Lecture 1: Information Processing and Signal Detection

Lecture 01 part 01

The Process of Perception

Relevance

Tarr, B., Slater, M. and Cohen, E., 2018. Synchrony and social connection in immersive virtual reality. *Scientific reports*, *8*(1), pp.1-8.

Piumsomboon, T., Lee, G.A., Ens, B., Thomas, B.H. and Billinghurst, M., 2018. Superman vs giant: A study on spatial perception for a multi-scale mixed reality flying telepresence interface. *IEEE transactions on visualization and computer graphics*, *24*(11), pp.2974-2982.

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Learning Objectives

The learning objectives of the lecture “Information Processing and Signal Detection” Part 1 of 4 are:

To develop an understanding of why the study of perception is important in interface design.

To develop an appreciation of the process of perception and the contributors to that process.

To understand some of the approaches that have been used to study perception.

To develop an appreciation of how approaches to the study of perception have been applied to interface design and evaluation.

Learning Outcomes

The learning outcomes of the lecture “Information Processing and Signal Detection” Part 1 of 4 are:

To be able to define perception and its contributory elements.

To be able to describe perception as a continuous process.

To be able to provide examples of why the study of perception is useful for interface design and evaluation.

To be able to describe 2 main approaches to the study of perception.

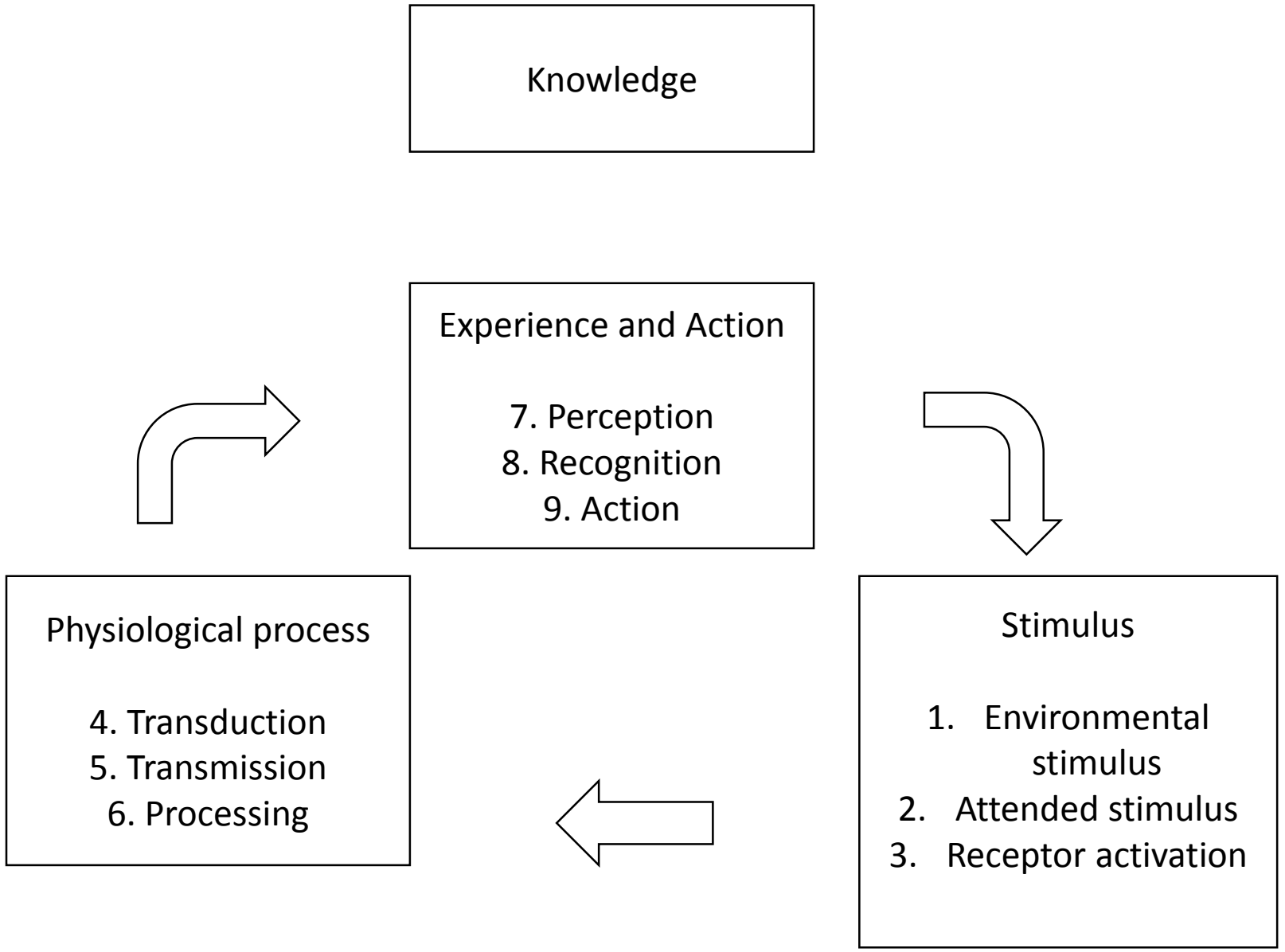
What is Perception?

