The role of the personal relevance of images in retrieving autobiographical memories for emotion regulation: A randomized controlled trial study

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Abstract

Little is known about what types of positive specific autobiographical memory-inducing images are most effective in regulating emotions. This study analyses the effectiveness of personal relevance of images associated with specific positive autobiographical memories as a method of emotional regulation. The sample comprised 263 participants (179 women), divided into a group of young adults (N = 139) aged 18–28 years and a group of older persons (N = 124) aged 65 years and over. In a randomized controlled trial study, participants were randomly assigned to three experimental conditions based on the type of image used (images of International Affective Picture System (IAPS), images of places and personal photographs). Negative mood was induced by viewing a film clip. Positive mood induction was subsequently conducted through the presentation of six images (according to the group) associated with specific positive autobiographical memories. Changes in mood state were measured using the Positive and Negative Affect Schedule (PANAS) before and after each induction. SPSS 28.0 (IBM) statistical software was used for the data analysis. The positive mood induction procedure repaired participants' mood state, increasing positive affect and decreasing negative affect. The older adults showed a greater increase in positive affect while their younger counterparts recorded a greater decrease in negative affect. The three types of images were equally effective in augmenting positive affect. Regarding the reduction in negative affect, the personal photographs scored highest in the group of young adults, while, in the older group, the IAPS images were the most effective. The findings of this study show that using images associated with positive specific autobiographical memories is an effective mood induction method. Consequently, the use of such images might be effective in interventions designed to enhance emotion regulation and reduce depressive symptomatology.

Keywords Memory, episodic · Emotional regulation · Biological variation, population

Introduction

Autobiographical memory

Autobiographical memory (AM) refers to the collection of memories of past events from a person's life, which can be retrieved using sensory information, emotions, narratives, etc. (Conway & Pleydell-Pearce, 2000). According to these authors, autobiographical memories are generated at different levels of specificity, with the ability to retrieve specific personal events being associated with autonoetic consciousness. An individual's ability to access specific autobiographical memories (events lasting no more than one day) is an indicator of emotional well-being, with relationships having been established between the presence of certain psychopathologies (e.g., depression) and difficulties in retrieving such memories (Williams et al., 2007). Older adults have been reported to retrieve autobiographical memories with less specificity and less detail than do younger adults (Wilson & Gregory, 2018).

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Emotion regulation and autobiographical memory

Emotion regulation is the process by which a person influences the specific emotions they experience by increasing and/or decreasing their positive and/or negative emotions. Difficulties in this process have been found to be a risk factor for the development of psychological disorders such as depression and anxiety (Sloan et al., 2017).

The nature of autobiographical memories makes them particularly suitable for emotional regulation processes as they can be constructed in a way that emphasizes positive or negative details (Pascuzzi & Smorti, 2016). Indeed, previous studies have shown that access to specific positive AMs facilitates mood regulation, reducing negative emotions and increasing positive emotions (Latorre et al., 2015).

Emotion regulation through access to AMs is especially important in older individuals. The literature suggests that older adults better dissipate negative affect and regulate negative moods than younger adults, preferring positive information to negative and/or neutral information. This leads older people to recall more positive than negative information compared to younger people (Carstensen & DeLiema, 2018). In addition, older adults also rate past events more positively than younger adults (Schryer & Ross, 2014).

Mood induction procedures and autobiographical memory

Accessing autobiographical memories is one of the most widely used Mood Induction Procedures (MIPs), as it has proven effectiveness, especially in inducing positive emotional mood states (Zhang et al., 2014). According to El-Ziab (2016), the more accessible and significant the memories are, the more effective will be the emotion regulation. Under this approach, we can highlight three main variables that might increase the effectiveness of this positive emotion regulation: the relevance, reliving and positivity of the memory. Regarding relevance, relevant memories are those that act as a reference in terms of timelines that help individuals organise their life story and represent who they are (Rubin & Siegler, 2004). According to Dal Fabbro et al. (2021), emotions are the result of synchronised and inter-related changes in response to stimuli that a person feels to be relevant and it is this relevance that triggers the emotion. Furthermore, when events are remembered with a great sense of reliving, they are more affectively powerful and, thus, allow stronger emotions to be induced, encouraging emotion regulation (Talarico et al., 2004). In this sense, the recall of specific details (e.g., sensory details) is necessary for the mental reliving of past events. Thus, the more

details there are in the cue used to retrieve the memory, the greater is its capacity to stimulate this reliving. In relation to these variables, studies show that younger people tend to rate their memories as more vivid and detailed than older people (Janssen et al., 2011).

The retrieval of positive memories is valuable in reliving the pleasant feelings experienced in the original event. Thus, the more positive these feelings, the more valuable they are as an emotion regulation strategy (Fredrickson, 2013). According to the positivity effect, compared to younger people, older people show a preference for attending to, and remembering, emotionally meaningful and positive stimuli (Reed et al., 2014).

Another key aspect related to emotions and autobiographical recall is the feeling of nostalgia (Routledge et al., 2013) that seems to be especially triggered by meaningful memories with great personal relevance (Hepper et al., 2012). Although nostalgia can be an ambivalent emotional experience, encompassing feelings of longing and loss (Hepper et al., 2012), its impact on an individual's affective state seems to be primarily positive.

Visual stimuli associated with autobiographical memories in mood induction

The use of visual stimuli for positive events generates positive emotions and improves mood state more than verbal processing (e.g., Hackmann et al., 2011). Thus, images may be powerful cues for retrieving memories and associated emotions, given their close correspondence to the experience of the events (Kosslyn et al., 2001). But, what types of images are most effective in accessing specific positive AMs and in re-experiencing their emotions associated? We can find various types of images, some of which are more generic (e.g., standardised images) and others that are more personal (e.g., personal photos).

Concerning generic images, some studies on emotion regulation have used images from the International Affective Picture System (IAPS; Lang et al., 2008) as a standard method in mood induction, finding they allow for greater mood regulation than other stimuli, such as film clips (Dhaka & Kashyap, 2017). Other generic images are those associated with the recall of physical places. Previous studies have reported that memories associated with places represent a multimodal way of encoding recalling and reliving past experiences (Markowitsch & Staniloiu, 2011). Thus, a person's feelings towards a certain place may continue to influence them and be used as effective emotional regulators (Hartig et al., 2003).

Meanwhile, given their direct correspondence to a past event, personal images are also powerful cues that contain much of the sensory and emotional information present in an AM, and thus facilitate the immediacy of retrieval (Addis et al., 2012).

The present study

Our main aim was to analyse the effectiveness of different types of images (IAPS images, images of places and personal photographs) associated with positive specific AMs, as a method of mood recovery following a negative mood induction (based on viewing a film clip). To the best of our knowledge, no studies have yet attempted to determine what types of positive specific AM-inducing images are most effective in regulating emotions.

