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IAPS INCLUDES PHOTOGRAPHS THAT ELICIT LOW-AROUSAL PHYSIOLOGICAL RESPONSES IN HEALTHY VOLUNTEERS

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ABSTRACT

This article describes pleasant IAPS pictures that elicit low-arousal rather than the high-arousal physiological responses previously reported in the literature. Thirty two International Affective Picture System (IAPS) photographs were grouped into 4 sets of 8 photographs: highly pleasant-arousing (sexual content and adventures), highly pleasant-relaxing pictures (landscapes, flowers or babies), neutral on both valence/arousal, and highly unpleasant-arousing ones. These stimuli were shown to 24 healthy Brazilian University students (12 males) who had their physiological responses recorded [corrugator and zygomatic facial electromyography activity, skin conductance, heart rate, and peripheral temperature]. Zygomatic EMG differentiated low-arousal pleasant photographs from high-arousal pleasant stimuli of the same valence.

KEY WORDS: emotion, IAPS, low-arousal, high-arousal, physiological responses.

INTRODUCTION

The International Affective Picture System (IAPS) [1] is a set of visual stimuli for use in experimental investigations of emotion and attention. It contains photographs that can be subjectively rated on two dimensions (valence and arousal) which reflect appetitive and defensive motivational systems [2]. When results of these ratings are plotted in a graph (affective space), the typical result is a boomerang shape in both North American [1] and Spanish [3,4] populations that reflects higher arousal ratings for both high (positive) and low (negative) valence photographs and lower arousal for more neutral stimuli in terms of valence.

In contrast, in a normative study conducted in Brazilian University students [5] there was an over-representation of low arousal ratings for pleasant pictures, the graphic representation of which was more linear than boomerang shaped. In other words, the study conducted in Brazil showed that some positive pictures were rated as highly arousing (e.g. those of sexual content), others as low in terms of arousal (e.g. beautiful scenery), while neutral stimuli in terms of valence were rated with intermediate arousal values. The North Americans and Spaniards treated the arousal scale differently. Ratings near one extreme were used for neutral pictures in terms of valence, with the opposite end of the scale having been used as an arousal rating for both positive and negative photographs.

This difference in terms of arousal occurred despite the fact that the Brazilian study [5] involved a large representative sample with the same proportion of men and women (N=1062; 364 men) and having strictly followed the methodology of the original IAPS standardization study in the USA [1], including instructions, examples, rating methods, etc. In addition, most of the results of this study were generally similar to the North-American and Spanish ones, confirming its adequacy. That is, gender effects were equivalent, arousal results for unpleasant pictures were comparable and correlations between valence and arousal were significant.

Hence, the reason for the difference between studies in terms of the arousal dimension is unclear. It could have derived from cultural differences in terms of emotional reactivity or from distinct interpretation of this scale due to the translated terms used to describe each of its extremities. This is not surprising if one considers that there is a great deal of controversy surrounding the general concept of emotion [6], specifically arousal [7; see also 5), which seems to stem from different approaches in studying affect (e.g. see 6, 7, 8). This is beyond the scope of the present paper. However, arousal is one of the two main dimensions evaluated by subjects in studies using the widely employed IAPS stimuli, so the issue of interest here is the better understanding of peoples' physiological arousal reactions to high valence pictures. The aim of the present study was therefore to determine if positive pictures can, depending on their

content, elicit physiological responses compatible with high and low arousal in such a way as to provide support for the emotional subjective ratings obtained in the Brazilian IAPS norms.

To this end, facial EMG and autonomic measures of affective valence and arousal were recorded while healthy volunteers looked at IAPS photographs grouped into sets of highly pleasant-arousing (sexual content and adventures), highly pleasant-relaxing (landscapes, flowers or babies), neutral on both valence/arousal, and highly unpleasant-arousing pictures. We aimed to investigate the relations between physiological changes and subjective ratings of these sets of photographs. Facial EMG activity for the muscle regions responsible for frowning (*corrugator supercili)* and smiling (*zygomaticus major*) were targeted since electrical activity from these muscles appears to be reliably correlated with processing affective valence of stimuli [9,10]. For instance, it has been shown that looking at or imagining pleasant scenes increased zygomatic activity, whereas viewing or recalling unpleasant scenes raised the level of corrugator activity [11]. Autonomic measures such as heart rate (HR) and skin conductance (SC) were recorded because they are believed to index processes linked to orienting response or emotional arousal [12].