Perception refers to how we experience the world through our senses (vision, hearing, touch, taste, smell).

Perceiving the environment through our senses helps us to gain an understanding of our immediate environment. This understanding and interpretation can help us identify and recognize the different elements that make up our immediate environment. This information can also be used to help us to plan our action(s) in response to this sensory information.

Perception includes organization, identification and interpretation of sensory information.

The Process of Perception



The perceptual process can be broken down into 4 categories:

Knowledge

Experience & action

Stimulus

Physiological Processs (i.e.) Neural Activity

The Process of Perception

The stimulus can refer to an object in the real world that we may/may not pay attention to. This can sometimes be called the distal stimulus.

So,
The stimulus may/may not require (or capture our attention).
When detected ->
A sensor organ receptor of one of our 5 senses (vision, hearing, smell, taste, touch) is activated.

Stimulus

1. Environmental stimulus
2. Attended stimulus
3. Receptor activation

The Process of Perception

Physiological Process

4. Transduction
5. Transmission
6. Processing

Physiological Process often refers to neural activation.

For neural activation, electrical signals are generated by sense organ receptors in response to the stimulus and this neural activity is transmitted to the brain.

E.g., hearing someone say your name. The name is “heard” by the ear and converted to neural signals within the inner part of the ear (sense organ), and these electrical signals are then progressed (via a network of neural connections) to the brain for further processing.

The Process of Perception

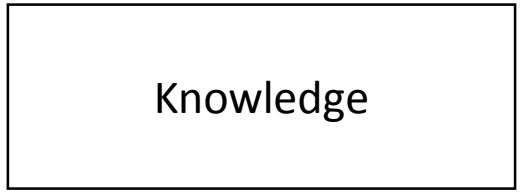
Experience and Action

7. Perception
8. Recognition
9. Action

Experience and action can refer generally to our goal of perception, recognition, and reaction, and ultimately how we may wish to act on the stimulus.

In recognising, we are able to categorise an object, and this may affect our action towards it.

