

# Maths+Music

## Video 1: Introducing Periodicity

### Lesson objectives:

Understand what a periodic sequence is and how to find the period of a sequence. Identify examples of periodicity in everyday life and in music. Understand that a sequence which is not periodic is called 'aperiodic'. Appreciate that musical pieces are usually constructed using a mixture of repeated and non-repeated elements.

### Keywords:

- Periodicity
- Periodic
- Aperiodic
- Sequence
- Period

### Part 1:

'Periodicity' describes whether or not something repeats. If a sequence (or list) can be broken down into smaller, repeated chunks, then it can be described as a periodic sequence. The smaller chunk that is repeated to create the sequence is called the period. If a sequence is not periodic, it is described as being an aperiodic sequence.

### Examples of periodic sequences (from the video):

- Turning a light switch on and off:
  - ON OFF ON OFF ON OFF... (period: ON OFF)
- Days of the week:
  - M T W T F S S M T W T F S S M T W T F S S... (period: M T W T F S S)
- Groupings of black notes on the piano keyboard:
  - 3 2 3 2 3 2... (period: 3 2)

### Examples of aperiodic sequences (from the video):

- Flipping a coin and writing down H or T:
  - H H T H H T T T H T...
- Colour of cars passing you on the street:
  - Yellow Blue White Red White Silver Black Orange...

## Exercise 1:

Can you think of any other periodic and aperiodic sequences that appear in our day-to-day lives? Try to think of:

- 3 periodic sequences
- 3 aperiodic sequences

NOTE: You could also ask students to come up with processes or events that would allow them to create periodic and aperiodic sequences of their own.

### *Suggested examples*

#### Periodic sequences:

Traffic lights (red, amber, green, amber, red, ...)

Simple geometric examples, e.g. stripes on a radiator, arches on a viaduct, train tracks, tiles, honeycomb, frets on a guitar

Rhyming schemes in poems

Hours of the day (1am, 2am, 3am, ..., 12pm)

#### Aperiodic sequences:

Weather each day (e.g. sun, rain, cloudy, cloudy, rain, ...)

Dice roll

Football/sports results

Eating smarties and writing down the colour

Recording birds you see out of the window

## Part 2:

Music can be thought of as being constructed out of sequences of notes that need to be played at the right time in the right order to create the piece.

Turning periodic sequences into music (assigning each element of the sequence to a note) creates pieces that are extremely repetitive.

Turning aperiodic sequences into music creates pieces that sound random and are hard to familiarise yourself with (we will look at randomness more in the next video).

Successful music tends to be built from a combination of repeated (periodic) and non-repeated (aperiodic) elements. Case study: Ed Sheeran: *Shape of You*

Looking at the main musical 'idea' of *Shape of You*:

- The pitches of the notes played form an aperiodic sequence (it begins looking like a periodic sequence, but then changes):
  - C# E C# C# E C# C# E C# D# C# B (# = 'sharp')
- The rhythm of the idea (how long do you wait after playing a note before you play the next one) forms a periodic sequence:
  - 3 3 2 3 3 2 3 3 2 3 3 2
- The main musical idea is repeated throughout the whole song, turning it into the period of a much longer periodic sequence.

## Exercise 2:

Think about a piece of music. Can you find elements of the music that repeat? Are there moments that almost repeat but that are actually different?

NOTE: You could also ask students to turn the sequences they made in Exercise 1 into music, by assigning a note or a sound (any sound: slap the table, jump loudly, vocal noises) to each element of their sequence.

### *Suggested examples*

#### Musical examples that repeat:

The rhythm of Queen's *We Will Rock You* (stamp stamp clap, stamp stamp clap...)  
<https://www.youtube.com/watch?v=-tJYN-eG1zk>

The clapping pattern in Anna Kendrick's *Cups* / Pitch Perfect's *When I'm Gone*  
<https://www.youtube.com/watch?v=cmSbXsFE3l8>

The bass line in Ray Charles' *Hit the Road Jack* (G# F# E D#, G# F# E D#...)  
<https://www.youtube.com/watch?v=SnWp5O0DEs>

The lyrics to Daft Punk's *Around the World* (Around the world, around the world...)  
<https://www.youtube.com/watch?v=LKYPYj2XX80>

*Around the World* is a good example for identifying musical elements because the music video represents each of part of the music as characters:

- Bass line = tracksuits
- High synth = swimmers
- Funky synth = skeletons
- 'Around the World' = robots
- Drum beat = mummies

The camera focuses on each of them as they feature, and the choreography matches the music (tracksuit people climb the stairs as the bass line rises, and run down the stairs as the bass line falls)

Musical examples that almost repeat:

Lyrics of *Happy Birthday*:

Happy Birthday to you  
Happy Birthday to you  
*Happy Birthday dear XX*  
Happy Birthday to you

Small variation with each repetition in the lyrics of Nina Simone's *Sinnerman*:

<https://www.youtube.com/watch?v=QH3Fx41Jpl4>

Oh, sinnerman, where you gonna run to?  
Sinnerman, where you gonna run to?  
Where you gonna run to?

All on that day.

Well I run to the rock, please hide me  
I run to the rock, please hide me  
I run to the rock, please hide me Lord.

All on that day.

But the rock cried out, I can't hide you  
The rock cried out, I can't hide you  
The rock cried out, I ain't gonna hide you guy.

All on that day.

Instruments playing the main theme from Michael Giacchino's *Married Life* from *Up*:

<https://www.youtube.com/watch?v=O297xF tsds> (*Married Life* starts at 0'12")

0'15" Trumpet - T

0'31" Violin - V

0'45" *Trumpet in dialogue with Violin on a different theme*

1'00" Piano (and Glockenspiel) - P

1'19" *Vibraphone and Clarinet (short excerpts)*

1'31" Piano - P

1'58" Trumpet - T

2'16" *Violin in dialogue with clarinet on a different theme*

2'34" Piano (and Vibraphone) - P

2'42" Violin - V

2'47" Piano (and Vibraphone) - P

2'52" *Clarinet and orchestra on a different theme*

3'12" Clarinet - C

3'29" Piano - P

= T V P P T P V P C P

(In general, *Married Life* is a brilliant example of how a single melody can be presented in different ways to create totally different emotions)

Another case study: Pharrell Williams' *Happy*

<https://www.youtube.com/watch?v=y6Sxv-sUYtM>

#### Repeated Elements

- The rhythmic pattern / drum beat (it changes at the break down 1'49")
- Group vocals in the chorus 0'35": 'Because I'm Happy, Because I'm Happy...'
- Choir vocals in the break down 2'00": 'Happy, happy, happy, happy...'

#### Moments that almost repeat but that are different

- Solo vocals in chorus 0'35":
  - Clap along if you feel like *a room without a roof*
  - Clap along if you feel like *happiness is the truth*
  - Clap along if you *know what happiness is to you*
  - Clap along if you feel like *that's what you wanna do*
- Solo vocals in break down 1'49":
  - *Uh,* Bring me Down
  - *Can't nothing,* Bring me Down
  - *My level's too high to* Bring me Down
  - *Can't nothing,* Bring me Down