The Besançon affective picture set-adult (BAPS-Adult): Development and validation

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ABSTRACT

We developed and validated a new picture database of attachment-related photographs, the BAPS-Adult. Participants ($N = 315$) rated 256 pictures, according to dimension (valence, arousal, and dominance) using Self-Assessment Manikins (SAM), emotional category (positive, negative, mixed, and neutral) using labels, and discrete emotion (comfort, joy, complicity, distress, horror, and hate) using linear scales. Pictures were then classified into four types, depending on content (distress, comfort, complicity-joy, and neutral). Dimensional ratings of valence, arousal, and dominance, as well as discrete emotion ratings, differed significantly from each other between picture types. The BAPS-Adult is a new, highly discriminated database, allowing researchers to select from a variety of pre-rated, attachment-related pictures.

1. Introduction

Attachment theory has become one of the most important frameworks for understanding emotions related to interpersonal relationships, personality functioning, and psychopathology across lifespan, in both clinical and research fields (Ainsworth et al., 1978; Allen and Land, 1999; Bifulco et al., 2006; Bowlby, 1969, 1982; Buchheim and George, 2011; Hazan and Shaver, 1987; Kobak et al., 2006; 2009; Mikulincer and Shaver, 2007; Van Ijzendoorn et al., 1999; Zimmermann and Iwanski, 2014). Many normative and clinical studies have been conducted since Bowlby first defined attachment as an innate cognitive and affective system that motivates individuals to form and maintain proximity with a significant attachment figure (Bowlby, 1969, 1982). This system serves two principal functions: to regulate distress, and to provide comfort and security (Mikulincer et al., 2005). Based on this innate behavioral system, the quality of early attachment interaction with an attachment figure leaves an enduring mark on the developing person at several levels: (i) cognitive (representational models of self as worthy of care and of others as capable of providing care), (ii) behavioral (comfort and proximity-seeking behaviors), and (iii) psychobiological (reaction to distress).

Following the principles of theory and research proposed by Bowlby (1969, 1982) and Ainsworth, 1985; Ainsworth et al., 1978), several emotions are specifically linked to attachment: distress, comfort, and complicity. Distress is defined here as a basic emotion: a reaction to aversive, unpleasant, uncomfortable, and upsetting experiences (Monin and Schulz, 2010). Distress elicits the activation of the attachment system (i.e., support-seeking), and usually disappears when a sense of security is reached (Sroufe and Waters, 1977). Comfort is an emotional state that serves to alleviate distress, grief, and sorrow (Kolcaba and Kolcaba, 1991; Kolcaba et al., 2006), consequently de-activating the attachment system. Complicity is related to reciprocity and emotional support from peers and romantic relationships (Belsky and Cassidy, 1994; Werebe, 1987).

One of the most important tasks for researchers, when studying the influence of attachment on emotion regulation or emotion processing, is the selection of appropriate and controlled stimuli to induce the specific emotional states cited above. Together with self-reports (e.g., Borelli et al., 2014b) and interviews (e.g., Bifulco et al., 2006), researchers have used several types of visual stimuli to investigate attachment-related processing: standardized pictures (e.g., Vrticka et al., 2008), or self-validated facial expressions (e.g., Vandevivere et al.,

2014). Databases focusing on facial expressions, with professional actors expressing basic emotions, often present no context of interpersonal interaction, and evoke different levels of arousal. When reactions to pictures from the IAPS database (Lang et al., 2008) were compared with reactions to facial expressions, subjective arousal was higher for IAPS pictures (Britton et al., 2006). Looking at facial expressions is therefore thought to involve emotional recognition instead of emotional experience. Furthermore, a lack of discrimination has been identified between negative and positive valence (Dan-Glauser and Scherer, 2011), and between attachment-related emotions (Szymanska et al., 2015).

Currently, few databases contain standardized, attachment-related stimuli: the Adult Attachment Projective Picture System (AAP, George and West, 2001), the Besançon Affective Picture Set-Ado (BAPS-Ado, Szymanska et al., 2015), and the Attachment Affective Picture System (AAPS, Liu et al., 2016).

The AAP (George and West, 2001) is based on seven drawings depicting attachment-related events (e.g., departure of an adult man and woman facing each other; a child and a woman sitting opposite each other on the child's bed; a woman and a child watching ambulance workers load a covered stretcher into an ambulance). The AAP was created to assess attachment representation in adults via analysis of the individual's narrative responses to the drawings. Although such a tool is useful to identify some aspects of attachment-related emotion processing, many components of physiological responses are not available for self-report or interviews, in particular the emotions felt before responses that have been distorted and modulated through cognitive processes (such as deactivation and cognitive disconnection).

The BAPS-Ado database (Szymanska et al., 2015) was validated in an adolescent population with a mean age of 14 years, but its limited size makes it unsuitable for some research paradigms (fMRI or EEG). In addition, several studies have provided strong evidence for age-related changes in emotion processing and the development of facial expression recognition mechanisms throughout adolescence, with ongoing brain development, such as a gradual increase in frontal control over subcortical regions (Vink et al., 2014; Yurgelun-Todd, 2007; Zimmermann and Iwanski, 2014), and the modification of amygdala function (Herba and Phillips, 2004). These differences in brain activity could depend on the valence of pictures, especially those of fearful and angry faces (Hariri et al., 2003). Little is known to date about correlation between age-related changes in brain development and emotional processing. Monk and coworkers found that adults endorsed greater fear of faces than adolescents, whereas both age groups exhibited appropriate changes in fear levels (Monk et al., 2003). Recently, Zimmermann and Iwanski (2014) found age differences in self-reported emotional intensity when participants (adolescents and adults) rated emotional experiences in specific situations commonly inducing the emotions of fear, anger, and sadness.