Furthermore, considering the inconsistent findings on the different effects that emotionally loaded images might have depending on the age of the person, this study will also compare the effectiveness of such images in two different age groups: young and older adults. In this regard, previous studies suggest that emotionally loaded images generate memories regardless of their emotional valence in young adults, whereas in older adults this recall would be preferentially restricted to those with a positive emotional valence (Charles et al., 2003). Other studies, however, have reported the non-existence of a positivity bias in the rating of images according to their emotional characteristics in older and younger adults (Denburg et al., 2003).

Additionally, it is worth noting that very few studies on mood induction have primarily been conducted with adults (e.g., Ramírez et al., 2014). However, performing studies with older population is now essential since, as underlined by the United Nations (2017), the number of people aged over 60 has increased significantly in the last 30 years, and by 2030 this population is expected to exceed that of children under the age of 10. On the other hand, emotional problems (e.g. depression) in this life stage are emerging as a key public health problem (van den Besselaar et al., 2021). Thus, taking into account the exponential growth in the ageing population, as well as the high prevalence of emotional disorders in this age group, it is necessary to develop interventions to promote greater psychological well-being and a higher quality of life, among older people. Consequently, we believe that the use of images could be an effective procedure in inducing positive emotions and reducing negative emotions and could therefore help improve and prevent depressive symptoms in older adults. Finally, this study will also analyse the differences between the various types of images in terms of the level of personal relevance, the degree of reliving the past event, the degree of positivity of the memory and the feeling of nostalgia generated.

Methods

Design

A randomized controlled trial study was conducted in which we evaluated the effectiveness of three different types of autobiographical images as a positive mood induction procedure.

Participants

Our sample comprised a group of older adults aged 65 years and over and a group of young adults aged between 18 and 35 years. Calculation of the required sample size yielded a necessary sample of at least 120 participants aged 65 and over and at least 120 participants aged between 18 and 35 (divided into three groups, according to the experimental condition in both cases). For the calculation, we used GPower version 3.1, considering the following parameters: a 95% confidence interval ($p < 0.05$), an estimated power of 95%, an expected mean effect size of 0.06 (partial eta squared), 6 repeated measures (6 images), an expected correlation of 0.80, and 6 experimental groups (3 types of images × 2 age groups).

The participants in the group of older adults were recruited from various socio-cultural centers in the city of Albacete, while the participants in the young adults group were recruited from among students of the University of Castilla-La Mancha enrolled in degrees courses in medicine, law and education. The inclusion criteria were being aged between 18 and 35 years, in the case of young adults, and 65 years and above, in that of older adults, and having signed the informed consent form. The exclusion criteria established for both young and older adults were as follows: 1) presence of clinical symptoms of depression and/or anxiety (assessed using PROMIS-Depression and PROMIS-Anxiety; Cella et al., 2010); 2) presence of sensory deficits that might hinder performance of the experimental tasks; and 3) absence of sufficient literacy skills to understand the experimental tasks and complete the tests. Additionally, in the case of older adults, we also established the presence of cognitive impairment as an exclusion criterion. This was, assessed using Test Your Memory (TYM; Brown et al., 2009; Ferrero-Arias & Turrión-Rojo, 2016).

Finally, a total of 263 participants (179 women) took part. The young adult group consisted of 139 persons (67.6% female), with an age range of 18–28 years ($M = 19.57$, $SD = 1.86$). Regarding current employment status, 97.8% were students, and 2.2% were students who also worked. As regards education level, 95.6% had completed secondary education and 4.4% had completed a university degree. Meanwhile, the group of older adults comprised 124 participants (68.5% female) with an age range of 65–88 years ($M = 72.26$, $SD = 5.59$). As regards employment status, most were retired or pensioners (77.4%), followed by homemakers (26.9%), salaried employees (4.8%) and self-employed (0.8%). As for level of education, 5.6% had no educational qualifications, 27.4% had completed primary education, 41.9% had finished secondary education and 25% held a university degree. The groups (younger vs. older) were statistically significantly

different in depressive symptomatology as assessed with the Beck Depression Inventory II (BDI-II; Beck et al., 1996; adapted to Spanish by Sanz & Vázquez, 2011) (t (261) = 4.13; $p < 0.001$, $d = 0.52$) with mean scores being higher in the young adult group ($M = 12.29$, $SD = 7.84$) compared to the older adults ($M = 8.65$, $SD = 6.29$).

Questionnaires

Measures

Test Your Memory (TYM, Brown et al., 2009; adaptation to Spanish by Ferrero-Arias & Turrión-Rojo, 2016). This cognitive performance test (orientation, sentence copying, semantic information, calculation, verbal fluency, similarities, confrontation, naming and perception), is used in the detection of Alzheimer's disease (AD) and mild cognitive impairment. It consists of 10 tasks (with different scores), with a possible maximum score of 50. The cut-off points established are equal to or less than 40 in the case of AD and 36 in the case of dementia. The psychometric properties of the Spanish version are $\alpha = 0.86$ (Ferrero-Arias & Turrión-Rojo, 2016) with $\alpha = 0.85$ in the present study.

Patient-reported outcomes measurement information system -A (PROMIS®-Anxiety 4, short form) (Cella et al., 2010). This questionnaire consists of four items to measure anxiety symptoms experienced by an individual in the last seven days. The responses range from 1 = never to 5 = always, where the higher the score, the higher is the anxiety. Total scores range from 4 to 20. The cut-off point was set at 11 points (https://healthmeasures.net). The reliability of this instrument is $\alpha = 0.96$ (Cella et al., 2010), with $\alpha = 0.76$ in the present study.

Patient-reported outcomes measurement information system -D (PROMIS®-Depression 4, short form) (Cella et al., 2010). This questionnaire consists of four items used to measure the negative affect experienced by an individual in the last seven days. Responses range from 1 = never, to 5 = always, where the higher the score, the higher is the negative affect. Total scores range from 4 to 20. The cut-off point was set at 11 points (https://healthmeasures.net). The reliability of this instrument is $\alpha = 0.96$ (Cella et al., 2010), with $\alpha = 0.77$ in the case of this study.

Measures of the properties associated with each image

Personal relevance of the image: a set of 4 items taken from the study by Wood and Conway (2006) on the self-relevance of events associated with autobiographical memories. The items were scored on a Likert-type scale from 1 to 7 points (1 = not at all, 7 = very much): 1) "*This past event has had a big impact on me*"; 2) "*I feel that I have grown as a person since experiencing this past event*"; 3) "*Having had this*

experience, I have more insight into who I am and what is important to me*"; and 4) "*Having had this experience, I have learned more about what life is all about*"*. The reliability in the present study was $\alpha = 0.91$.

Degree to which the memory is relived: participants were asked to what extent they had been able to relive the positive emotions experienced in the original event recalled, on a scale from 0 to 9 points (0 = could not relive the emotions, 9 = was able to completely relive the emotions).

