# Connectionism

## General

Connectionism, today defined as an approach in the fields of artificial intelligence, cognitive psychology, cognitive science and philosophy of mind which **models mental** or **behavioral phenomena** with **networks of simple units**[1], is not a theory in frames of behaviorism, it **preceded** and **influenced behaviorist school**. Although it is today used in different contexts (mostly referring to neural networks and artificial neural networks that have not emerged until second half of the 20th century) it has origins dating as far back as Greek philosopher Aristotele, who claimed that memory is composed of simple elements connected in a variety of ways[2].

## What is connectionism?

Connectionism represents psychology's first comprehensive theory of learning[3]. It was later introduced by Herbert Spencer, William James and his student Edward Thorndike in the very beginning of the 20th century. Connectionism was then **based on principles of associationism** which claimed that[4]:

- Mental elements or ideas become associated with one another through experience
- Experience consists of such things as spatial and temporal contiguity and (dis)similarity of ideas
- Complex ideas are composed and can be reduced to a set of simple ideas
- Simple ideas are sensations
- Simple additive rules are sufficient to predict complex ideas

But connectionism **expands** this **ideas of associationism** by introducing distributed representations or supervised learning[5] and should not be confused with associationism. Although he is considered one of the first true connectionist, William James' student Edward Thorndike also made the move towards behaviorist ideas.

At the very end of 19th century Thorndike performed experiments first on chickens and later on cats and dogs. In one experiment he placed a hungry cat inside a *puzzle box*, which had a mechanism that would open the doors of the box every time a string would be pulled or a button pushed. Behavior which was “rewarded” by opening the doors was slowly increased and learning occurred. Based on this experiment Thorndike concluded all learning is **incremental** and **not insightful**. Established connections or knowledge, according to Thorndike also cause and determine intelligence.

To explain observed properties of learning, Thorndike introduced two laws of learning[6]. The first law is the ***law of exercise or use or frequency***, which states that **stimulus-response** (S-R) **associations** are **strengthened through repetition** or weakened through lack of repetition. His second law, ***law of effect***, states that the consequence or **outcome** of a situation-response event **can strengthen or weaken** the **connection** between situation and response. If an event is followed by a reinforcing stimulus, the connection will be strengthened and vice versa. Thorndike later changed some of his views admitting that he was wrong and that negative reinforcement (punishment) does not really lead to any kind of learning. This had great influence on educational process helping to end the practice of punishing the students for incorrect answers. This laws have

set the **basic principles** of **behaviorist stimulus-response** views on **learning**.

Another point of Thorndike's interest in the first two decades of 20th century was the **knowledge transfer** in terms of generalizing the knowledge or skills and applying them for another problem. Thorndike performed experimental studies by which he showed knowledge transfer is specific rather then general and will not occur unless learned problem and given problem share many characteristics. This was the opposite of what school systems mostly suggested at the time, that some school subjects improve student's mind in general (*doctorine of formal discipline*).

In his book on learning of mathematics[7], Thorndike suggested problems children are expected to solve and learn from should be realistic. He also emphasizes importance of **repetition** and insists on repetitive practice of basic arithmetic operations. Some of the principles in this book even seem inconsistent with his views on learning: here he refers to learning as meaningful and insightful. Well-learned basic skills enable learning of higher-order skills.

Thorndike is also credited for introduction and standardization of a number of tests of knowledge and intelligence. In his own words,

- *Whatever exists at all exists in some amount.*[8]

## What is the practical meaning of connectivism?

Connectionism was at its time considered a general theory of learning for both humans and animals. Thorndike's ideas which could well be applied for learning are the idea that rewards promote learning and that repetition enhances learning. For example, learning to multiply by three should be learned in context of converting feet to yards.

Thorndike tried to apply this to learning **mathematics**[9], **spelling and reading** [10], measurement of **intelligence** [11] and adult learning [12] mostly through his laws of learning. Thorndike was one of the pioneers of **active learning**, proposing children should learn by themselves rather than being thought.

## Keywords and most important names

- **Connectionism**, **stimulus-response**, **S-R**, **networks of simple units**, **associationism**, **supervised learning**, **law of exercise or use or frequency**, **law of effect**, **incremental learning**
- Herbert Spencer, William James, Edward Thorndike

## Criticisms

Thorndike tried to prove that all forms of thoughts and behaviors can be explained through S-R relations with use of repetition and reward, without need for introducing any unobservable internal states, yet this is **today** generally **considered incorrect**. This *learning through response* was later in 20th century replaced by *learning as knowledge construction*. Connectionism was in the first decades

of 20th century succeeded by behaviorism, but Thorndike's experiments also inspired gestalt psychology.

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## Read more

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