The AAPS (Liu et al., 2016) contains attachment-related pictures validated by 85 Chinese students, based on a two-dimensional approach (valence and arousal), and a self-reported evaluation of attachment relevance. Participants were asked to assess if the pictures had high attachment relevance, referring to perceived close relationships, or low attachment relevance, referring to basic social activities. Participants did not assess any emotions, as pictures were pre-divided subjectively by the authors into negative, positive, and neutral categories. Emotions such as distress and comfort are not represented in their pictures, and some artificially constructed pictures fail to drive the intended emotional process accurately.

Taking into consideration these limitations in existing attachment-related databases containing visual stimuli, together with the ever-growing interest of behavioral and neuroimaging studies for attachment-related emotions in young adults, we developed a novel, standardized, affective picture database, the BAPS-Adult. It contains 256 highly realistic, complex photographs, validated according to dimensional, categorical, and discrete emotion approaches. For the dimensional approach, the pictures were validated according to the pleasantness of the stimulus (valence), the intensity of emotion provoked by the stimulus (arousal), and the degree of control exerted by the stimulus (dominance, Lang, 1980). Although dimensions have been debated, this approach has been used successfully in many attachment studies (Borelli et al., 2014a; 2014b; Strathearn et al., 2009), and has provided much insight into attachment experience.

Picture validation was also applied for the categorical approach, where pictures were associated with categorical labels (negative, positive, mixed, or neutral) attributed by participants (Mikels et al., 2005). Finally, to discriminate discrete emotions (Ekman, 1984; Ekman et al., 1983), participants were given several options to describe the type of emotion perceived in the pictures.

We provide appropriate, attachment-related picture stimuli, combining several approaches specifically focusing on the field of attachment. The number of pictures will facilitate the use of sophisticated paradigms. Our database can be used to investigate attachment-related emotion regulation, through affective, cognitive, and neurophysiological approaches.

2. Materials and methods

2.1. Stimuli

The authors pre-selected 276 pictures, representing four different emotional states (distress, comfort, complicity, and neutral, see Fig. 1), collected from free online picture databases, with 4 pictures from the IAPS database (Lang et al., 2008). Four naive judges independently assigned each picture to one of the four types: distress (e.g., faces expressing sadness, anguish, or scenes of loss and separation), comfort-related scenarios (e.g., a parent comforting an infant or an adolescent after an episode of distress), complicity (e.g., joyful moments: parent/child interaction, and partner or peer interactions), and neutral scenes (e.g., people walking along a street, or in the subway). The photographs, in either landscape or portrait format, were cropped or resized to measure 1024 pixels in width and/or 768 pixels in height, with a resolution of 300 dpi. Text and comments were removed to leave only the pictorial aspects. The selected pictures represent a wide variety of people, both male and female, from infancy to old age. Photographs were adjusted in luminance and contrast, so that the mean luminance was equal for all types. After adjustment, no statistical difference was observed between types for luminance or contrast.

2.2. Participants

All 385 participants (24.2% male, mean age = 21.5, *S.D.* = 4; 75.8% female, mean age = 20.4, *S.D.* = 3) were recruited from faculties and departments at Besançon University, France. Seventy participants were removed (see Section 2.4 for details). Finally, 315 participants were included (238 female and 77 male; mean age = 20.9 ± 3.4; 47% from the psychology department, 39% from medicine, and 14% from biology). They reported normal or corrected-to-normal vision, and were not familiar with picture content. Written informed consent was obtained from each participant. No compensation was given for participation. The ethics committee validated the protocol. This study complied with the principles in the Declaration of Helsinki.

2.3. Validation procedure

The database was divided into three sets, with similar proportions of each type of picture (distress, comfort, complicity, and neutral), in order to shorten the rating procedure, and thus avoid cognitive overload for participants, as in previous studies (e.g., Langner et al., 2010). Following the method proposed by Dan-Glauser and Scherer (2011), 10% of the picture database (28 photographs, 7 of each type) was common to all three sets, thus facilitating inter-group comparison.

Fig. 1. A sample image for each type in the database. A = distress, B = comfort, C = complicity-joy, D = neutral.
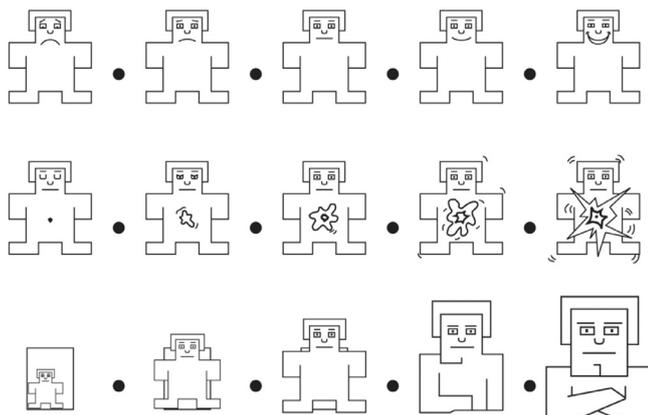

Fig. 2. Self-Assessment Manikin: valence, arousal, and dominance.

Fig. 3. (a) Emotional category labels: 'Neutral', 'Positive', 'Mixed', or 'Negative'.
(b) Continuous scales: Réconfort = Comfort, Complicité = Complicity, Joie = Joy, Détresse = Distress, Horreur = Horror, Haine = Hate.

