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Emotion processing without awareness: Features detection or significance evaluation?

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ABSTRACT

Studies on the physiological responses to emotional stimuli demonstrated that they can occur even when emotional stimuli are not consciously perceived. In this study, the subliminal stimulation was obtained by means of Backward Masking. Specifically, we analyzed the cardiac and electrodermal responses evoked by the unmasked and masked presentation of spider shapes in arachnophobic individuals. To evaluate whether unaware processing entails discrimination of physical features vs emotional significance, crabs, morphologically similar to the spiders but different for emotional significance, and squirrels, different in both shape and emotional content, were also employed.

The response to unmasked spiders consisted of a typical defense response (sympathetic activation), while that to innocuous stimuli of an orienting response (moderate electrodermal and vagal activations). In the subliminal condition, the electrodermal response to masked spiders was greater than that to the other animals suggesting an early detection of emotional content rather than of physical characteristics. In contrast, cardiac responses to the masked stimuli did not show any differences as a function of valence.

These findings suggest that individuals can appraise the emotional content of unconsciously perceived stimuli and react with an arousal response. However, subliminal emotional stimuli does not seem able to elicit the complete pattern of autonomic responses typical of the defense response.

1. Introduction

Several evidences have indicated that elaboration of emotional information can occur without awareness. de Gelder et al. (1999) have described the case of a patient (G.Y.) with lesion of the left visual cortex and right hemianopia, blind for faces presented in the hemifield contralateral to the lesioned cortex but, on the other hand, able to discriminate facial expression with a certain degree of accuracy. In the same patient, the non-conscious perception of emotions could also influence the recognition of normally seen emotional faces. Recently, a similar interaction across hemispheres between conscious and non-conscious perception of emotions has been described also in normal observers (Tamietto and de Gelder, 2008).

Studies on the physiological responses elicited by emotional stimuli also demonstrated that affective modulation of peripheral responses can occur even when these stimuli are not consciously perceived. In particular, by using Backward Masking, a well known method suitable for producing a condition of "unawareness" of a stimulus by means of the subsequent presentation of a patterned "mask" (Enns and Di Lollo, 2000), it has been found that masked affective pictures are able to evoke electrodermal (Öhman and Soares, 1993; Öhman and Soares, 1994), startle and cardiac responses (Ruiz-Padial and Vila, 2007; Ruiz-Padial et al., 2010) and activate those cerebral areas involved in emotion processing such as the amygdala-prefrontal cortex network (Whalen et al., 1998; Morris et al., 1998; Gläscher and Adolphs, 2003; Williams et al., 2006). On these bases, it can be hypothesized that the explicit identification of emotional valence of stimuli is not a necessary prerequisite for the appraisal of their biological relevance.

Nevertheless, some findings have challenged the "unconscious affective processing" hypothesis. One of the most critical issue concerns the adequate assessing of perceptual awareness (Cornwell et al., 2007). In fact, for instance, it has been shown that many individuals can discriminate masked target faces with extremely short SOAs (17–33 ms) (Maxwell and Davidson, 2004; Pessoa et al., 2005), and, also, that responses can be driven by detectable differences such as luminance or stimulus size (i.e. Morris et al., 1998) independently of forming representations necessary for stimulus identification (Lovibond and Shanks, 2002; Pessoa, 2005).

Moreover, it is not clear which type of stimulus analysis could be pre-attentively made. According to some authors it would consist of a pre-semantic analysis based on the fast and rudimentary detection of stimulus features (features detection). On the contrary, other authors consider the pre-attentive elaboration as the implicit analysis of stimulus meaning (significance evaluation) that would be successively

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followed by a full semantic decoding (Van den Hout et al., 2000). Common to both hypotheses there is the assumption that automatic elaboration necessarily involves the arousal system activation to dispose the organism to a ready reaction to potentially threatening events. In this regard, however, it is still controversial whether the autonomic changes evoked without the aware perception of the aversive stimulus represented a generic orienting response or an early defense response. Although the orienting and the defensive reflexes are functionally different, they are both characterized by an increase in skin conductance. One of the easiest way to discriminate the two reflexes is to examine the heart rate changes: the orienting reflex is associated with heart rate deceleration, while the defensive reflex with heart rate acceleration (Graham, 1979; Graham and Clifton, 1966).Thus, two different patterns of autonomic activity can be associated with the two behavioral reactions. Namely, HR acceleration associated with electrodermal activation would be the expression of the typical defense reaction, while, HR deceleration joined to moderate electrodermal activation would reflect a general orienting response to relevant stimuli regardless of their valence (Campbell et al., 1997).

