

February 4, 2022
Keio University

Music evolves like genes

—Analysis of over 10,000 Japanese and British/American folk song melodies reveals cross-cultural regularities—

An international team led by Associate Professor Patrick Savage, and including co-authors Project Research Associate Sam Passmore, Gakuto Chiba (master's student at the Graduate School of Media and Governance), and Associate Professor Haruo Suzuki, all of Keio University, published a research article in the journal *Current Biology* on February 3, 2022. The team analysed a set of 10,062 folk song melodies (4,125 British/American songs and 5,937 Japanese songs) to show that folk melodies evolve via descent with modification. Using alignment algorithms originally designed for molecular genetics, the team shows that there are predictable changes in folk melodies across cultural environments: Musical notes that contribute to the rhythm of songs are less likely to be changed than ornamental notes; musicians are more likely to add or delete notes of a song than they are to substitute them for different notes; and, if a substitution does occur, it is likely to be a neighbouring note. These findings demonstrate that creative art forms, such as music, are subject to cross-culturally regular evolutionary constraints - analogous to those governing the evolution of genes, languages, and other domains of culture.

1. Main Points of Research

- Melodic change is constrained by evolutionary processes.
- The melodies of Japanese and English folk songs evolve in similar ways.
- Musical notes with strong rhythmic functions are less likely to change.
- It is more common to add or delete notes, rather than to substitute them for new notes.
- When substitutions do occur, they tend to be between neighbouring notes.

2. Background of Research

Researchers of human history are increasingly turning to evolutionary theory to understand contemporary cultural diversity. However, there is no agreement on whether the processes of cultural change work the same way in different societies. Folk music is a culturally universal, but also highly variable phenomenon that is repeatedly transmitted between individuals over time, creating the conditions for an evolving musical process. By studying music in Japanese and English folk songs, the team uses this novel cultural domain to show that melodies evolve in analogous ways in different cultural environments.



Figure 1: Co-author Gakuto Chiba plays the tsugaru shamisen (津軽三味線), a Japanese instrument that traditionally accompanies folk songs. Photograph © Takata Photography; used with permission.

3. Content of Research and Results

The team analysed a set of 10,062 folk song melodies (4,125 English songs and 5,937 Japanese songs), including well-known songs such as “Scarborough Fair” and “Soran Bushi”. Savage manually converted 10,062 melodies into sequences of letters from the staff notation, creating sequences of notes analogous to a genetic sequence. Savage writes “translating the melodies into sequences took a long time, but it was actually quite fun as I sang along to each song as it was being coded”. The coding allowed the use of alignment algorithms originally designed for molecular genetics, to identify 328 pairs of highly related melodies used in more detailed analysis

(Figure 2).

The subset of highly related melodies allowed the team to observe how songs changed between recordings and used that information to inform patterns of evolutionary change. Musical notes that were identified as important to the rhythm of the song, were seen as less likely to change than notes that were purely ornamental. The final notes of songs showed a particular resilience to change, followed by notes that are stressed. Unstressed and ornamental notes were most likely to change. In addition to which notes are likely to change, the team also observed that notes were more likely to be added or removed, rather than changed. These two results reflect the fact that singers often feel free to add, remove, or substitute ornamental notes, but do not alter notes that reflect the overall melodic shape. When substitutions were made, the team showed that musicians tended to choose the next closest note on the scale.

While there was some cultural variability to the results, the pervading pattern was one of cross-cultural regularity, suggesting a cultural system that is subject to a variety of constraints. The team proposes that motor and cognitive constraints are two likely mechanisms. Motor constraints suggest that when changes occur between notes, they are more likely to occur to nearby notes due physical limitations of the performer. That is, smaller distances between notes are easier to move between than larger notes. Alternatively, it may be that performs are capable of larger changes, but cognitive constraints on pitch, production, and perception mean that smaller differences are less likely to be noticed between performances.

