Carpenters and Drummers

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The unusually large numbers of tau proteins that have been found in the brains of members of the Picidae family may be an indication that woodpeckers sustain neurological trauma from their activities. At a pecking frequency of twenty strikes per second and an impact speed of 25 km/h, the braking forces can be as strong as 1200 g. The composition of the skull with its partly spongy bone structure, the low volume of cerebrospinal fluid, the strong neck muscles, the unequal length of upper and lower bill which creates a cushioning effect, the highly elongated and curved hyoid bone and the position of the brain not directly behind but slightly above the chisel-like bill—all these factors seem to be an indication of a very practical model for biomimicry that could be applied, for example, to the design of protective helmets. All the anatomical features listed here serve to cushion and transfer impact forces in order to protect the brain. The birds' need for this is undeniable: some woodpeckers strike up to 12,000 blows per day. Massive headaches and brain damage, which would quickly result from the impact of such forces on the skull of a *homo sapiens*, would be incompatible with the lifestyle of these birds. It is assumed that the combination of the mechanisms mentioned above provides reliable protection for the brain. However, the extremely high concentration of tau proteins, which has not been observed in of *Agelaius phoeniceus* for instance, might suggest something else. In humans, such a concentration would indicate craniocerebral trauma, acute stroke, Creutzfeldt-Jakob disease or other degenerative neurological disorders.

Would bionics then be wrong to take the anatomical blueprint of these "carpenters and drummers of the forest" as a model for constructing helmets or containers for fragile technical components?

A closer examination of woodpecker behavior reveals just how crucial knocking, chiseling, and drumming is for species like the black woodpecker or the great spotted woodpecker—and not only in the context of looking for food.

Woodpeckers start to drum intensively in late winter and spring. They seek out suitable resonating bodies to use for social communication through drum rolls—an effective means of conveying information over long distances in a densely overgrown environment with poor visibility. The sound of their drumming carries for two to three kilometers. Experienced ornithologists can identify every domestic woodpecker species by its unique drumming rhythm—if the species uses drumming for communication. *Leiopicus medius*, for example, does not drum at all, or does so only in extremely rare conflict situations. *Dendrocopos major*, the great spotted woodpecker, is an assiduous drummer. Since it is also the most common woodpecker in our part of the world, its rhythm is the most familiar to our ears. Instead of hollow trees, the birds often use building facades, tin roofs, and fiber cement panels, since these materials not only make excellent resonating bodies, but also allow the birds to give their sounds a personal character. For drumming rhythms not only allow woodpeckers to recognize members of the same species, they also convey additional information. Males use them to mark their territory and keep rivals at a distance while simultaneously attracting females. Both endeavors only seem to succeed, however, when the information is transmitted with conviction. While the human ear is incapable of differentiating between the drumming frequencies in this way, and while science can only do so with the right technical equipment, other woodpeckers can evidently detect a potential rival's ability to put up a fight from the sound of his drumming, while a female woodpecker can ascertain a male's fitness and assess his desirability as a mate. When a male and a female come together, the male drums to point out suitable places for building nests in his territory or guides her to existing cavities. When the courtship display is well advanced, the mates will drum together to become attuned and "synchronized" to each other.

The woodpeckers' building activities are of special ecological significance. They use their chisel-like bills to excavate nest hollows in suitable tree trunks—a herculean task that may take years to complete. For example, *Dryocopus martius*, the largest woodpecker native to our region, may take up to seven years to build a suitable nest cavity in a European beech. Such cavities can be used for up to fifty years by woodpeckers and successor species (including stock doves, tawny owls, and bats). A black woodpecker's nest hollow is approximately 40 cm deep and features an overhang at the top of the entrance and a beveled lip at the bottom edge. In this way, the avian carpenter ensures that its chicks are safely out of reach of birds of prey and keeps them from drowning when it rains. To excavate a hollow in the hard beechwood, woodpeckers depend on the help of wood-eating organisms. A black woodpecker's territory often contains several partially completed hollows, where wood-rotting fungi can do their job before the woodpecker continues its chiseling the following year. Large, elongated hollows in dead trees made by black woodpeckers are signs of foraging activity; nesting hollows are not built in such trees.

So we can conclude that woodpecker brains must indeed have excellent protection, since the extreme forces to which they are subjected would otherwise quickly prove fatal. Further research is needed to determine whether woodpeckers sustain cumulative neurological damage in the course of their lives, as the current sample size is too small to draw clear conclusions.