Interpreting Data through Multisensory Modalities for Deeper Awareness & Inclusion

Renée Walker

On a June morning, I went for a walk at an environmental center just outside Philadelphia. Amidst the fragrant landscape adorned with wild roses, my senses became attuned to a symphony of sounds—birds chirping, planes soaring overhead, and water cascading down a rocky stream bed. It was this auditory kaleidoscope that captivated me most, particularly the diverse calls of the birds. Woodpeckers, Yellow Flickers, and Cardinals distinguished themselves with uniquely patterned vocals.

As a visual communication designer, information designer, and researcher, I am interested in how multisensory experiences can enhance our daily activities and interactions—tapping into sensory information we often overlook and opening communication channels to those lacking specific sensory abilities.

How might a visual evoke the sensation of hearing a bird?

On that walk, I aimed to gather data for a new research endeavor focused on translating sensory data using computational principles to make data visualizations that are more inclusive and go beyond what people see. The bird songs I collected that day commenced a research trajectory that blends my interest in perceptual awareness, data visualization, and inclusive design.

Data visualization, by name, is biased towards the visual. This approach excludes a visually impaired person from experiencing the synthesis of order and formal choices that create an understandable visual explanation—or experiencing the awe of absorbing a well-designed data visualization.

Even as inclusive design has become a priority, and best practices include text-to-voice descriptions of visualizations to accompany diagrams, these translations often need more thought and consideration to match the level of perceptual experience given to the visual aspect.

What if we were to approach data design through not just one sensory output but multiple, with the same level of emotional impact? Could it be more inclusive and awaken sighted people to sensory perception capabilities we overlook?

Methodologies for cross-sensory design

Methods of translating one sensory output to another have been around for centuries. Artists and designers in the abstract periods used methods to translate sensory experiences into formal properties. We can compare these methods to the perceptual phenomenon of synesthesia, where individuals experience involuntary sensations parallel to other sensory experiences. One form of synesthesia, described as "color-hearing," causes individuals to experience the sensations of different acoustic tones in color.

We can see how this might manifest in a representation of a bird call according to descriptions of the blind musician Paul Dorken.

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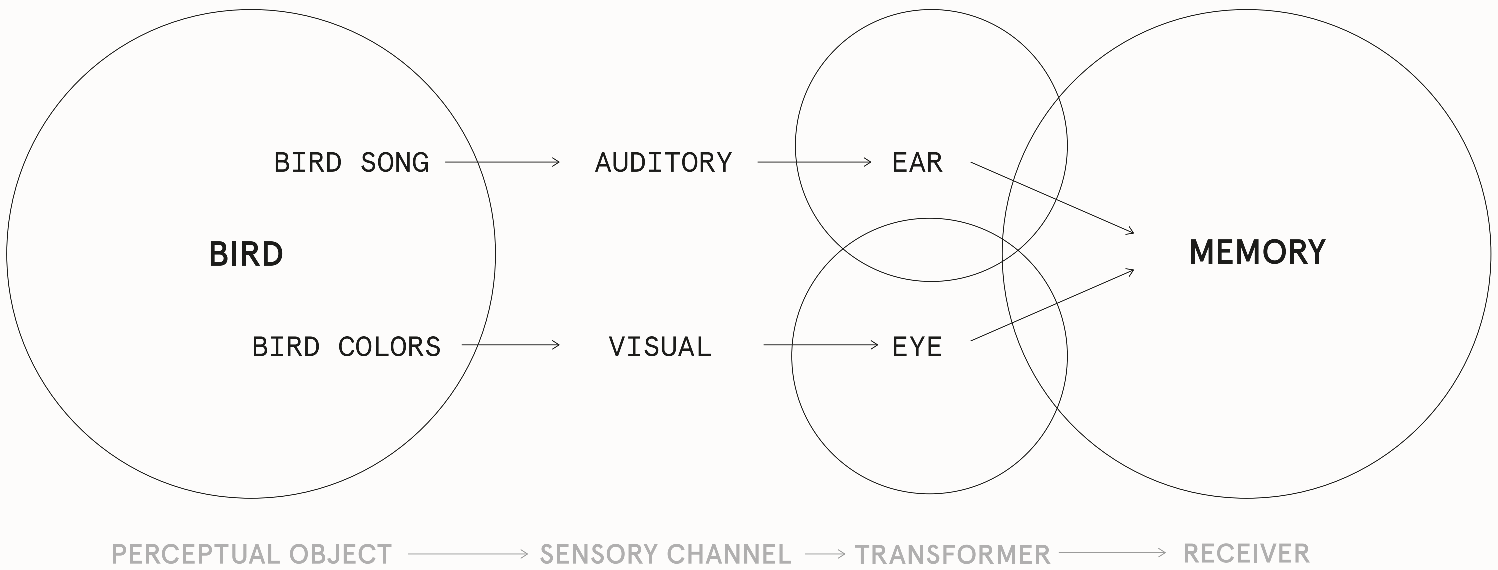
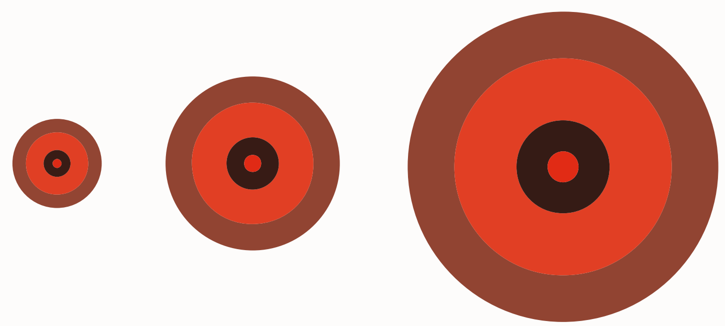
In contrast to this more individualized approach, efforts to create color-sound relationships through connections to tone and color-light frequency first arose with Aristotle's attempt to systemize color brightness to intervals synced to the cosmos.