METHODS

Subjects

Subjects were 24 native Portuguese speaking, healthy University students (12 women), who were drug-free with no history of epilepsy, head injury, stroke, psychiatric disorders, neurological illness, alcoholism or eyesight problems. The study was approved by the local Ethics Committee (UNIFESP) and all subjects provided signed informed consent.

Material (see table 1)

Thirty-two photographs were selected from the Brazilian IAPS norms [5] on the basis of valence and arousal ratings and were divided into four sets: eight highly pleasant-arousing (PA) pictures (sexual content and adventures), eight highly pleasant-relaxing (PR) pictures (landscapes, flowers or babies), eight neutral on both valence and arousal (N) pictures and eight highly unpleasant-arousing (U) pictures. The IAPS has no unpleasant non-arousing photographs.

Psychophysiological recording

Facial EMG activity, autonomic measures (heart rate, skin conductance) and peripheral temperature were recorded using an I-410 Physiological Monitoring System (J. & J. Engineering, USA) connected to a PC. Muscle activity was recorded over the left *corrugator supercilii* and *zygomaticus major* regions using two miniature Ag/AgCl surface electrodes filled with paste and placed bipolar on the lines [13]. Before attaching electrodes, skin target sites were cleaned with alcohol and slightly rubbed to reduce inter-electrode impedance. Zygomatic and corrugator EMG activity were recorded individually; an EMG change score was calculated by subtracting the mean corrugator change score from the mean zygomatic change score to assess overall facial muscle pattern [13]. A positive difference score indicates predominance of zygomatic activity, while a negative score indicates predominance of corrugator activity. Skin conductance (SC) was transduced using Ag/AgCl electrodes filled with conducting biogel and attached with a Velcro strap to the volar surface of the distal phalanges of the second and third fingers of the nondominant hand. Heart activity was recorded with two active Ag/AgCl electrodes filled with conducting biogel for the dominant pulse and one non-active Ag/AgCl electrode for the nondominant pulse. A computerized input command allowed a threshold control to detect R wave pulses and displayed on-line heart rate (HR) in beats per minute. Basal temperature (TEMP) was recorded through a thermal sensor attached to the fourth finger of the nondominant hand (J. & J. Engineering, USA).

Procedure

The procedure followed as closely as possible that proposed by Greenwald *et al*. (1989) [13]. Participants were tested individually. On arrival, they sat in a comfortable reclining chair in a small (3 x 1.5 m) cubicle. After attaching physiological sensors, subjects were asked to remain relaxed during the experimental sessions. They were then asked to rest quietly and a 2 min baseline was initiated to facilitate laboratory adaptation. They were told that pictures differing in emotional content would be displayed for 5 s on a screen 2 m in front of them, and that each picture should be viewed for this entire period. Each rating was preceded by a 5-second preparatory slide showing the number (1-30) of the next photograph to be presented (baseline period). The photograph to be rated was then screened for 5 seconds (stimulus period), while the physiological responses were being recorded. Immediately after each slide, subjects had 10 s to rate their emotional experience on affective dimensions (pleasure and arousal) using 9-point Self Assessment Manikin (SAM) scales [9]. Self-reported affective valence ranged from extremely unpleasant (1) to extremely pleasant feeling (9). Subjective emotional arousal was rated along a calm/arousal feeling dimension, ranging from extremely

calm (1) to extremely aroused (9). The inter-trial interval was set at 30 s permitting recovery from the previous slide on all physiological measures. Slide presentation was randomized for all subjects. Prior to the onset of the experimental trials, three pictures served as practice stimuli.

