Scholars Journal of Arts, Humanities and Social Sciences **ISSN 2347-5374 (Online)**
Sch. J. Arts Humanit. Soc. Sci. 2014; 2(5A):658-661 **ISSN 2347-9493 (Print)**
©Scholars Academic and Scientific Publishers (SAS Publishers)
(An International Publisher for Academic and Scientific Resources) DOI : 10.36347/sjahss.2014.v02i05.010

Have attempts at developing computer based cognitive models resulted in good models? An examination of the effectiveness of computer models compared with the human mind.

Ignatius Isaac Dambudzo*, Hope Virginia Mawere
Zimbabwe Open University, PO Box 1119, Mount Pleasant, Harare, Zimbabwe

***Corresponding Author:**
Ignatius Isaac Dambudzo
Email: idambudzo@yahoo.co.uk

Abstract: This was an evaluation study which sought to answer the research question:' Have attempts at developing computer based models resulted in good models?' 'Do computer operated representations work the same as the human mind?' This was a qualitative study using literature sources. The following criteria were used to evaluate the effectiveness of the computer operated cognitive models: behaviour of the models compared to human performance, model validity compared with psychological theory and model complexity. It was conceptualised that a good model would replicate human processes namely, representing 'goodness of fit'. In other words, to what extent do a model's prediction approximate observed data, such that the smaller the discrepancy the better the model. Results have demonstrated that computer operated models of the human mind were capable of showing the structure and functions of the human mind. Computer operated models had contributed immensely to the development of cognitive psychology. The models have been used as tools for research which has enhanced understanding of the human mind such as reasoning, language processing, and recording and information processing. They have also enabled cognitive psychologists to gain insight into human mind processes, behaviour, study of relationships between theoretical constructs and human behaviour such as homophone effect and meaning making, phonological mediation and problem solving. The models have provided both the framework for describing complex behaviour and also the means of testing enabling cognitive psychologists to make more rapid progress in understanding complex human behaviour which would be impossible without them. Though some of the models lack 'goodness of fit' and do not work as fast as the human mind, cognitive psychologists continue to refine them as they go along. Increase in, and reliance on computer operated models represents cognitive psychologists' confidence in the models hence they are good enough representations of the human mind. It can be therefore concluded that attempts at developing computer based cognitive models have resulted in good models. More research is necessary as the computer technology is dynamic and rapidly changing.
Keywords: computer, model, qualitative, cognitive, psychologist, computer technology, goodness of fit.

DISCUSSION

Cognitive psychologists have tried and continue to try to make computer operated representations of the human mind to show the structure of the human mind, and how it works. However, the question remains as to whether such efforts have produced or yielded representations of the human mind that work or fit the purpose. The purpose of the essay is to evaluate whether such efforts have produced computer-operated representations of the human mind that work the same as the human mind. It is my intention to argue that computer operated cognitive models produced so far are good. Examples from literature will be cited to illustrate the arguments. In evaluating the question, reference will be made to some key criteria that have been used to determine whether a model is good or bad. These include: the behaviour of the model vis-à-vis human performance, model validity vis-à-vis psychology theory and model parsimony or model complexity.

A model is good if it replicates human processes or if it achieves what Pitt and Myung described as 'goodness of fit.'[1] In other words, how much does the model's predictions approximate observed data. Generally, the smaller the deviation from empirical data, the better the model. For example, Paulesu's phonological model used to measure brain activation patterns in phonological and non-phonological memory tasks. However, it is rather difficult to explain the order of encoding or how errors are generated. Such problems arise due to the volume and complexity of knowledge that is encountered daily. Computer simulations can overcome such problems by

moving away from using informal and verbal conceptual theories to more formal, explicit computational accounts. Such a computer based model can then produce same behaviour as humans. Though the model reflects what the model builder seeks to achieve, the fact that the model could behave as required giving results that adequately described human behaviour means that the cognitive model was good.

However, it should be noted that such a computer model may not always yield the same data. There will be errors resulting from differences in human responses, imprecise measurements and variations in participants' performance over time. These weaknesses cannot invalidate the entire model. The fact that modifications can be made means the computer model is adaptable to take care of any circumstances hence good. In the phonological loop model the computer was supposed to correct weaknesses detected in the manual representation [1]. Este's mathematical model could account for distribution of order errors [2]. Burgess and Hitch [3] and computational model coded order by association between items and timing signals varying with position, could explain the zig-zag variation of recall for phonemically similar and dissimilar items. This was achieved by assuming a two stage recall process. Hitch et al [3] managed to capture in their computational model the hierarchical effects of position in memory. Thus, computer based models like any other have limitations but have advanced understanding cognitive representations and processes hence, they are good models.

Cognitive psychologists have sought to understand human brain, structure and functions. To do so they have programmed artificial neurons into networks to match human performance though artificial neurons are simpler in terms of structure and interconnections than human brain. Such a PDP model symbolises how a neural-like structure demonstrates human-like cognitive behaviour[1]. These can be activated to transmit messages just like the human brain. Because it is difficult to access human brain to observe the neurons and how they operate, a computer-based model can do it thereby gaining insight into how the brain functions. Consequently, it can be argued that attempts at developing computer-based cognitive models have yielded good models that work according to the objectives of the modeller. The view is underscored by O'Reilly [4] on biologically based computational models of high level cognition when he said: 'Computer models based on the detailed biology of the brain can help us understand the myriad complexities of human cognition and intelligence.' On the other hand, rule based models (ACT-R) can be used for information processing without reference to how the brain functions. However, computer programmes like E-Prime have been developed to enhance our understanding of cognitive processes and representations making the study of language (a cognitive psychology concept) much easier. For example, comprehension and word recognition have been simplified by the use of computer-based models. Rules drawn up to follow when building computer programmes make repeated application of the model in different situations possible [5]. Thus, efforts to develop computer-based cognitive models can be said to have produced good models.