Level of positivity of the memory: participants were asked how positive the autobiographical memory was, on a scale from 1 to 7 points (1 = a little, 7 = a lot).

Nostalgia: participants were asked about the degree of nostalgia they experienced when recalling the autobiographical memory, on a scale from 1 to 7 points (1 = not at all nostalgic, 7 = very nostalgic).

Mood state measures

Beck Depression Inventory II (BDI-II; Beck et al., 1996; Spanish adaptation by Sanz & Vázquez, 2011). This self-report scale comprises 21 Likert-type items and is designed to detect depressive symptoms in adults. It measures the most frequent clinical symptoms, such as anhedonia, sadness, loss of energy and interest, changes in eating and sleeping patterns, loss of concentration and suicidal ideation, among others. The total scores ranges from 0 to 63 points (the higher the score, the greater the severity of depressive symptoms). It has a reliability of $\alpha = 0.83$ (Sanz & Vázquez, 2011), and reliability in this study was $\alpha = 0.83$.

Positive and negative affect schedule (PANAS, Watson et al., 1988). This instrument consists of two ten-item subscales that measure the primary dimensions of mood, namely, positive, and negative affect. It presents a list of adjectives related to common feelings and emotions, which can be scored on a five-point Likert-type scale (1 = very slightly or not at all, 5 = very much). Separate scores according to affect type and an affect balance score can be obtained by subtracting the negative affect score from the positive affect score (Watson et al., 1988). The Spanish version has a reliability of $\alpha = 0.96$ for both subscales (Watson et al., 1988). In the present study, reliability ranged between $\alpha = 0.74$ and $\alpha = 0.85$ (Positive Affect) and between $\alpha = 0.82$ and $\alpha = 0.85$ (Negative Affect).

Intervention

The study was implemented over a series of phases (for further information, see study protocol by Fernández et al., 2020) and was carried out from January to December 2021.

During the selection phase (see Fig. 1), potential participants were screened at different group sessions held at the recruitment centres. Participants were informed that

their participation was completely voluntary and that their answers would be treated confidentially. All participants signed the informed consent form. After screening, a total of 11 participants (5 young and 6 older) were excluded from the study due to either not meeting age criteria (1), exceeding the PROMIS anxiety/depression cut-off point (6), or cognitive impairment (4).

During the pre-experimental phase (conducted seven days after the selection phase), participants were randomly assigned (1:1:1 allocation ratio) to one of the three experimental conditions:

1) IAPS: 40 images from the IAPS (Lang et al., 2008) previously selected by the research team according to their level of positive valence (values between 7.03 and 8.34) (for further information, see Annex 1).
2) Places: images taken from the Internet and associated with important and significant places in the person's life (e.g. the village where they grew up, the city where they live, places visited on trips, etc.).
3) Personal photographs selected by the participant from their own collection.

Participants were asked to select a total of six images depending on the condition to which they had been assigned prior to the experimental phase. All the images used had to be related to participants' specific positive autobiographical experiences.

The Randomizer version 3.0 online software was used to randomly assign a minimum of 40 participants to each
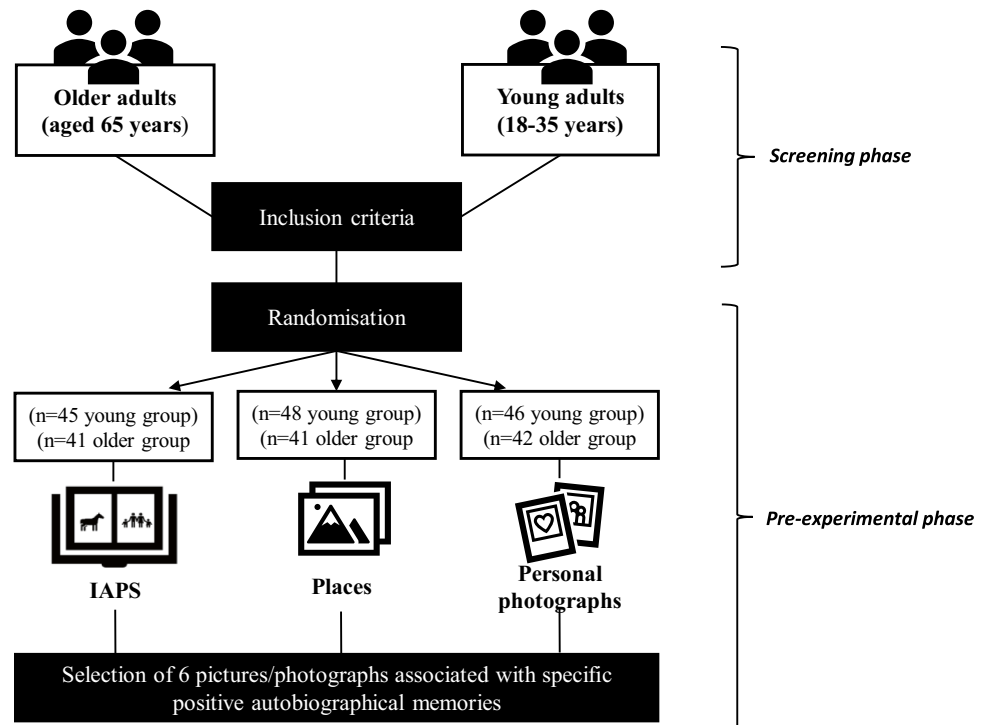
of the conditions and within each group (young adults and older adults). This allocation was conducted by a member of the research team that was not involved in recruiting the participants or in assessing the results. The experimental groups were balanced according to age group and sex.

The experimental phase (see Fig. 2) was conducted individually in a single session (21 days after randomisation of participants to groups) lasting approximately 60 min. The experiment was conducted in an air-conditioned room, isolated from noise, with subdued lighting and a suitable temperature. Before starting the experiment, participants were again informed of the general procedure to be followed and were assured that they could drop out the trial at any time if they so wished (none, in fact, did). Subsequently, we administered the BDI-II (Beck et al., 1996) as a control measure of depressive symptomatology.

For the experimental task, the participants sat in front of a computer screen (27"). The E-PRIME 3.0 software (Psychology Software Tools, Inc.) was used to conduct the task. All the participants were first given the same instructions about the experiment and any doubts that arose during the explanation of the task were resolved for both the young and old participants. The experiment was conducted autonomously by the participants, while the experimenter remained in an adjoining room in order to solve any problems that might arise during the course of the session. It was not necessary to suspend any experiment once it had started.

