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Organization of Nucleus Laminaris in Different Species of Birds

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Bird species with complex vocalization systems are widely used as models to study auditory computation. Auditory psychophysical tests of small birds such as budgerigars, zebra finches, and canaries show that they share a high degree of both spectral and temporal resolving ability. Birds appear to be almost three times more sensitive than humans to changes in temporal fine structure. In sound localization experiments canaries have similar localization abilities as budgerigars, but zebra finches are about three times worse than both of the other species. Temporal coding precision must have its substrate in the central auditory system of these birds. While complex auditory processing should take place in higher neuronal centers, the temporal features of the stimulus must be faithfully preserved throughout the pathway to ensure precise computation. We have taken a bottom up approach to this problem by analyzing the neurons and synaptic organization of the auditory hindbrain in zebra finches canaries and budgerigars. The overall organization of the cochlear nuclei was comparable in these three species. We found, however, differences in the expression of calcium binding proteins. Both zebra finches and canaries, but not budgerigars, show high expression of calretinin in all auditory nuclei. Budgerigars express parvalbumin in all three auditory nuclei and calbindin in nucleus laminaris. In addition, we found differences in the morphology of cells in nucleus laminaris. While the overall organization of the auditory circuit is fundamentally similar, small differences in the components may contribute to the precision of temporal coding along the brainstem temporal axis.