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Effects of exposure to food images on physiological reactivity and emotional responses in women with bulimia nervosa

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Abstract

Background: The aim of this study is to compare the effectiveness of two exposure procedures on habituation of emotional responses to food stimuli: (a) exposure to external cues (food images) without eating forbidden food (CE) and (b) exposure to external cues eating forbidden food (with purge prevention). The influence of craving-trait and mood state on the habituation process is also studied. **Method:** Emotional modulation of the defense startle reflex was assessed in 26 women at risk of bulimia nervosa. After four exposure trials, changes in the following variables were measured: (a) food craving-state; (b) physiological measures: hearth rate (HR) and skin conductance response (SCR); (c) motivational patterns towards food (defense startle response); and (d) valence, arousal and dominance of the emotional response to food images. **Results:** After treatment, subjects tended to show non-significant lower SCR and heart orientation responses (vs. defense responses); defense startle response was also significantly lower. **Conclusions:** The exposure procedure, the induced emotional state and the number of exposure trials are analyzed.

Keywords: Bulimia nervosa, exposure, emotions, psychophysiology, psychological intervention.

Resumen

Efecto de la exposición a imágenes de comida sobre la reactividad psicofisiológica y las reacciones emocionales en mujeres con bulimia nerviosa. **Antecedentes:** en este estudio comparamos la eficacia de dos procedimientos de exposición sobre la habituación de reacciones emocionales a alimentos: a) claves externas (imágenes de comida) sin ingerir alimentos prohibidos, y b) claves externas en personas que sí los han ingerido (impidiendo que se produzca el vómito). Además consideramos la influencia de la intensidad del craving rasgo y del estado de ánimo. Evaluamos la modulación emocional del reflejo defensivo de sobresalto motor (RMS) en 26 mujeres con riesgo de padecer bulimia nerviosa. **Método:** tras cuatro bloques de exposición, se midieron los cambios en: a) craving estado por la comida; b) tasa cardíaca (TC) y respuesta electrodérmica de conductancia (SCR); c) patrones motivacionales ante la comida (RMS); y d) estimaciones afectivas de valencia, arousal y dominancia de las emociones producidas por las imágenes de los alimentos. **Resultados:** como consecuencia del tratamiento los sujetos tendían a mostrar de forma estadísticamente no significativa menores SCRs y una tendencia de cambio de patrón de respuesta de defensa cardíaca (RD) a respuesta de orientación (RO); sí se apreciaban diferencias significativas en RMS. **Conclusiones:** se comenta el papel desempeñado por el tipo de exposición utilizado, los estados emocionales inducidos y el número de ensayos de exposición.

Palabras clave: bulimia nervosa, exposición, emociones, psicofisiología, intervención psicológica.

The relevance of classical conditioning procedures in the attainment of physiological responses of craving for substance consumption stands out in the field of addictive disorders (Tiffany, 1994). In the context of food disorders, food intake (unconditioned stimulus or US) is repeatedly associated with certain conditioned stimuli (CS) that can be both external (places, contexts, specific times, sight, smell or food texture), or internal (negative moods, feelings of loneliness, sadness, boredom, etc.). The presence of these cues generates a state of anticipatory anxiety that precedes eating binges. From a clinical perspective, and following Jansen's conditioning model of binge eating (1998), binge eating could be treated by intervening on the association between previous stimuli and the resulting physiological responses that are responsible for the appearance of an intense urge to eat. The idea is to individually expose patients to the eliciting stimuli with the purpose of extinguishing these conditioned responses and manage to spread this extinction to the different contexts that are meaningful for the patient. In the field of addictions (Havermans & Jansen, 2003), exposure with response prevention refers to treatment where a person who is addicted to a certain substance is repeatedly exposed to the stimulus associated with its consumption. These techniques use the anxiety reduction model as a basis to explain the persistence of bulimia nervosa (BN): the binge-purge cycle persists due to an immediate anxiety reduction effect (negative reinforcement) produced by the latter (Rosen, Leitenberg, Gross, & Willmuth, 1985). The elicited conditioned