Rating took place in a university lecture hall. Before the validation session, participants signed consent forms and were given details about the validation procedure and the content of the pictures. In addition, participants were informed that if they felt any discomfort during the session, they should immediately report it, in order to be excused if necessary. Participants familiarized themselves with the task through a short training session with sample stimuli. Based on the procedure in the Technical Manual and Affective Ratings of Lang and coworkers (1997), the video-projector screen system was used to display slide-shows with the pictures, and then the rating scales, each with a number indicating which stimulus was being rated. Each trial started with the presentation of the stimulus alone (displayed for 3000 ms), followed by SAMs (Lang, 1980), emotional category labels, and linear scales (presented for 5000 ms each). All scales were presented in French. At the same time, participants rated each picture on a paper rating sheet, with SAMs on one side (Fig. 2), and with emotional category labels, followed by linear scales, on the other side (Fig. 3).
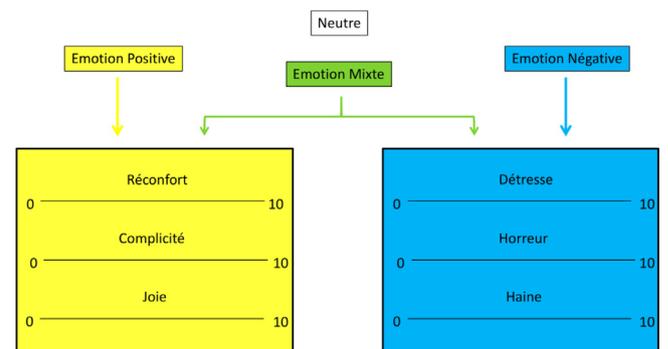
The SAMs (Bradley and Lang, 1994) were used to rate valence, arousal, and dominance. The first SAM scale was valence, ranging from a frown to a smile (1 = "unhappy" to 9 = "happy"). If participants felt completely happy, pleased, satisfied, contented, and/or hopeful while viewing the picture, they were instructed to indicate this by placing an 'X' over the figure at the right. If they felt completely unhappy, annoyed, unsatisfied, melancholic, despaired, and/or bored, they placed an 'X' on the left end of the scale. The scale also allowed intermediate feelings of pleasure to be described, by placing an 'X' over any of the other figures. If participants felt completely neutral, neither happy nor sad, they placed an 'X' over the figure in the middle. The calm vs. aroused dimension (1 = 'calm' to 9 = "aroused") was the second scale. If participants felt completely relaxed, calm, sluggish, dull, sleepy, and/or unaroused, they placed an 'X' over the figure on the left of the row.

At the other end of the scale, participants placed an 'X' if they felt completely aroused while viewing the picture. The third scale was the dominated/dominating scale (1 = 'dominated' to 9 = 'dominating'). If participants felt completely controlled, influenced, or awed by an emotion, they placed an 'X' over the figure on the left. If they felt completely in control of an emotion, important, and autonomous, they placed an 'X' over the figure on the right of the SAM scale. If they felt neither in control nor controlled, they placed an 'X' over the middle figure, or between the figures.

Participants then had to choose between four emotional category labels: 'neutral', 'positive', 'negative', or 'mixed'. Beneath the 'positive' label were three unipolar continuous scales (ranging from 0 = not at all to 10 = very much) to evaluate levels of comfort, complicity, and joy. Beneath the 'negative' label were three unipolar continuous scales (ranging from 0 = not at all to 10 = very much) to evaluate levels of distress, hate, and horror. The 'mixed' label led to both sets of scales (comfort, complicity, and joy, and distress, hate, and horror). Participants selecting the 'neutral' label would proceed directly to the next picture, without further rating. The three additional descriptors (joy, hate, and horror) used for the continuous scales served to discriminate more precisely the target terms linked to attachment (distress, comfort, and complicity). The selected additional descriptors represent basic or secondary emotions (Arnold, 1960; Izard, 1971; Shaver et al., 1987). The experiment lasted approximately 55 min. To limit the effects of sensitization (the effect of repetitive exposure to pictures of the same affective valence), the viewing order was randomized (Bradley and Lang, 1994). Visual tasks were programmed using E-Prime software (E-Prime, Version 2.0.8.90).

2.4. Exclusion criteria

2.4.1. Technical errors and omissions

Prior to data analysis, 28 participants were excluded for technical reasons (e.g. illegible rating sheets). In the absence of a rating for valence or arousal, the dimension rating was not retained for analysis. If valence and arousal were both rated, dimension was analyzed even when dominance was unrated. If the value of a linear scale was < 1, it was set to 0.

2.4.2. Participants

All the rating sheets of each participant were assessed as follows, to eliminate outliers:

(a) Each set contained a given number of "Neutral" pictures. If twice as many pictures as this number were rated "Neutral", the participant was excluded. Based on this criterion, 18 participants were excluded from further data analysis (Supplementary Fig. 1).
(b) The emotional category ("Positive", "Negative", "Mixed", or "Neutral") assigned to a picture was compared with its valence rating. Consistent valence ratings were: > 5 for "Positive", $\in [4; 6]$ for "Neutral", and < 5 for "Negative". The number of inconsistent ratings was compared to the number of pictures rated by that participant. Participants with an inconsistency score of over 10% were excluded. Based on this criterion, 24 participants were excluded from further data analysis.

The total number of participants retained for further data analysis was 315.

2.4.3. Pictures

In order to exclude incorrectly rated pictures, a series of chronological steps was used to assess ratings for each picture:

(a) The number of inconsistent ratings (see previous Section 2.4.2 b) was counted for all participants, and compared with the number of times the picture was rated. The threshold for inconsistency was set

at 10%. For pictures common to all three sets, only ratings for the first set were taken into account. No picture reached the threshold, so no pictures were removed at this step.
(b) The percentage of emotional category ratings for each picture was also used to determine picture outliers. Opposing emotional category ratings had to be below 20% for a given picture (neutral vs positive or negative; positive vs distress, horror, or hate; negative vs comfort, complicity, or joy). Thirteen pictures were removed at this step.