Previous studies investigating the non-conscious modulation of the cardiac defense response by masked emotional pictures are controversial. In fact, while in a previous study Ruiz-Padial et al. (2005) found a small but significant effect of a masked phobic stimulus on the potentiation of the cardiac defense response, in a more recent study on the effect of masked emotional pictures on emotion-modulated phasic heart rate (Ruiz-Padial et al., 2010), the same authors did not find any differential HR responses as a function of valence.

The present research was designed to clarify:

1) whether pre-attentive processing is based on the discrimination of the features or of the significance of the affective stimulus.
2) whether the autonomic reactions evoked by the "unaware" exposition to fearful stimuli represent a generic orienting response or an early defense response.

To this aim, we analyzed the cardiac and electrodermal responses of arachnophobic individuals exposed to the masked presentation of the shapes of spiders that represent their phobic object, crabs that are morphologically similar to the spiders but different as for emotional significance, and squirrels that are different from the spiders in both shape and emotional content.

In addition, in order to identify possible residual awareness of the masked stimuli, we checked the efficiency of the mask at each presentation by means of a subjective criterion based on a forced choice test.

2. Methods

2.1. Subjects

Volunteers were recruited from a group of 190 students at the University of Pisa. The Italian version of the Spider Phobia Questionnaire (SPQ) (Klorman et al., 1974; Sarlo et al., 2002) was used to rate the aversion to spiders of each subject. In subjects with scores higher than 20, the presence of specific phobia for spiders was assessed by a psychiatrist, according to the DSM-IV (American Psychiatric Association, 2000). Eighteen individuals (2 males, 16 females, age 22.92 ± 2.46, mean ± SD), with a mean SPQ score of 24.22 (range 21–28), corresponding to the 90° percentile of the sample's scores distribution, were assigned to the group of Phobics. Eighteen participants (2 males, 16 females, age 23.53 ± 1.99) with a mean SPQ score of 2.5 (range 0–5) corresponding to the 60° percentile of the sample's distribution served as controls.

The prevalence of women in our sample of phobic individuals reflects the gender differences in the prevalence of animal/spider phobia in the general population (Fredrikson et al., 1996).

Subjects included in the study were drug free, had normal or corrected-to-normal vision and did not present any medical, neurological or psychiatric disorders, apart from phobia.

2.2. Stimuli and procedure

A schematic drawing of the experimental paradigm and stimuli is shown in Fig. 1. Test stimuli consisted of spider, crab and squirrel schematic shapes, coloured in grey. Four different shapes for each animal category were employed. Crabs and spider shapes were matched for orientation. They were presented in the centre of a screen at a distance of 57 cm from subject's eyes so that each image covered an area

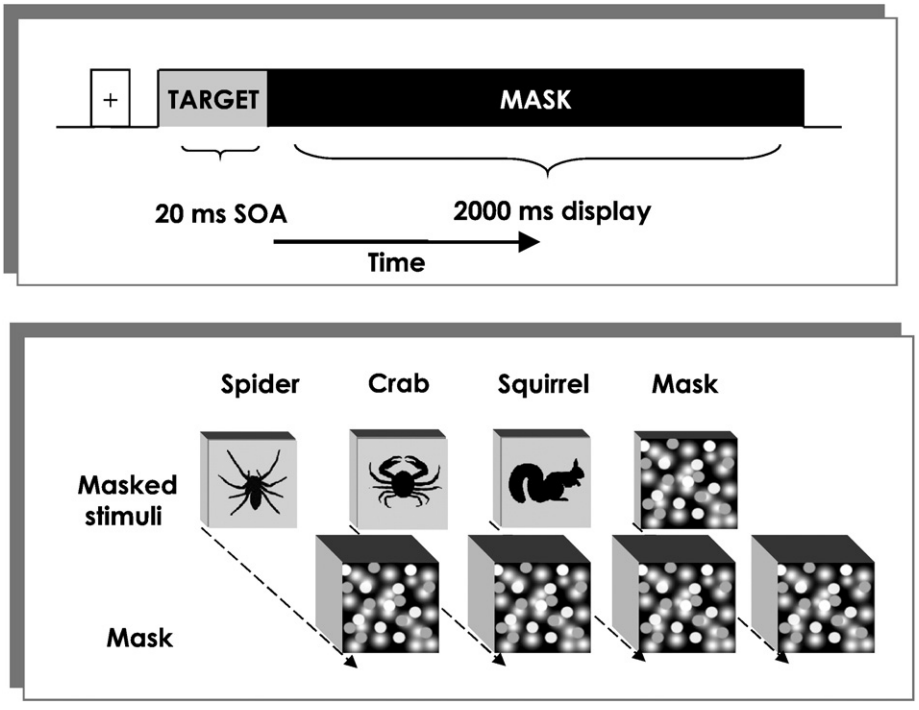

Fig. 1. Subliminal session. Schematic representation of the experimental paradigm and stimuli.