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responses can be subjective (urge to eat), psychophysiological (changes in heart rate, pulse volume, changes in defence startle response) or behavioural (search for the substance), and they could motivate or increase the probabilities of persistence of the eating disorder. As Gómez (2007) and Gómez, Castro, García, Dúo and Yela (2003) point out, there are several exposure and response prevention methods in this field: exposure to binge eating and purge prevention, exposure to the cues that trigger binge eating and prevention of it, exposure to anxiety generating thoughts, planning of scheduled binge eating, exposure of the subject to her own body and to social situations that she tries to avoid.

One of these methods is exposure to cues associated with binge eating (*cue exposure, CE*). This method requires less professional and material resources for its setting up than other forms of exposure consisting in the intake of the forbidden food and purge prevention (Agras & Telch, 1998; Bulik, Sullivan, Carter, McIntosh, & Joyce, 1998). Throughout the sessions, the subject is exposed to the cues associated with binge eating (sight, smell, touch and handling of food), while being prevented from eating the food. Continued exposure to these stimuli leads to the extinction of the binge eating urge as a conditioned response and of the cephalic phase or hyperinsulinaemic and hypoglycaemic conditioned response that triggers it (Jansen, 1998; Benítez, Llamedo, Quintana, Gómez, & Yela, 2006; Gómez & Yela, 2006).

There are indeed data to support exposure as an effective therapeutic alternative (Bulik et al., 1998; Jansen, 1994; Toro, Cervera, Feliu, Garriga, Jou, Martínez, & Toro, 2003; Yela, Barreto, Gómez, Salgado, & Duque, 2008). It would even seem reasonable to measure the increase in treatment efficacy when systematic CE sessions are introduced. In this regard, although cognitive behavioural treatments for BN (Fairburn, Marcus, & Wilson, 1993) involve self-exposure to "forbidden food", attention is hardly ever paid to the assessment of motivational parameters and their emotional consequences. The evaluation of the defensive startle response (SR) could be of interest when assessing the efficacy of these exposure techniques.

Our study is the continuation of that conducted by Gómez, Yela, Salgado and Cortés (2011). Using the same sample, measuring instruments and general procedure, we aim to continue research in the field of emotional eating by focusing on the conditioning model of binge eating as an explanatory framework for the efficacy of exposure techniques in the treatment of eating disorders. From this perspective, negative moods would trigger binge eating in so far as they work as internal CSs; on the other hand, food intake—and therefore not being deprived—as well as triggering an emotional reaction of frustration would automatically elicit the *craving* response. When exposure to the CS is repeated or prolonged and there is no US, *craving* disappears, so that it could be interesting to use motivational and emotional variables to study this effect. The level of food *craving*-trait can also function as an internal conditioned stimulus. Theoretical models of emotional eating identify it as one of the clearest factors that trigger binge eating (Wathers, Hill, & Waller, 2001; Alpers & Tuschen-Caffier, 2001; Rodríguez, Mata, Moreno, Fernández, & Vila, 2007; Gómez et al., 2011). Nevertheless, on a more global level, when it comes to explaining the clinical efficacy of exposure techniques, the overall activation level during treatment is a variable of minor importance in the final result (Echeburúa, Corral, & Ortiz, 2008).

Working with the same sample that took part in the study by Gómez et al. (2011), our aim is to compare the efficacy of a procedure consisting of exposure to external cues (food images) without forbidden food intake, with exposure to external cues in subjects that have eaten such food (preventing purge). In addition, we also consider the role of the *craving*-trait and mood variables in achieving habituation in the same dependent variables used in the aforementioned study, namely: a) food *craving*-state; b) psychophysiological parameters of the cephalic phase (HR and SCR); c) defensive motivational patterns as a response to food (SR), and d) valence, arousal and dominance (SAM) of the emotional response to food images.

