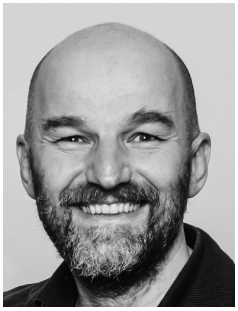
Voice Science Terms in the *Journal of Singing*: A Historical Analysis

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In this column, we use the *Journal of Singing* index to analyze the historic use of voice science terms in over five thousand NATS publications from the *Journal of Singing*, *NATS Journal*, *NATS Bulletin*, and *The Bulletin*. This retrospective analysis reveals a steady growth in NATS publications referencing voice science and provides insights into the development of science-informed voice pedagogy.

Voice science is not a new field. Two recent publications in this column examined the scientific contributions of nineteenth-century voice science innovators, Hermann von Helmholtz and Emma Seiler.[1] Their seminal research predated audio recording, computers, and even the invention of the International Phonetic Alphabet. Nevertheless, their work is relevant to our contemporary understanding of voice acoustics and source filter theory, central tenets of science-informed voice pedagogy. It may seem counterintuitive that research from the distant past can have contemporary relevance, but looking back on the work of our predecessors is an essential precursor to developing new knowledge. In this column, we examine the historic use of voice science terms in NATS publications to better understand where our science-informed pedagogical knowledge base is deep, and what nascent topics are beginning to make an important contribution.

To find scholarly research on a topic, one typically begins by searching an online index such as Google Scholar, Web of Science, Scopus, or MEDLINE/PubMed.[2] Prior to the digitization of publications and their indices, users would have to travel to library stacks to physically search printed journals, a difficult and time-consuming undertaking. Online databases have transformed research by allowing electronic access to a broad corpus of knowledge on a given subject. A recent study by Kyriakos Drivas argues that Google Scholar in particular has made older papers (published between 1950 and 1969) more discoverable and accessible, leading to an increase in their citations.[3] In the world of science, this is generally a good thing: prior to conducting research, we need to know what is already known on the given topic.

Beginning in 2000, John Burgin, Roy Delp, and others led the effort to create an online index of NATS publications.[4] Today, the Journal of Singing Index references over five thousand NATS publications from *The Bulletin*, the *NATS Bulletin*, the *NATS Journal*, and the *Journal of Singing*.[5] One can search for content by author, title, or keyword, and NATS members can download PDF copies of NATS publications. This labor-intensive project represents a significant achievement by NATS leadership.

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There is a problem, however: NATS publications (including the *Journal of Singing*) are a rich source of information on the singing voice, but they may not appear in online database searches. Indices such as Google Scholar rely on a cataloging system that uses a unique and persistent digital object identifier (DOI) to reference content.[6] The use of DOI numbers in the *Journal of Singing* began in 2021 (with vol. 78) at the recommendation of an ad hoc "digital initiatives" committee appointed by editor in chief emeritus Richard Sjoerdsma.[7] At the time of this writing, pre-2021 NATS publications are not referenced in the DOI system, and many will only appear in searches of the Journal of Singing Index. Important work is underway to retroactively assign NATS publications DOI numbers, though it is a cost-prohibitive and laborious process.

If we take as a priori assumptions (a) that NATS publications are an important repository of information on singing and the training of singers, and (b) that the use of voice science terminology in these publications reflects our profession when these articles were published, then it follows that an exhaustive search of voice science terms, tracking their first appearances and frequency of use, may provide useful insight into the history of science-informed voice pedagogy.

METHOD

Numerous (486) voice science terms were compiled in 2022 by the NATS Pedagogy Workshop "Working Group Three," cochaired by Matthew Hoch and Ken Bozeman. The charge of this group was to: "Collect and collate a thorough list of science-informed voice pedagogy terminology and their definitions, and inclusive language (including inclusive language guidelines), for 21st century voice pedagogy."[8]

We queried the web interface of the Journal of Singing Index for the NATS Pedagogy Workshop Working Group keywords with a script written in the Python language by coauthor CTH.[9] In particular, we searched for the occurrence of all 486 keywords in the following three search fields: (a) title keyword; (b) article-summary keyword; and (c) full-text keyword (search entire article). Results were stored in a temporary database for subsequent analysis and the generation of the graphs included here.