The Process of Perception

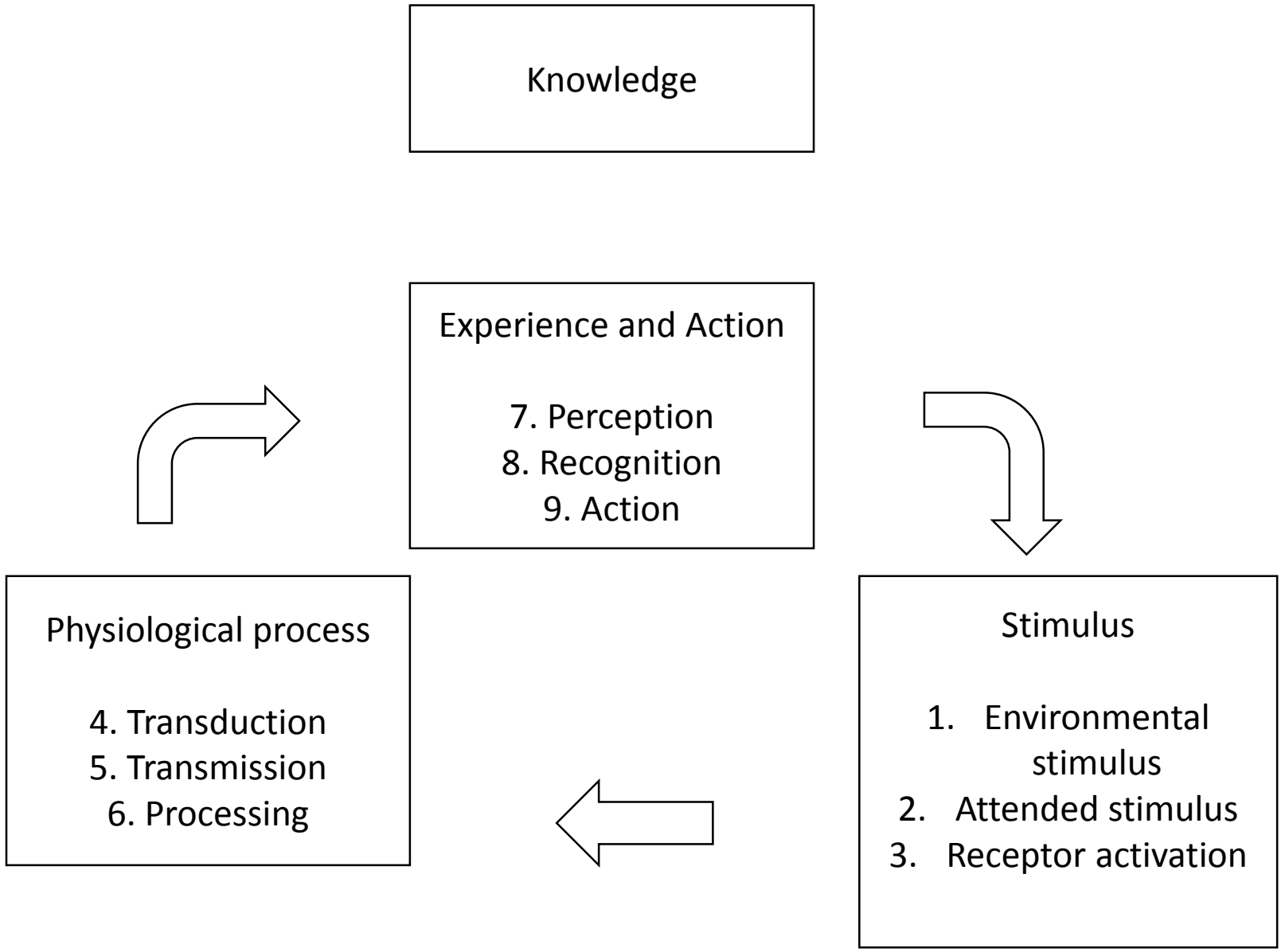


Knowledge refers to prior knowledge about the world, events, or situations, which can influence the response that can apply to a given environmental stimulus situation.

Knowledge can influence different parts of the process, including perception.

Sometimes this can be referred to as “Top-Down Processing”, as it is higher-level brain information that is being applied to the situation.

The Process of Perception



The process of perception can be summarised as in the flow diagram:
An environmental stimulus is encountered. The stimulus may/may not require (or capture our attention).
A sense organ receptor of one of our 5 senses (vision, hearing, smell, taste, touch) is activated.
Receptor activation results in a physiological process involving neural transduction, transmission, and further processing of this information.
This results in our perception, recognition and relevant action on the stimulus.

