Perhaps the Plaintive Numbers Flow

Alice Major

Edmonton, Canada; alice.major@shaw.ca

Abstract

Poetry has been referred to as 'numbers' from ancient times and the question occurs, “So, what are we counting?" In fact, we have traditionally counted a variety of features, such as the number of lines in stanzas, rhyming words, the rhythmic chunks called “feet,” and, most typically, syllables. However, languages vary widely in how the continuous flow of speech sound should be divided into syllables. Recent research has identified a neural landmark that seems fundamental to processing speech—a change in how fast the amplitude of sound is increasing—which offers the possibility of a consistent marker across languages, and is perhaps the basis for the intuitive sense of counting that poets engage with when they are composing.

“Numbers” as a synonym for poetry

One of Shakespeare’s characters, in despair over the ineffectiveness of his verse, declares, “These numbers will I tear and write in prose.” [14]. Shakespeare’s use of “numbers” as a synonym for poetry was familiar in his time and has been used in English for at least five or six centuries. It’s not the only example of linking ideas about composing poetry to concepts from mathematics. That thread can be traced much further back in time, through words such as “rime” (from Old English rīm, which ultimately derives from a Proto-Indo-European stem that means “to regulate, count”); or “meter,” which can be traced to the Ancient Greek “métron”, which meant “measure, size” and was applied to poetic meter.

We poets count compulsively in composing our work. But what is being counted? Generally a measurement system defines a basic unit that can be combined with itself to create other numbers. On a typical straight-edge ruler, for instance, the centimeters are notched at consistent distances along the edge. Searching for a similar, consistent unit in prosody—the metrical/rhythmic analysis of verbal patterns—has puzzled poets for centuries.

The most basic building block of language is the phoneme—the smallest unit of sound that can carry meaning to discriminate one word from another. For example, the difference between ‘p’ and ‘b’ lets us tell “pit” from “bit.” Roughly speaking, phonemes are the consonants and vowels used in each language.

However, basic as they are, phonemes are too complex to reliably constitute a consistent and universal unit for counting. They vary widely across languages, with relatively little overlap in the sounds used to convey meaning between, for example, English and a tonal language like Chinese. Within a language, the specific divisions between phonemes are arbitrary [15]. For instance, the difference between ‘p’ and ‘b’ is the difference between unvoiced and voiced sounds; to get from ‘p’ to ‘b’, you must engage the vocal cords. As we learn to speak, we come to think these are distinct sounds. But in fact they exist on a continuum; we learn to arbitrarily pick a point where ‘p’ turns into ‘b’, and no longer hear the intermediate versions; different languages settle on different points on that spectrum [9].

We do count phonemes, but not as a kind of number-line measurement. Instead, our brains track them statistically; we acquire an unconscious but accurate sense of their relative frequency and notice when they are repeated more often than expected. This becomes the basis of poetic patterns like alliteration (the repetition of initial consonants) and consonance (the repetition of vowel sounds).

The syllable is often considered to be the basic temporal building block of language, carrying the speed and rhythm of speech. The word comes from the Greek roots meaning "what is taken together"—in other words, phonemes joined to make a sonic unit [13]. The basic package consists of a nucleus, usually a vowel, with consonants before and after. We easily agree on how many syllables are found in a word or phrase, even when the incoming flow of sound is continuous.

However, *how* they get counted varies significantly among languages. Human languages can be divided into two main groups depending on how they treat syllables, which in turn affects the perception of underlying rhythm. *Syllable-timed* languages treat all syllables as essentially the same kind of unit, giving each one the same emphasis when it is vocalized. However, *stress-timed* languages like English treat emphasis much more variably. Syllables are given more prominence through a variety of subtle vocal changes. They can be slightly louder or different in pitch [10]. Unstressed vowels can virtually disappear (think of the second syllable in "trouble") Any word can be stressed for semantic purposes (as in "Yes *I* can do it" vs. "Yes, I *can* do it).

The overall rhythm of a stress-timed language has been compared with Morse code (dit-dit-DA-dit) rather than with the more metronome-like regularity of syllable-timed languages such as Ancient Greek or modern French. Babies are surprisingly sensitive to this difference between language categories, indicating that syllables are a fundamental aspect of speech [10].

Like anything else in linguistics, however, the categorization of languages into discrete stress- and syllable-timed categories is by no means neat. Finnish, for instance, has been "notoriously difficult" for linguists to assign to either side of the dichotomy [11].

Counting syllables into poetry

Fundamental as they are to language, there are complications when we build syllables into the poetic units we call lines. In languages worldwide, lines of poetry tend to last approximately 3 seconds [16]. One theory is that this fits comfortably with the length of a breath. However, it may also be related to the capacity of working memory. The average syllable in non-tonal language like English takes about 0.25 seconds to pronounce [16]; this translates to approximately 12 syllables per three-second line. Since this is somewhat beyond the number of units we can comfortably handle in working memory, we generally group syllables into a more manageable chunks.

