Study on experimental cognitive psychology

It is very likely, that the worst part about this scenario would not be the pain, neither amputation, nor even the possibility of death, but the worst part would be the immediate thought that might come in mind; “ this moment a shark is going to attack me.” (English translation of passage taken from: http://tech. pathfinder. gr/xpaths/unexplained/622736. html) By this simple example we can clearly view the complexity of the human mind and the variation of human responses to intense external stimulations. By this simple example someone could introduce one of the biggest enigmas that science is trying to solve: The mystery of the mind. Inside our head, we have the most complex machine in the known universe.

Cognitive psychology is the attempt to understand human cognition, and by providing basic scientific tools for measuring the mind, can help us begin to understand how the brain gives rise to the mind, the part that controls all our behaviour. There are four main approaches to human cognition: Experimental cognitive psychology; Cognitive neuroscience; Cognitive neuropsychology; and Computational cognitive science.

Experimental cognitive psychology is concerned with discovering the processes underlying behaviour and cognition. Cognitive psychologists used the information-processing approach, in which a stimulus is presented. This stimulus produces the desired response by causing internal processes to occur. This is described as bottom-up processing. In some situations the stimulus itself is not absolute and it involves top-down processing, which is a process based on the individuals’ expectations and knowledge. These processes can be serial, where the process is completed before the next one, or parallel, where two processes occur at the same time.

The findings of cognitive psychologists have had a great influence on research managed by cognitive neuroscientists, and also strongly influenced social, clinical, and developmental psychology.

The limitations of experimental cognitive psychology are that it sometimes lack ecological validity, suffers from paradigm specificity, and possesses theoretical vagueness.

According to recent advancements in technology, scientists have developed numerous ways of measuring the brain’s activity and structure. In regard, we can find out where and when specific cognitive processes occur in the brain. This allows us to obtain information about different parts of the brain and in which way they become active while performing a task. Another thing it allows to find out is, while performing two tasks if it will involve the same parts of the brain in the same way or if there will be differences.

There are various techniques that cognitive neuroscientist use for studying the brain. Each technique has its own strengths and limitations, so to obtain valuable information about brain activity, researchers have to use the technique that best matches what they want to address. The techniques vary regarding to the accuracy with which they identify the active brain areas, when a task is performed (spatial resolution), and the time course of such activation (temporal resolution). Therefore, the techniques differ in their ability to provide precise information concerning where and when brain activity occurs.

Single-unit recording studies brain functioning by inserting a micro-electrode to study the activity in single neurons. An advantage about this technique is

that you can obtain information about neuronal activity over time periods. This means that you can obtain data after a few seconds or after several hours or even days. The limitation of this technique is that it only provides information about activity of single neurons, so to appraise the functioning of larger cortical areas other techniques should be used.

Event-related potentials (ERPs) are any measured brain responses that are obtained by presenting the same stimulus over and over again and then allow us to work out the timing of different cognitive processes. To achieve these measures we use a device which records the electrical brain activity at the surface of the scalp via a series of electrodes: electroencephalogram (EEG). Basically the EEG recordings produce event-related potentials that allow us to recognize the actual effects of simulation from background brain activity. ERPs temporal resolution is excellent. They can often indicate when a given process occurred to within a few milliseconds. Although ERP provides more detailed information about the time course of brain activity, it does not indicate with any accuracy which brain regions are most involved, and that is because the skull and brain tissue distorts the electrical fields created by the brain. Also ERPs are mainly of value when stimuli are simple and task involves basic processes.

Positron emission tomography (PET) is a technique that detects positrons, which are the atomic particles emitted from some radioactive substances. The way it works is by injecting radioactively labeled water into the body. Then the water gathers in the brains' blood vessel, and when part of the cortex becomes active, the labeled water moves rapidly to that place. Next a

scanning device measures the positrons emitted, and a computer translates this information into pictures of the activity levels in different brain regions.

PET has a reasonable spatial resolution since it can detect active areas of the brain within 5-10 millimetres. However, its temporal resolution is very poor. A period of 30-60 seconds is needed to indicate any activity in each region of the brain, and therefore it cannot asses the rapid changes in brain activity. Also the measurement of neural activity is indirect with PET.

