

Psychogenic influences on the cardiac response of the duck (*Anas platyrhynchos*) to forced submersion

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The dabbling duck (*Anas platyrhynchos*) shows very different cardiac responses when dabbling voluntarily compared with forced submergence of the head (Butler & Jones, 1968; Gabrielsen, 1985). In forced dives the response involves pronounced bradycardia and peripheral vasoconstriction, which results in blood flow being distributed preferentially to those organs susceptible to a lack of oxygen. In contrast, in voluntary dabbles little change in heart rate occurs during submergence of the head (Gabrielsen, 1985). Hence it is often claimed that in forced dives the response is a product of, or is accentuated by, fear or stress (Kanwisher, Gabrielsen & Kanwisher, 1981).

In experiments designed to investigate the influence of psychogenic mechanisms on the response to forced diving we found that repeated dives caused the response to habituate. Habituation was so pronounced in some ducks that after 100 training sessions the bradycardia during 40 s forced dives was abolished. Habituation of the cardiac response appeared dependent on the intensity of chemoreceptor stimulation, because the bradycardia was present in all dives if the duck breathed 15% O₂ before submergence. Maintained sensitivity of arterial chemoreceptors was implied by the lack of change in oxygen breathing tests before and after training. These results suggest that habituation is the reason for the different cardiac responses in long free and forced dives.

On the other hand, bradycardia in forced dives was prevented in naïve ducks by permitting them to breathe 100% O₂ before a dive. This argues against the contention that the diving response is a fear response. Furthermore, the diving response remained intact following transection across the rostral mesencephalon below the level of the hypothalamus in ducks decerebrated some weeks previously under 'Halothane' anaesthesia. We believe that these results show that the forced-dive response is largely reflexogenic and that psychogenic influences play a larger role, with respect to the cardiac adjustments involved, in voluntary rather than forced dives.

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