

JAF04 Unit 8 Chaos

Task 1 Video – Introduction

Before you watch the video, study the vocabulary:

(<http://www.youtube.com/watch?v=JnlkKdDXk-I>)

predictable – unsolvable – faith – simplified – premise – initial – vast – curiosity - advent – decimal – flap – garbage – consequently – by-product – pattern – inherent property – pendulum – reverse – emerge – cluster – on the edge

Watch the footage and complete the sentences:

1. What is the main premise of Chaos theory?
2. What facilitated the development of Chaos theory?
3. Explain the butterfly effect.
4. What are fractals?
5. What is the promise of Chaos theory?

Task 2 Read an extract from the book *Chaos* and complete the gaps with clauses below. Can you guess the meaning of the underlined words?

1 *How big is it? How long does it last?* These are the most basic questions a scientist can ask about a thing. They are so basic to the way people conceptualise the world that it is not easy to see that they imply a certain bias. They suggest that size and duration, qualities that depend on scale, are qualities with meaning, _____ A _____. When a biologist describes a human being, or a physicist describes a quark, *how big* and *how long* are indeed appropriate questions. In their gross physical structure, animals are very much tied to a particular scale. Imagine a human being scaled up to twice its size, keeping all proportions the same, and you imagine a structure whose bones will collapse under its weight. Scale is important.

2 The physics of earthquake behaviour is mostly independent of scale. A large earthquake is _____ B _____. That distinguishes earthquakes from animals, for example – a ten-inch animal must be structured quite differently from a one-inch animal, and a hundred-inch animal needs a different architecture still, if its bones are not to snap under the increased mass. Clouds, on the other hand, are scaling phenomena like earthquakes. Their characteristic irregularity – describable in terms of fractal dimension – changes not at all as they are observed on different scales. That is why air travellers lose all perspective on how far away a cloud is. Without help from cues such as haziness, a cloud twenty feet away can be indistinguishable from two thousand feet away. Indeed, analysis of satellite pictures has shown an invariant fractal dimension in clouds observed from hundreds of miles away.

3 It is hard to break the habit of thinking of things _____ C _____. But the claim of fractal geometry is that, for some elements of nature, looking for a characteristic scale becomes a distraction. *Hurricane*. By definition, it is a storm of a certain size. But the definition is imposed by people on nature. In reality, atmospheric scientists are realising that tumult in the air forms a continuum, from the gusty swirling of litter on a street corner to the vast cyclonic systems visible from space. Categories mislead. The ends of the continuum are of a piece with the middle.

4 It happens that the equations of fluid flow are in many contexts dimensionless, _____ D _____. Scaled-down airplane wings and ship propellers can be tested in wind tunnels and laboratory basins. And, with some limitations, small storms act like large storms.

5 Blood vessels, from aorta to capillaries, _____ E _____. They branch and divide and branch again until they become so narrow that blood cells are forced to slide through single file. The nature of their branching is fractal. Their structure resembles one of the monstrous imaginary objects conceived by Mandelbrot's turn-of-the-century mathematicians. As a matter of physiological necessity, blood vessels must perform a bit of dimensional magic. Just as the Koch curve, for example, squeezes a line of infinite length into a small area, the circulatory system must squeeze a huge surface area into a limited volume. In terms of the body's resources, blood is expensive and space is at a premium. The fractal structure nature has devised works so efficiently that, in most tissue, no cell is ever more than three or four cells away from a blood vessel. Yet the vessels and blood take up little space,

_____ F _____ (...)

6 How did nature manage to evolve such complicated architecture? Mandelbrot's point is that the complications exist only in the context of traditional Euclidean geometry. As fractals, branching structures can be described with transparent simplicity, _____ G _____. Perhaps the simple transformations that gave rise to the shapes devised by Koch, Peano, and Sierpinski have their analogue in the coded instructions of an organism's genes. DNA surely cannot specify the vast number of bronchi, bronchioles, and alveoli or the particular spatial structure of the resulting tree, but it can specify a repeating process of bifurcation and development. Such processes suit nature's purposes.

(adapted from Gleick, J. *Chaos. Making a New Science*. Penguin Books, 1998)

1. no more than about five percent of the body.
2. in terms of how big they are and how long they are.
3. qualities that can help describe an object or classify it.
4. form another kind of continuum.
5. with just a few bits of information.
6. just a scaled-up version of a small one.
7. meaning that they apply without regard to scale.

Task 3 Prepositions

3.1 Complete the gaps with suitable prepositions.

independent ____

different ____

distinguish A ____ B

analysis ____

habit ____

____ a premium

give rise ____

3.2 What prepositions are most common after these passive verbs?

as at in into of on to with

1. be defined/ known/ regarded ____
2. be applied/ attributed/ related ____
3. be associated/ correlated ____
4. be comprised/ made up ____
5. be included/ involved ____
6. be divided/ translated ____
7. be based/ centred ____
8. be aimed/ estimated ____

3.3 Now complete the sentences with suitable verb forms.

1. The total cost of the project was _____ at nearly 2 billion dollars.
2. This chapter is _____ into three sections.
3. Japan's high saving rate has been _____ to several factors, including less access to consumer credit and cultural factors.
4. Since the late 1940s, France has been widely _____ as the leader of European integration.
5. Policy debates in modern Britain are often _____ on the assumption that care for the elderly has been taken over by the state.
6. This protein is _____ in the development of the growing brain.
7. The book is _____ of 12 chapters.
8. A straight line can be _____ as a curve of infinite or very large radius.

(3.2 and 3.3. adapted from Hewings, M; Thaine, C. *Cambridge Academic English Advanced*. CUP, 2012)

More about Chaos:

<http://www.youtube.com/watch?v=njf8jwEGRo>

Watch Robert Sapolsky (Stanford University) giving a lecture on Chaos and Reductionism.