Ancient Greek literature—which has formed a template for theories of prosody in Western literatures since the classical period—was syllable-timed. Counting syllables for the purposes of poetry was a relatively straightforward process related to counting vowel sounds: "long" vowels took literally twice as long to pronounce as short ones. Syllables were arranged into fixed patterns known as feet. The foot known as a 'dactyl,' for instance, is based on one long syllable followed by two short ones. The foot known as a spondee consisted of two syllables, both with long vowels. What gets counted in Ancient Greek poetry is the number of feet in a line: each line of Homer's *Iliad*, for instance, is built from six dactylic feet. Such patterning requires listeners to register the count of feet within each line as well as the count of syllables within each foot.

Counting feet as the basis for poetry is not nearly so straightforward in stress-timed languages. Writers from the Middle Ages on have tried diligently to apply the patterns of classical meters to poetry in English, using strong and weak stresses instead of long and short vowels. So the classical dactyl became strong-weak-weak. (Think of a word like "gunnery" or a phrase like "strong as a…".) However lines of English poetry seldom seemed to quite fit neatly into counting feet—there were usually toes missing or left over. The heartbeat of poetry in English is a line with five iambic feet: da-DUM-da-DUM-da-DUM-da-DUM-da-DUM. But even in *Paradise Lost*, John Milton's almighty long poem written entirely in that meter, the first 165 lines have only two perfect examples of that pattern [15, p.156].

As George Puttenham wrote in 1589 in his *Arte of English Poesie,* the Greek meters have "a marvelous good grace" but don't translate well to our language, which requires "a certaine musicall numerositie in utterance, and not a bare number as that of the Arithmeticall computation is." [7]

One of the oldest approaches to counting in stress-timed languages is "accentual meter": simply the requirement that a line of poetry contain the same number of strongly stressed syllables with no concern for how many unstressed ones fall between [4]. Strong stress can be a useful proxy for counting notches on the ruler as far as practicing poets are concerned. However (as with phonemes) stress exists on a sliding continuum, not a yes-no binary, and unstressed syllables count too. No poet would consider a line with four strong syllables to be "equal" to a line with four strong stresses plus seven or eight lightly stressed ones. And stress can be quite arbitrary: rap poet-performers often emphasize syllables that rhyme even if they aren't the ones that would normally receive stress in a word or line [2].

Rhyme itself has a long history as a countable patterning device in poetry. Traditionally it is used at the end of a line, and the recurrence of rhyme words becomes a way to build and track the larger units known as stanzas. These can be fairly simple a-b-a-b patterns (the traditional ballad meter) or much more complex ones like the Spenserian stanza of the 16^{th} century, which requires you to keep track of three separate end-rhyme sounds as well as a shift from a five-stress to a six-stress line, in order to know you've reached the end of a stanza [3].

In the end, counting stresses, feet, or rhymes doesn't reliably indicate that language has been patterned into poetry. In free verse—an approach that has taken hold in literatures around the world from Arabic to Japanese—the requirement for specific numbers of stressed syllables or feet within lines, or rhyme in stanzas, has almost disappeared. And the prose poem even dispenses with the line itself. Yet it is still poetry, and there is still a sense that we are tracking some sort of recurring sonic pattern.

Neurological signals

Recent research indicates our brains may be listening for a very specific, discrete signal out of the continuous, undulating wave envelope that follows the varying amplitude of incoming sound. It has been recognized for some decades that perception of this wave envelope (which tracks overall energy rather than specific moment-to-moment frequencies) is critical to making speech intelligible, though it has been difficult to work out why. The brain can't use the continuous envelope information to comprehend individual words—our cortex needs the detailed analysis of frequencies at each point in time to process specific vowels and consonants into understandable speech.

However, from the continuous blur of the wave envelope, we *can* reliably identify syllables. Recent work indicates how: certain neurons are watching for a very specific signal, namely a rapid rise in amplitude [12]. A universal feature of syllables is that the speech amplitude peaks locally on "syllabic nuclei"—i.e., the sounds that require the greatest sonic energy to produce. These are typically vowels, but may also include certain types of consonants or consonant clusters, particularly "sonorant" consonants like the "m" in "rhythm" or the "l" in "bottle." Our neurons are not monitoring the wave envelope for points of greatest loudness, but for the points where loudness starts to increase most rapidly—in effect, the peaks in the first derivative of the wave envelope. These recurring peak-rate firings serve as a reliable temporal landmark and an elegantly simple neural mechanism for counting syllables. They are also important for distinguishing stress: the magnitude of a peak-rate response correlates with the degree of stress on that particular syllable.