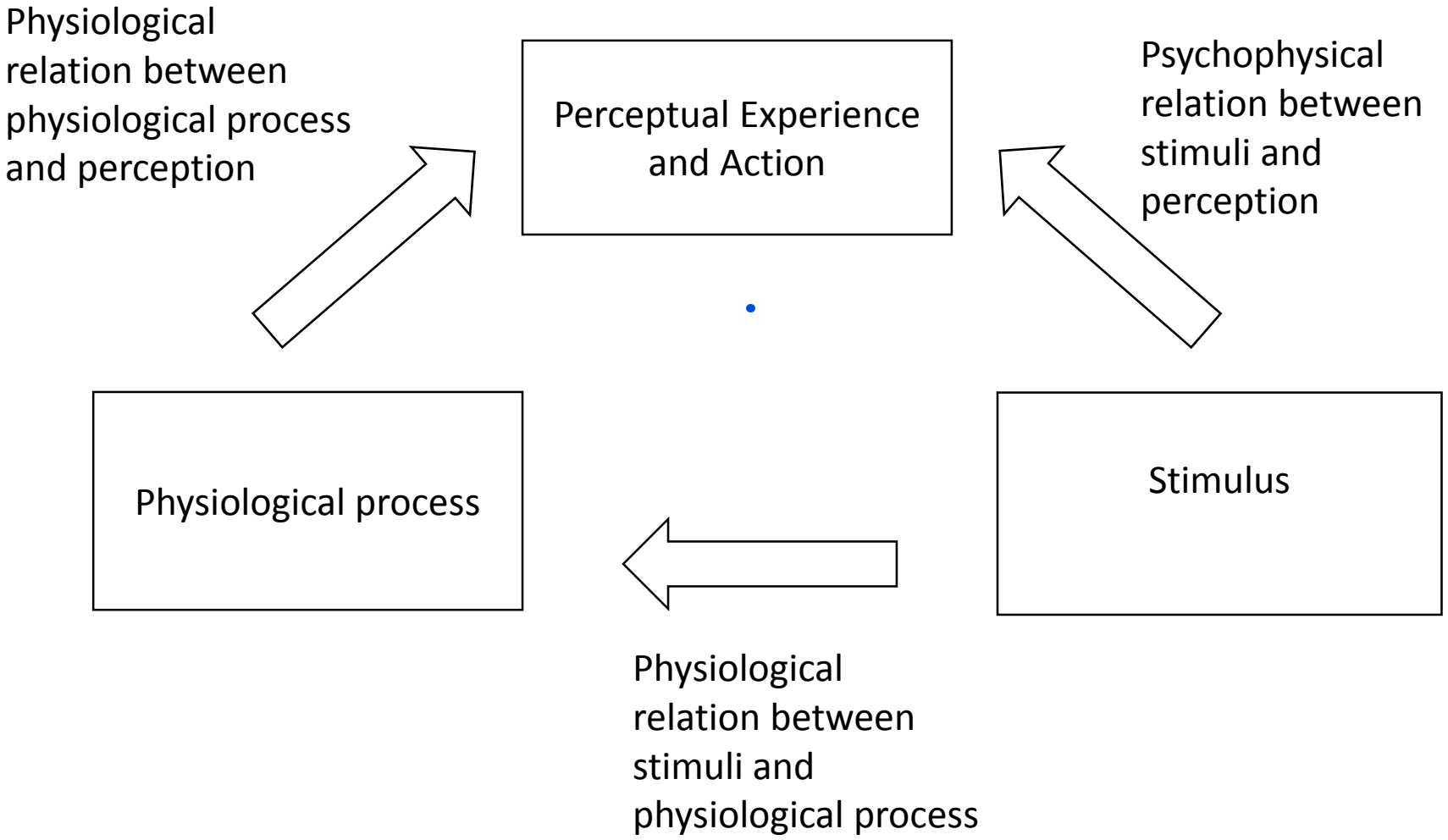
Questions to Consider (10 mins)

Q1: Is it possible to perceive but not be able to recognise or act on the information?

