How The Buffalo Model Came to Be

BY JACK KATZ

The Buffalo Model—a comprehensive approach to evaluate and remediate auditory processing disorders—was first introduced nearly 40 years ago. Developed by Dr. Jack Katz, it is based on the results of a three-test battery: the Phonemic Synthesis Test, the Staggered Spondaic Word test, and the Speech-in-Noise test. Read on to learn how this model came to be.

The Buffalo Model started, unknowingly, in 1958 when I developed the Phonemic Synthesis Test (PST) while working at three central schools. The next major element was conceptualized in 1960 when I was bottle-feeding my son at midnight. The Staggered Spondaic Word (SSW) test is a procedure used to identify problems from the cochlea up to the auditory reception center of the brain and beyond and is the basis for the four categories of the auditory processing disorder (APD). The third Buffalo Model procedure—the Words-in-Noise Test—was developed in the late 1960s when the first few children whom I saw for APD also had speech-in-noise issues. When I started teaching at the University at Buffalo in 1974, I revised the speech-in-noise procedure. These three basic tests of the Buffalo Model are widely used in the United States and other English-speaking countries. They, as well as other tests and therapy procedures, have been adapted into many languages around the world and used in many countries (Kedar and Katz, 1976; Soto Ramos et al, 1992; Wilson et al, 2007; Negin et al, 2020; Irani et al, 2022).

When I was a master of science student at Syracuse University, Dr. Louis DiCarlo told us, "If the person you are working with has a problem, it is your job to figure out how to help them!" Consequently, when I developed each of the tests, the next thing I did was to develop a procedure to improve that problem. The PST, Words-in-Noise Test, and Dichotic Offset Training programs all immediately showed positive results and are still used effectively today (Emanuel et al, 2011).

STEP 01 The Phonemic Synthesis Test

One day at Syracuse University in 1957, Dr. Charles Mange was giving a lecture when he suddenly stopped and said, "You know, there is a skill with which children with articulation problems and children with reading problems have difficulty." I was baffled. In those days, we thought that reading problems were visual and that articulation problems were mouth and tongue muscle problems. How could both of those groups have trouble with his test? I did not listen to the rest of his lecture and right after class dashed to his office to find out what he was referring to. He told me about his Phonetic Synthesis Test, with altered speech sounds of words that he made with his fancy equipment. It was very interesting but way over my head.

A few months later, after I finished my master of science degree, I took a job as a speech and hearing therapist. When I learned that I had 17 students with articulation problems, I thought that it would be interesting to give them a test similar to the one used by Dr. Mange. I could not possibly duplicate his test, but I thought I could give them one sound at a time and see if they could give me the word.

That night, I recorded my 15-item test and later tested those children. Sixteen of them had awful scores, but one had no problem at all. She had an interdental /s/ problem. I did not realize why at the time, but she had a motor problem and not APD. I then asked the reading therapist if she would

test those 16 children. When she looked at my list, she said, "I do not have to test them; they are my children, too." Wow, Dr. Mange was right—articulation and reading!

I then had to follow Dr. DiCarlo's directive to figure out how to help the children. I had no clue what the problem was, so the only thing I could think of doing was to turn the test around and make it into a therapy. I was amazed how quickly they caught on and improved their articulation skills. Once I did that, I had a brilliant thought: If some young children had this problem, I could give all the children in a class training and help all of them. I did that for the first-grade class for the rest of the semester and then told the teacher that I would be working with kindergartners the next semester. She replied in a sad voice, "You mean you are not going to work with my children anymore?" I said, surprisingly, "No, why do you ask?" She said, "Oh, it has been so helpful to the children!" She began to tell me all the ways the children improved, but I was so dumbfounded—I did not listen to or remember what she said. The next semester, I left the job early to start my PhD program and never found out how it worked for the kindergartners, but I am sure the training was beneficial.