Method

Given the fact that this study is a methodological continuation of that of Gómez et al. (2011), in this instance we will briefly summarize the following sections, which are further developed in the aforementioned study.

Participants

We worked with the same 26 students of the Faculty of Psychology (average age= 21.5, *SD*= 1.2) as in the aforementioned study. Their body mass index (BMI) was between 18.36 and 35.99 (average= 22.12, *SD*= 3.68). They were selected from among 240 students based on their scores in the *Bulimic Inventory Test Edinburgh* [BITE] and in the *Food Craving Questionnaire-trait* [FCQ-T] questionnaires.

Tools

Biopac MP-150 computerized system for recording psychophysiological answers; Lafayette Mod. 15012 white noise generator connected to an amplifier with a full power output of 120 dB; Toshiba TDP-S35 projector for visualizing images on a 2 × 2 m screen; Superlab-Pro 2.0.4 software for image presentation management.

Measurements

Psychophysiological measurements. The calculation of the indices for each of the following variables was carried out using the same methodology as that used in the study by Drobes, Miller, Hillman, Bradley, Cuthbert & Lang (2001). For further details see Gómez et al. (2011):

- SR: Recording of EMG activity of the orbicular muscle of the left eye, within the 100 milliseconds following the beginning of the intense auditory stimulus.
- HR: A calculation was made between the average score resulting from 6 seconds of exposure to the image and the second before it was presented.
- SCR: Same calculation as for HR but using the maximum score.

Self-Report measurements:

- *Bulimic Investigatory Test Edinburgh* [BITE].
- *Food Craving Questionnaire-Trait* [FCQ-T] and *Food Craving Questionnaire-State* [FCQ-S].
- *Self-Assessment Manikin* [SAM].

Procedure

A 2 × 2 × 2 × 2 (×2) mixed factorial design was set, with a first factor consisting of 2 independent groups and referred to the *craving*-trait (higher or lower), a second factor referred to *deprivation* (deprived vs. non-deprived), a third two-group factor for *mood* (positive and negative), a fourth two-group factor—*emotional category of the images*—with two different levels (food and emotions, the latter classified as pleasant or unpleasant), and a fifth factor of repeated measurements—*assessment time*— with two levels (pre- and post-treatment following repeated exposure to food images).

The experimental approach was organized in four stages. The first two are devoted to the work of Gómez el al. (2011), which we will present once again in order to facilitate understanding of our study.

1. Induction of a positive or negative mood through exposure to 15 images belonging to the same emotional category selected from the Spanish IAPS.[1]
2. Twenty startle tests (pre-treatment assessment), where SR was tested using a white-noise generator for 50ms at an intensity of 120 dB (Drobes et al., 2001) while participants were exposed to 20 selected images also taken from the Spanish IAPS: 10 of food and 10 pleasant or unpleasant.[2] The food images and the pleasant vs. unpleasant ones were mixed; subjects were to complete the SAM and the FCQ-S (see Gómez et al., 2011).
3. Exposure to food images. Immediately after, participants were exposed four times to the same set of 20 images used in stage 2, in this case, with no startle white noise. In other words, a total of 80 images were presented during this exposure task. As in previous stages, we used the same stimulus presentation methodology as that used by Drobes et al. (2001), so that the images were shown for 6 seconds and the inter-assay interval ranged between 2.5 and 6 seconds.
4. Post-treatment assessment: SR, SCR and HR were assessed again using the same 20 startle tests upon exposure to 10 pleasant or unpleasant food images from phase 2. The remaining dependent variables were also assessed (SAM, FCQ-S and FCQ-T).

Data analysis

The Statistical Package for Social Sciences (SPSS) version 13 for Windows was used to carry out the statistical analysis. Mean differences were used to calculate group homogeneity at the beginning of the study regarding BMI and FCQ-S and BITE questionnaires (for further details see Gómez et al., 2011). As the purpose of this article is to shed further light on the effects of exposure to food images, we will focus on analysis where the pre- and post-treatment measurements of the different variables are compared.