Physiological data reduction and analysis

The relationship between subjective ratings of pleasure and arousal to all picture types were investigated through Pearson correlations. Also, mean scores for subjective assessments of pleasure and arousal for the selected photographs were compared with those obtained from the Brazilian standardization using Student t-tests. To compare subjective assessments of pleasure and arousal for different types of pictures, one-way ANOVAs were used (type of photograph) with 4 levels (PA, PR, N, and U). Change scores were calculated separately for each physiological measure by subtracting mean activity during the 3 s preceding picture onset (baseline period) from the average response during the last 3 s picture viewing interval (stimulus period) [13]. For each physiologic measure one-way ANOVAs were used (type of photo) with 4 levels (PA, PR, N and U) followed by Tukey t tests. A 5% significance level was adopted for all analysis.

RESULTS

The mean scores for pleasure and arousal assessments obtained from the 24 volunteers in the present experiment are shown in Table 1. The arousal and valence subjective evaluations of the photographs in the sample were equivalent (t-test ps>0.83) to, and highly correlated (pleasure: r = 0.99; arousal: r = 0.95; $p<0.05$) with, normative values for the Brazilian population. The values for the pleasure and arousal dimensions for this set of photographs showed linear correlation (r = -0.74, $p<0.05$) and are similar to the values between normative data for the pleasure and arousal dimensions for all subjects in the Brazilian standardization (r = - 0.82, $p<0.05$) [5]. For both men and women, the arousal and valence subjective evaluations were equivalent to (t-test ps≥0.95) normative values for the Brazilian population and the same correlation between normative values for the pleasure and arousal dimension was maintained (r = -0.71, and r = -0.76, respectively), which was also the case in the Brazilian standardization (r = -0.63 and r = -0.84, respectively) ($p<0.05$).

[TABLE 1 NEAR HERE]

In relation to subjective assessments of pleasure [$F(3,69) = 344.25$, $p<0.001$], U photographs were classified by volunteers as significantly less pleasant than N or PA and PR ones ($p<0.001$) which in turn were classified as being more pleasant than the N and U ($p<0.001$). There was no difference in valence between PA and PR photographs ($p=0.71$).

In relation to the arousal assessment [$F(3,69) = 74.40$, $p<0.001$], the U photographs were classified as significantly more arousing than the N, PR and PA ones ($p<0.001$). The PA photographs were also classified as more arousing than the PR ones ($p<0.001$), but not more so than the N ones ($p=0.40$), while the PR photographs were classified as less arousing than the N ones ($p<0.001$).

EMG change score [$F(3,69)=11.48$, $p<0.001$; figure 1] and the zygomatic muscle electromyogram [$F(3,69)=6.39$, $p<0.001$] showed that PR photographs increased contraction in relation to the remaining pictures ($p<0.05$), while greater corrugator muscle contractions [$F(3,69)=9.69$, $p<0.001$; table 2], and greater heart deceleration [$F(3,69)=4.85$, $p<0.01$; figure 2] were observed for U stimuli in relation to the others ($p<0.01$), although this difference in heart rate between U and N photographs fell short of significance ($p=0.07$).

[FIGURES 1 AND 2 NEAR HERE]

The skin conductance measures [$F(3,69)=3.71$, $p<0.02$; table 2] showed that U photographs elicited higher levels of conductance than PR ($p<0.02$) and tended to do so in relation to the N ($p=0.09$), whereas the peripheral temperature [$F(3,69)=2.66$, $p\leq0.05$; table 2] showed that only the PR photographs increased TEMP in relation to the N photographs ($p\leq0.05$).

[TABLE 2 NEAR HERE]

DISCUSSION

Subjective affective evaluation of pleasure and arousal of the photographs selected in the present study did not differ from the values obtained in the Brazilian norms, thus showing consistency in affective classification of these stimuli when the same instructions and population are used. Furthermore, analyses of the subjective evaluation of stimuli in terms of arousal and pleasure confirmed the classification of the sets of stimuli used here into pleasant relaxing and

arousing, neutral in terms of valence and arousal and unpleasant arousing. The physiological responses as a whole also showed that photographs vary in terms of arousal and pleasure, eliciting different responses including significant contrasts between pleasant arousing stimuli and pleasant relaxing ones, as will be discussed below.