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I started my PhD program primarily working in speech-language pathology, but when I was nearly laughed out of the department because I wanted to study the PST for my dissertation, I switched to audiology to work with Dr. Aubrey Epstein. My dissertation introduced me to the effects of otitis media on auditory skills. This led me to another road that eventually hooked up to phonemic training and the effects of otitis media on auditory processing (Katz et al, 2012).

STEP 02 The Staggered Spondaic Word Test

After I thought up the SSW test, I could not wait to get my PhD and start teaching. I taught at Northern Illinois University. After the first semester, a group of students asked me to supervise their master's theses. I assigned three of them to work on the SSW test (FIGURE 1). This was before there was such a thing as APD; we were working to locate temporal lobe tumors. I assigned one student to study adults with hearing loss because my original purpose was to make a central test that would work despite peripheral hearing loss. A second student evaluated older adult patients (I must have been somewhat ahead of my time, as the article we submitted for publication was denied because they said that older people did not have central problems). Because we had no medical faculty or support, our temporal lobe brain lesion group had to meet certain criteria: a history of skull trauma resulting in unconsciousness and also a temporal region scar and paralysis on the opposite side. Each of the students also contributed to gathering the control group data (Katz et al, 1963).

The results were significant for each group. The peripheral hearing loss findings were very interesting. Those with cochlear hearing losses did not have the normal results I had hoped for, but their SSW and word recognition score errors (W-22 words)

were almost identical. This finding eventually led to a correction factor for patients with cochlear and other hearing losses (Katz, 1962).

In 1963, I was teaching at Tulane Medical School. I applied for a National Institutes of Health (NIH) grant to see if the SSW test could identify temporal lobe tumors. Site visitors from NIH came to visit. One of them took me aside and told me that my test was looking only at temporal lobe tumors when it could be much broader. He stated that I would not get the grant, but I should look at broader aspects, and I probably would get it next time. How great was that? The next semester, I reapplied and received the three-year NIH grant. I also had both neurologists and ear, nose, and throat physicians collaborate on the study.

We found that temporal lobe cases had very poor total scores, but especially in one of the two competing conditions (FIGURE 1), which indicated Heschl's gyrus involvement on the opposite side. We also found that anterior region lesions were associated with other signs on the test. This research eventually provided the loci of more than 20 SSW regional signs and later the associated academic and communication problems. This further provided understanding of 20 more signs on the other two tests (Katz, 1962). The research formed the basis of the Buffalo Model for APD using multidimensional scoring, which was not used in audiology at the time.

Multidimensional scoring looks for more than one diagnostic indicator on a test. It provides backup support and expanded diagnostic information. I was very comfortable with this type of scoring because my mother taught me that "it is a sin to waste." This test was able to provide multiple indicators of central auditory disfunction, and each of the three tests in the Buffalo Model obey my mother's directive.