At the inter-subject level, repeated measures ANOVA could not be performed to assess the role of post- vs. pre- exposure, as none of the variables had more than two levels. This was the reason we used *T*-tests for related samples when establishing such comparisons. The significance level was fixed at 5% in all cases.

Results

SAM

T-tests were conducted for related samples comparing pre- and post- measurements in the different SAM emotion estimations (see figure 1). A tendency towards significance in the valence dimension (t= -1.84, p= .08) was observed, so that the food images tended to be perceived as more unpleasant after exposure (M= 4.13; SD= 1.59) compared to the beginning (M= 3.84, SD= 1.53). These valence changes do not involve the variable *craving*-trait FCQ-T, although there were differences regarding moods (subjects who experienced positive emotions found the images significantly more unpleasant after exposure, M= 3.14, SD= 1.16, than at the beginning, M= 2.62, SD= .74, t= -2; p= .07- while no significant changes were perceived in those who experimented negative emotions) and depending on the deprivation variable (deprived subjects found the food images more unpleasant after exposure, M= 4.51, SD= 1.17 than at the beginning, M= 4.14, SD= 1.23, t= -2.18, p= .05). No significant changes were perceived in non-deprived subjects.

SCR

T-tests were carried out for related samples comparing pre- and post- measurements when exposed to food images vs. other stimuli

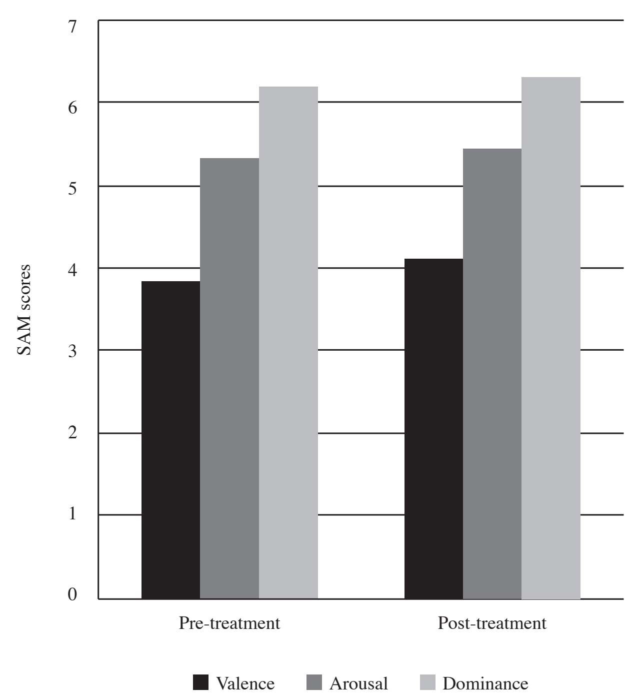

Figure 1. *Scores in the valence, arousal and dominance dimensions of the SAM when exposed to food images during pre- and post-treatment stages*

[1] The IAPS images used in our study were those used by Drobes et al. (2001). Positive emotions: 2341, 2352, 2387, 2395, 2665, 4614, 4622, 4623, 4625,4626, 4670, 4687, 5831, 8461, 8496. Negative emotions: 2399, 2455, 6315, 9429, 2375.1, 3550.1, 2688,9435,9635.1, 9253, 9280, 3005.1, 3150, 9341, 6415.

[2] Food images: 723, 733, 735, 740, 741, 743, 745, 746, 747, 748. Pleasant stimuli images: 144, 208, 466, 468, 819, 820, 837, 847, 849, 851. Unpleasant stimuli images: 107, 112, 130, 212, 300, 301, 313, 315, 602, 619.