In relation to the physiological responses obtained, our results for facial muscle activity, based on scoring the difference between the activity of the zygomatic and corrugator muscles (EMG change score [13]), showed an increase in this parameter for pleasant relaxing stimuli in relation to pleasant arousing ones, although they did not differ in terms of the subjective pleasure elicited. This finding probably reflects the difference obtained for electromyography recordings from the zygomatic muscle (the muscle involved in smiling) when analyzed separately. So it would seem that there are qualitative differences in the physiological alterations elicited by these two types of stimuli (pleasant relaxing vs. pleasant arousing), as was also found for the subjective judgments of arousal prompted by these figures. EMG-score and zygomatic muscle electromyograms also showed differences between the pleasant relaxing photographs on the one hand, and the neutral and unpleasant ones on the other, thus partly corroborating previous reports of EMG-score and zygomatic muscle activity discriminating pleasure judgements [9,10]. The results suggest, however, that only one subset of the positive stimuli, here defined as relaxing, boost zygomatic muscle activity as a differential in relation to unpleasant ones. In this respect, it was found that activities triggered by unpleasant stimuli ("disgust" type responses) and pleasant arousing ones are equivalent in descriptive terms, which is in accordance with the strong quadratic correlation found between the affective reports of pleasure and zygomatic muscle activity [8,10].

Increased contraction of the corrugator muscle, on the other hand, was greater for the negative photographs than for the remainder, thus confirming that greater responses on the corrugator facial electromyogram are found in response to negative photographs compared with positive ones [10], regardless of their arousal level.

In relation to heart rate, the present results were also similar to those described previously [10,14,15]: a secondary deceleration starting about 3 s after viewing unpleasant photographs, compared to that elicited by neutral and pleasant stimuli (relaxing and arousing). Prior to this secondary deceleration, there seems to be an initial deceleration followed by an acceleration that was not measured here due to the methodology used. Both are considered as fear bradycardia related to alterations mediated by the vague nerve, similar to that found in passive aversive conditioning [2,14-17], although the role of the secondary slowing down as such is not clear. Since this difference occurred both in relation to the relaxing and high-arousal

pleasant photographs, and tended to do so in relation to the neutral ones, this physiological parameter seems in fact to be related to the pleasure rather than the arousal dimension [10].

In terms of electrodermic measurements, which are seen as highly correlated with affective reports of arousal [8], it should be emphasized that unpleasant photographs induced higher conductance than pleasant relaxing ones, although the responses were equivalent to those from pleasant high-arousal stimuli. This suggest that some positive stimuli may in fact diminish arousal even though others elicit the same responses as unpleasant photographs, as reflected in the subjective evaluation of arousal in the Brazilian population. These results do not corroborate the findings of Lang *et al*. (1993) [10] who describe similar alterations of skin conductance on viewing pleasant and unpleasant photographs. However, Lane *et al*. (1997) [18] and Cobos *et al*. (2002) [15] also observed higher levels of skin conductance in response to unpleasant photographs than to pleasant ones. In the first case, the authors attributed the differences found to the set of pleasant stimuli selected in their study being elicitors of lower arousal levels. In the second, a qualitative analysis of the set of pleasant photographs used showed that they also had the characteristics necessary for verification of low-arousal levels as observed here. Hence, the above mentioned studies may have found differences in electrodermic activity due to the fact that on average pleasant photographs tend to elicit lower arousal levels than unpleasant ones. However, it may also be that these reports indicate the existence of sets of pleasant photographs that on average elicit lower-arousal levels than unpleasant photographs because they include both photographs that are “arousing” and “relaxing”.

Further evidence that might be discussed in this context involves Positron Emission Tomography (PET) studies. Lane *et al*. (1997) [18] found higher levels of activation of the thalamus and occipital cortex visual areas 18 and 19 in response to unpleasant IAPS photographs; these areas are, in principle, activated in cases of high arousal. Unexpectedly, cerebral activity level elicited by pleasant photographs was lower than that triggered by unpleasant stimuli. Since the pleasant photographs elicited significantly less electrodermic activity than the unpleasant stimuli, the researchers attributed the lower alteration in activation to their eliciting lower arousal levels. Another explanation would be that they in fact were more “relaxing”.