In 1911, painter and musician Alexander Wallace Rimington created a color-tone scale corresponding to the tone octave and color light frequency. Other methods consciously construct logic through cross-sensory correlations of form, color, texture, pitch, frequency, temperature, etc.

Today, our technologies offer the potential to integrate and expand on these methods in our daily interactions with data. Bird identification apps like Merlin allow us to identify birds via song, displaying the sound data in a spectrogram (a computer-generated graph that shows the basic shape of an audio wave and how its frequencies change over time), with pictures of the identified birds.

With designers and artists having more access to coding platforms, such as the JavaScript-based p5 platform, sensory form relationships can be algorithmically explored to produce more intuitive and recognizable data outputs.

The process of bird song translation

Using a sampling of the bird sounds recorded from that morning walk; I began translating the auditory data from spectrogram readings of the bird songs into visuals using the JavaScript-based p5 sound library. By stripping down the complexity of the full spectrogram visuals, adding colors that represent the bird species, and reframing through a time-based animation, I could achieve something that felt visually matched to the ease and pleasantness of listening to the sounds in nature.

The resulting output is a time-based sequence that radiates bursts of circles scaled to the decibel levels of the sounds. With the application of color in the ratio it appears on the birds, the resulting visual began to feel more akin to the bird making the song, as opposed to the more scientific-looking spectrogram visual. With this method in place and the help of a bird-loving research assistant, I could quickly test the technique by replacing the audio files in the code and updating the color schema with the various bird songs collected.

Potential applications

My appreciation for birds and their songs outweighed my expertise as a birder, especially when identifying them by sound. Yet, a shift occurred as I engaged with the visualizations and accompanying sounds. I began to recognize distinct bird calls echoing through our wooded Philadelphia campus or mingling with the tranquility of my back garden while sipping a cup of coffee. The Blue Jay's familiar "Jay, jay, jay" suddenly transformed into the comforting chatter of an old friend passing by.

This intriguing relationship between vision and sound engages two sensory channels, allowing our brains to connect these data points that—when combined—offer a richer view of the bird by allowing for pattern recognition of the bird's song and colors. Can this parallel also increase the opportunity for recognition and retention of information?

