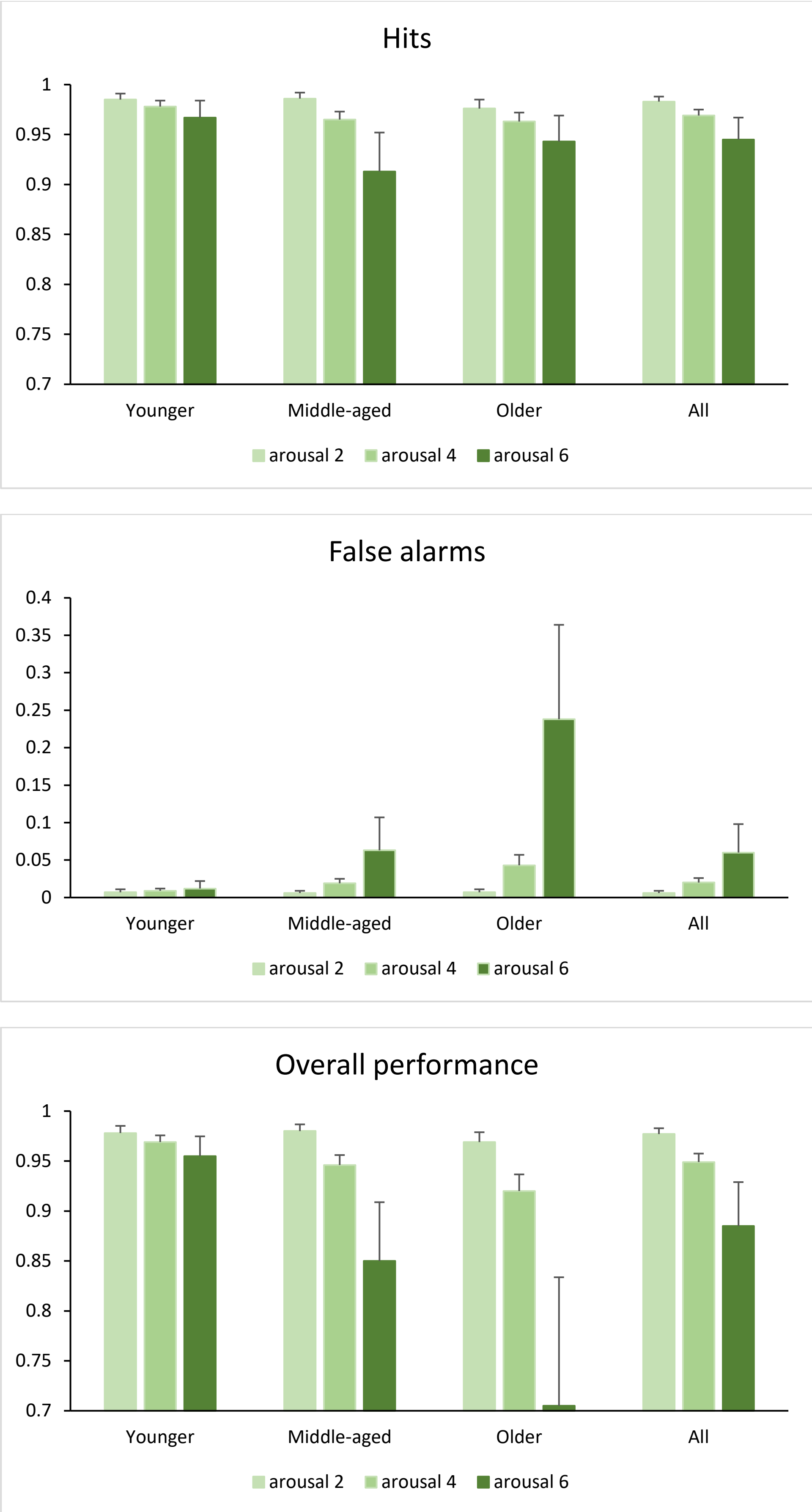
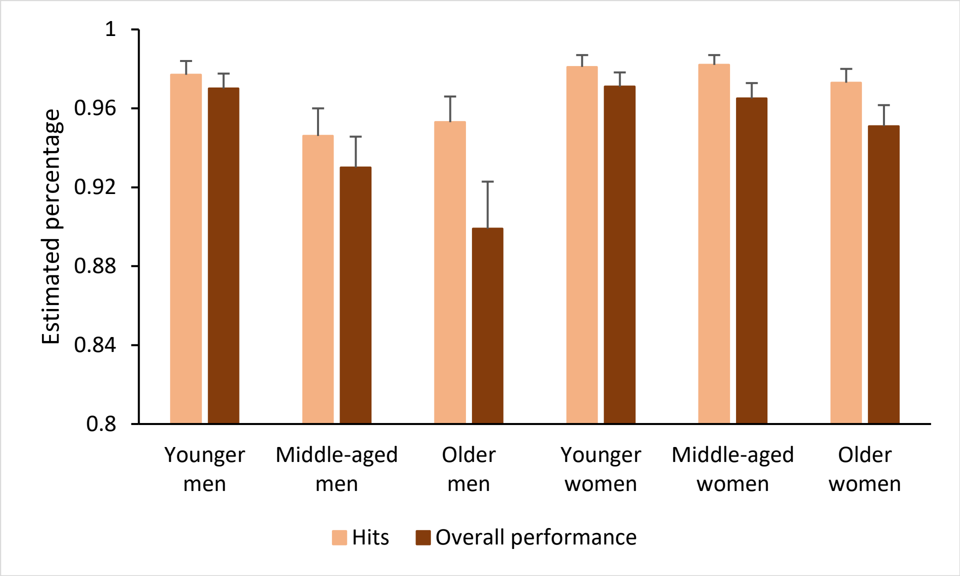