(figure 2). Positive differential scores show that SCRs were higher in the case of exposure to food images than during the second before baseline. No significant changes were perceived as a result of the exposure sessions, neither in relation to the food images, *t*= -.23, *p*= .82 (*Mpre*= .28, *SD*= .30; *Mpost*= .29, *SD*= .41), nor in relation to the images corresponding to other stimuli, *t*= 1.40, *p*= .17 (*Mpre*= .21, *SD*= .25; *Mpost*= .14, *SD*= .21).

Although no significant habituation was perceived in the global sense, effects of habituation can indeed be perceived depending on the mood and deprivation level variables: a) habituation to the non-food-related images was perceived in the subjects who experienced negative emotions (*Mpre*= .23, *SD*= .31; *Mpost*= .09, *SD*= .12), *t*= 2.14, *p*= .05, but not in those belonging to the positive emotions group; b) habituation to the images corresponding to other types of non-food-related stimuli was perceived in non-deprived subjects (*Mpre*= .23, *SD*= .20; *Mpost*= .11, *SD*= .18), *t*= 1.96, *p*= .07, when compared to those deprived.

HR

T-tests were carried out on related samples comparing pre- and post- measurements when exposed to food images vs. other stimuli (Figure 3).

No significant changes were perceived as a result of exposure sessions, neither in relation to food images, *t*= 1.34; *p*= .19 (*Mpre*= -.46, *SD*= 2.76; *Mpost*= -1.22, *SD*= 2.52), nor in relation to the images corresponding to other stimuli, *t*= 1.06, *p*= .30 (*Mpre*= -.30, *SD*= 2.03; *Mpost*= -1.01, *SD*= 2.89).

However, there are differences in the mood variable that follow a significant pre- post- trend (see Figure 4) when exposed to the food images in those subjects who experienced negative emotions (*Mpre*= .13, *SD*= 3.07; *Mpost*= -1.09, *SD*= 1.49), *t*= 1.87, *p*= .09, which is not the case for the positive emotions group. Significant pre- post- differences when exposed to images corresponding to stimuli other than food were perceived in the negative emotions group (*Mpre*= .52, *SD*= 2.08; *Mpost*= -1.87, *SD*= 3.86), *t*= 2.16, *p*= .05, although not in the positive emotions group.

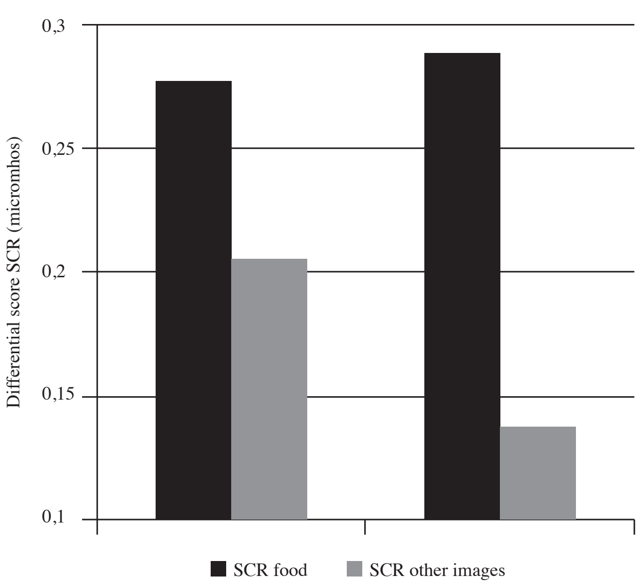

Figure 2. *Differential scores in SCR (micromhos) when exposed to food images and other images in pre- and post-treatment stages (SCR differential score = max. SCR during the 6 seconds of exposure to the stimulus – max. SCR in the immediately previous second)*

SR

As shown in Figure 5, habituation effects were perceived both in relation to the food images (*Mpre*= .00137, *SD*= .0002; *Mpost*= .0012545, *SD*= .00018, *t*= 2.433, *p*= .02) and in relation to those corresponding to other stimuli (*Mpre*= .0013803, *SD*= .00019; *Mpost*= .0012574, *SD*= .00015, *t*= 2.88, *p*= .01).