Participants first completed the PANAS scale (Watson et al., 1988) and the negative mood induction procedure then

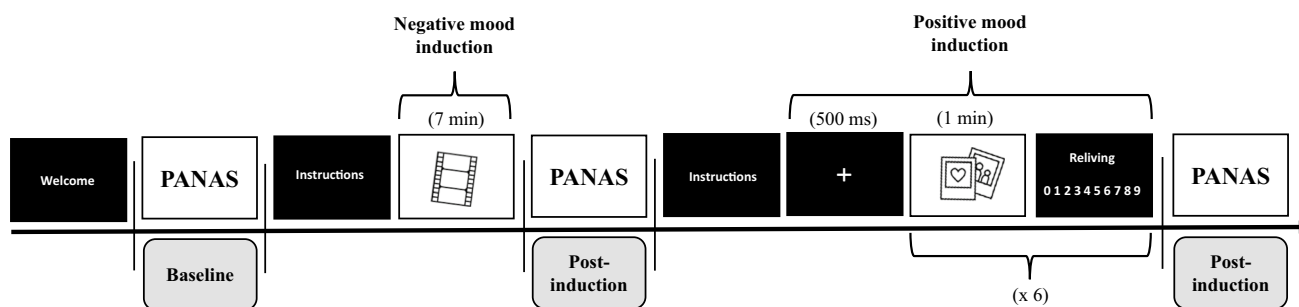Fig. 1 Screening and pre-experimental phase flow diagram

Fig. 2 Experimetnal phase flow diagram

began with the viewing of a seven-minute clip from the film "Dead Man Walking" (Polygram Filmed Entertainment, Havoc, Working Title Films) (Robbins et al., 1995), which depicts the execution of a prisoner sentenced to death in the United States. Before viewing the video clip, participants were asked to experience the feelings that the clip produced as intensely as possible. Once the clip was finished, participants again completed the PANAS mood scale (Watson et al., 1988).

We then began the positive mood induction procedure, in which participants were asked to look at a total of six images (previously selected according to the experimental condition) in order to generate specific positive autobiographical memories. Each image remained on screen for one minute. Before presenting the images, participants were asked to focus on the memory evoked by each image, and to try to relive the positive emotions they had felt in the original event. Following the presentation of each image, participants were asked to indicate the extent to which they had been able to relive the event. Finally, after viewing all six images, participants again completed the PANAS scale (Watson et al., 1988).

This study was carried out in accordance with the guidelines in Agreement 06/2016 of the Clinical Research Ethics Committee (CREC). The protocol was approved by the Clinical Research Ethics Committee of the Castilla-La Mancha Health Service. All participants gave their written informed consent in accordance with the Declaration of Helsinki.

Data analyses

We used SPSS 28.0 (IBM) statistical software for the data analysis. First, ANOVAs were carried out to evaluate the differences between the types of images in relation to the variables of relevance, reliving, positivity and nostalgia of the memory generated by the image. We also performed t-tests to analyse the differences in these variables according to age group (young vs. old).

Second, to measure the effect of the negative mood induction, we performed a 2×2 repeated measures ANCOVA 2 (time: pre-induction (time 1) vs. post-film viewing (time 2) $\times$ 2 (age group: young adults vs. older adults) and post hoc Bonferroni tests. Given the differences in depressive symptomatology between the two age groups, the BDI score was used as a covariate variable.

Finally, to analyse the effectiveness of the positive mood induction, a $3 \times 2 \times 2$ repeated measures ANCOVA (type of image: IAPS, places and personal photographs) $\times$ 2 (age group: young adults vs older adults) $\times$ 2 (time: post-viewing film (time 2) vs post-viewing images (time 3)) was conducted. In this second model, we included as covariate variables, in addition to the BDI score, the percentage change in the measures of positive and negative affect derived from the negative mood induction procedure ((time 2- time 1)/time 1) as measures of control for the previous mood induction.

Results

Properties of the specific positive autobiographical memories evoked according to the type of image

The results showed statistically significant differences in the variables of relevance ($F_{(2, 260)} = 6.49$, $p < 0.050$, $\eta^2 = 0.05$), reliving ($F_{(2, 260)} = 4.10$, $p < .050$, $\eta^2 = 0.031$), positivity of recall ($F_{(2, 260)} = 14.154$, $p < 0.001$, $\eta^2 = 0.098$) and nostalgia ($F_{(2, 260)} = 3.093$, $p < 0.050$, $\eta^2 = 0.023$) (See Table 1). The post hoc tests showed that personal photographs, compared to places, scored higher on personal relevance (B = 0.49, $p < 0.010$), reliving (B = 0.55, $p < 0.050$) and nostalgia (B = 0.30, $p < 0.050$). Meanwhile, statistically significant differences were observed in the level of positivity, with personal photographs scoring higher than IAPS images (B = 0.36, $p < 0.001$) and places (B = 0.47, $p < 0.001$).

We also found statistically significant differences for relevance (t (261) = -2.783; $p < 0.010$, $d = -0.34$) and reliving the memory (t (261) = -4.946; $p < 0.001$, $d = -0.61$) according to age group, with the older adults scoring higher than

Table 1 Mean and standard deviation of the variables of personal relevance of the memory, reliving the memory, positivity of the memory and nostalgia according to age group and type of image

	Age group		Intervention group		
	Young adults	Older adults	IAPS	Places	Personal photographs
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Relevance	5.11(0.86)	5.43(0.99)	5.23(0.83)	5.02(1.00)	5.52(0.90)
Reliving	7.00(1.24)	7.76(1.24)	7.36(1.24)	7.08(1.41)	7.63(1.17)
Positivity	6.12(0.63)	6.18(0.67)	6.07(0.69)	5.96(0.68)	6.43(0.45)
Nostalgia	5.85(0.79)	5.79(0.82)	5.79(0.77)	5.69(0.84)	5.99(0.84)

their younger counterparts. However, no differences were found between the two groups on the variables of memory positivity (t (261) = -0.863; $p = 0.180$, $d = $ -0.09) and nostalgia (t (261) = -0.575; $p = 0.066$, $d = 0.07$).

Results of the negative mood induction

The results of the repeated measures ANCOVA (see Table 2) showed significant main effects of the time variable (time 1 vs. time 2) on both positive affect ($F_{(1, 260)} = 205.600$, $p < 0.001$, $\eta^2 = 0.44$), with a 21.7% decrease, and negative affect ($F_{(1, 260)} = 162.971$, $p < 0.001$, $\eta^2 = 0.38$) with a 59.9% increase. This confirms the effectiveness of the negative mood induction procedure. No statistically significant differences were found between groups for the effectiveness of the negative mood induction (positive affect:

$F_{(1, 260)} = 2.167$, $p = 0.142$, $\eta^2 = 0.01$; and negative affect: $F_{(1, 260)} = 0.065$, $p = 0.798$, $\eta^2 = 0.00$).

The tests of between-participants effects showed that, overall, the older adults scored higher on positive affect ($F_{(1, 260)} = 11.653$, $p < 0.001$, $\eta^2 = 0.04$) (B = 2.39, $p = 0.001$) and exhibited less negative affect ($F_{(1, 260)} = 12.647$, $p < 0.001$ $\eta^2 = 0.05$) (B = -2.37, $p < 0.001$) than the younger adults (B = -2.37, $p < 0.001$).

