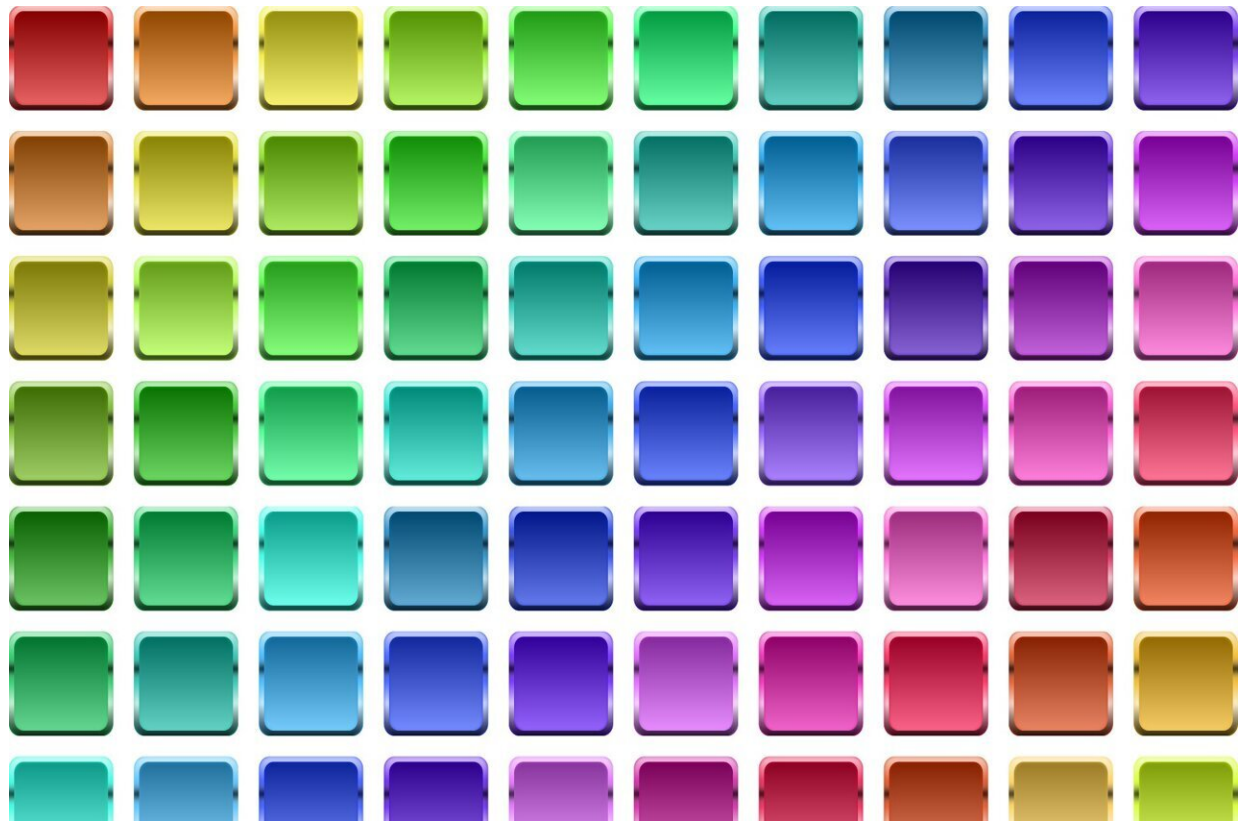


The role of history in how efficient color names evolve

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Suppose two speakers of the same language are playing a guessing game where each has the same color swatches, and Player 1 tries to get Player 2 to guess a hue by naming the color. If the second player consistently

guesses correctly as often as possible, that indicates their language has an efficient color naming system.

Past research has shown that efficient [color](#) vocabularies are constrained both by how people perceive colors and by how much they want or need to communicate about a given color. For example, Penn researchers found in a [2021 study](#) that the need to communicate about reds and yellows is high across languages, while greens are more important in some languages.

Now, Penn scientists have identified another constraint: history. Colin R. Twomey, interim executive director of the Data Driven Discovery Initiative in the School of Arts & Sciences, worked with psychology professor David H. Brainard and biology professor Joshua B. Plotkin in a new paper showing how a language's past color [vocabulary](#) shapes its ability to evolve, shedding light on how the number and meaning of color words have changed over time.

Their work is published in [*Proceedings of the National Academy of Sciences*](#).

"The main takeaway is that, once you as a linguistic community have an efficient vocabulary, that starting point restricts the next possible efficient vocabulary that you could have when you introduce a new term," says Twomey, the first author. "As the vocabulary grows, the number of different vocabularies that you could move to is increasingly constrained."

This takeaway shares a principle with [evolutionary biology](#). The existence of an evolutionary pathway limits available future pathways, compared to the number of options available if a species were to arise anew. Plotkin and Twomey come from a background in evolutionary theory for biology, and here they are trying to better understand how

some of the same theory applies to cultural evolution.

The authors used the publicly available World Color Survey (WCS), in which about 25 speakers from each of 110 languages were asked to name the same set of 330 color stimuli. This dataset provides the likelihood that a speaker from each of the languages would use a certain term to describe a color.

The WCS was the work of anthropologist Brent Berlin and linguist Paul Kay, who identified 11 color categories in English: red, orange, yellow, green, blue, purple, pink, black, white, brown, and gray. While English uses 11 color categories, the most common color vocabulary size among WCS languages is six words.

Using the WCS, the Penn researchers explored the introduction of new terms and the probability that a given word will change meaning as the size of the color vocabulary increases. For example, a term identified as green-blue could shift in meaning to "green" if a new term is established as "blue." Green-blue and blue are quite susceptible to changes in meaning as new terms are added, whereas red, black, and yellow remain relatively stable in meaning.

One example the authors show is a color vocabulary that evolved into a six-word set with red, pink, yellow, black, white, and a green-blue shade. But if one were to make a six-word vocabulary from scratch—de novo—based on the same communicative needs for that language, the vocabulary could instead have separate colors for green and blue and still include red but have no word for pink, and it would still be efficient.

Moreover, and despite facing the exact same constraints, from there the historical vocabulary would most likely split green-blue into separate terms whereas the de novo vocabulary is more likely to introduce light green or orange than pink.

"Since we know that history matters, it means we can infer history from the present language state. In principle, we can infer what ancestral color vocabularies were and then compare that to the historical record," Plotkin says. An example he provides is that at certain points in history, certain commercial dyes were introduced that became economically important to a culture.

The paper also notes that history should also constrain how people talk about and categorize aspects of culture aside from color; Plotkin and Brainard respectively point to the ways we categorize [consumer products](#) and [weather conditions](#), for example.

Their color study "represents a general theory that categories are refined based on communicative needs, historical constraints, and this principle of efficiency," Brainard says. "The ideas, we would hope, would apply to how we name and categorize and communicate about all kinds of things."

More information: Colin R. Twomey et al, History constrains the evolution of efficient color naming, enabling historical inference, *Proceedings of the National Academy of Sciences* (2024). [DOI: 10.1073/pnas.2313603121](#)

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