2.5. Picture type assignment criteria

Pictures temporarily assigned to a type by the four judges were then permanently assigned to a type according to the following criteria:

(a) For "distress" pictures, valence was set at < 5. For "neutral" pictures, valence must be $\in [4; 6]$. For "comfort" and "complicity" pictures, valence was set at > 5. Possible types were then attributed to each picture.
(b) The maximum value from the six linear scales was used to fine-tune picture assignment. For a picture to be assigned to a given type (distress, comfort, or complicity), its maximum linear scale score had to be concordant. For pictures of complicity, the score for comfort had to be lower than the scores for complicity or joy. To avoid assigning a type based on the ratings of only a small number of participants, the linear scale scores were not taken into account if they were obtained from less than 10% of the total number of ratings for that picture.
(c) If one of the possible types was concordant with the maximum linear scale score, the picture was permanently assigned to that type. If no concordance existed, the picture was removed before statistical analysis ($N = 7$).

Based on these criteria, 256 pictures were taken into account for statistical analysis.

2.6. Statistical analysis

Following a previous study (Dan-Glauser and Scherer, 2011), correlation analyses between pictures common to the three sets used a Spearman rank order test. We conducted parametric one-way ANOVAs, followed by Tukey post-hoc tests, to compare dimension ratings (valence, arousal, and dominance) for the four picture types. Pearson's X^2 statistic was used to test for significant differences between the percentages of emotional category label ratings for the four picture types. Finally, a repeated-measures ANOVA, with the six linear scales for specific emotions as a within-factor variable, was performed for each picture type, followed by Tukey post-hoc tests. As there was considerable disproportion between the number of male and female participants, gender was added as a covariate in the ANOVAs. To test the age effect between BAPS-Ado and BAPS-Adult, ratings for all 34 pictures common to both picture set were compared using paired t tests (normality was verified using the Shapiro–Wilk test). A threshold of 5% was set for the tests. Ratings were analyzed with SAS 9.4 TS Level 1M3.

3. Results

3.1. Comparison of pictures common to all three sets

Ratings for the 28 pictures common to all three sets were strongly correlated for all variables (valence, arousal, and dominance). All correlation coefficients were statistically significant: for valence (*r-values* > 0.96, $p < 0.0001$), for arousal (*r-values* > 0.81, $p < 0.0001$), and for dominance (*r-values* > 0.64, and $p < 0.0001$). The three picture sets were thus considered to be from the same sample, and all pictures were considered as one database with comparable ratings. For pictures

Table 1
Summary statistic (mean) and standard deviation (*S.D.*) for valence, arousal, and dominance, assessed by the SAM scale, for each picture type.

	Distress (N = 92)	Comfort (N = 53)	Complicity-joy (N = 55)	Neutral (N = 56)
Valence	2.6 (1.4)***	6.4 (1.5)***	7.2 (1.3)***	4.9 (0.8)***
Arousal	4.7 (2.1)***	3.6 (2.1)***	4.1 (2.3)***	3.0 (2.0)***
Dominance	4.3 (1.8)***	5.1 (1.4)***	5.4 (1.5)*	5.3 (1.7)*

Valence: 1 = unhappy, 9 = happy. Arousal: 1 = calm, 9 = aroused. Dominance: 1 = dominated, 9 = dominating.
N = number of pictures per category. Mean is shown directly, *S.D.* is presented in parentheses.

   * $p < 0.05$ between complicity-joy and neutral, $p < 0.001$ with other groups.
  *** $p < 0.001$, with all other groups.

common to all three sets, only ratings from the first set were taken into account for statistical analysis of the entire database.

3.2. Dimensional ratings

Dimensional ratings for each picture in the database are presented in Supplementary Table S1.

3.2.1. Valence
The analysis of variance showed a significant picture type effect for valence $F(3, 25,245) = 17,995$, $p < 0.001$ (Table 1). Tukey's post-hoc tests indicated that valence ratings differed significantly from each other ($p < 0.001$). The highest rating was for complicity-joy (7.2 ± 1.3), while the lowest was for distress (2.6 ± 1.4). Comfort was slightly positive (6.4 ± 1.5), and neutral images were close to 5 (4.9 ± 0.8).

3.2.2. Arousal
The analysis of variance showed a significant picture type effect for arousal $F(3, 25,245) = 877.95$, $p < 0.001$ (Table 1). Tukey's post-hoc tests indicated that arousal ratings differed significantly from each other. The "neutral" subset elicited less arousal than other categories ($p < 0.001$).

3.2.3. Dominance
The analysis of variance showed a significant picture type effect for dominance $F(3, 25,111) = 739.66$, $p < 0.001$. Tukey's post-hoc tests indicated that dominance ratings differed significantly from each other (Table 1). Pictures of "distress" were associated with significantly low dominance ($p < 0.001$). There was less difference between dominance ratings for the "complicity-joy" and "neutral" picture types, but the results were still significant.

3.3. Picture distribution across affective areas

Ratings from the BAPS-Adult database show an association between the dimensions of valence and arousal, with the typical boomerang-

shaped distribution previously observed in the International Affective Picture System (Bradley et al., 2001), and in the BAPS-Ado (Szymanska et al., 2015), see Supplementary Fig. 2 a.

3.4. Per emotional category labeling percentages

Labeling percentages for each picture in the database are presented in Supplementary Table S1.

Pearson's $X^2(9) = 38,609.11$, $p < 0.0001$ showed that results for labeling within each subset were significantly different. Pictures of "distress" were labeled 91.8% negative, 5.2% neutral, 2.4% mixed, and 0.6% positive. Pictures of "comfort" were labeled 73.8% positive, 7.7% neutral, 15.6% mixed, and 2.9% negative. Pictures of "complicity-joy" were labeled 93.5% positive, 5.6% neutral, 0.5% mixed, and 0.5% negative. The "neutral" pictures were labeled 87.9% neutral, 5.0% positive, 4.9% negative, and 2.2% mixed.

3.5. Summary statistics and comparisons for emotion ratings on linear scales

Emotion ratings for each individual picture in the database are presented in Supplementary Table S1.

