great moments in science

Paws for Applause

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Our world is full of rhythms. Birds flock and fly together, schools of fish, thousands thick, turn as one, and Asian fireflies flash together in bursts of light that can be seen for a kilometre. In your heart, millions of muscle cells draw together in a beautifully-timed wave of contraction, that squirts out 80 ml of blood on each beat. The mathematicians called these systems "globally coupled oscillators". And if you've spent a lot of time being in audiences, you'll almost certainly have heard humans turning themselves into a "globally coupled oscillator", and indulging in "Synchronised Clapping".

Immediately after the performance ends, there's loud and raucous random applause, as people in the audience clap their hands together. After about 10 seconds, this can suddenly turn into synchronised clapping, when all of the hands in the audience suddenly hit together in pairs at the same time. For another 15 seconds or so, the audience shows their collective single-minded appreciation by clapping in unison. But the rhythmic synchronised clapping soon speeds up, before disintegrating back into louder random racket. This strange social self-organised spontaneity expresses itself several times, with the synchronisation disappearing and reappearing, as the applause ripples on.

This happened one night at a performance of the play, The Bald Singer, at a Hungarian theatre. In the audience that night was Zoltan Néda, a professor of Theoretical Physics at Babes-Bolyai University in Romania. And as he and other members of the audience showed their appreciation, "a beautiful rhythmic applause appeared".

What was going on? Well, an essential part of any scientific experiment

is to take some measurements.

So Zoltan teamed up with Albert-Laszlo Barabasi, an associate professor of physics at the University of Notre Dame, and they and their colleagues recorded several opera and theatre performances, in Romania and Hungary. They analysed the applause for loudness, "order parameter", average noise intensity, and the average time between clapping. They also analysed the clapping of single volunteers in their laboratory.

They found that during the thunderous, and random, applause, people clap, on average, every 0.4 of a second. But then there's a brief transition period of a few seconds where the clappers omit every second clap. The period doubles to 0.8 seconds, and almost magically, you now have synchronised clapping. People are clapping in unison, but half as frequently.

Now here's an odd mathematical observation.

In the random applause, the average time between claps is about 0.4 seconds - but the scatter is quite wide. Some people are clapping every 0.3 of a second, and some are clapping every 0.5 of a second.

But in the synchronised clapping, where the time between claps has stretched out to 0.8 seconds, the scatter is much less. Practically everybody is clapping close to that 0.8 seconds.

If you analyse the maths of "globally coupled oscillators", it turns out that one of the essential conditions, is that there is very little scatter in the period of each of the individual oscillators - and that's what the physicists found when people clap in synchrony.

But why do we drift in and out of synchronised clapping?

The scientists theorised that we humans, when we're in an audience, have two conflicting desires.

One is keep synchronised with our fellow humans with whom we have just shared a marvellous performance. This explains the synchronisation. The other conflicting desire is to increase, or at least maintain, the average noise intensity. Unfortunately, when we synchronise, we clap half as frequently, and generate half as much noise. (But at some of the gigs that I've been to, some people compensate for the reduced noise by stamping their feet.)

We can't have both at the same time, so we have them one after the other - and drift in and out of synchronised clapping.

We're still not sure whether the synchronised clapping is initiated by stretching out the time between claps, or by human herd instinct. Either way, there's a kind of synchronised applause all performers hope to avoid - and that's the slow hand clap.

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