So we might think of those discrete peaks as tally-marks in the continuous stream of speech sounds. According to one model of counting both events and time, the brain tracks "pulses" and accumulates them to provide a given estimate of magnitude and compares this to some remembered tally of a given duration or number [1]. This sounds like a model with particular relevance to how we hear (and enjoy) poetry.

Research already suggests that newborns are capable of matching the number of syllables they hear with a corresponding number of objects presented to them visually [8]. In doing so, babies are relying on the Approximate Number System, the rapid, intuitive sense of numbers and their relations that is with us from birth. In matching the number of sound units to a geometric shape, infants are not relying on anything approaching symbolic comprehension, suggesting that instead they are relying on some perceptual feature of the sound they are hearing and linking it to an abstract, non-verbal capacity for counting.

Concluding remarks

"Perhaps the plaintive numbers flow / for old, unhappy far-off things / and battles long ago." William Wordsworth penned these lines in "The Solitary Reaper" two centuries ago [17]. In that poem you can count four stanzas, each built of eight lines. Every line has four stressed syllables—except for the fourth line in each stanza which only has three strong stresses.

Such rhythmic use of language is found in cultures around the world [6]. In fact, the count of four stresses in Wordsworth's line is typical of nursery rhymes from Croation to Turkish to Arabic [5]. A patterning that is so widespread calls for exploration. So insights from neuroscience that reflect universal aspects of human cognition are of interest to practising poets, translators and literary theorists. It will be relevant, and very pleasant, if future neuroscience confirms that, as we listen to the rhythms of poetry, our brains somehow link the firing of particular neurons to the systems underlying the Approximate Number Sense—implying that math and poetry are linked at the most fundamental levels of the human brain.

Acknowledgements

The author thanks Dr. Sarah Glaz for her invaluable suggestions on this paper.

References

[1] Allman, M. J., Pelphrey K and Meck W. "Developmental Neuroscience of Time and Number." *Frontiers in Integrative Neuroscience,* vol 6, 2012. https://www.frontiersin.org/articles/10.3389/fnint.2012.00007/full.

[2] Bradley, *A. Book of Rhymes: The Poetics of Hip Hop.* BasicCivitas, 2009, pp. 49-83.

[3] Cuddon, J. A., *A Dictionary of Literary Terms.* London, 1979, p. 649.

[4] Hanna, P. L., Lindner, K and Dufter, A. "The Meter of Nursery Rhymes: Universal versus Language-Specific Patterns" *Sounds and Systems: A Festschrift for Theo Vennemann.* Mouton de Gruyter, 2002, pp. 248-254.

[5] Gioia, D. "Accentual Verse." http://danagioia.com/essays/writing-and-reading/accentual-verse/.

[6] Hogan, P. C. "Literary Universals." *Poetics Today,* vol 18, no. 2, 1997, pp. 223-249

[7] Ing, C. *Elizabethan Lyrics*: *A Study in the Development of English Metres and their Relation to Poetic Effect*. London, 1951, p. 45.

[8] Izzard, V., Sann, C., Spelke, E. S. and Streri, A. "Newborn Infants Perceive Abstract Numbers." *PNAS.* June 23, 2009, pp. 10382-10385.

[9] Ladefoged, P. *Vowels and Consonants: An Introduction to the Sounds of Language.* Blackwell Publishers, 2001, pp. 118-121.

[10] Nespor, N., Shukla M., and Mehler, J. "Stress-Timed vs. Syllable-Timed Languages." *The Blackwell Companion to Phonology, Vol 2.* John Wiley & Sons, 2011, p. 1151.

[11] O'Dell, M. and Nieminen, T. "Reasons for an Underlying Unity in Rhythm Dichotomy." *Liguistica Uralica, Proceedings lf the Finnic Phonetics Symposium, Aug 11-14, 1998.* pp. 78-9.

[12] Ognian, Y. and Chang, E. "A Speech Envelope Landmark for Syllable Encoding in Human Superior Temporal Gyrus" *Science Advances*, Nov, 2019. https://advances.sciencemag.org/content/5/11/eaay6279.full.

[13] Online Etymology Dictionary. https://www.etymonline.com.

[14] Shakespeare, W. *Love's Labours Lost*, Act IV, scene 3, line 1378. http://shakespeare.mit.edu/lll/full.html.

[15] Tsur, R. *Towards a Theory of Cognitive Poetics.* Sussex Academic Press, 2008, pp. 216-222.

[16] Turner, F. and Poppel E., "The Neural Lyre: Poetic Meter, the Brain and Time." *New Expansive Poetry.* Story Line Press, 1999.

[17] Wordsworth, W. "The Solitary Reaper." https://www.poetryfoundation.org/poems/45554/the-solitary-reaper.