Results of positive mood induction

The results of the repeated measures ANCOVA show that the main effects of the time variable (time 2 vs. time 3) were statistically significant for both the positive affect measure ($F_{(1, 254)} = 17.827$, $p < 0.001$, $\eta^2 = 0.07$) (see Table 3), with a 30.5% increase, and for the negative affect measure

Table 2 Estimated marginal means and comparative pre-test and post negative mood induction according to age group for the positive negative affect measures

		Total (N = 263) Mean[2] (CI95%)	Time 1: Pre-test (N = 263) Mean (CI95%)	Time 2: Mean (CI95%)	Total (N = 263) Mean (CI95%)	p-valor[1]
Positive Affect	Total	28.90 (28.23, 29.57)	32.42 (31.64, 33.20)	25.38 (24.65, 26.12)	-7.04 (-6.32, -7.76)	< 0.001
	Young Adults	27.71 (26.77, 28.64)	31.50 (30.41, 32.59)	23.91 (22.88, 24.94)	-7.59 (-6.59, -8.60)	0.142
	Older Adults	30.10 (29.11, 31.10)	33.34 (32.18, 34.49)	26.86 (25.77, 27.95)	-6.48 (-5.42, -7.55)	
	p-value[3]	0.001				
Negative Affect	Total	19.98 (19.34, 20.61)	15.37 (14.82, 15.92)	24.58 (23.60, 25.57)	9.21 (8.25, 10.17)	< 0.001
	Young Adults	21.16 (20.27, 22.05)	16.62 (15.86, 17.38)	25.70 (24.33, 27.08)	9.08 (7.74, 10.42)	0.798
	Older Adults	18.79 (17.85, 19.73)	14.12 (13.31, 14.93)	23.46 (22.00, 24.92)	9.34 (7.92, 10.76)	
	p-value[4]	0.001				

[1]F test for fixed effects of the linear model: the first p-value is the TIME (pre-post) effect and the second the TIME*GROUP effect

[2]Marginal mean estimated by the model: in a 2-factor design, the marginal means for a factor are the means of that factor averaged across the level of the other factor

They provide the mean response for each factor adjusted for the other variables in the model

[3]F test for fixed effects of the linear model: the p-value is the GROUP effect

[4]F test for fixed effects of the linear model: the p-value is the GROUP effect

$(F_{(1, 254)} = 31.004, p < 0.001, \eta^2 = 0.11)$ (see Table 4), with a 46.9% decrease. This reveals that, overall, the positive mood induction procedure was effective.

However, our results showed differences according to age group. We found main effects of age on both positive affect $(F_{(1, 254)} = 4.251, p < 0.050, \eta^2 = 0.016)$ (see Table 3) and negative affect $(F_{(1, 254)} = 15.196, p < 0.001, \eta^2 = 0.056)$ (see Table 4). In the results of the post-hoc tests, the older adults exhibited a higher percentage change in positive affect (32.1%) $(B = 8.446, p < 0.001)$ compared to the younger adults (28.9%) $(B = 7.042; p < 0.001)$. However, the young adults exhibited a higher percentage change in negative affect (-48.6%) $(B = -12.837, p < 0.001)$ compared to their older counterparts (-45.1%) $(B = -10.205, p < 0.001)$. Despite these differences, positive affect increased and negative affect decreased in both groups after the positive mood induction procedure.

Regarding image type, our results revealed a main effect of picture type in relation to time (time 2 vs. time 3) on negative affect $(F_{(2, 254)} = 4.103, p < 0.050, \eta^2 = 0.031)$ (see Table 4). The post-hoc results showed that personal photographs yielded the highest percentage change (-50%) $(B = -12.739, p < 0.001)$, followed by place images (-46.7%) $(B = -11.339, p < 0.001)$ and IAPS images (-43.9%) $(B = -10.485, p < 0.001)$. In other words, personal photographs have a greater capacity to reduce negative mood

compared to other types of images. No differences were found according to type of image in relation to positive affect $(F_{(2, 254)} = 0.836, p = 0.435, \eta^2 = 0.007)$.

The time x group x intervention interaction (see Fig. 3) showed a statistically significant effect on the measure of negative affect $(F_{(2, 254)} = 4.768, p < 0.05, \eta^2 = 0.036)$. Post-hoc tests showed that, in the case of the older adults, IAPS pictures yielded the highest percentage change (-45.9%) $(B = -10.451, p < 0.001)$, followed by personal pictures (-45.3%) $(B = -10.259, p < 0.001)$ and place pictures (-44%) $(B = -9.904, p < 0.001)$. However, the highest percentage change for the young adults was obtained with the use of personal photographs (-53.84%) $(B = -15.218, p < 0.001)$, followed by place images (-49.1%) $(B = -12.775, p < 0.001)$ and IAPS images (-42%) $(B = -10.518, p < 0.001)$. These results suggest that the intervention that best reduces negative effect in older adults is that using IAPS images (albeit with little difference to personal pictures), whereas in the young adult group, the personal pictures intervention is the most effective, followed by place images.

We found no significant effects of the time x group x intervention interaction in relation to positive affect $(F_{(2, 254)} = 0.551, p = 0.557, \eta^2 = 0.004)$.

Finally, the results of the tests of between-participants effects revealed statistically significant differences between

Table 3 Estimated marginal means and comparison between post negative mood induction and post positive mood induction according to age group and image type for the positive affect measure

	Total (N=263)	Post 1 (negative mood induction) (N=263)	Post 2 (positive mood induction) (N=263)	Difference Post 2-Post 1 (N=263)	p-value[1]
	Mean[2] (IC 95%)	Mean (IC 95%)	Mean (IC 95%)	Mean (IC 95%)	
Total	29.23 (28.57, 29.89)	25.36 (24.74, 25.98)	33.10 (32.27, 33.94)	7.74 (7.10, 8.38)	< 0.001
Young Adults	27.91 (26.98, 28.40)	24.39 (23.52, 25.26)	31.43 (30.26, 32.61)	7.04 (6.14, 7.94)	0.040
Older Adults	30.55 (29.56, 31.54)	26.33 (25.41, 27.25)	34.76 (33.53, 36.02)	8.45 (7.49, 9.40)	
p-value[3]	< 0.001				
IAPS (N=86)	30.05 (28.88, 31.22)	26.20 (25.11, 27.29)	33.89 (32.42, 35.37)	7.69 (6.56, 8.82)	0.435
Places (N=89)	27.57 (26.42, 28.73)	23.95 (22.87, 25.02)	31.20 (29.74, 32.66)	7.25 (6.14, 8.37)	
Personal Photographs (N=88)	30.07 (28.92, 31.22)	25.93 (24.86, 27.00)	34.21 (32.77, 35.66)	8.29 (7.18, 9.39)	
p-value[4]	0.003				

