Scientists can listen to proteins by turning data into music

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Transforming data about the structure of proteins into melodies gives scientists a completely new way of analyzing the molecules that could reveal new insights into how they work - by listening to them. A new study published in the journal *Heliyon* shows how musical sounds can help scientists analyze data using their ears instead of their eyes.

The researchers, from the University of Tampere in Finland, Eastern Washington University in the US and the Francis Crick Institute in the UK, believe their technique could help scientists identify anomalies in proteins more easily.

"We are confident that people will eventually listen to data and draw important information from the experiences," commented Dr. Jonathan Middleton, a composer and music scholar who is based at Eastern

Washington University and in residence at the University of Tampere. "The ears might detect more than the eyes, and if the ears are doing some of the work, then the eyes will be free to look at other things."

Proteins are molecules found in living things that have many different functions. Scientists usually study them visually and using data; with modern microscopy it is possible to directly see the structure of some proteins.

Using a technique called sonification, the researchers can now transform data about proteins into musical sounds, or melodies. They wanted to use this approach to ask three related questions: what can protein data sound like? Are there analytical benefits? And can we hear particular elements or anomalies in the data?

They found that a large proportion of people can recognize links between the melodies and more traditional visuals like models, graphs and tables; it seems hearing these visuals is easier than they expected. The melodies are also pleasant to listen to, encouraging scientists to listen to them more than once and therefore repeatedly analyze the proteins.

The sonifications are created using a combination of Dr. Middleton's composing skills and algorithms, so that others can use a similar process with their own proteins. The multidisciplinary approach - combining bioinformatics and music informatics - provides a completely new perspective on a complex problem in biology.

"Protein fold assignment is a notoriously tricky area of research in molecular biology," said Dr. Robert Bywater from the Francis Crick Institute. "One not only needs to identify the fold type but to look for clues as to its many functions. It is not a simple matter to unravel these overlapping messages. Music is seen as an aid towards achieving this

unraveling."

The researchers say their molecular melodies can be used almost immediately in teaching protein science, and after some practice, scientists will be able to use them to discriminate between different protein structures and spot irregularities like mutations.

Proteins are the first stop, but our knowledge of other molecules could also benefit from sonification; one day we may be able to listen to our genomes, and perhaps use this to understand the role of junk DNA.

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