RESULTS

Overall, our search retrieved a total of 5,415 articles distributed between 1944 and 2025, with an ever-increasing number of published articles in more recent years (see figure 1a). Currently, NATS publishes about 100 articles per year, of which roughly 25 percent are peer reviewed.[10] Setting aside an initial growth phase from 1944 to 1950, the number of NATS publications doubled from 1950 to 2025, resulting in an exponential growth factor of about 0.93 percent per year. At first glance, this appears to be impressive, but this figure is dwarfed by the global growth of scientific publications worldwide: about 4.10 percent per year with a doubling time of 17.3 years.[11] Notably, over a span of seventy-five years, a growth factor of 5 percent would result in an increase of publications by a factor of about twenty, not two (as found for NATS). Of course, the *Journal of Singing* is not solely a scientific journal, and growth factors vary considerably across disciplines such as the social sciences and humanities.[12] A possible reason for the comparatively modest increase in publication growth factor is that NATS prioritizes quality over quantity, and the fact that the *Journal of Singing* does not charge the authors for publication, limiting available financial resources.

Terms that were used early and frequently in the publications included "sound" (n=3474), "range" (n=2701), and "practice" (n=2388). We plotted these "top three" terms as a percentage of the overall articles published to determine if the use of these terms remained constant over the years, which appeared to be the case (see figure 1b). Figure 2 illustrates the 40 most commonly used keywords found in NATS publications from 1944 to 2025. Unsurprisingly, six of the top ten voice science terms were descriptors used to discuss a singer's sound: "sound, range, tone, period, pitch, vowel" (see figure 2). Of the remaining four terms, three are elements of the learning process ("practice, attention, focus"), indicating the importance of the cognitive process in voice science. For further visualization, a world cloud of the top 100 terms is shown in figure 3.

To better understand the historical use of voice science terms in NATS publications, we examined the first appearances of each term, plotting the top ten "new" terms per decade, and how many times each term was used in subsequent NATS publications (see figure 4). As

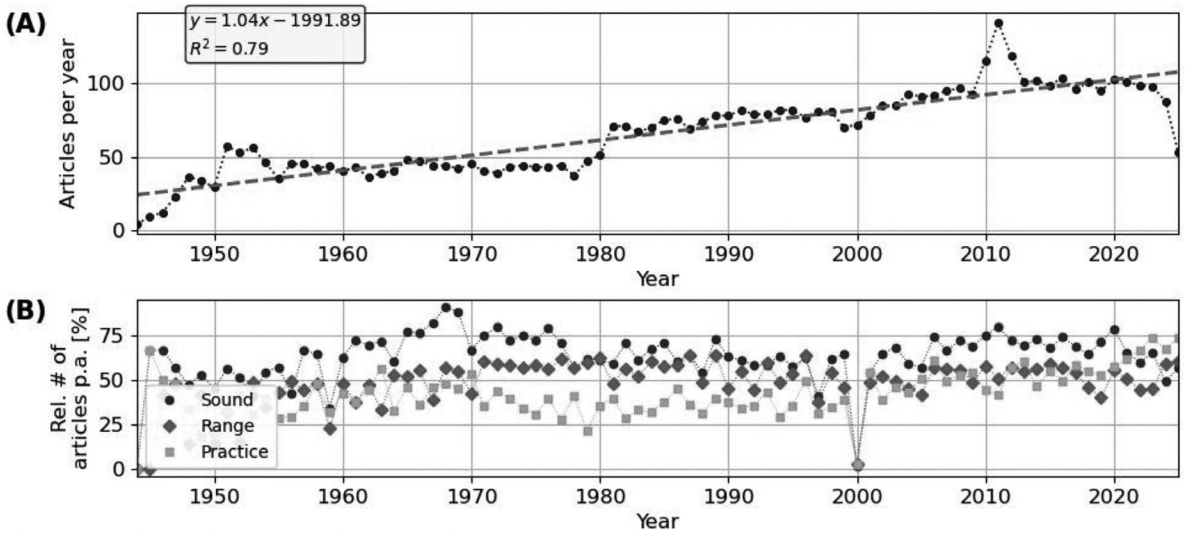


Figure 1. Scatter plot representation of (a) the number of index articles plotted chronologically by year, and (b) the number of instances the top three voice science terms appear as a function of the percentage of articles published in each year. The zero values found for the year 2000 are caused by an internal *Journal of Singing* database error. As of writing this manuscript, it was impossible for the database maintainers to fix this error.