Hits
1
0.95
0.9
0.85
0.8
0.75
0.7
Younger
Middle-aged
Older
All
arousal 2
arousal 4
arousal 6
False alarms
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Younger
Middle-aged
Older
All
arousal 2
arousal 4
arousal 6
Overall performance
1
0.95
0.9
0.85
0.8
0.75
0.7
Younger
Middle-aged
Older
All
arousal 2
arousal 4
arousal 6

Fig. 2



1
0.96
0.92
0.88
0.84
0.8
Estimated percentage
Younger men
Middle-aged men
Older men
Younger women
Middle-aged women
Older women
Hits
Overall performance

Fig. 3

Figure captions

Fig. 1. Model-predicted estimated marginal means (*SE*s) of hits (upper), false alarms (middle), and overall recognition memory performance (lower) along the valence dimension (higher values correspond to higher pleasantness) for younger adults, middle-aged adults, older adults, and all participants. The estimated marginal means are shown for valence values between 2 and 8 in line with the actual valence values of the pictures, which ranged from 1.96 to 7.97. Each estimated mean is computed by holding valence at the specified values of 2, 4, 6, and 8 when testing the statistical model. A value of 1 on the y-axis corresponds to 100%.

Fig. 2. Model-predicted estimated marginal means (SEs) of hits (upper), false alarms (middle), and overall recognition memory performance (lower) along the arousal dimension (higher values correspond to higher arousal) for younger adults, middle-aged adults, older adults, and all participants. The estimated marginal means are shown for arousal values between 2 and 6 in line with the actual arousal values of the pictures, which ranged from 2.19 to 6.17. Each estimated mean is computed by holding arousal at the specified values of 2, 4, and 6 when testing the statistical model. A value of 1 on the y-axis corresponds to 100%.

Fig. 3. Model-predicted estimated marginal means (*SE*s) of hits and overall recognition memory performance for younger men, middle-aged men, older men, younger women, middle-aged women, and older women. A value of 1 on the y-axis corresponds to 100%.