The repeated-measures ANOVAs showed a significant linear scale effect for pictures of "distress" ($F(2, 16,408) = 7.2$, $p < 0.001$), for pictures of "complicity-joy" ($F(2, 9804) = 3.3$, $p < 0.05$), and for pictures of "comfort" ($F(2, 8586) = 8.4$, $p < 0.001$). Post-hoc tests indicated that linear scale ratings differ significantly from each other ($p < 0.001$, Table 2).

3.6. Comparison of ratings for pictures common to BAPS-Adults and BAPS-Ado

Paired *t*-tests on SAM dimensions (valence, arousal and dominance) and linear scales (Distress, Horror, Hate, Comfort, Complicity, Joy) were used to compare picture ratings ($N = 34$) between adults and adolescents. Valence ratings were similar for the two populations ($t(33) = 1.4759$, $p = 0.149$), while arousal and dominance ratings differed significantly between the two populations ($t(33) = -2.5908$, $p = 0.014$, $t(33) = 3.0402$, $p = 0.004$, respectively). For linear scales, complicity ratings were comparable between groups ($t(17) = 1.6901$, $p = 0.109$), but comfort and joy ratings differed significantly ($t(17) = 2.4680$, $p = 0.024$, $t(17) = 3.9291$, $p = 0.001$, respectively). Horror ratings were similar ($t(13) = 0.8000$, $p = 0.438$), but distress and hate differed between groups ($t(13) = 2.1860$, $p = 0.047$, $t(13) = 5.859$, $p = < 0.0001$, respectively; see Supplementary Table S2).

4. Discussion

In the present work, we propose the BAPS-Adult: a new attachment-related database, containing 276 pictures eliciting emotional states of distress, comfort, complicity-joy, and a neutral state, validated by a panel of 385 adult participants. This database has the same theoretical
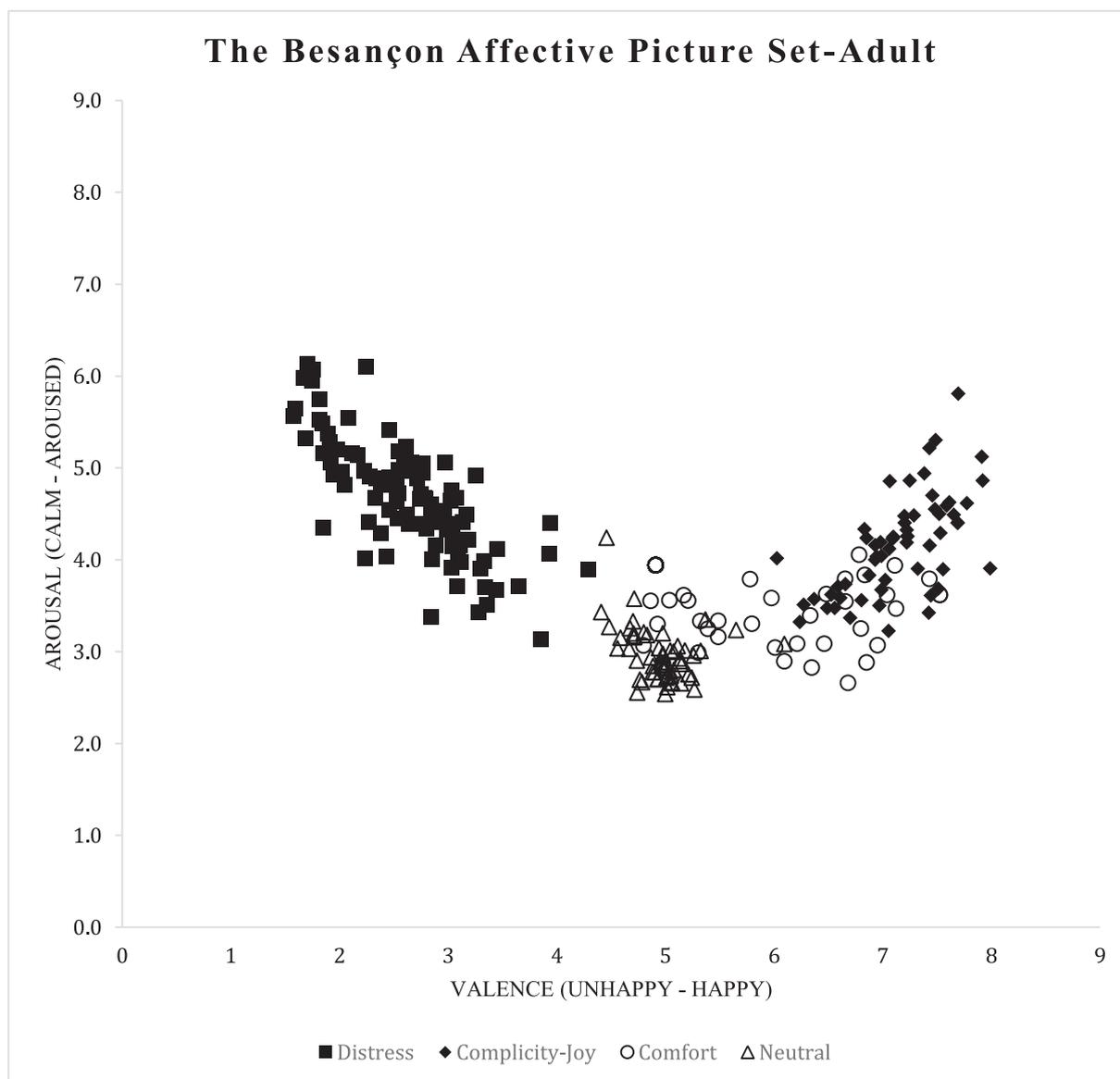
Table 2
Summary statistic (mean) and standard deviation (*S.D.*) of linear scales, for each picture type.