Q2: In which ways could top-down processing/knowledge affect perception?

(We can discuss this in the Question and Answer Sessions)

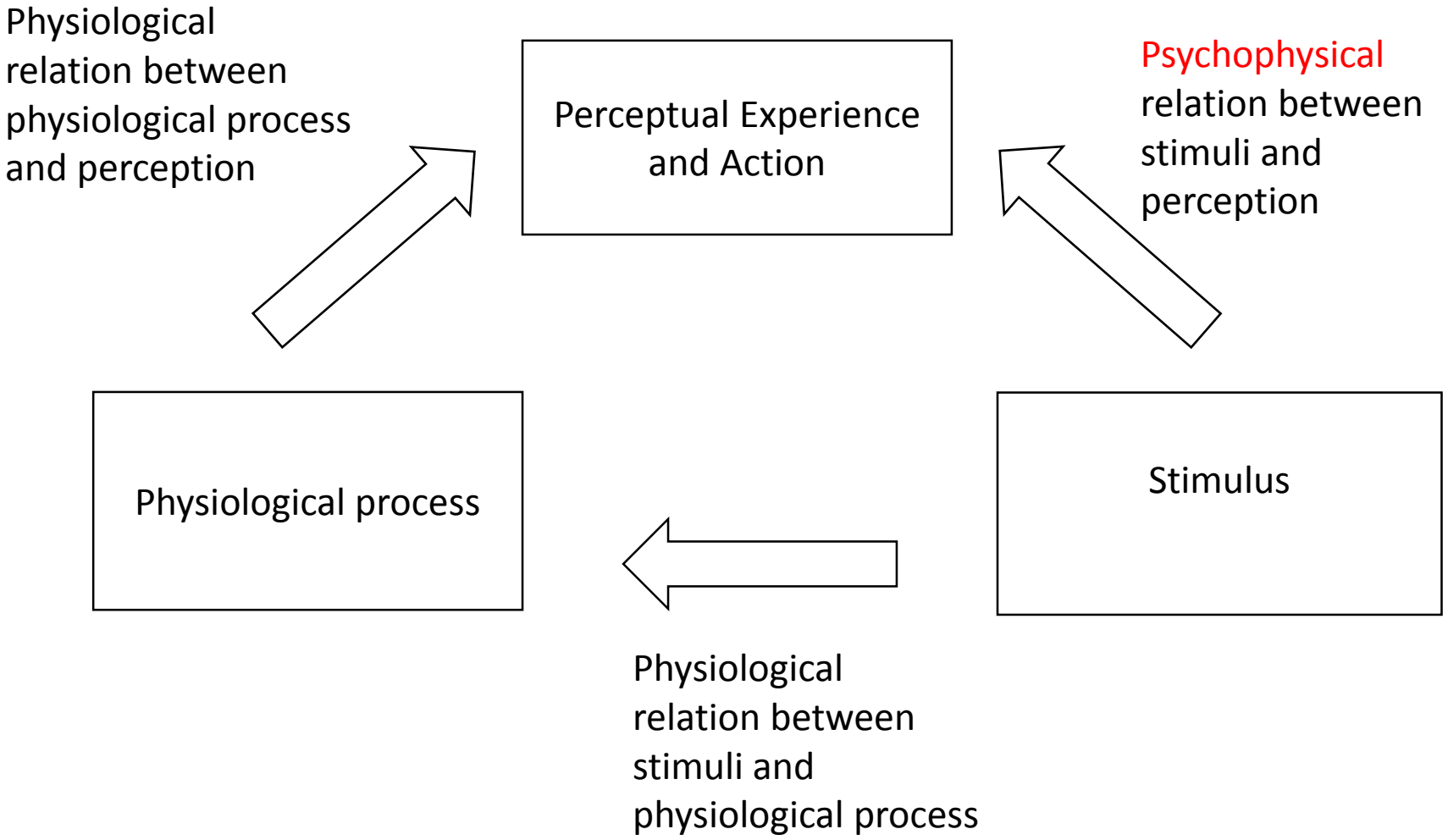
How is Perception Studied?