There were also differences in habituation depending on the FCQ-T, so that subjects that had obtained low FCQ-T scores were closer to habituation when exposed to food (*Mpre*= .0013908, *SD*= .00022; *Mpost*= .0012332, *SD*= .00019. *T*= 1.99, *p*= .07) and became significantly accustomed to exposure to other stimuli

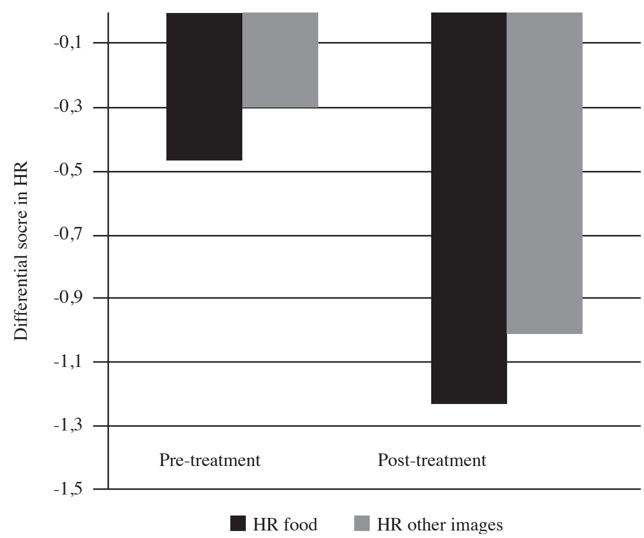

Figure 3. *Differential scores in HR when exposed to food images and other images in pre- and post-treatment stages (differential score in HR = average HR during the 6 seconds of exposure to the stimulus – average HR in the immediately previous second)*

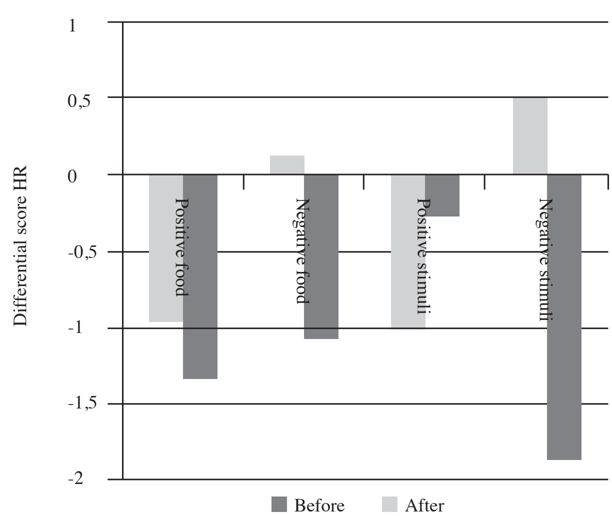

Figure 4. *Differential scores in HR before and after exposure to food images and other food; effect of positive and negative emotions on HR habituation*

(*Mpre*= .001432, *SD*= .00020; *Mpost*= .0012420, *SD*= .00017. *T*= 2.53, *p*= .03), in relation to those who had obtained high FCQ-T scores, who did not become accustomed to any type of image.

Depending on the mood variable, habituation was only perceived in those subjects who experienced negative emotions when exposed to other stimuli (*Mpre*= .00138558, *SD*= .00021327; *Mpost*= .0012486, *SD*= .00017505. *T*= 2.95, *p*= .04), although this was not the case when they were exposed to food images. Depending on the deprivation variable, habituation was perceived in the deprived subjects when exposed to food images (*Mpre*= .0014358, *SD*= .0002631; *Mpost*= .0012301, *SD*= .00024113. *T*= 2.35, *p*= .04), but not when exposed to other stimuli (*Mpre*= .0013042, *SD*= .00003106; *Mpost*= .0012790, *SD*= .00007115. *T*= 1.34; *p*= .20).