In magnetic resonance imaging (MRI), is a technique that uses radio waves to excite atoms in the brain. MRI scans only tell us about the structure of the brain and not its functions. However, MRI can provide functional information in the form of functional magnetic resonance imaging (fMRI). What (fMRI) measures is know as BOLD (blood oxygen-level-dependent contrast. Increase in neural activity produces changes in the BOLD signal. Those changes take some time to occur, so the temporal resolution of fMRI is 2 to 3 seconds. Its spatial resolution is approximately 1 millimetre which is very good. Since both spatial and temporal resolution of fMRI are better than those of PET, fMRI has replaced PET to a great extend.

The limitations of this technique are that it provides indirect measures of neural activity. Also, in some brain regions there is distortion in the BOLD signal and it is hard to obtain accurate measurements. Lastly, because even small movements can distort the BOLD signal participants usually do not respond using speech, so there are constraints on the kind of stimuli that can be presented.

The last technique that we are going to analyze is the transcranial magnetic stimulation. In this technique magnetic pulses disrupt the functioning in a particular brain area, and this creates momentary (less than 1 ms) a lesion; when several pulses are operating the technique is known as repetitive transcranial magnetic simulation (rTMS). TMS and rTMS are very useful techniques because it increases our confidence that a given brain area is necessary for the performance of some task, and it can control any part of the brain that is involved in the performance of some cognitive task. It can provide an understanding of when that given brain area is most involved in task performance.

The limitations of this technique are that we do not really understand what TMS does to the brain. It usually reduces activation in the brain areas affected. Another thing is that it can not be applied in areas with overlying muscle, so that limits its overall usefulness. Lastly, the brain areas affected when TMS is used are very difficult to be established.

Cognitive neuropsychology has been established in the past years as a separate scientific approach that studies the operation of the brain in brain-damaged patients and according to neuropsychologists its increases our understanding of normal human cognition.

Neuropsychologists made several assumptions about the cognitive system. The first key assumption is that of modularity, which refers to the idea that the mind is composed of independent domain specific modules which means that they respond only to a particular stimuli. The second major assumption is that of anatomical modularity, which assumes that each module is located

in a specific area of the brain. Third key assumption is the uniformity of functional architecture which assumes that the arrangement of modules is the same for all the people. Last assumption is that of subtractivity which assumes that brain damage can subtract modules from the system, but cannot add to it.

To try understanding the cognitive system, neuropsychologists use dissociation, which occurs when a patient performs well in one task (X), but poorly in a second task (Y). We cannot come to sweeping conclusion from dissociation because the task that was performed poorly instead of needing specific modules affected by brain damage it could just be more complex. The solution is looking for double dissociations which find that some patients perform well on task X and poorly on task, whereas others show exact opposite. This provides some evidence that two separate modules or systems are involved.

It can be very hard to interpret the findings from brain-damaged patients and the reason for that is because patients may develop compensatory strategies, because the brain damage may have affected several modules and complicates interpretation of findings, and they may have had specific cognitive impairments before the brain damage.

Computational cognitive science is an approach, trying to understand human cognition, by constructing computational models. A few of these models take in consideration what is known about brain functioning along with behavioural evidence. Computational models are basically programs that simulate or mimic human cognitive functioning. These models allow us to

indicate behaviour in new situations, given by a theory. A major advantage of computational models is that they can provide an explanatory and predictive basis for a phenomenon.

Production systems are an important type of computational model. It consists of productions, each of which consists of an “ IF…. THEN” rule, and a working memory containing information.

Connectionist networks are another important type of computational model and they consist of elementary units or nodes connected together; each network has various structures. Also they can learn using rules such as back-propagation which is a learning mechanism that is based on comparing actual responses against correct ones. It mainly focuses on language and cognitive development.

The limitations in experimental cognitive psychology are that many computational models do not make new predictions. They tend to ignore emotional factors and de-emphasise motivational factors. Lastly, claims to neural plausibility are not justified.

After analyzing all the major approaches we come to the conclusion that since each approach has its own strengths and limitations, using one method will not be sufficient enough to address a given issue. By combining different approaches we can have better results, since the strengths of one approach will balance the limitations of the other.