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Fear-inhibited light reflex: effects of conditioned stimulus intensity and fear stimulus modality

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Background

Fear conditioning (e.g., by the threat of an electric shock) causes an increase in initial pupil diameter, and a decrease in the amplitude of the light reflex response ("fear-inhibited light reflex"). Studies of the fear-inhibited light reflex have always assumed that the conditioned stimulus (a low intensity acoustic tone) has no effect in itself, on any of the two pupillary responses to threat. Furthermore, these studies have uniformly employed a standardised light intensity as the unconditioned stimulus while for fear conditioning, they have always employed the association of the conditioned stimulus to a potentially painful tactile electric shock. The aim of this parametric study was to examine the role of conditioned stimulus, light intensity and fear stimulus modality in the mediation of the fear-inhibited light reflex.

Material and Methods

16 healthy male volunteers aged 20–25 years participated in one experimental session. Pupil diameter was monitored in the dark, in dark-adapted eyes by an infra-red binocular television pupillometer (PROCYON 2000D). The experimental session consisted of three parts, and each part comprised six identical blocks of four 200 ms light stimuli (0.35, 5, 50 and 140 cd/m^2). In Part 1, responses in each block were recorded under either the presence or the absence of a continuous low intensity acoustic tone, in an alternating fashion. In this part, the presence of the acoustic tone was not associated with any threat. In Parts 2 and 3, responses in half the blocks were recorded under the presence of the same continuous low intensity acoustic tone, which was associated with the anticipation of an electric shock (threat of shock – "Tsh" blocks) in Part 2, and with the anticipation of a sound blast (threat of sound blast – "Tsb" blocks) in Part 3. The remaining half of blocks in Parts 2 and 3, were recorded under the absence of the acoustic tone (safe condition – "S" blocks);"S" and "Tsh" blocks in Part 2 and "S" and Tsb" blocks in Part 3 alternated regularly. No shocks or sound blasts were in fact administered at any point during the session. At the end of each S, and Tsh or Tsb block in Parts 2 and 3, subjects self-rated their mood and feelings on Visual Analogue Scales.

Results

Part 1: the presence of the acoustic tone did not affect the light reflex response amplitude across all four light intensities but it was associated with a trend for an increase in initial pupil diameter. Parts 2 and 3: "Tsh" and "Tsb" blocks were associated with significant increases in initial pupil diameter and subjectively rated "anxiety" and "alertness", and a decrease in the amplitude of the pupillary light reflex response across all light intensities, the threat of shock being more potent in effecting the pupillary results. Calculation of the effect of threat (safe-threat subtractions) on light reflex amplitude and subsequent analyses of these derived data with 2-way ANOVAs (fear stimulus modality and light intensity as the within-subject factors), revealed a significant main effect of light intensity but no significant interactions.

Discussion

These results suggest that the conditioned stimulus per se does not modify the light reflex response unless it is associated with a fear stimulus (threat). The fear-inhibited light reflex is independent of the modality of the fear stimulus and may be sensitive to variations in the amount of fear induced by different fear stimuli (threats). Finally,

these results suggest that the manifest effect of threat on light reflex amplitude is greater, with increasing light intensity.