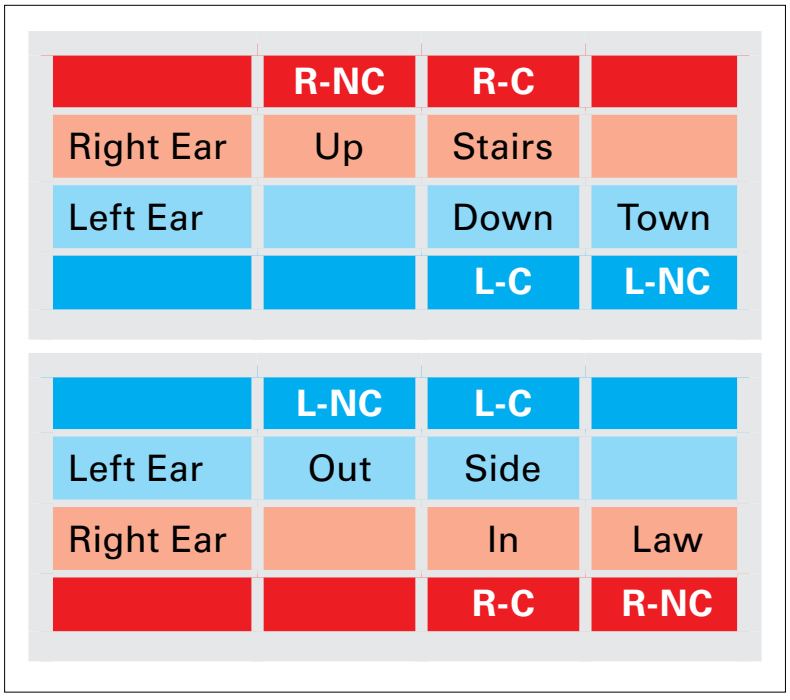

FIGURE 1. Two Staggered Spondaic Word test items showing the noncompeting (NC) and competing (C) words for both ears. Items alternate starting in the right (R) and left (L) ears to provide both challenges.

STEP 03 The Words-in-Noise Test

When APD came on the scene, most of the children or their families also indicated problems in noise. I had no test for speech-in-noise, and, based on these complaints, I developed a Speech-in-Noise test in our apartment, where my children and wife would be talking and using dishes and pots to make other noises. This was okay, but when I started teaching at the University of Buffalo, the university had another procedure using W-22 words and white noise. Before long, I developed a compromise between the two tests. I had four male speakers on one side of the table, farther from the microphone, and four female speakers on the other side. Each person had a different book they were to read out loud for 10–15 minutes. I found a 3-minute section at a consistent noise level and played it over and over for the competing noise. We were, then, able to use W-22 words on one track and the multitalker noise on the other.