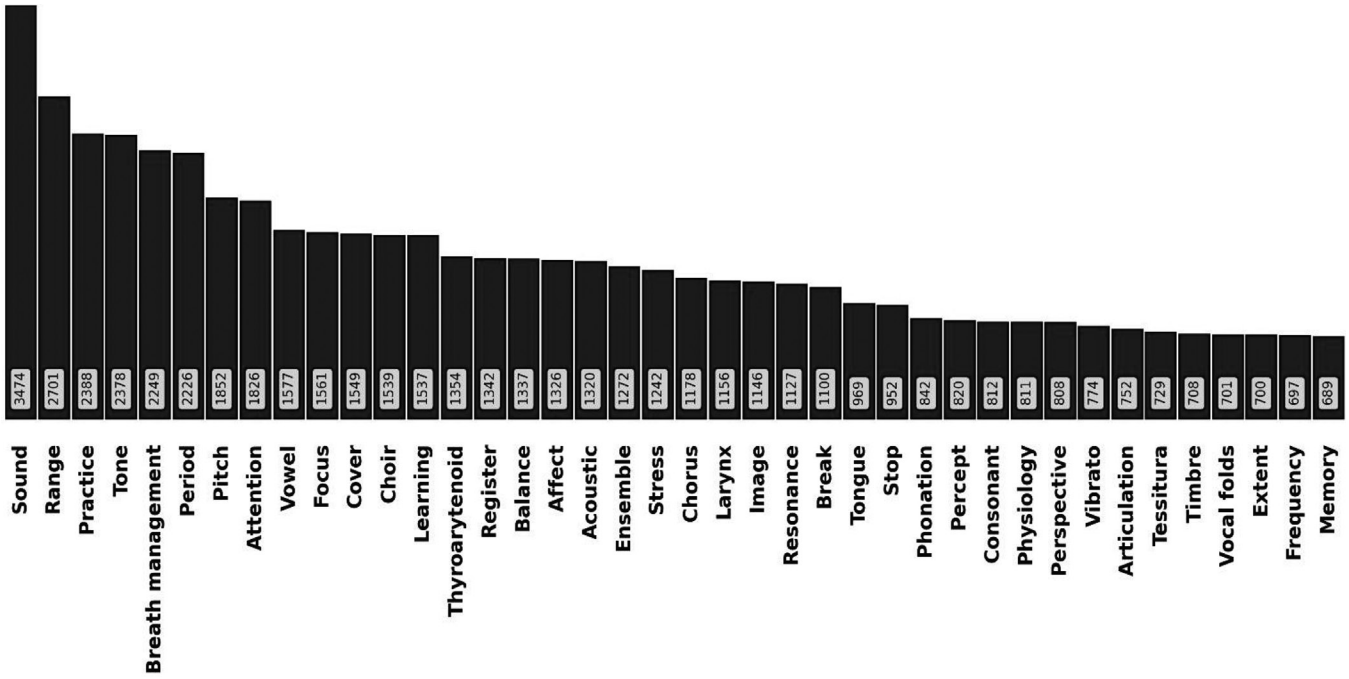


Figure 2. Bar chart representation of the top forty voice science terms found in the Journal of Singing Index. The number above each term indicates its frequency of occurrence.

expected, the data are skewed toward earlier decades: when a term appears early and is used persistently (e.g., "breath management"), we see higher values than terms introduced more recently. Our analysis thus reasonably illustrates developmental phases in our field.