[1]F test for fixed effects of the linear model: the first p-value is the TIME (pre-post) effect and the second the TIME*GROUP effect

[2]Marginal mean estimated by the model: in a 2-factor design, the marginal means for a factor are the means of that factor averaged across the level of the other factor

They provide the mean response for each factor adjusted for the other variables in the model

[3]F test for fixed effects of the linear model: the p-value is the GROUP effect

[4]F test for fixed effects of the linear model: the p-value is the INTERVENTION effect

Table 4 Estimated marginal means and comparison between post negative mood induction and post positive mood induction according to age group and image type for the negative affect measure

	Total (N = 263)	Post 1 (negative mood induction) (N = 263)	Post 2 (positive mood induction) (N = 263)	Difference Post 2-Post 1 (N = 263)	p-value[5]
	Mean[6] (IC 95%)	Mean (IC 95%)	Mean (IC 95%)	Mean (IC 95%)	
Total	18.78 (18.25, 19.30)	24.54 (23.85, 25.22)	13.01 (12.48, 13.55)	-11.52 (-12.15, -10.89)	< 0.001
Young Adults	20.01 (19.27, 20.75)	26.43 (25.47, 27.39)	13.59 (12.84, 14.35)	-12.84 (-13.73, -11.95)	< 0.001
Older Adults	17.54 (16.75, 18.32)	22.64 (21.62, 23.66)	12.44 (11.64, 13.24)	-10.21 (-11.15, -9.26)	
p-value[7]	< 0.001				
IAPS (N = 86)	18.66 (17.73, 19.59)	23.90 (22.69, 25.11)	13.42 (12.47, 14.36)	-10.49 (-11.60, -9.37)	0.018
Locations (N = 89)	18.58 (17.66, 19.49)	24.26 (23.05, 25.44)	12.91 (11.97, 13.84)	-11.34 (-12.44, -10.23)	
Own Photographs (N = 88)	19.09 (18.18, 20.01)	25.46 (24.28, 26.65)	12.72 (11.80, 13.65)	-12.74 (-13.84, -11.64)	
p-value[8]	0.701				

[5]F test for fixed effects of the linear model: the first p-value is the TIME (pre-post) effect and the second the TIME*GROUP effect

[6]Marginal mean estimated by the model: in a 2-factor design, the marginal means for a factor are the means of that factor averaged across the level of the other factor

They provide the mean response for each factor adjusted for the other variables in the model

[7]F test for fixed effects of the linear model: the p-value is the GROUP effect

[8]F test for fixed effects of the linear model: the p-value is the INTERVENTION effect

age groups, both in positive ($F_{(1, 254)} = 14.041$, $p < 0.001$, $\eta^2 = 0.052$) and negative affect ($F_{(1, 254)} = 19.398$, $p < 0.001$, $\eta^2 = 0.071$). In this sense, the older adults scored higher on positive affect and lower on negative affect compared to the younger participants (see Tables 3 and 4). Statistically significant differences were also found according to image type in the positive affect variable ($F_{(2, 254)} = 5.897$, $p < 0.05$, $\eta^2 = 0.044$). The post hoc results showed that both personal photographs ($M = 30.07$, $SD = 0.58$) and IAPS images ($M = 30.05$, $SD = 0.59$) generated more positive affect than the place images ($M = 27.57$, $SD = 0.59$) ($B = 2.498$, $p = 0.009$ and, $B = 2.476$, $p = 0.011$, respectively). No between-participants differences were found for negative affect depending on image type ($F_{(2, 254)} = 0.356$, $p = 0.701$, $\eta^2 = 0.003$).

Discussion

The main aim of this study was to analyse the effectiveness of different types of images (IAPS images, images of places and personal photographs) associated with specific positive autobiographical memories, as a method of positive mood induction and mood recovery following a negative mood induction. In addition, we also analysed the differences in the variables of personal relevance, reliving, positivity, and

nostalgia related to the memory generated according to the type of image. Given the differences that exist in emotion regulation between young and older individuals, we examined whether the effectiveness and characteristics of the different types of images vary according to age group (young vs. old). The main findings are presented below.

Degree of personal relevance, reliving, memory positivity, and nostalgia according to image type

As regards the relevance of the memory, our results suggest that the three types of images used facilitate access to specific positive autobiographical memories that are relevant to an individual. The memories the participants retrieved through the images were significant to them and were affectively related to their identity in a vivid and intense way. There thus emerges a combination of the generation of specific positive autobiographical memories and the linking of these past experiences to the conceptual structures of a person's identity. This combination has been proposed as key to psychological health and well-being (Singer & Conway, 2011), indicating an association between the ability to use memories to bring a meaning to positive personal growth and higher levels of well-being.
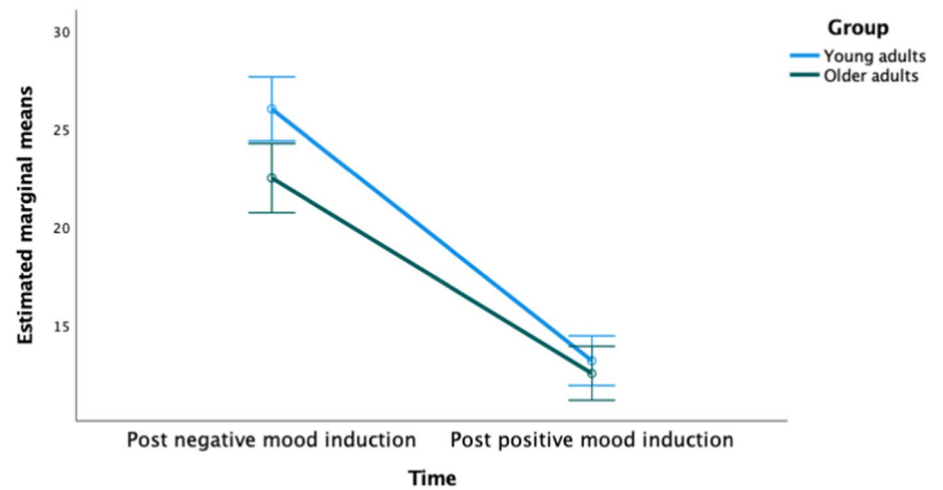
Our results show personal photographs are those associated with the highest level of personal relevance of the