Perception has often been studied using 2 approaches:

A psychophysical approach and a physiological approach.

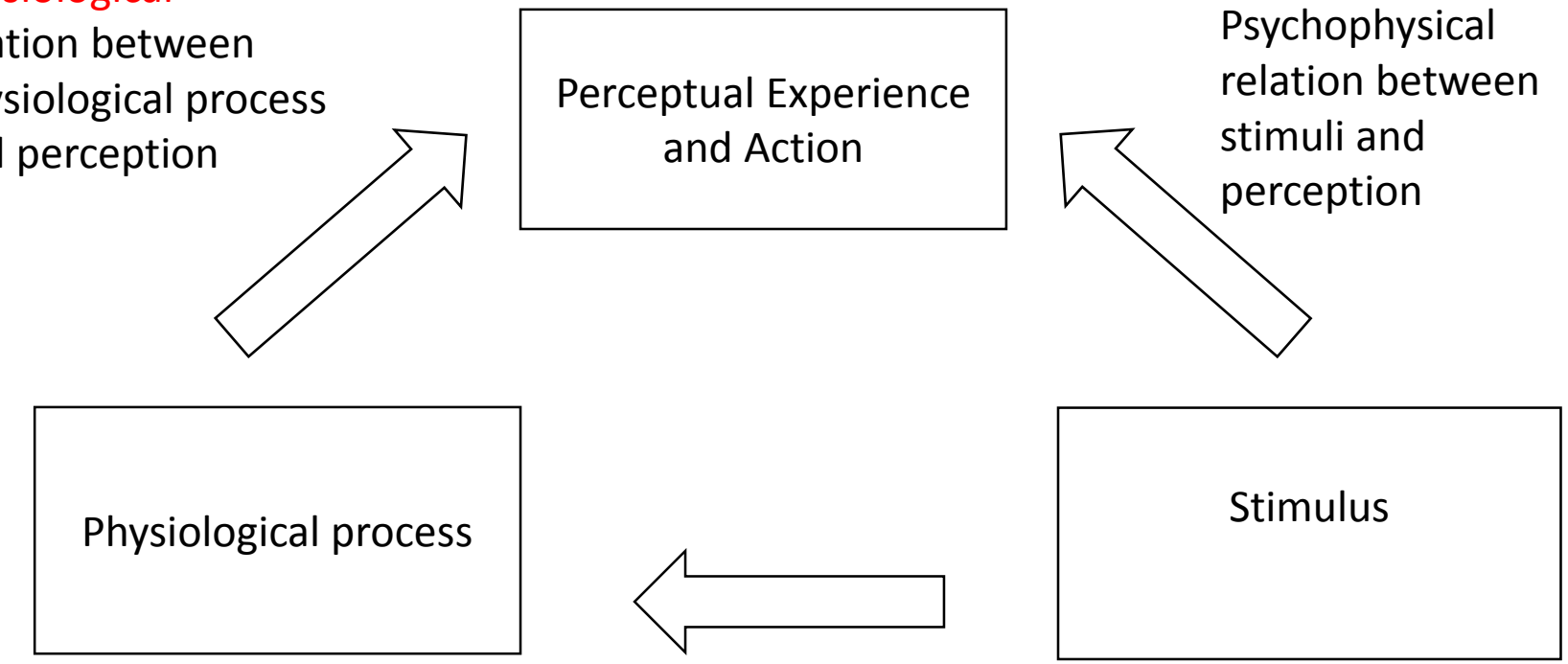
How is Perception Studied?



The psychophysical approach studies the relationship between the stimulus (in particular *physics* of the stimulus (e.g., light, sound) and the perception and/or resultant action towards that stimulus.

How is Perception Studied?

Physiological
relation between
physiological process
and perception



Physiological
relation between
stimuli and
physiological process

The <u>physiological</u> approach studies the relationship between the stimulus and the physiological process generated by that stimulus, or the relationship between the physiological process and the resulting perception and/or action.