In the beginning, NATS publications used terms common in "classic" voice pedagogy, such as "breath management" and "tone." In the 1960s, we see a shift toward functional terms such as "airflow," "mucosa," or "hyperfunction." Terms such as "sternothyroid"

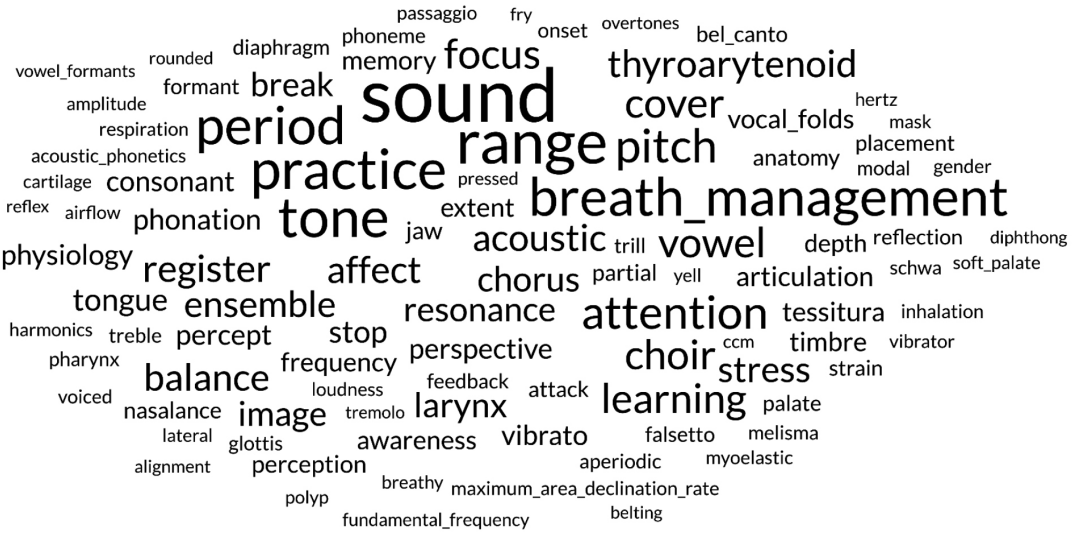


Figure 3. **Word cloud representation of the top one hundred voice science terms found in the Journal of Singing Index. The font size is proportional to the term's frequency of occurrence.**