Fig. 3 Time x group x intervention interaction, **a**) IAPS images intervention group, **b**) Location images intervention group, **c**) Personal pictures intervention group
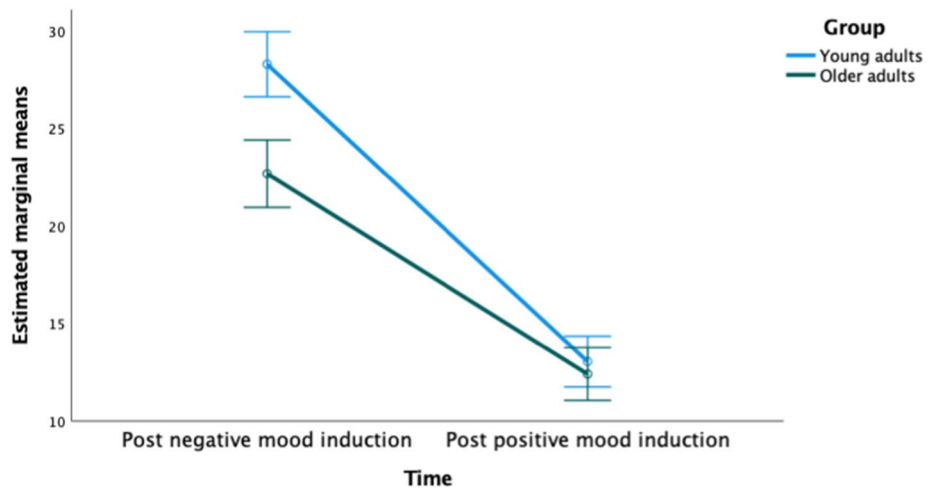
a) *IAPS images intervention group*
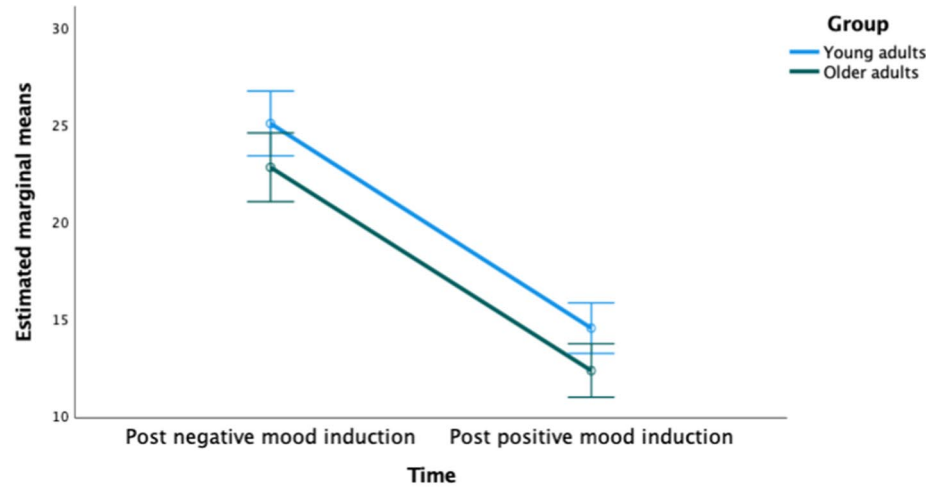
b) *Location images intervention group*

c) *Personal pictures intervention group*

memory, followed by images from the IAPS and images of places. This may be because the memories associated with personal photographs involved past events that were very important from the perspective of an individual's life story (e.g., weddings, birth of children and grandchildren, graduations, bringing a pet home, first jobs, family celebrations, childhood moments with attachment figures, etc.). However, IAPS images also triggered access to the same types of events because of their similarity to personal photographs, being images of pets, couples, small children, family celebrations, etc. In contrast, the lower personal relevance of the place images may be due to most of the images chosen by the participants being mainly related to travel, work, leisure, etc., and thus associated with more trivial aspects.

Regarding differences between age groups, the older adults scored higher on the personal relevance of their memory. According to the socioemotional selectivity theory (Carstensen et al., 1999), changes in an individual's information processing styles occur as the end of their live draws closer, leading them to create more emotional meaning and to remember their past in a more emotionally satisfying way. This, in turn, lends their memories greater personal relevance.

In relation to reliving, the results show that the three types of images allowed the participants to relive the past event. The ability to relive is closely associated with vividness, i.e. the power of the visual images during memory retrieval (Janssen et al., 2011). In this respect, the use of images is particularly key since previous studies have shown that highly relived memories are associated with strong visual imagery (Rubin et al., 2003). In our study, personal photographs are those that facilitate the highest level of memory retrieval, followed by IAPS images and images of places. The highest recall ratings are associated with the encoding of the original event itself, its nature, as well as the role the event played in a person's life, for example, in identity formation (Janssen et al., 2011). It is thus logical that images with greater personal relevance, personal photographs, in this case, are also those with greater capacity for memory reliving.

In addition, personal photographs may imbue the memory with greater familiarity, thus facilitating the retrieval of the memory and the degree of detail and vividness of the memory (Robin et al., 2019). With respect to age groups, statistically significant differences were found in reliving, in line with previous studies (e.g., Janssen et al., 2011). This is interesting if we recall that access to more specific details is necessary for a person to relive the event, while previous studies point to a lower recall specificity in older adults (Wilson & Gregory, 2018). The contradiction in this regard in our results suggests that when support for recall is provided, as, in this case, through powerful visual cues, possible age-related differences in recall quality may be mitigated.

Regarding memory positivity, all three types of images facilitated access to highly positive past events. However, personal photographs scored higher than the other two types. In this sense, the greater relevance of the memory might, at the same time, confer a greater level of positivity. In other words, the events considered most meaningful in a person's life are also those that generate the most positive emotions. Furthermore, it is worth noting that some of the personal photographs may have been taken by the person themselves, thus increasing their engagement with the experience portrayed, as well as their enjoyment of the positive experiences (Diehl et al., 2016).

No significant differences were found between age groups in the level of memory positivity. This is inconsistent with previous literature pointing to a relative difference between older and younger people in recalling positive memories (Carstensen & DeLiema, 2018), which are rated as more positive by older people than by younger ones. However, other studies have found the opposite pattern (Grühn et al., 2005). These results challenging the positivity effect suggest the existence of a key moderating effect: experimental constraints. In this sense, experimental studies that do not foster age differences with respect to the positivity effect are those in which constraints are imposed on emotional information processing (e.g., evoking a specific positive autobiographical memory) by altering a participant's mood, goals, attention, and resources (Reed et al., 2014).

As for the feeling of nostalgia, the results suggest that personal photographs are associated with a higher score on this variable, followed by IAPS images and images of places. Personal photographs, given their association with the greater relevance of a memory, could generate a greater sense of nostalgia, promoting a sense of coherence, self-continuity, and a greater connection between past and present (Sedikides et al., 2016). In addition, personal nostalgic cues generate a more numerous sets of emotions with a more positive emotional valence (Muehling & Sprott, 2004). Finally, no age-related differences were found, which is consistent with previous studies indicating that nostalgia is not an exclusive domain of older individuals (although it does appear to be more pronounced in their case). Rather, it emerges in both young and older people, finding its peak in young people between 20 and 30 years of age, and in older people from 75 years of age, coinciding with transitional life stages (Galambos et al., 2005).