4. Future Developments

These findings show that creative art forms are constraints to similar evolutionary mechanisms found in biological, genetic, and other cultural domains. While general principles can be applied to change in folk songs, the specific mechanisms are likely to be considerably different. Future work should explore the relative influence of cognitive and motor processes on melodic evolution, as well as the interplay of micro-level and macro-level processes in musical performance. Savage and Chiba (both award-winning performers of Japanese folk music) say “we are excited to quantify factors of melodic evolution that we have found influential in our own performance experience, but we are also studying how other aspects of performance, such as lyrics or physical appearance, are important to the transmission and evolution of music”. The findings in this paper suggest that even art forms as malleable as music can be understood as an evolutionary process with cross-cultural regularities.

5. Special notes

This research was supported from the following organizations and grants.

- Dr. Savage: Grant-in-Aid no. 19KK0064 from the Japan Society for the Promotion of Science and startup grants from Keio University (Keio Global Research Institute, Keio Research Institute at SFC, and Keio Gijuku Academic Development Funds).
- Professor Atkinson: a Royal Society of New Zealand, Rutherford Discovery Fellowship (#11-UOA-019).
- Dr Currie: a grant from the European Research Council (ERC) under the European Union’s Horizon 2020 research and innovation programme (Title: The Cultural Evolution & Ecology of Institutions; Grant Agreement 716212)

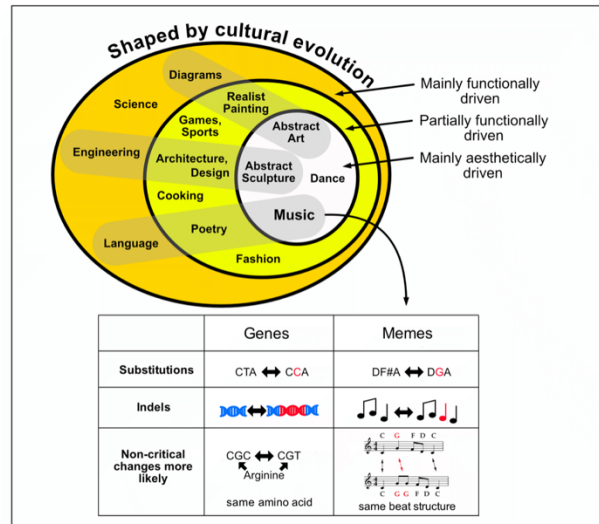


Figure 2: Visual depiction of how artistic culture evolves (top). The relationship between genetic and melodic evolution, with examples for substitutions, insertions-deletions (indels) and non-critical changes (bottom). Figure © Hoeschele & Fitch (2022) *Current Biology* Dispatch, used with permission.

<Details of Journal Article>

Title: Sequence alignment of folk song melodies reveals cross-cultural regularities of musical evolution

Authors: Patrick E. Savage^{1,2,3,*}, Sam Passmore¹, Gakuto Chiba¹, Thomas E. Currie⁴, Haruo Suzuki¹, Quentin D. Atkinson⁵

¹*Faculty of Environment and Information Studies, Keio University, Shonan Fujisawa Campus, Endo, Fujisawa, Kanagawa 252-0882, Japan*

²*School of Anthropology and Museum Ethnography, University of Oxford, Banbury Rd., Oxford OX2 6PE, United Kingdom*

³*Department of Musicology, Tokyo University of the Arts, Uenokoen, Taito, Tokyo 110-8714, Japan*

⁴*Centre for Ecology & Conservation, College of Life & Environmental Sciences, University of Exeter, Penryn Campus, Cornwall TR10 9FE, United Kingdom*

⁵*School of Psychology, University of Auckland, Symonds St., Auckland 1010, New Zealand*

Journal: *Current Biology*

<https://doi.org/10.1016/j.cub.2022.01.039>

*Please direct any requests or inquiries to the contact information provided below.

• Inquiries about research

Keio University Faculty of Environment and Information Studies

Associate Professor Patrick Savage

Tel: +81- 80- 6551 - 4063 E-mail: psavage@sfc.keio.ac.jp

<http://compmusic.info>

• Inquiries about press release

Keio University Office of Communications and Public Relations (Mr. Mochizuki)

Tel: +81-3-5427-1541 Fax: +81-3-5441-7640 E-mail: m-pr@adst.keio.ac.jp

<https://www.keio.ac.jp/en>