In relation to the significant difference in temperature alteration between the relaxing pleasant photographs and neutral ones, our results seem to point to the familiar increase in peripheral temperature in relaxation situations [19]. There was a trend for similar alterations in

temperature for the pleasant high-arousal photographs and for the unpleasant ones in relation to the neutral ones, suggesting that pleasure alterations in general affect this physiological variable. This effect possibly did not reach significance owing to high variability of responses or to low sensitivity of this measure.

In short, by obtaining measures of facial and visceral physiological reactions while viewing static IAPS stimuli we were able to subdivide pleasant stimuli into high- and low-arousal ones reflecting subjective ratings found in the Brazilian norms. This provides physiological support for the notion that the arousal dimension may in fact be subjectively evaluated using bipolar scales, ranging from “relaxing or calming” to “arousing”. It may be that this subdivision of pleasant stimuli has not been found previously due to the fact that positive affect is much harder to elicit in the laboratory. Alternatively, this may occur depending on the culture of the subjects under investigation. Harmon-Jones & Allen (2001) [20] showed that individual with different affective styles (based on resting asymmetries in the frontal brain regions) reacted differently to stimuli they deemed more positive. Such differences could in part be the basis of cultural distinction in reacting to affective stimuli, an issue that should be further investigated. Another alternative explanation suggested by an anonymous referee for the different physiological response to positive high and low arousal photographs considers approach vs. withdrawal motivational systems [for review see 21] and not appetitive and defensive systems used in the theory surrounding the IAPS pictures. Low arousal positive pictures may relate to states that do not motivate for any action, while the high arousal ones may do the opposite. The literature may gain from studies that take this into account when selecting appropriate test stimuli from the IAPS.

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Table 1: Mean and standard deviation (SD) scores of pleasure, arousal and dominance assessments obtained from the 24 volunteers to the different IAPS photograph sets: pleasant-arousing (PA), pleasant-relaxing (PR), neutral (N) and unpleasant (U) pictures.

Sets	IAPS no.	Description	**Pleasure**		**Arousal**		**Dominance**	
			Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
	4611	**Erotic Couple**	8.08	1.14	4.54	2.98	6.38	2.12
	4669	**Erotic Couple**	8.08	1.14	6.63	2.83	6.96	1.43
	4689	**Erotic Couple**	8.04	1.16	5.63	2.67	6.29	1.43
PA	**5910**	**Fireworks**	8.04	1.12	5.42	2.48	5.83	1.86
	7230	**Turkey**	7.63	1.13	5.13	2.46	6.54	1.41
	8185	**Skydivers**	7.58	1.44	5.46	2.60	6.21	2.34
	8370	**Rafting**	7.92	1.28	6.46	2.43	6.21	1.96
	8501	**Money**	6.96	2.07	5.92	2.19	6.67	1.97
	1710	**Puppies**	8.08	1.14	4.92	2.34	6.46	1.50
	2058	**Baby**	8.08	0.97	3.33	1.76	6.83	1.49
	2165	**Father**	7.54	2.06	3.29	1.81	6.21	1.82
PR	**2550**	**Couple**	7.96	1.40	2.79	1.44	5.29	2.05
	5780	**Nature**	8.21	1.10	2.96	2.33	6.13	1.78
	5830	**Sunset**	8.04	1.12	2.46	1.86	6.42	2.08
	5831	**Seagulls**	8.29	1.08	2.92	2.26	6.54	1.61
	7325	**Watermelon**	8.08	1.35	2.79	1.56	6.04	1.49
	2372	**Woman**	5.83	1.34	5.17	1.13	5.58	1.56
	5535	**Still life**	5.04	0.75	5.33	1.55	5.21	0.72
	7000	**Rolling Pin**	5.25	0.85	4.92	0.50	5.38	1.17
N	**7035**	**Mug**	5.46	1.14	4.38	1.10	5.38	1.21
	7130	**Truck**	5.58	1.50	5.46	1.61	5.21	2.06
	7184	**Abstract Art**	4.42	1.25	6.17	1.17	4.88	0.80
	7500	**Building**	5.33	0.92	5.25	1.22	4.63	0.88
	7705	**Cabinet**	5.42	1.28	4.38	1.47	5.50	1.06
	3053	**Burn Victim**	1.17	0.48	8.50	0.88	1.96	1.27
	3060	**Mutilation**	1.21	0.59	8.46	0.83	2.25	1.65
	3170	**Baby Tumor**	1.54	1.47	8.13	1.23	2.83	1.88
U	**3266**	**Injury**	1.04	0.20	8.58	0.93	2.83	2.06
	6260	**Aimed Gun**	1.96	1.27	8.42	1.10	1.75	1.07
	9300	**Dirty**	1.63	1.13	6.71	1.83	3.71	1.63
	9410	**Soldier**	1.79	1.56	7.96	1.43	3.04	1.97
	9921	**Fire**	2.13	1.51	7.79	1.18	3.42	1.18