Picture type	Linear scale Comfort	Complicity	Joy	Distress	Horror	Hate
Distress (N = 8206)	–	–	–	7.6 (2.4)***	4.6 (3.5)***	2.6 (3.1)***
Complicity-Joy (N = 4904)	5.1 (3.2)***	8.0 (2.1)***	7.8 (2.2)***	–	–	–
Comfort (N = 4295)	8.0 (2.2)***	7.0 (2.6)***	4.5 (3.2)***	–	–	–

Repeated-measures ANOVAs were computed on pictures of "distress", "complicity-joy", and "comfort", with the six linear scales for specific emotions as a within-factor variable (gender added as a covariate).
  *** indicates a post-hoc value of $p < 0.001$ (Tukey post-hoc tests), with all other linear scales within the picture type. Mean is shown directly, *S.D.* is presented in parentheses. *N* = number of valid ratings per picture type.

Fig. 4. Distribution of the BAPS-Adult pictures, plotted in affective space, determined by the mean ratings for valence (*x*-axis) and arousal (*y*-axis). Each dot represents the rating for a particular picture. Valence: 1 = "unhappy" to 9 = "happy". Arousal: 1 = "calm" to 9 = "aroused".

background as the BAPS-Ado (for more details, see Szymanska et al., 2015). Statistical analysis confirmed the validity of the ratings for 256 of the pictures, by 315 participants, after exclusion of outliers, with a threshold set at 10%. To our knowledge, there are no standard guidelines about setting up selection criteria in the framework of emotion attachment. To avoid all ambiguity, our team of clinicians, statisticians, and engineers consensually chose 10% for inconsistency scores generated by pictures or participants.

Pictures were rated according to three dimensions underlying affect: the pleasantness of a stimulus (valence), the intensity of emotion provoked by a stimulus (arousal), and the degree of control exerted by a stimulus (dominance), evaluated by Self-Assessment Manikins (Bradley and Lang, 1994). Participants also assessed emotional category, using positive, negative, mixed, and neutral labels, and degree of emotion, for comfort, joy, complicity, distress, hate, and horror, using linear scales.

Concerning self-reported affects, i.e., valence and arousal, we found that ratings for each picture type showed consistency and great homogeneity. Picture distribution effectively covers the affective space, forming the "boomerang-shaped" relationship (Fig. 4) found in

previous studies (Bradley et al., 2001; Libkuman et al., 2007; Szymanska et al., 2015).

As expected, "distress" pictures evoked higher negative valence and arousal than other picture types. Regarding discrete emotion evaluation, we notice that the emotion of distress was accurately discriminated from hate and horror. These results are similar to evaluations found in previous studies i.e., BAPS-Ado (Szymanska et al., 2015) and AAPS (Liu et al., 2016). The "comfort" pictures were rated moderately pleasant, and less arousing compared to other picture types. We observed that valence evaluation differed significantly from the valence of complicity-joy pictures. Additionally, we found that pictures of "comfort" evoked comfort more than joy, complicity, or negative emotions. Consequently, these pictures seem to induce pleasant sensations of security (Ainsworth, 1985) that clearly diverge from other positive emotions, such as joy and complicity, related to a general attraction to or fondness for something or someone.

The pictures of "complicity-joy" were rated as very pleasant and more arousing than "comfort", "distress", and "neutral" pictures. In general, they were labeled as positive, and were rated high for complicity and for joy, and lower for comfort. Finally, "neutral" pictures

were mostly labeled neutral. Furthermore, the relatively low arousal, and valence around the midpoint, indicated homogenous ratings.

To investigate whether groups of adolescents and young adults had similar affective responses to pictures, we compared the psychometrics of the Self-Assessment Manikin, and linear scale ratings for all pictures common to BAPS-Ado and BAPS-Adult. Results for arousal and dominance ratings were different, but no difference was observed for valence ratings. Young adults were more aroused and felt more dominated by the pictures than adolescents did. This result suggests age differentiation of emotional processing, which could be explained by greater affect intensity and lower emotional control for the young adult group. Our results diverge from those of McMains and coworkers (McManis et al., 2001), who found that affective evaluations of pictures, in terms of pleasure, arousal, and dominance, were similar among children, adolescents, and adults. We also found that young adults felt less comfort, joy, distress, and hate during picture rating than adolescents did. This result may indicate age-related differences in emotion regulation. These results are in line with the literature (Backs et al., 2005; McManis et al., 2001) on emotion and aging, indicating that aging influences several aspects of emotional functioning. However, more research is necessary to explore lifespan changes in emotional processing.

There are some minor drawbacks to this study. The BAPS-adult ratings were collected from a general population of young adults, recruited mainly at university (students of psychology, medicine, or biology). As there is some evidence of the effects of age and sociocultural factors on valence and arousal evaluation, and on modulating emotion processing (Gruhn and Scheibe, 2008), replication among older adults from other environments should be a focus for future studies. The importance of gender differences has been documented in cognitive processes such as memory or vision (Cahill, 2006), and in affective experiences in response to different contents (Bianchin and Angrilli, 2012; Gomez et al., 2013). As the gender ratio in our population was not balanced, we investigated gender differences in the self-reported emotional experience. Statistical analysis showed that this gender imbalance did not influence SAM and category labeling ratings. Further investigation is needed to better understand gender differences in emotional processing in both healthy and clinical populations.

During the rating process, "dominance" was difficult to understand for some participants, despite the use of Self-Assessment Manikins (SAM, Bradley and Lang, 1994), so the results for this dimension should be taken with caution. The BAPS-Adult contains a large proportion of negative and positive pictures, whereas neutral pictures remain relatively limited in number. Consequently, this picture database is asymmetrical, with many more emotional than neutral pictures. Picture validation used a paper-and-pencil version of the rating sheet, because of the large number of participants. Future studies should use computer-based scales to avoid human error and to facilitate data analysis.