How is Perception Studied?

To summarise,

Psychophysical approach to study perception: This involves the use of quantitative methods to study the relationship between the stimulus (in particular *physics* of the stimulus, e.g., light, sound and the perception (*psycho*).
Methods can involve specially designed tests that users can perform and make a judgement about a stimulus characteristic or stimulus event.

Physiological approach to study perception: This involves the use of specialist methods to study a) the relationship between the stimulus and physiological process or b) the relationship between the physiological process and the resulting perception.
Methods used can involved measuring directly from the nervous system, or chemical processes.

An Example Application (see slide 3 for more examples)

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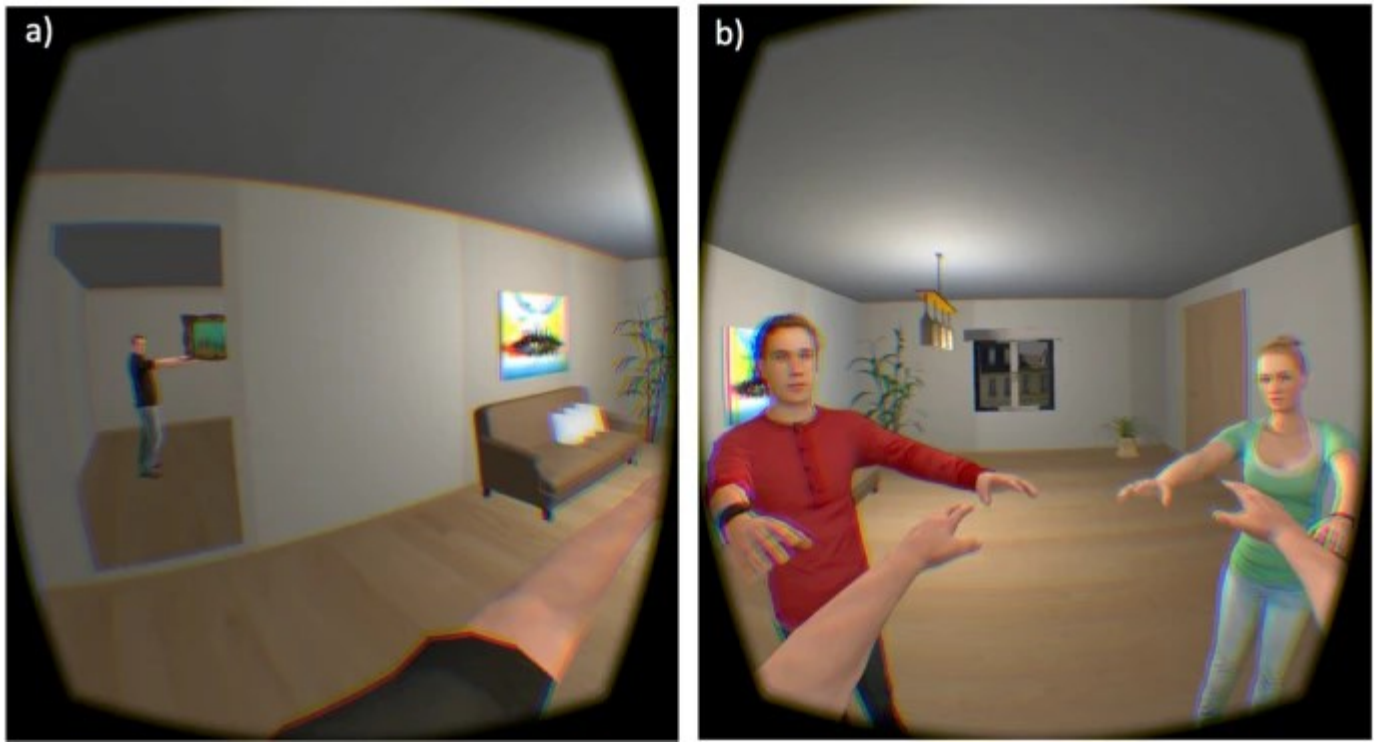

Synchronizing movements in time with others can have significant positive effects on affiliative attitudes and cooperative behaviours.