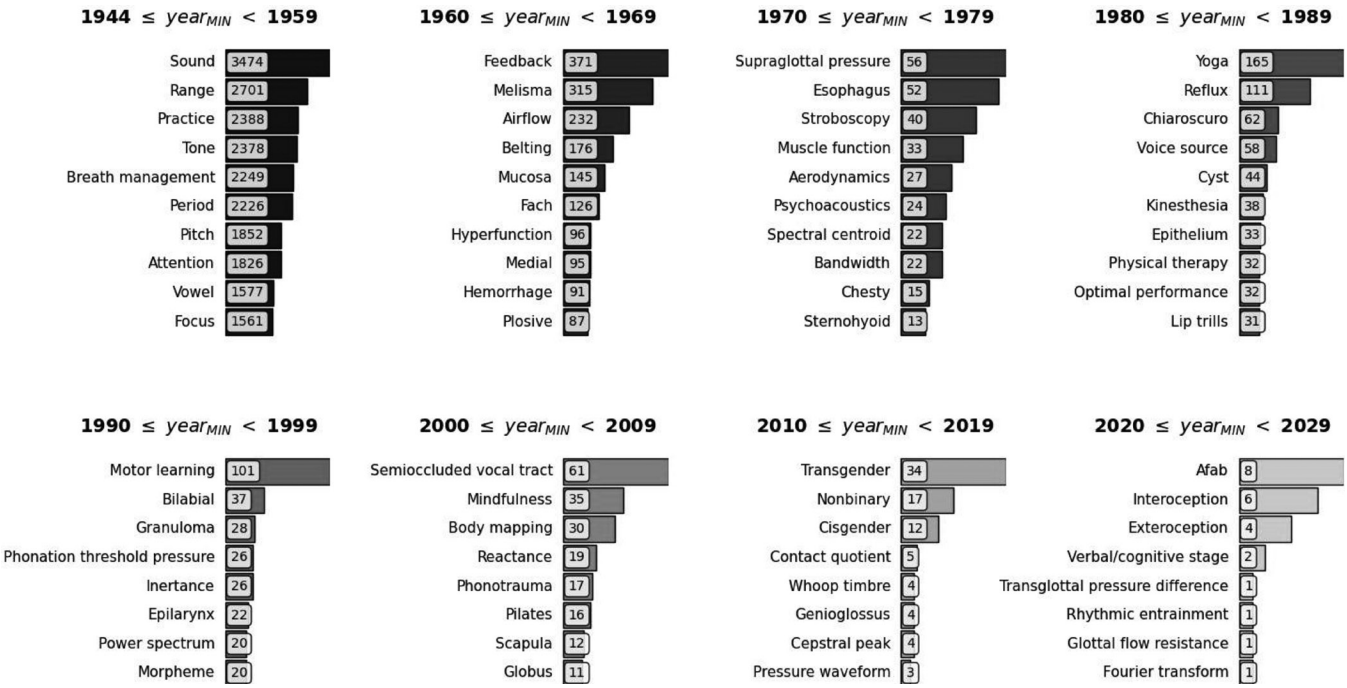


Figure 4. **Horizontal bar chart representation of the top ten voice science terms, grouped by chronological decade, as found in searches of the Journal of Singing Index. Terms that already appeared in an earlier decade are not considered in bar charts of later decades, in order to highlight each decade's newly appearing terms.**

appear early in the data, and by the 1980s, fully one-third of the top ten terms had a medical connotation: "reflux," "cyst," and "epithelium." This trend continued in the 1990s, where five of the top ten terms were anatomical in nature: "bilabial," "granuloma," "epilarynx," "sternocleidomastoid," and "trapezius." The use of anatomical/medical terminology may reflect increased interest in science-informed pedagogy seen in the writings of Richard Miller, Scott McCoy, Robert Sataloff, and Ingo Titze during this period. It may also reflect

the late-twentieth-century inception of the "singing voice specialist (SVS)," a voice pedagogue who works in a medical setting with singers who have experienced injury.[13] "Mindfulness" appears near the top of the list for the early 2000s, a period that sees the incorporation of cognitive science in the "Mindful Voice" column written by Lynn Helding and (later) Lynn Maxfield.[14]

Certain familiar terms emerge as anticipated in the timeline. "Semioccluded vocal tract," for example, appears in the early 2000s due to the work of Titze and others.[15] Other voice science terms, such as "supraglottal pressure," "stroboscopy," "aerodynamics," "psychoacoustics," "spectral centroid," and "bandwidth," are now commonplace in the literature, but surprisingly, did not appear in NATS publications prior to 1970. "Fourier transform," a foundational concept in voice acoustics, remarkably appears only once in the database, and that occurrence was after 2020. Finally, in contemporary NATS publications, we noted a welcome and deliberate shift towards science and pedagogy that addresses a wide range of singers (e.g., "transgender," "nonbinary," "cisgender," and "AFAB").

DISCUSSION

As we work to move voice science and its practical application forward, it is important to understand where we as a discipline have been. The publications of the National Association of Teachers of Singing are a rich historical repository for voice scientists, singing instructors, and performers alike. The 5,400+ indexed articles reveal the state of our profession and its development over time, and many articles from the distant past continue to be quite relevant today. The "roots" of science-informed voice pedagogy run deep in NATS. It is encouraging to note the use of language that includes singers from all backgrounds, and the growing interdisciplinarity with neighboring fields such as the cognitive and medical sciences. We are profoundly grateful to the hundreds of colleagues who devoted tens of thousands of hours of time and energy to produce this repository. Their dedication and contributions are a testimony to the richness of our profession.

Moving forward, we hope to see the *Journal of Singing* continue the important work of indexing articles written prior to 2020 within the DOI system so that they may easily be found in databases such as Google Scholar, Scopus, or MEDLINE/PubMed. We are also thankful for the continued increase in rigor as demonstrated in the expansion of the peer review process in NATS publications. This time-consuming endeavor serves both authors and the readership immeasurably, improving the quality of our scholarship. Without peer review, there is a danger that published—and thus publicly accessible—information may be inaccurate, misleading, or even harmful. Here, the *Journal of Singing* can be an exemplar of accuracy, rigor, and honesty in scholarly publishing.

Additionally, we hope to see the continued publication of commentaries, opinion-based literature, and experiential reports from the singing studio. Subjective observations are just as important to our profession as empirical studies published in this column and elsewhere. Science-informed voice pedagogy is not only driven by much-needed, rigorous research, but also by its practical application—the "human touch" that changes the lives of students and teachers alike. The *Journal of Singing* is the perfect place to find balance between these two apparent extremes, which actually are just two sides of the same coin. For as pedagogues over the years have often noted, we do not teach voice; we teach people.

Acknowledgments

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NOTES

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