Investigating the electrical response of the brain of the domestic chicken (*Gallus gallus domesticus*) to nociception through the use of depth electroencephalography (dEEG)

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Abstract

Nociception is an unavoidable side effect of many routine management and clinical procedures in animals. Electroencephalography (EEG) has previously been used to investigate the effect of nociception on mammalian brain activity. This study aimed to develop a method of assessing the avian response to nociception through depth electroencephalography (dEEG) of brain regions believed to be involved in central pain processing. Two groups of chickens were used in this study to investigate two brain regions, the rostral hyperpallium apicale (HA) and the caudomedial nidopallium (NCM). These regions were chosen due to the afferent and efferent projections they receive from the sensory thalamus and their previous implication in pain processing. Subjects were anaesthetised, and a concentric needle electrode was inserted into the brain to record the electrical activity in response to a number of stimuli. These stimuli included one non-painful, somatosensory stimulus, and four nociceptive stimuli (mechanical, thermal, feather removal and electrical). The dEEG data was then run through a spectral analyser which generated the median frequency (F50), spectral edge frequency (F95) and total power (P_{TOT}). Inspection of these variables determined that within the HA there were two populations of birds, therefore these birds were treated as separate groups in the analysis (hHA and lHA).

It was seen that spectral characteristics of the three groups investigated differed significantly, indicating differences in activity and function. The response to stimulation was seen to be significantly different between these brain regions. Following stimulation, the hHA was seen to have a significantly lower percentage of baseline spectral edge frequency and median frequency compared to the NCM and lHA. In response to stimulation the activity of the NCM and lHA remained constant and showed no distinguishable response, while the hHA was more variable. The hHA was much more variable. Although there was no consistent response to stimulation, there was a significant decrease in total power following electrical stimulation in the hHA.

This study presents a number of interesting findings and demonstrates that different regions of the brain respond in differing ways to stimulation. The findings suggest that the hyperpallium apicale may respond to nociceptive stimulation, however further work is required to distinguish this. The presence of two populations within the HA group suggests that recordings were taken from two distinct brain regions, one of which displayed comparatively higher sensitivity to nociceptive stimulation. Elucidation of this brain region and further research into the response to nociception is required to further understand the

response of the avian brain to pain. For future studies, the development of more precise methods will be required to enable more accurate recording of the activity occurring throughout the avian brain.

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Abbreviations

ACC – Anterior cingulate cortex

EEG – Electroencephalogram

dEEG – Depth electroencephalogram

FFT – Fast Fourier transformation

F50 – Median frequency

F95 – Spectral edge frequency

hHA –'High' Hyperpallium apicale

lHA – 'Low' Hyperpallium apicale

NCM – Caudomedial nidopallium

P_{TOT} – Total Power

S1 – Primary somatosensory cortex

S2 – Secondary somatosensory cortex