Picture numbers of the stimuli from the IAPS

A. Pictures used in the emotion task

Pleasant series

Appetizing food: 7200, 7270, 7330, 7470, 7480, 7488; erotic heterosexual couples: 4659, 4660, 4680, 4687, 4690, 4800; pleasant family scenes: 2299, 2311, 2332, 2360, 2530, 2598; pleasant nature: 5200, 5594, 5631, 5780, 5781, 5811; romantic heterosexual couples: 2550, 4624, 4625, 4640, 4641, 4650; sport scenes: 5621, 8080, 8180, 8186, 8400, 8490.

Unpleasant series

Environmental contamination: 9090, 9110, 9280, 9290, 9342, 9390; human loss: 2205, 2455, 2490, 2590, 9001, 9220; mutilated/burned bodies: 3010, 3030, 3068, 3071, 3110, 3150; physical violence: 2683, 3500, 3530, 6313, 6550, 6821; sick/injured human beings: 2053, 2710, 3181, 3230, 3261, 9415; suffering/dead animals: 2981, 9180, 9181, 9560, 9561, 9571.

Neutral series

Household objects: 7000, 7004, 7035, 7090, 7233, 7234; neutral human activities: 2357, 2393, 2396, 2397, 2745.1, 2850.

B. Pictures presented in the emotion task and in the recognition task

Pleasant series

Appetizing food: 7270, 7488; erotic heterosexual couples: 4659, 4660; pleasant family scenes: 2299, 2311; pleasant nature: 5594, 5811; romantic heterosexual couples: 4625, 4650; sport scenes: 8080, 8400.

Unpleasant series

Environmental contamination: 9290, 9342; human loss: 2490, 9001; mutilated/burned bodies: 3030, 3110; physical violence: 3500, 6550; sick/injured human beings: 2053, 3181; suffering/dead animals: 2981, 9180.

Neutral series

Household objects: 7000, 7004, 7035, 7090, 7233, 7234; neutral human activities: 2357, 2393, 2396, 2397, 2745.1, 2850.

C. Novel pictures used in the recognition task

Pleasant series

Appetizing food: 7260, 7291; erotic heterosexual couples: 4658, 4695; pleasant family scenes: 2358, 5836; pleasant nature: 5201, 5991; romantic heterosexual couples: 4599, 4645; sport scenes: 8030, 8370.

Unpleasant series

Environmental contamination: 9340, 9341; human loss: 2490, 9001; mutilated/burned bodies: 3060, 3100; physical violence: 6312, 6315; sick/injured human beings: 2661, 3180; suffering/dead animals: 2688, 9570.

Neutral series

Household objects: 7006, 7010, 7030, 7040, 7080, 7150; neutral human activities: 2191, 2435, 2579, 2593, 2840, 2870.

Table S1 Mean valence ratings and *SE*s (in parentheses) by gender and age group for the fourteen series