5. Conclusions

The BAPS-Adult was created to serve the growing interest in attachment-related emotion regulation, in the fields of psychology and psychiatry. Researchers should considerably benefit from this new collection of 256 visual stimuli, complementary to previously validated picture sets, as they will now be able to select pre-rated, attachment-related pictures. The BAPS-Adult offers a combination of ratings for affective dimensions and attachment-related emotions. Multidimensional, highly discriminated ratings will allow pertinent stimuli to be selected according to the requirements of the experimental design. The database could supply valid material for studies assessing emotional physiological reactions and brain activity.

The BAPS-Adult database (images and ratings) is freely accessible to the scientific community, for non-commercial use, upon request.

References

Ainsworth, M.D., 1985. Patterns of infant-mother attachments: antecedents and effects on development. Bull. N. Y. Acad. Med. 61 (9), 771–791.

Ainsworth, M.D., Blehar, C.M., Waters, E., Wall, S., 1978. Patterns of Attachment: A Psychological Study of the Strange Situation. Lawrence Erlbaum Associates, Hillsdale, NJ.

Allen, J.P., Land, D., 1999. Attachment in adolescence. In: Cassidy, J., Shaver, P.R. (Eds.), Handbok of Attachment Theory and Research and Clinical Applications. Guilford, New York, pp. 431.

Arnold, M.B., 1960. Emotion and Personality. Columbia University Press, New York.

Backs, R.W., da Silva, S.P., Han, K., 2005. A comparison of younger and older adults' self-assessment manikin ratings of affective pictures. Exp. Aging Res. 31 (4), 421–440.

Belsky, J., Cassidy, J., 1994. Attachment: theory and evidence. In: Rutter, M.L., Hay, D.F., Baron-Cohen, S. (Eds.), Development Through Life: A Handbook for Clinicians. Blackwell, Oxford, pp. 373–402.

Bianchin, M., Angrilli, A., 2012. Gender differences in emotional responses: a psycho-physiological study. Physiol. Behav. 105 (4), 925–932.

Bifulco, A., Kwon, J., Jacobs, C., Moran, P.M., Bunn, A., Beer, N., 2006. Adult attachment style as mediator between childhood neglect/abuse and adult depression and anxiety. Soc. Psychiatry Psychiatr. Epidemiol. 41 (10), 796–805.

Borelli, J.L., Sbarra, D.A., Snavely, J.E., McMakin, D.L., Coffey, J.K., Ruiz, S.K., Wang, B.A., Chung, S.Y., 2014a. With or without you: preliminary evidence that attachment avoidance predicts nondeployed spouses' reactions to relationship challenges during deployment. Prof. Psychol. Res. Pr. 45 (6), 478–487.

Borelli, J.L., West, J.L., Weekes, N.Y., Crowley, M.J., 2014b. Dismissing child attachment and discordance for subjective and neuroendocrine responses to vulnerability. Dev. Psychobiol. 56 (3), 584–591.

Bowlby, J., 1969. Attachment and Loss. Basic Books, New York, NY.

Bowlby, J., 1982. Attachment and Loss, 2nd ed. Basic Books, New York, NY.

Bradley, M.M., Codispoti, M., Cuthbert, B.N., Lang, P.J., 2001. Emotion and motivation I: defensive and appetitive reactions in picture processing. Emotion 1, 276–298.

Bradley, M.M., Lang, P.J., 1994. Measuring emotion: the self-assessment Manikin and the semantic differential. J. Behav. Ther. Exp. Psychiatry 25 (1), 49–59.

Britton, J.C., Taylor, S.F., Sudheimer, K.D., Liberzon, I., 2006. Facial expressions and complex IAPS pictures: common and differential networks. Neuroimage 31 (2), 906–919.

Buchheim, A., George, C., 2011. Attachment disorganization in borderline personality disorder and anxiety disorder. In: Solomon, J., George, C. (Eds.), Disorganized Attachment and Caregiving. Guilford Press, New York, NY, pp. 343–382.

Cahill, L., 2006. Why sex matters for neuroscience. Nat. Rev. Neurosci. 7 (6), 477–484.

Dan-Glauser, E.S., Scherer, K.R., 2011. The Geneva Affective Picture Database (GAPED): a new 730-picture database focusing on valence and normative significance. Behav. Res. Methods 43 (2), 468–477.

Ekman, P., 1984. Expression and the nature of emotion. In: Scherer, K.R., Ekman, P. (Eds.), Approaches to Emotion. Erlbaum, Hillsdale, N.J., pp. 319–344.

Ekman, P., Levenson, R.W., Friesen, W.V., 1983. Autonomic nervous system activity distinguishes among emotions. Science 221 (4616), 1208–1210.

George, C., West, M., 2001. The development and preliminary validation of a new measure of adult attachment: the adult attachment projective. Attach. Hum. Dev. 3, 30–61.

Gomez, P., von Gunten, A., Danuser, B., 2013. Content-specific gender differences in emotion ratings from early to late adulthood. Scand. J. Psychol. 54 (6), 451–458.

Gruhn, D., Scheibe, S., 2008. Age-related differences in valence and arousal ratings of pictures from the International Affective Picture System (IAPS): do ratings become more extreme with age? Behav. Res. Methods 40 (2), 512–521.

Hariri, A.R., Mattay, V.S., Tessitore, A., Fera, F., Weinberger, D.R., 2003. Neocortical modulation of the amygdala response to fearful stimuli. Biol. Psychiatry 53 (6), 494–501.

Hazan, C., Shaver, P., 1987. Romantic love conceptualized as an attachment process. J. Pers. Soc. Psychol. 52 (3), 511–524.

Herba, C., Phillips, M., 2004. Annotation: Development of facial expression recognition

from childhood to adolescence: behavioural and neurological perspectives. J. Child Psychol. Psychiatry 45 (7), 1185–1198.