Virtual Reality (VR) first-person immersive environment in which 76 participants, represented as virtual humans, took part in a joint movement activity with two other programmed virtual humans.

Movements of the virtual humans were either synchronised or not synchronised

Post-activity questionnaire - scores of self-assessed degree of synchrony.

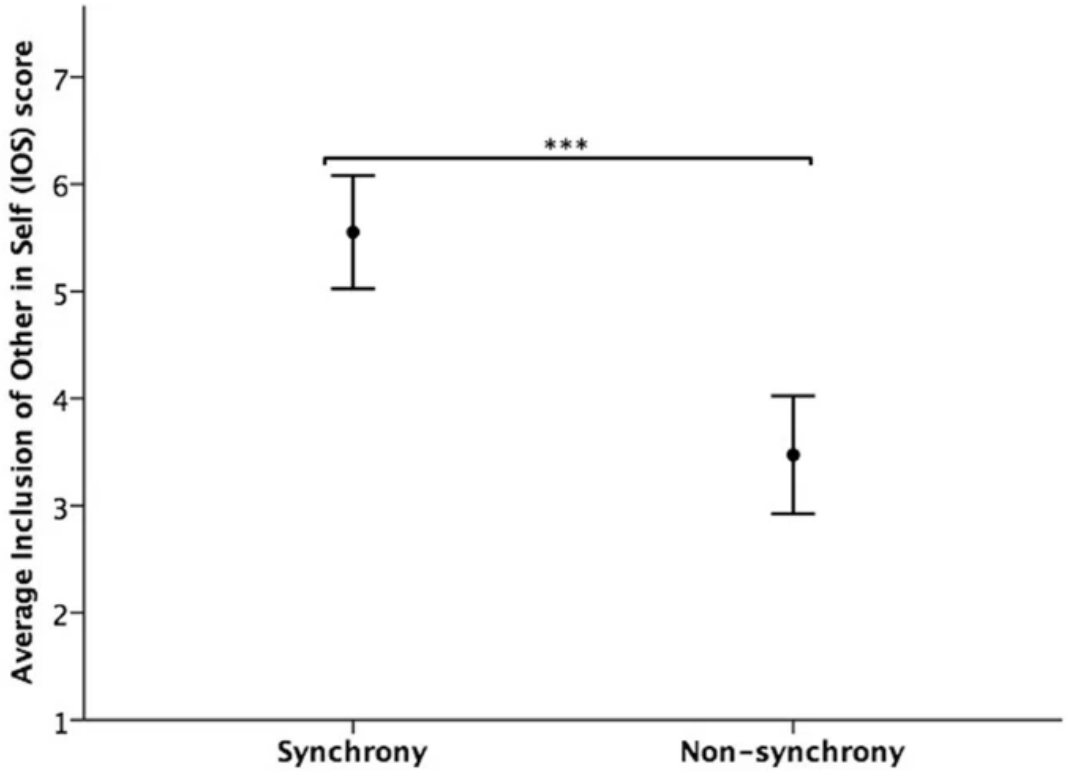

Fig. 1. from Tarr, B., Slater, M. and Cohen, E., 2018. Synchrony and social connection in immersive virtual reality. *Scientific reports*, *8*(1), pp.1-8.

Overall, study showed the positive effect of synchrony on social closeness and other metrics

Overall Summary

Perception refers to how we experience the world through our senses (vision, hearing, touch, taste, smell)

The study of perception is important to the design and evaluation of interfaces.

The perceptual process can be broken down into 4 categories: Knowledge, Experience & action, Stimulus, Neural Activity.

Perception can be measured using psychophysical and physiological approaches.

Resources

Essential:

Sensation and Perception 8th edition (book), pages 5-12.

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Supplementary:

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