Armed with various bird sound visualizations, and two bird-enthusiastic research assistants, we imagined the practical applications. As a team, we read Kat Holmes's book on inclusive design, *Mismatch*, and we started by considering who is excluded from hearing bird sounds. Using Holmes's persona spectrum as a template, we thought about the needs of someone with no auditory abilities, a person experiencing hearing loss—or someone birding in an urban setting where bird sounds compete with traffic, airplanes, and other human-generated noises.

With these personas in mind, we realized this could be part of an app that alerts users to sounds as they are picked up in the environment. The app could be on a wearable device such as a smartwatch, allowing for in-the-moment awareness rather than clicking through screens and buttons on a smartphone, as one frequently does with the many birding apps we tested. A gentle haptic vibration could accompany the visual, adding the tactile experience to the perceptual awareness channels.

We also considered applications outside of the experience of a bird walk. A flipbook that manually presents the sound animation on one side with a mnemonic pronunciation on the other can reinforce the bird song to memory for a budding birder. Other physical applications, such as window decals of sound visualizations, would assist the birds' safety by deterring them from flying into windows, one of the leading causes of bird deaths.

All of these potential applications offer new ways of tapping into a more profound awareness of the bird through visualizing its song, rather than the typical figurative representations

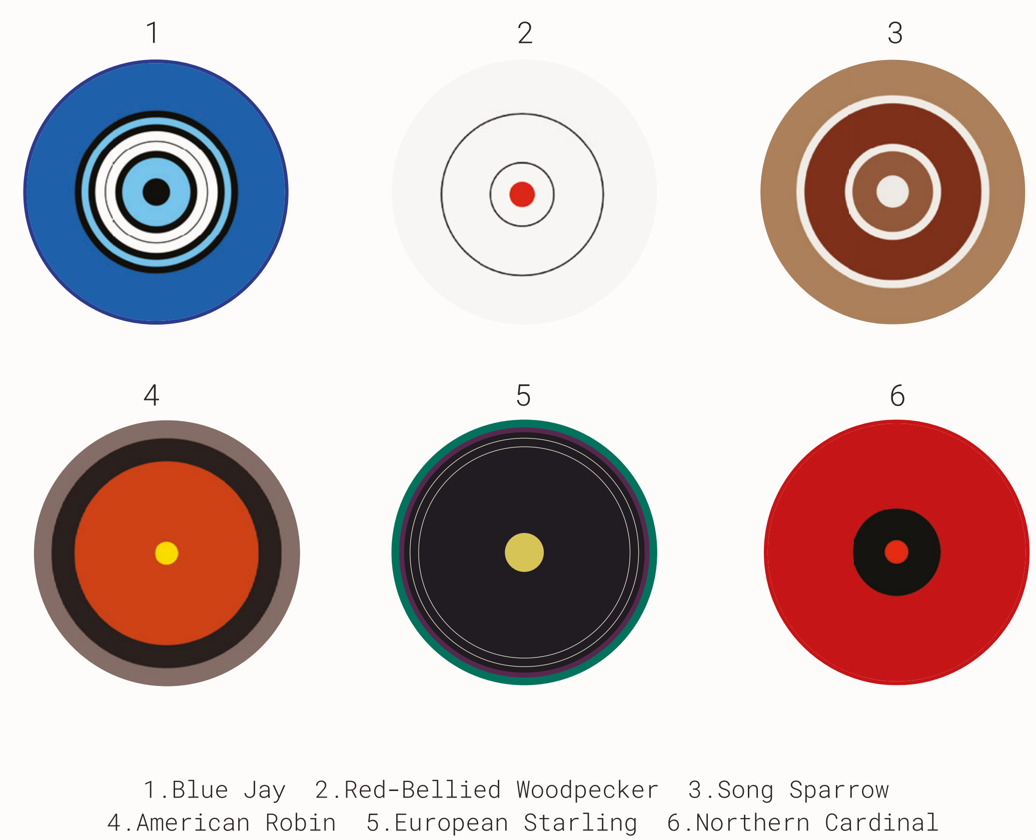


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Figure 1. Diagram displaying the perceptual communication model for the bird songs visualizations.