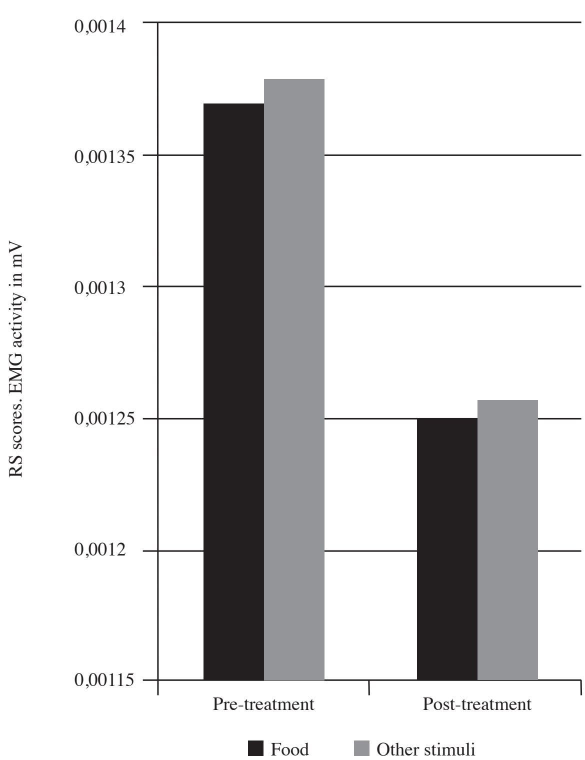

Figure 5. *Pre- and post-treatment SR scores when exposed to food images and other stimuli (SR was assessed through EMG activity in mV of the orbital region of the left eye, starting within the 100 milliseconds after the beginning of the intense auditory stimulus)*

Discussion and conclusions

In terms of emotion triggered by the images (SAM), treatment seems to modify the valence dimension only, increasing the unpleasant emotional reaction in deprived subjects who experience positive emotions before exposure. In this regard, certain factors that determine efficacy in exposure techniques should be taken into account: attention levels that are not optimal (exposure to images in the deprived group, or *partial exposure*) and distraction at the emotional level (positive emotions that are not internal CSs) are likely to influence subjects' assessment of those images to which they have been exposed as the most unpleasant; this is not the case under the rest of conditions (non-deprived or *total exposure* group; negative emotions). It seems necessary to safeguard these parameters so as not to significantly worsen the results of exposure (Echeburúa et al., 2008).

No significant changes were perceived in the emotional estimates of *arousal* and dominance, which could be due to an insufficient number of exposure trials. In spite of this, the effects are promising, since there was a tendency for subjects to feel more relaxed and in control when exposed to the food images.

No habituation effects were perceived in the *craving*-trait scores (FCQ-S), so that exposure treatment does not seem to modify situational anxiety for food.

No significant habituation was perceived in SCR resulting from treatment, although results showed a decreasing trend when exposed to other types of images, and a non-decreasing trend when exposed to food images. This is a foreseeable difficulty with respect to this sample. As far as the influence of other variables is concerned, the subjects have more difficulty in growing accustomed to food images when they experience positive emotions while deprived (when they are not exposed to internal CSs). As we have just seen in the emotional valence dimension of emotional estimates, the insufficient number of tests, inadequacy in attention levels and emotional distraction seem to also hinder habituation regarding this variable.

As for HR, negative differential scores show that HR was lower during exposure to the images than in the second immediately before baseline, which implies the presence of an OR pattern. Generally speaking, no habituation effect is perceived at heart level since, both before and after, their reaction continues to show OR to all types of stimuli.