Table 2: mean and standard deviation (SD) scores of corrugator EMG, skin conductance (SC) and peripheral basal temperature (TEMP) physiological measures according to type of IAPS photograph sets: pleasant-arousing (PA), pleasant-relaxing (PR), neutral (N) and unpleasant (U) pictures.

Sets	CORRUGATOR EMG		SC		TEMP	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
PA	0.052	0.43	0.222	0.55	0.029	0.03
PR	-0.027	0.63	0.092	0.43	0.032**	0.03
N	0.268	0.48	0.152	0.37	0.015	0.02
U	0.979*	1.36	0.333#	0.67	0.027	0.03

note: * $p<0.01 \neq$ PA, PR and N. # $p<0.02 \neq$ PR. ** $p \leq 0.05 \neq$ N.

Figure 1: Means (±SE) of the EMG change score to the different IAPS photograph sets: pleasant-relaxing (PR), pleasant-arousing (PA), neutral (N) and unpleasant (U) pictures. * $p<0.02 \neq$ PA, N and U.

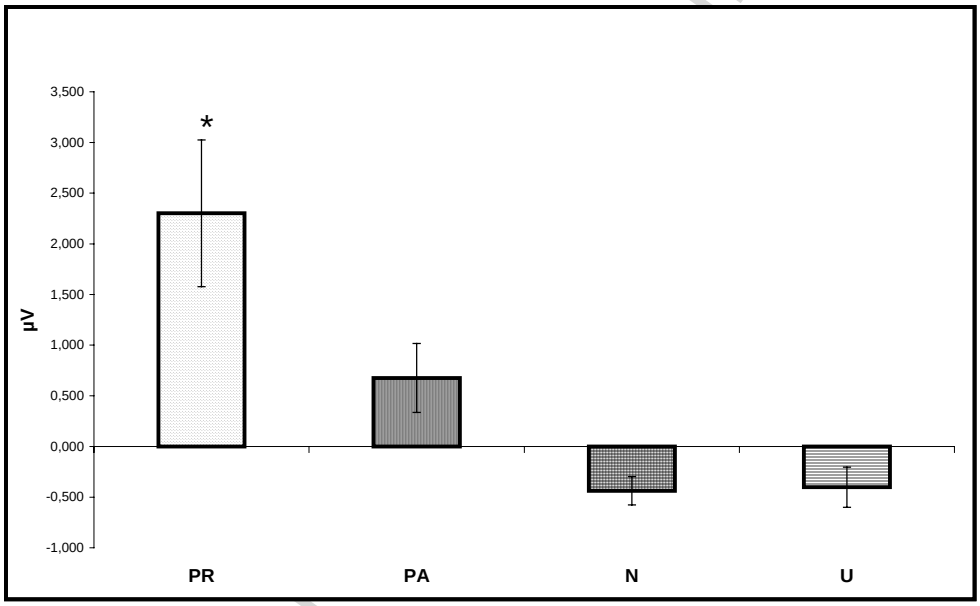

Figure 2: Means (±SE) of the heart rate to the different IAPS photograph sets: pleasant-relaxing (PR), pleasant-arousing (PA), neutral (N) and unpleasant (U) pictures. * $p<0.01 \neq$ PR and PA.