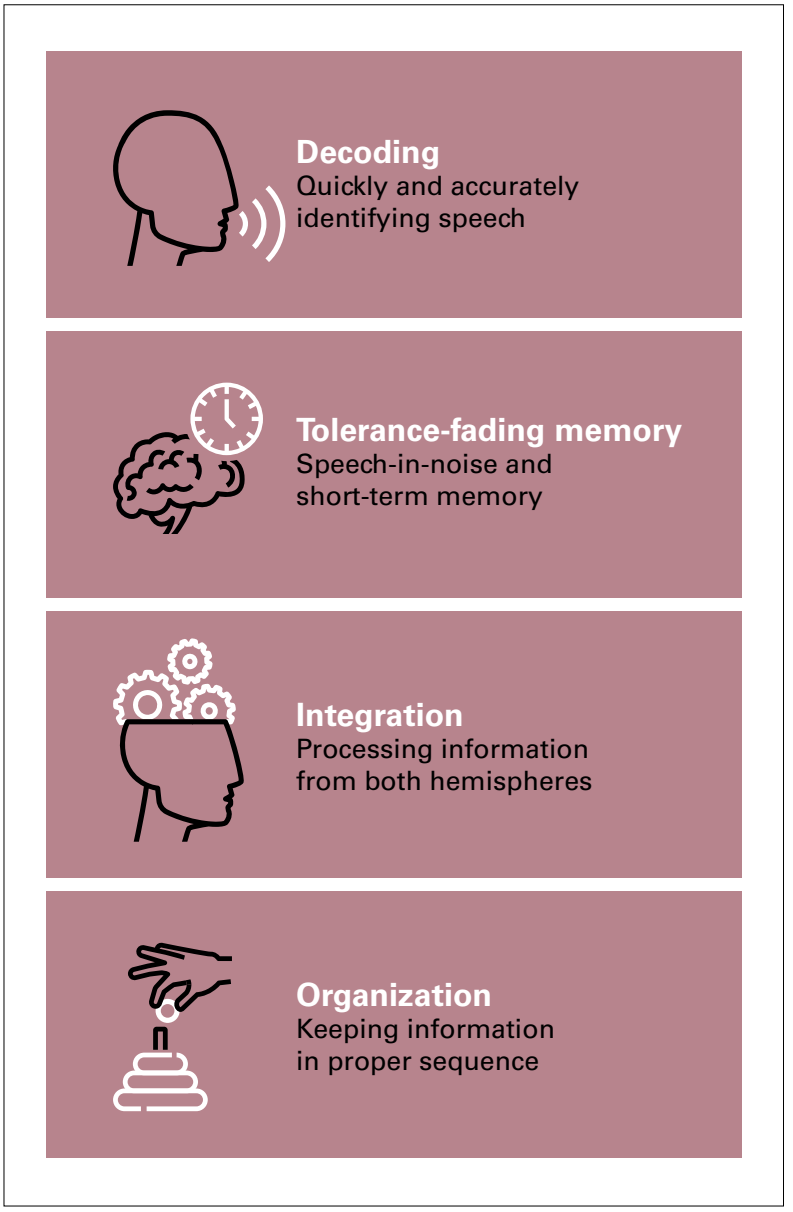

FIGURE 2. The four categories of test results.
SOURCES: Katz, 1962, 1992.

STEP 04 Norms

I asked colleagues who were experienced in using these tests to assist me in gathering the normative data. These colleagues were from across the country and Canada, and each was asked to test about 10 people, aged 5–60 years. They were to have normal hearing and no history of speech or reading therapy or academic difficulties. When we calculated the test results, subjects with scores greater than two standard deviations below the mean were removed from the sample,

as their scores could have been a sign of APD difficulty. After working with those audiologists and contacting additional colleagues to increase the sample sizes in each age group, I asked the colleagues to send their final normative samples.

STEP 05 Four Diagnostic Categories

We now had data for about 40 test findings across the three tests and had norms for the test signs to associate with the neurological information. The auditory difficulties (Katz, 1992) and neurological sites (Katz, 1970) enabled us to divide them into four categories (FIGURE 2). A few signs that did not fall neatly into one category were labeled as "various." By this time, we had effective therapies for each of the four categories and related each to academic and conversational functions (Katz et al, 2024).

STEP 06 Sharing the Buffalo Model with Our Colleagues in the United States and Beyond

The Buffalo Model was first described, not by name, in 1992 (Katz, 1992). However, in 1994, the American Speech-Language-Hearing Association had a consensus conference for central APD in Albuquerque, New Mexico. The purpose of the conference was to come up with a definition of central APD. I was invited to speak, so I thought it would be good to have a program name. Because Nancy Stecker and I were attending from the University of Buffalo, and Kim Tillery would be starting her PhD program there, I decided to call it the "Buffalo Model."

> The Buffalo Model tests and program have been used successfully in the United States and other countries for nearly 40 years.

The Buffalo Model was the first model of APD. It is based on the anatomical information obtained from the 3-year NIH grant study with neurologists and otolaryngologists and the abnormal anatomical regions associated with signs on the

SSW test. Once we had these data, we were able to correlate the results with other tests and subtests to produce the current model.

The Buffalo Model tests and program have been used successfully in the United States and other countries for many years (Kaul and Lucker, 2016). Some who adapted the original SSW test to their language were not aware that "perceptual centering" was needed for the competing words. Perceptual centering for the SSW is made by listening to both competing words through a loudspeaker to be sure that they sounded maximally overlapped. If not, we moved the timing of one of the spondees to ensure that the competing words maximally overlapped.

Summary

This describes the long journey of the Buffalo Model. It started in 1958 when I was so surprised that the PST and therapy could be so effective, continued in 1960 when the SSW test popped into my head, was followed by the NIH grant, and finally developed into the Buffalo Model in 1994.

In my opinion, the most important aspect of the Buffalo Model is that it has helped countless patients throughout the world with a "simple and effective" program to diagnose and treat APD.

Jack Katz, PhD, attended Brooklyn College, Syracuse University, and the University of Pittsburgh. He was a speech therapist at three parochial schools and then at three central schools. His first audiology teaching job was at Northern Illinois University, followed by Tulane Medical School. He served as Fulbright-Hays Senior Lecturer at Hacettepe University, Ankara, Turkey; founded the speech and hearing clinic at Menorah Medical Center; and taught at the University at Buffalo for 28 years and Kansas University Medical School. He recently retired from private practice, Auditory Processing Service, in Kansas City.

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