Life really is a tuneful little number

Mathematics and music, they say, often go together. I have no idea whether this factoid is truth or urban myth, but I do know many musical mathematicians. There is definitely something about music that appeals to the mathematical mind, and I think it may be a deep feature of human evolution. The intellectual traffic runs the other way, too: many composers like to play games with patterns. Mozart incorporates masonic numerology into The Magic Flute. Bach, Chopin and Schoenberg wove mathematics into their music.

The same goes for poets, sculptors, writers, and painters. The human mind is sophisticated and likes its patterns to be subtle, imperfect and intriguing. Nevertheless, poetry hinges upon clear patterns of metre and rhyme, and even when it deliberately flouts those rules, it does so self-consciously. There is a definite affinity between the sculptures of Henry Moore and the shapes beloved of topologists. Mathematical influences on painting include Alberti's Renaissance theory of perspective and Salvador Dali's

Mozart: music by numbers

use of the hypercube — a form from four-dimensional geometry — in his Crucifixion. Even dance cannot escape: Chris Budd, a mathematician, has analysed the beautiful symmetries of country dancing.

How did we evolve the kind of mind that enjoys the patterns in mathematics, music, poetry, dance? There are many more musical minds around than mathematical; yet, ironically, it is easier to explain the evolutionary appeal of mathematics than that of music. The mathematical mind is rooted in the human visual, tactile and motor systems. Counting is based on touch and movement, geometry is visual. These abilities of the mind have obvious survival value, helping us spot the lion lurking in the bushes, or feel the

The universe is full of mathematical patterns. Large-scale ones, such as the swirling spirals of galaxies; small-scale ones, such as the mysterious symmetries of fundamental particles; human-scale ones, such as honeycombs and rainbows and waves and snowflakes. In such a universe, it is not surprising that pattern-detection improves the prospects of survival; agriculture, for instance, depends on knowing the cycle of the seasons. Mathematics is a cultural system that describes, characterises, formalises and exploits patterns that already exist in nature.

A standard objection to this line of argument holds that our minds just impose their preferred patterns on our perceptions. I don't think that objection holds water. Most of the patterns we think we perceive must be genuine, or else the mind would never have evolved the ability to notice them: there is no survival value in imaginary patterns. Some supposed patterns, however, stem from self-deception — reading tea leaves to foretell the future, say. So important have patterns been in the evolution of the human mind that it seeks them obsessively, even where none exists.

What of the arts, especially music? Music touches parts of our pysche that maths cannot reach. It seems to short-circuit our perceptions directly to an emotional level. So our musical tendencies may be evolutionarily older, and therefore deeper, than our mathematical ones. Our response to music depends on physiology, culture, and how our minds work. The structure of the ear implies that certain combinations of sounds will be pleasant, others ugly. The ancient cult of the Pythagoreans based an entire philosophy on mathematical patterns in musical harmony. Our current western musical scale derives from this discovery. However, as this very fact shows, our ears can be trained by our culture, for different cultures employ different scales.

The basic rhythms of music, its most obviously mathematical aspect, seem closely related to the rhythms of the body — heartbeat, breathing, locomotion. It is no accident that music and dance go together, and feedback from movement to the brain is crucial in our appreciation of music.

The basic rhythms of the body have a mathematical source: networks of nerve cells known as "central pattern generators" produce the body's default rhythms. The catalogue of possible patterns is mathematical — our walk, left-right-left-right — has a symmetric, repetitive structure. The connection between mathematics and movement is especially clear in four-legged locomotion, such as the trot of the horse, the pace of the camel, or the amble of the elephant. In all three gaits the timing of footfalls is regular, their pattern geometric.

We respond to music because our minds have evolved a deep bias towards the detection and appreciation of mathematical pattern. Music transfers those patterns directly into our emotional circuitry, pushes ancient buttons and makes us respond at a primal level.

This may be an accident, but I'm pretty sure it isn't. I think it's cultural feedback, working by what Jack Cohen, the Warwick University biologist, and I call "complicity". Music — drums, whistles, chants — knits a tribal culture together, making it evolutionarily worthwhile for humans to evolve the kind of mind that reacts positively to music. The mind, already primed to respond to patterns, does so, and this in turn reinforces the cultural preference for certain musical forms. And so it goes, for a hundred thousand generations.

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Professor Ian Stewart presents this year's Royal Institution Christmas Lectures on BBC2 from today until Thursday.