Word shapes and rhymescapes: Translation symmetry at work

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When you are not a mathematician, the word 'symmetry' simply calls to mind a decorative quality to the surface of things, something pleasant to look at. But when I read Herman Weyl's classic book, "Symmetry," I began to get an inkling of the much deeper concept that mathematicians use – a *transformation*, an operation that leaves things the-same-but-different after they have been reflected or rotated or slid over a plane. And I began to think of the pervasive tension between ideal, mathematical symmetry and symmetry-*breaking,* which seems to drive the creation of structure in so many things from the Big Bang to a human work of art.

It's easy to see how visual artists use symmetry transformations in creating their work. However, as a poet I did not immediately realize they are also part of my own toolkit. That's because we are so habituated to the idea of a symmetry as something we see, while I work in an art form that occurs in time and is based on sound. However, there are indeed ways in which I work with symmetry every time I construct a few lines. And my tools are rather similar to those used by musicians. This may not sound surprising – people often feel, vaguely, that poetry and music are similar. "That line of poetry is so musical" we murmur without being able to specify exactly what we mean. In fact, the underlying loom on which both are woven is translation symmetry.

It has taken human beings a long while to extract the mathematics underlying symmetry, but brains have been noticing such patterns for a very long stretch of evolution. Regularities in the world are useful things to notice, and symmetrical relationships are particularly useful patterns to abstract from the environment. Human brains then turn the process around and use these abstracted patterns to create tangible things that please us.

However, different modes of perception are biased in how they detect (and subsequently use) symmetry. For instance, our visual systems handle reflection symmetry superbly, especially the 'bilateral' type where the left side of a face is reflected in the right. We detect such balanced, vertically reflected patterns immediately and unconsciously. Our visual systems are much less clever at noticing 'translation' symmetries – the kind of transformation that picks up a pattern and shifts it to another part of the plane. When researchers have us peer at configurations of dots and lines, we're less quick to detect that the same pattern has been repeated (without being flipped into its mirror image) on the other side of our visual field.[1]

When it comes to hearing, our detection capacities are reversed.[2] We don't easily notice that notes have been 'mirrored' (i.e. an identical sequence of musical notes has been repeated backwards). Nor do we quickly hear palindromic words like "rats" and "star" as being made up of the same sounds forward and backwards. But our ears do recognize *translation* symmetry – a chunk of sound that has been shifted like a tile on a floor – very well. So art forms based on sound – music and poetry – employ this kind of patterning a great deal.

Beat, a recurring pulse, is the most obvious form of translation symmetry in sonic performances. However, a regular beat, whether it's a quick-march in music or the ta-TUM / ta-TUM / ta-TUM of a line of iambic poetry has very restricted symmetry. Like one of those patterns crimped around the rim of a pot, it's a one-track line in time. (I'm talking here about the way beat is generally used in Western music, not the patterns of, say, African music where so many different rhythms are happening at once.)

Sound symmetries get more interesting when they show up in patterns like melody and rhyme. Both are clusters of sounds that recur in the same order and are as easily recognized by our ears as balanced splashes of red in a painting are noticed by our eyes. As Daniel Levitin writes, "A melody is an auditory object that maintains its identity in spite of transformations."[3] Rhyme is the same kind of 'object.'

At the heart of their identity is a pattern of *stress*, which is critical to recognizing both rhyme and melody. We distinguish a tune by the notes' duration and accentuation, and notes that fall on downbeats or at other important rhythmic junctures usually become the most recognizable ones. In fact, the stress pattern is so important to melody that we can identify familiar tunes when their rhythm is tapped out on a single pitch – although we do not do as well when the tune's rising/falling tones are used but they are all made the same length.[4]

Rhyme depends just as heavily on getting the stress patterns to match. This is why *entered* and *interred* are not good rhymes, even though they group almost exactly the same sounds in the same order. However, we happily accept Jack and Jill's pairing of *water* and *after* as a satisfactory duplication of sounds.

What kind of space do the translation symmetries of rhyme and melody inhabit? After all, we tend to think of sound as occurring in the single dimension of time. Music has the option of shifting tunes up and down in pitch. But rhyme adds an especially interesting dimension to the (usually) one-way arrow of time.

Rhyme kicks you back to hear again something that you heard before – something you may not even have noticed the first time. It does this by delaying the processes in the brain that strip away auditory information as incoming sound is handed off to the semantic modules that assign it to an abstract category (like *p* vs *b).* In normal speech, we lose the actual puff or pop quickly from consciousness and focus on assembling meaning. Rhyme delays this process of stripping out the sensory data, allowing us to hold it in a kind of echo chamber, the auditory short-term memory. Reuven Tsur, one of the earliest scholars to apply cognitive theory to literary studies, points out that in some circumstances, rhyme will reverberate more intensely and longer than most other aspects of poetic language. The brain perceives rhyming units as being closely knit together even if they are relatively far apart, so that rhyme spreads "a kind of sensory net over a considerable region of a poem."[5] It is almost as though the rhyme inhabits a dimension that is space-like as well as time-like.