Series	Men			Women		
	Younger	Middle-aged	Older	Younger	Middle-aged	Older
Pleasant Series						
Appetizing food	7.2 (0.2)	7.3 (0.3)	6.9 (0.3)	7.3 (0.2)	7.4 (0.3)	7.2 (0.3)
Erotic heterosexual couples	7.3 (0.2)	6.8 (0.4)	7.4 (0.3)	7.1 (0.3)	6.6 (0.3)	6.4 (0.2)
Pleasant family scenes	7.6 (0.2)	7.6 (0.3)	7.9 (0.4)	7.7 (0.2)	8.3 (0.2)	8.6 (0.1)
Pleasant nature	7.1 (0.2)	7.7 (0.4)	7.9 (0.3)	7.8 (0.2)	7.5 (0.4)	8.7 (0.1)
Romantic heterosexual couples	7.3 (0.3)	7.0 (0.3)	7.9 (0.4)	7.2 (0.3)	7.7 (0.3)	8.5 (0.2)
Sport scenes	7.2 (0.2)	6.6 (0.3)	6.9 (0.3)	7.2 (0.2)	6.4 (0.4)	6.9 (0.3)
Neutral Series						
Household objects	5.1 (0.1)	5.5 (0.2)	5.9 (0.3)	5.2 (0.1)	5.5 (0.3)	5.6 (0.2)
Neutral human activities	5.1 (0.2)	5.3 (0.3)	5.1 (0.4)	5.1 (0.1)	5.7 (0.3)	5.3 (0.3)
Unpleasant Series						
Environmental contamination	3.5 (0.2)	2.6 (0.4)	2.8 (0.4)	3.3 (0.2)	3.0 (0.3)	2.3 (0.2)
Human loss	2.9 (0.2)	3.8 (0.5)	3.1 (0.4)	3.0 (0.2)	2.9 (0.3)	2.7 (0.3)
Mutilated/burned bodies	2.2 (0.2)	2.3 (0.3)	1.7 (0.2)	2.4 (0.2)	1.6 (0.3)	1.7 (0.2)
Physical violence	2.9 (0.2)	2.5 (0.3)	1.6 (0.3)	2.5 (0.2)	1.8 (0.2)	1.4 (0.1)
Sick/injured human beings	2.6 (0.2)	2.4 (0.3)	2.0 (0.3)	2.4 (0.2)	1.9 (0.3)	1.9 (0.2)
Suffering/dead animals	2.6 (0.2)	2.4 (0.3)	2.3 (0.3)	1.9 (0.2)	1.6 (0.2)	1.7 (0.2)

Table S2 Mean arousal ratings and *SE*s (in parentheses) by gender and age group for the fourteen series

Series	Men			Women		
	Younger	Middle-aged	Older	Younger	Middle-aged	Older
Pleasant Series						
Appetizing food	4.4 (0.4)	3.5 (0.5)	3.7 (0.5)	3.6 (0.4)	3.4 (0.5)	3.0 (0.4)
Erotic heterosexual couples	5.7 (0.4)	5.4 (0.5)	5.7 (0.4)	5.9 (0.4)	5.0 (0.4)	4.6 (0.4)
Pleasant family scenes	3.6 (0.4)	3.3 (0.5)	3.0 (0.5)	3.0 (0.3)	2.2 (0.4)	2.6 (0.4)
Pleasant nature	2.1 (0.2)	2.4 (0.3)	2.8 (0.5)	2.0 (0.3)	2.1 (0.3)	2.6 (0.4)
Romantic heterosexual couples	3.6 (0.4)	3.5 (0.5)	3.5 (0.4)	3.5 (0.4)	3.2 (0.4)	3.2 (0.4)
Sport scenes	5.7 (0.4)	3.6 (0.5)	4.9 (0.4)	5.2 (0.4)	4.9 (0.4)	4.7 (0.4)
Neutral Series						
Household objects	1.9 (0.3)	2.5 (0.4)	2.5 (0.4)	2.1 (0.3)	1.9 (0.3)	2.2 (0.2)
Neutral human activities	2.1 (0.2)	2.7 (0.3)	2.8 (0.4)	2.2 (0.2)	2.1 (0.3)	2.2 (0.2)
Unpleasant Series						
Environmental contamination	3.9 (0.4)	5.1 (0.6)	4.9 (0.5)	4.4 (0.4)	5.2 (0.4)	4.4 (0.4)
Human loss	3.2 (0.3)	3.4 (0.5)	4.5 (0.4)	3.4 (0.3)	3.9 (0.3)	3.8 (0.3)
Mutilated/burned bodies	5.8 (0.4)	5.1 (0.6)	6.3 (0.4)	6.4 (0.4)	7.5 (0.3)	5.9 (0.5)
Physical violence	5.4 (0.4)	5.0 (0.5)	6.6 (0.5)	6.1 (0.4)	7.2 (0.4)	6.1 (0.4)
Sick/injured human beings	4.4 (0.4)	4.8 (0.5)	6.0 (0.4)	5.1 (0.3)	5.3 (0.4)	5.2 (0.3)
Suffering/dead animals	5.5 (0.5)	4.7 (0.6)	5.5 (0.5)	6.4 (0.4)	6.7 (0.5)	6.1 (0.5)