Positive mood induction

Our findings show significant changes in both positive and negative affect following mood induction, and thus the use of images associated with specific positive autobiographical memories can be said to have effectively influenced participants' mood states. Specifically, increases in positive mood

and decreases in negative mood were observed. Drawing on our findings, we consider that the effectiveness of the induction using the three types of images could be a result of the following: 1) the images used were associated with positive memories relevant to the person; 2) the images allowed the person to re-experience the positive past event by reliving the emotions associated with it; 3) the images facilitated access to memories with a high level of positivity; and 4) the three types of images allowed the participants to generate memories that triggered feelings of nostalgia. Therefore, the properties of the autobiographical memories evoked through these images underlie the efficacy of images as a means of positive mood induction. These results are consistent with previous studies showing the effectiveness of the use of visual stimuli as a technique for accessing emotional memories (Kosslyn et al., 2001). Images, given their close correspondence to the sensory experience of the past event, make the recall of the event more real, transporting an individual to the past moment and allowing them to emotionally relive it. Thus, photographs can be particularly powerful memory cues due to the importance of visual images in episodic recall (Kosslyn et al, 2001).

Our results also showed age-related differences in the mood induction. The older adults presented higher positive affect scores after viewing the images, as well as a higher percentage of positive change compared to younger adults. However, on the measure of negative affect, the young adult group showed higher negative affect scores after the positive mood induction procedure, although their percentage of negative change was higher than that of the older adults. Thus, viewing the images can be said to have been more effective in increasing positive mood in the older adults, while it was more effective in decreasing negative mood in the young adult group. These results are consistent with the premises of the theory of socioemotional selectivity proposed by Carstensen et al. (1999), which posits that as people age and perceive their lives to be more limited, their goals focus more on emotion regulation, defined as maintaining a positive affective state.

Regarding picture type, all three were effective in mood recovery, especially as regards decreased negative affect, although personal photographs yielded a larger decrease in negative affect compared to the other types. This greater effect of personal photographs might be related to the properties of the memories to which the photographs bring access. These are more vivid memories containing a great deal of perceptual-sensory information, which promotes autonoetic consciousness, i.e. the subjective experience of the self in another time (Klein, 2016), enabling the past moment to be re-experienced. Thus, the greater vividness provided by personal photographs would be at the root of mood enhancement by reducing negative affect. Furthermore, a considerable body of literature suggests that the

nostalgia promoted by access to memories brings greater meaning and significance to life, distancing a person from feelings of sadness or despair (Routledge et al., 2013).

Another important aspect of personal photographs is the degree of their familiarity, as they are cues that are very familiar to those who own them. In this regard, several studies have indicated that when cues are familiar they tend to facilitate more vivid retrieval of memories (e.g., Robin et al., 2019). Furthermore, previous studies which have used different autobiographical stimuli, such as songs (Capoccitti, 2021), have suggested that the familiarity of the cue allowed more vivid memories to be recalled, and with greater emotional importance and intensity.

Furthermore, the power of place images in reducing negative affect should also be underlined. The use of this type of image allows a person to access past events associated with places of relaxation, leisure and enjoyment that have been meaningful in their life (e.g., honeymoon, summer holidays, trips abroad, etc.), generating emotions contrary to negative mood and more associated with positive emotions such as joy, pleasure and even love (Manzo, 2003).

Regarding age-related differences, we found that, in the older adults, IAPS images showed the highest percentage of decrease in negative affect, while, in our young participants, the highest percentage of change resulted from the use of personal photographs. The greater effectiveness of IAPS images in older compared to younger participants could be explained by the fact that older adults tend to rate IAPS pictures as more positive and arousing than do younger participants (e.g., Smith et al., 2005). It is worth highlighting the findings of a preliminary study with older adults (Carretero et al., 2020), in which the use of both IAPS images and personal photographs was equally effective in mood recovery following a negative mood induction procedure. In this line, our results for the older adult group show a similar percentage of change in the case of using both IAPS images and personal photographs. In relation to the younger group, we consider that the greater efficacy of personal photographs followed by images of places might be related to younger adults' use of both types of images. In recent years, the photographic recording of the most significant experiences of everyday life allows young people to bear witness to themselves and make their experiences even more relevant, especially when shared through social networks. In this sense, young people are accustomed to using photographs related to past events (which may be more, or less, recent) as well as places, to express themselves and build their identity, forming part also of their daily lives.

Despite both mood induction procedures (negative through film and positive through images) being equally effective for older and younger adults, we found age-related differences in affect. The older adults scored higher on positive affect and lower on negative affect than their younger

counterparts. These results are consistent with the premises of the socioemotional selectivity theory (Carstensen et al., 1999), which holds that, with age, people focus more on short-term emotion regulation goals, optimising their affective state, and prioritising strategies that enhance positive feelings in the present moment, while decreasing negative feelings.

The main limitation of the present study is the higher number of female participants in both age groups, which meant we were unable to analyse possible gender differences. For this reason, future studies should aim to obtain homogeneous samples in terms of gender and analyse their possible differences. Another limitation lies in no information having been collected on the characteristics of the personal photographs (e.g., type of event, people in the image, their emotional expression, colour of the image, etc.). In this sense, it would be useful and interesting for future studies to gather such information in order to improve the objective selection of the photographs that are most effective in inducing positive emotions.

In addition, future studies should assess the presence of attachment figures in the case of personal photographs, as well as attachment to different places, as these could be important elements of the emotional impact of the memory. It would also be useful for future studies to include the age of the person in each of the memories evoked in order to study possible effects of the reminiscence bump, with this being especially interesting in the case of older adults. Finally, it would be useful for future studies to include a control group, in both age groups, to allow for unbiased comparison of the efficacy of the different autobiographical images.

Conclusions

Accessing personal memories is one of the most commonly used and effective methods in the field of mood induction. Hitherto, no study has compared three different types of images that could evoke specific positive autobiographical memories and thereby promote mood enhancement. Our findings lead us to suggest that IAPS images, place images and personal photographs can all trigger these types of memories and enhance an individual's positive affect after a negative mood induction.

It is worth highlighting the different effectiveness of the images as regards the decrease in negative affect according to the age group. In the case of young adults, personal photographs show the greatest effectiveness, while in the group of older adults the most effective are the images taken from the IAPS. In the latter case and considering that older adults do not always have sufficient personal photographs or are unable to easily access them, the use of standardised

images would be an effective alternative. In the light of our results, the different types of images could be incorporated as elements in therapeutic interventions designed to improve mood in both young and old individuals. The use of images in therapy may allow for easier retrieval of personal memories, as well as the thoughts, feelings and emotions associated with them, access to which might be more difficult using verbal cues alone.

Declarations

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