In line with Abascal and Roa (2008), we recall that orienting responses and defence are antagonistic physiological patterns related to pre-attentional perceptual systems, which produce changes in receptors' sensitivity. OR (decrease in HR) is part of an independent functional system that is triggered by new, surprising or unexpected stimuli. This response is associated to a sensitivity increase in the sensory organs to increase and optimize the body's receptivity, as well as in the central processing levels. Nevertheless, CDR (increase in HR) is a defence reaction that is triggered by potentially dangerous or very high intensity stimuli, its functions seeming to be the limitation of the effects this type of stimuli could have on the body. Thus, for example, the number of defence responses produced by those subjects with anxiety disorders is higher compared to those who do not suffer this type of disorder, and the former also show a much lower habituation rate of CDRs than those who do not suffer from anxiety.

As for the effects of emotions on HR, a significant level of habituation can be perceived when exposed to other images, and a marginally significant one when exposed to food while the mood is negative. In both instances, negative emotions generate a CDR pattern that leads the subjects to perceive all stimuli as potentially dangerous or very intense. Under these circumstances, exposure treatment proves effective and eventually leads to a decrease in cardiac reactivity, which acquires a more adaptive OR. The presence of these negative emotional states, typical of binge eating episodes, favours a defensive pre-attentional reaction by the subject to all types of stimuli; this is when exposure manages to modify reaction until it is no longer defensive. However, when subjects are affected by positive emotional states, the images are perceived as less dangerous, which increases the difficulty in achieving a significant level of habituation. In this way we can conclude that our results concerning this variable support the theory that emotional states modulate subjects' pre-attentional reactions when exposure techniques are used, thus facilitating habituation processes when they are similar to their own internal CSs, and increasing their difficulty when the subjects experience positive emotional states.

No pre-post differences are perceived as far as HR is concerned, based on FCQ-T scores, which partly confirms the results already obtained. As Echeburúa et al. (2008) point out, if exposure is kept constant, the activations experienced by the subject during the process are of little relevance in the final results.

Both when exposed to food images and when exposed to other stimuli, there is a habituation effect in SR; in both cases the stimuli generate a less defensive motivational state than at the beginning. In this instance, it seems that the general *craving*-trait level does indeed influence the efficacy of the exposure technique: people with low levels of anxiety habituate more easily, so that their defensive motivational system becomes significantly weaker. When the emotional factor is taken into account, the presence of positive mood states conflicting with the internal emotional CSs of the subject makes SR habituation more difficult. Nevertheless, contrary to the results obtained in relation to the rest of dependent variables, in this case partial exposure (deprived group) has achieved a decrease in the defensive motivational state when exposed to the images. It might be worth interpreting that, since the aforementioned implies exposure only to the external elements of the stimulus (images), SR habituation is more easily achieved in relation to exposure to both the internal and external dimensions of the stimulus (eating high-calorie food and exposure to food images). The role played would be similar to that of an exposure hierarchy. From this perspective, it could function as an indicator of the highest degree of aversion when subjected to this type of exposure (internal and external) in relation to exclusively external exposure.

As a whole, all the results described have significant implications for the clinical area. No significant habituation effects resulting from the performed exposure were perceived. This could be interpreted on the basis of the high levels of reactivity elicited by the food images when compared to other images in people susceptible to suffer from bulimia nervosa; it could be concluded that the use of processes involving longer exposure times to those used in our laboratory study could achieve this goal. Nevertheless, despite this, the trend in the variables following exposure was to display weaker SCRs, patterns of OR as opposed to CDR, and weaker SR. As far as the modulating variables are concerned, the superiority of exposure processes that combine external CSs (food images) and internal ones (food intake) is clear, as well as those in which a negative mood has been generated, similar to their own internal emotional CSs triggered by food. All this would generally support Jansen's conditioning model of binge eating and the usefulness of *CE*. Despite the limitations of our study (with regard to the size of the final simple, the severity of their eating disorders and, above all, with regard to the brief laboratory exposure process), the startle reflex test and the OR/CDR pattern could prove extremely useful to assess changes in the aversive motivational system and in pre-attentional patterns triggered by food images in this type of population.

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