Figure 2. Stills from the time-based visual of the cardinal song. Visualization by Renée Walker.

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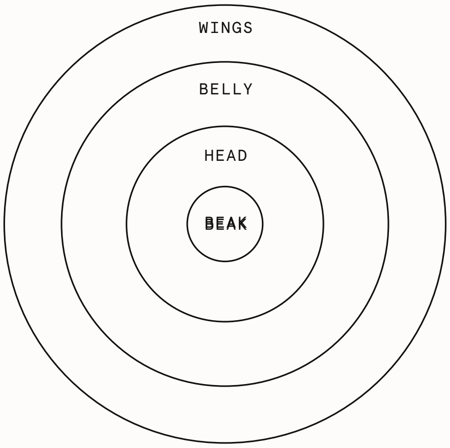
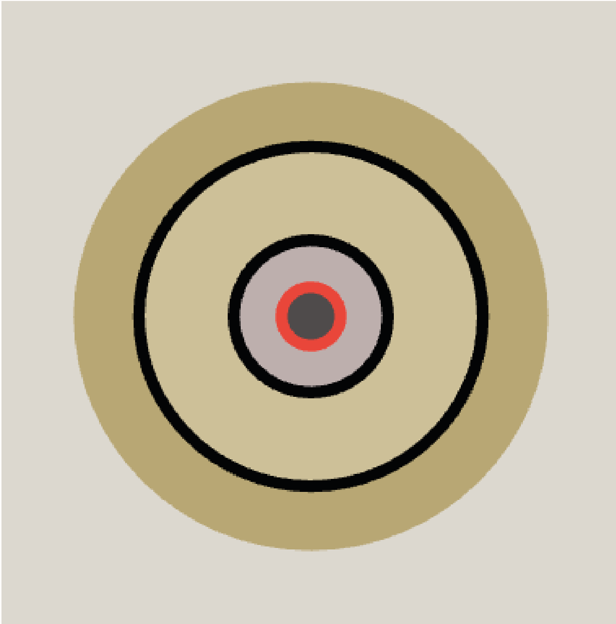
Variations of bird song data visuals applied to multiple birds through replacing audio files and bird colors. Visualization by Renée Walker.





Revised logic for constructing bird song visuals based on feedback received from birders. Visualization by Renée Walker.

used for bird identification and reference—reminding us that visual information is not the only data that shapes our perspective and how we interact with the natural world.

User testing with birders

To test these ideas, we took them to the bird communities to ask birders if these applications could be helpful and desirable. It was mid-October, a time of year on the East Coast when migratory birds make their way to their winter homes, so there was no lack of events for birders. Interested in the recent bird accessibility movement led by organizations like Birdability, my research assistant Annika and I attended an event called "Bird Sit." Among the groups that hosted were Pennsylvania Center for Adapted Sports, In Color Birding Club, Philly Queer Birders, and the Feminist Bird Club.

The people we spoke with were enthusiastic about the visualizations and the potential applications. Many could quickly identify the bird through the visualizations of the sounds and colors, and eagerly pocketed the stickers Annika designed representing their favorite birds. Many were interested in the potential to teach through a platform similar to existing apps like Larkwire, a quiz app that teaches how to identify birds through song and color—noting the more intuitive way of reading the bird sounds rather than the complexity of reading a spectrogram. Graduate research assistant Sarah also went on bird walks in the DC area to learn more about the birding experience and birders' methods to identify birds. Here, we learned from seasoned birders that the color identification process was specific to the parts of the bird body, and modified the visualizations to follow this logic.

Future implications

Case studies like this make our tools, artifacts, and designed experiences more accessible, prompting a deeper awareness of our perceptual capacities and forging connections between ourselves and the surrounding world. From eliciting delight to signaling alarm, sensory data can enrich our experiences, inviting us to perceive and engage with our environment in multifaceted ways.

Renée Walker is an Associate Professor at Thomas Jefferson University, specializing in typography, information design, and human-centered design systems within the Undergraduate Visual Communication Design Program.