Rhyme's tiles slide
        from line
to line, a not-so-rigid motion –
a knitted, shifting symmetry
        that matches 'tree'
to 'infinity', 'identity'
or 'melody.' Rhyme bides
        its time
until a tuneful congruence
chimes in –
        duplication
with a difference, like forests
that line a river with the glide
        of pine
and aspen, an automorphic chorus
of translation.

So what about congruence?

But is a rhyme really a translation symmetry? After all, one of the essential relationships in translation symmetry is congruence – you should be able to take the shape you started with and lay it over the end state with no bits that stick out as different.

It's easier to imagine musical melody as being like a translation. "There it is again," we think as we hear Da-Da-Da-DOMM come back in in Beethoven's Fifth Symphony. But the essence of rhyme is for the sounds *not* to come back in an exact repetition. The fun comes in when we hear Eminem rap: "Goin' through public housin' systems, victim of Munchausen's Syndrome"

The classic definitions of rhyme require every sound after an initially different element to be the same: [b]one/[st]one, or [n]unnery/[g]unnery. The Eminem rhyme clearly flunks that test. When we map 'public housin' systems' onto 'Munchausen's Syndrome,' there's *no* point where everything after an initial sound matches. So what do we hear to classify it as rhyme?

Table 1

p	≠	m
u	✓	u
b	≠	nch
lic	≠	
h	✓	h
ow	✓	ow
z	✓	z
i	≈	ə
n	✓	n
s	✓	s
i	✓	i
s	≠	
t	≠	n
	≠	dr
ə	✓	ə
m	✓	m
z	≠	

Notes to table:
≠ indicates there is no match at all between sounds.
✓ indicates there is an exact match between sounds
≈ indicates sounds that match to some degree; for instance we tend to hear 'n' and 'm' as similar enough to count as rhyme.
ə is the 'schwa' vowel that occurs so often in English. It's the indeterminate 'uh' sound that you hear in 'the.'

The table shows that we do hear nine sounds in each phrase that match up – and most importantly, they are *in the same order.* Order is critical. You can come up with a phrase that has the same sounds as "Munchhausen syndrome" and yet won't rhyme: "Sixteen Zen house chums" has even more matching sounds than 'public housin' systems', and even has a fairly similar pattern of strong and weak stresses. But because the order doesn't match, our ears don't register rhyme. In effect, the phrases are not the same shape.

Poets do often use sounds repeated in no particular order in their lines. This is the basis for alliteration and assonance, essential implements in the poet's toolkit. Our brains are very attuned to the statistical frequency of sounds in our own languages, and so we notice slightly atypical occurrences with great accuracy. But the math underlying alliteration and assonance is more like the math of averages and statistical dynamics. It's not the 'more-or-less-rigid motions in the plane' that create the geometry of rhyme.

This is where the analogy of symmetry breaking can be brought in. We can think of rhyme as *breaking* symmetry to create structure. The symmetry of a system with many identical components is very high – think of the many ways in which the molecules of gas can be rearranged without changing anything significant about the system as a whole. However, when that energetic sameness cools to liquid and then ice, the system has to acquire a preferred direction, a way that its components will line up. The changed system has less symmetry than it started with, but to a human observer, ice crystals are much more 'symmetrical' than gas molecules.

Likewise, our rhyme picks out a few sounds that we key onto as the preferred [and observed] axis – especially the 'ow', 'z', 's' and 'm' – and we discount the pieces that don't line up together. Rhyming 'how… how…. how… how…" indefinitely might have maximum translation symmetry but human brains want structure to emerge. And that takes a *change* in the words, a variation in their meaning.

Learning to abstract a pattern of translation symmetry from incoming sounds seems to be a fundamental exercise in young human brains, and we make such learning a priority. Getting sounds to match is the essence of learning both music and language, and we begin to be able do so around the same age. The four-year-old learning a nursery rhyme is learning a kind of practical translation symmetry in the syllables that construct her language. She's learning the subtle variations of sounds within words and how different consonants peg vowels down in different ways – the *a* of *cat* and *pat* is not the same as the *a* of *car* and *far*. Most importantly she's learning how sound adjusts itself to rhythm. When she recites "Peter, Peter pumpkin eater / had a wife and couldn't keep her," she finds that *eater* and *keep her* have something in common that overrules the difference between *-t-* and *-p h-*. That 'something' is the abstract translation symmetry underlying the rhythm.

And mastering 'cat' and 'hat,' we move on to Eminem. Try it yourself: take a pattern of sounds, a complex phrase, then try to pick out a few to form the spine of a complex rhyme.

"Ill-met by moonlight," wrote Shakespeare.

Ill-slept by moonlight.
Ill-mapped by moonlight
Aisles crept by moonlight.
Bells swept by tunes like …

References

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[2] Ibid, p. 26
[3] Daniel J. Levitin. *This is Your Brain on Music: The Science of a Human Obsession*, 2006, p. 25.
[3] Robert Jourdain. *Music, the Brain and Ecstasy: How Music Captures our Imagination*, 2002. p 81.
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[5] Jourdain, p 45