Izard, C.E., 1971. The Face of Emotion. Plenum, New York.

Kobak, R., Cassidy, J., Lyons-Ruth, K., Ziv, Y., 2006. Attachment, stress and psychopathology: a developmental pathways model. In: Cicchetti, D., Cohen, D.J. (Eds.), Handbook of Developmental Psychopathology. Cambridge University Press, Cambridge, pp. 333–369.

Kobak, R., Zajac, K., Smith, C., 2009. Adolescent attachment and trajectories of hostile-impulsive behavior: implications for the development of personality disorders. Dev. Psychopathol. 21 (3), 839–851.

Kolcaba, K.Y., Kolcaba, R.J., 1991. An analysis of the concept of comfort. J. Adv. Nurs. 16 (11), 1301–1310.

Kolcaba, K.Y., Tilton, C., Drouin, C., 2006. Comfort theory: a unifying framework to enhance the practice environment. J. Nurs. Adm. 36 (11), 538–544.

Lang, P.J., 1980. Technology in mental health care delivery systems. In: Sidowski, B., Johnson, J.H., Williams, T.A. (Eds.), Behavioral Treatment and Bio-behavioral Assessment: Computer Applications. Ablex, Norwood, NJ, pp. 119–137.

Lang, P.J., Bradley, M.M., Cuthbert, B.N., 2008. International affective picture system (IAPS): affective ratings of picture and instruction manual. Gainesville Technical Report A-8.

Langner, O., Dotscha, R., Bijlstraa, G., Wigboldusa, D.H.J., Hawkb, S.T., Van Knippenberga, A., 2010. Presentation and validation of the radboud faces database. Cogn. Emot. 24, 1377–1388.

Libkuman, T.M., Otani, H., Kern, R., Viger, S.G., Novak, N., 2007. Multidimensional normative ratings for the international affective picture system. Behav. Res. Methods 39 (2), 326–334.

Liu, Y., Chen, X., Zhai, J., Tang, Q., Hu, J., 2016. Development of the attachment affective picture system. Social Behav. Personal. Int. J. 44, 1565–1574.

McManis, M.H., Bradley, M.M., Berg, W.K., Cuthbert, B.N., Lang, P.J., 2001. Emotional reactions in children: verbal, physiological, and behavioral responses to affective pictures. Psychophysiology 38 (2), 222–231.

Mikels, J.A., Fredrickson, B.L., Larkin, G.R., Lindberg, C.M., Maglio, S.J., Reuter-Lorenz, P.A., 2005. Emotional category data on images from the international affective picture system. Behav. Res. Methods 37 (4), 626–630.

Mikulincer, M., Shaver, P.R., 2007. Attachment processes and emotion regulation. In: Mikulincer, M., Shave, P.R. (Eds.), Attachment in Adulthood: Structure, Dynamics, and Change. The Guilford Press, New York, NY, pp. 190.

Mikulincer, M., Shaver, P.R., Gillath, O., Nitzberg, R.A., 2005. Attachment, caregiving, and altruism: boosting attachment security increases compassion and helping. J. Pers. Soc. Psychol. 89 (5), 817–839.

Monin, J.K., Schulz, R., 2010. The effects of suffering in chronically Ill older adults on the health and well-being of family members involved in their care: the role of emotion-related processes. GeroPsych 23 (4), 207–213.

Monk, C.S., McClure, E.B., Nelson, E.E., Zarahn, E., Bilder, R.M., Leibenluft, E., Charney, D.S., Ernst, M., Pine, D.S., 2003. Adolescent immaturity in attention-related brain engagement to emotional facial expressions. Neuroimage 20 (1), 420–428.

Shaver, P., Schwartz, J., Kirson, D., O'Connor, C., 1987. Emotion knowledge: further exploration of a prototype approach. J. Pers. Soc. Psychol. 52 (6), 1061–1086.

Sroufe, L.A., Waters, E., 1977. Attachment as an organizational construct. Child Dev. 48, 1184–1199.

Stratheam, L., Fonagy, P., Amico, J., Montague, P.R., 2009. Adult attachment predicts maternal brain and oxytocin response to infant cues. Neuropsychopharmacology 34 (13), 2655–2666.

Szymanska, M., Monnin, J., Noiret, N., Tio, G., Galdon, L., Laurent, E., Nezelof, S., Vulliez-Coady, L., 2015. The Besancon affective picture set-adolescents (the BAPS-Ado): development and validation. Psychiatry Res. 228 (3), 576–584.

Van Ijzendoorn, M.H., Schuengel, C., Bakermans-Kranenburg, M.J., 1999. Disorganized attachment in early childhood: meta-analysis of precursors, concomitants, and sequelae. Dev. Psychopathol. 11 (2), 225–249.

Vandevivere, E., Braet, C., Bosmans, G., Mueller, S.C., De Raedt, R., 2014. Attachment and children's biased attentional processing: evidence for the exclusion of attachment-related information. PLoS One 9 (7), e103476.

Vink, M., Derks, J.M., Hoogendam, J.M., Hillegers, M., Kahn, R.S., 2014. Functional differences in emotion processing during adolescence and early adulthood. Neuroimage 91, 70–76.

Vrticka, P., Anderson, F., Grandjean, D., Sander, D., Vuilleumier, P., 2008. Individual attachment style and striatum activation during social appraisal. PLoS One 3, 1–11.

Werebe, M.J., 1987. Friendship and dating relationships among French adolescents. J. Adolesc. 10 (3), 269–289.

Yurgelun-Todd, D., 2007. Emotional and cognitive changes during adolescence. Curr. Opin. Neurobiol. 17 (2), 251–257.

Zimmermann, P., Iwanski, A., 2014. Emotion regulation from early adolescence to emerging adulthood and middle adulthood: age differences, gender differences, and emotion-specific developmental variations. Int. J. Behav. Dev. 38 (2), 182–194.