Nature's unique way of controlling color explains why birds never go gray

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A first-year Penn State College of Information Sciences and Technology doctoral student spent four months observing birds in an effort to learn what it would mean to design technologies from a more-than-human perspective. Her autoethnographic study contributes to addressing the challenging research problem of how to operationalize posthuman concepts into practice for human-computer interaction. House finchnigel. Credit: Wikimedia Commons

Birds use sophisticated changes to the structure of their feathers to create multi-coloured plumage, using a process that could pave the way for the creation of paints and clothing colours that won't fade over time.

Using X-ray scattering at the ESRF facility in France to examine the blue and white feathers of the Jay, researchers from the University of Sheffield found that birds demonstrate a surprising level of control and sophistication in producing colours.

Instead of simply using dyes and pigments that would fade over time, the birds use well-controlled changes to the nanostructure to create their vividly coloured feathers - which are possibly used for Jays to recognise one another. The Jay is able to pattern these different colours along an individual feather barb - the equivalent of having many different colours along a single human hair.

The Jay's feather, which goes from ultra violet in colour through to blue and into white, is made of a nanostructured spongy keratin material, exactly the same kind of material human hair and fingernails are made from.

The researchers found that the Jay is able to demonstrate amazing control over the size of the holes in this sponge-like structure and fix them at very particular sizes, determining the colour that we see reflected from the feather. This is because when light hits the feather the size of these holes determines how the light is scattered and therefore the colour that is reflected. As a result, larger holes mean a broader wavelength reflectance of light, which creates the colour white. Conversely, a smaller, more compact structure, results in the colour blue.

If the colours were formed using pigments created from the bird's diet, the feather colour would fade over time. However, since nature has developed a way to create the colours through structural changes, any

nanostructure will remain intact, explaining why birds never go grey as they age. In contrast, humans rely on pigments to colour hair. As these are not produced to the same extent as we age, we consequently go grey. The research findings are being published today in Nature *Scientific Reports* today (21 December 2015).

Dr Andrew Parnell, from the University of Sheffield's Department of Physics and Astronomy said: "Conventional thought was that to control light using materials in this way we would need ultra precise and controlled structures with many different processing stages, but if nature can assemble this material 'on the wing', then we should be able to do it synthetically too."

Dr Parnell added: "This discovery means that in the future, we could create long-lasting coloured coatings and materials synthetically. We have discovered it is the way in which it is formed and the control of this evolving nanostructure - by adjusting the size and density of the holes in the spongy like structure - that determines what colour is reflected.

"Current technology cannot make colour with this level of control and precision - we still use dyes and pigments. Now we've learnt how nature accomplishes it, we can start to develop new materials such as clothes or paints using these nanostructuring approaches. It would potentially mean that if we created a red jumper using this method, it would retain its colour and never fade in the wash."

Researcher Dr Daragh McLoughlin of AkzoNobel Decorative Paints Material Science Research Team added: "At AkzoNobel, the makers of Dulux paint, we aim to encourage and stimulate the innovation of more sustainable products that have eco-premium benefits. This exciting new insight may help us to find new ways of making paints that stay brighter and fresher-looking for longer, while also having a lower carbon footprint."

The work used feathers selected from the extensive collection at the Natural History Museum (NHM) in London.

Dr Adam Washington from the University of Sheffield added: "The research also answers the longstanding conundrum of why non-iridescent structural greens are rare in nature. This is because to create the colour green, a very complex and narrow wavelength is needed, something that is hard to produce by manipulating this tuneable spongy structures. As a result, nature's way to get round this and create the colour green - an obvious camouflage colour - is to mix the structural blue like that of the Jay with a yellow pigment that absorbs some of the blue colour."

Provided by University of Sheffield

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