According to Pike and Edgar [6] the boom in cognitive psychology coincided with boom in the use of computers in the study of psychology since 1956. Computers have greatly enhanced understanding how the mind works in processing and representing information when people perform certain behaviours which cannot be observed directly. Similarly, the study of memory has been made much easier through computer based models. ACT-R with the help of procedural memory can store procedures in the form of production rules making it possible to use over and over. Without using computers such a model would not be easily accessible on demand. Thus, computer-based cognitive models are good.

The ACT-R model has been matched with empirical data. However, it has been argued that a model that fits is good but a good fit may be restrictive, making the model difficult to yield generalisations. The latter is considered a negative evaluation of any model [1]. Thus, the extent to which a model fits the empirical data available is not enough evidence to judge its quality [1,7].

Rule-based architectures such as ACT-R provide a symbolic account of human cognition, operate in a largely serial way and are particularly strong at modelling consciously controlled processes such as problem solving, for example…language processing (homophone effect and comprehension). While ACT-R performs reasonably well across many situations of cognitive processes, it continues to display weaknesses in areas such as language, self-awareness and biological plausibility [1]. The weakness does not however, nullify the usefulness of the computer operated cognitive models because they can still perform the tasks as required.

Computer operated models can still be useful even if the quality of their empirical predictions is poor because they still enable researchers to be in contact and share research data and other evidence [8].

The introduction of computers has been central to the foundation of cognitive psychology. This is because computers provided new concepts that could be used to understand human behaviour and a new method that could be used to study cognitive psychology.

Attempts at developing a hybrid cognitive model that combines the benefits of symbolic and sub-symbolic features have had some success. For example, the model has been able to exhibit rational behaviour, cope with error very well as well as model real-time behaviour. However, it has not been able to use natural language, exhibit self-awareness as human brain does. Despite the shortcomings, the model has been able to allow researchers to share information more easily and faster and that ACT-R and PDP now share characteristics more frequently than before the introduction of computers [9]. These developments have made it possible to use cognitive models for empirical studies. This has also enabled integration of cognitive theory and cognitive psychology. In as far as models perform the tasks they have been made to do it can be argued that attempts at developing computer-operated models has resulted in good models.

Models have been made for specific cognitive tasks or competencies[8]. For example, spoken and visual word recognition, object and face recognition, episodic and autobiographical memory, speech and comprehension models. Though the division was done for practical convenience, the models reflect how the brain works. The brain has independent and special purpose systems which perform special information processing tasks, making the 'mind modular.' The use of computer software such as E-Prime and SPSS is a clear example of the computational nature of the mind. They fulfil key cognitive functions at the heart of cognitive psychology, that is, processing and transformation of structured mental representations. For example, Marr's model of visual processing and DRC model of word reading, traditional models such as Bruce and Young's face recognition-a connectionist model. Success of such specialised cognitive models is a demonstration of the fact that computer operated models are good. Their failure to perform integrated tasks does not make them bad models. Improvements continue to be made to make every model more efficient and effective in performing required tasks [5,10].

Computer operated models are meant to replicate human cognitive processes in terms of structure, speed and material. However, in reality human brain is faster and more complex than a computer operated model. The quality of the models largely depends on the ingenuity of the computer programmers who develop them. Despite the shortcomings computer models do help researchers to evaluate the validity of cognitive theories from primary research such as homophone effect on comprehension or language processing. This will improve our understanding of cognitive psychology. Though the models need refinement, the current models make the study of cognitive psychology easier hence they are good enough [8]..(Hornof, 2003).

Computer operated cognitive models inform research design of useful and usable human-computer interfaces by providing post-hoc explanations and providing a foundation for building accurate predictive models. For example, in the eye-tracking model, measurement and analysis of eye movement data is made possible provision of new dependent variables in addition to measurement of performance such as speed and accuracy. Such data and processes can validate and refine the accuracy of cognitive models. The use of computer cognitive models has become very popular, effective and informative way to understand the perceptual, memory and motor processing-all cognitive processes[8].

The discussion above has demonstrated that computer operated models have been key to the development of cognitive psychology. Cognitive models have been used as tools to aid our understanding of the human mind to which cognitive psychology appears to have a major commitment. Computer based models have been used as research tools to study cognitive processes such as reasoning, language processing, information processing, presentation of stimuli, recording responses, tabulating and analysis of data and control experiments. Such models have enabled cognitive psychologists to gain more insight of how the mind processes and represents information when people behave in a certain way. Models have been used to specify relationship between theoretical constructs and human behaviour such as homophone effect and meaning making, phonological mediation and language processing and problem solving. Connectionist models simplify the study of the human brain particularly neuron structure and functions. Though some of these models lack goodness of fit and do not work as fast as human mind cognitive psychologists have continued to use them and continue to refine them as they go along. Increased reliance on computer operated models is evidence of cognitive psychologist's confidence in the models hence they are good enough representations of the human mind. Thus, computer based models have provided both the framework for describing complex models of behaviour and also the means of testing the models. These developments help cognitive psychologists to make more rapid progress in understanding complex human behaviour which would not be possible without them. In view of the above evidence it can be concluded that attempts at developing computer based cognitive models have resulted in good models.

REFERENCES

1. Mulholland P, Watt S; Cognitive modelling and cognitive Architecture in Braisby, N. & Gellatly, A. (eds), Cognitive Psychology, Milton Keynes, The Open University. 2005.

2. Estes WK; Interactions of signal and background variables in visual processing. Perception & Psychophysics, 1972; 12(3):278-286.
3. Burgess N, Hitch G; Computational models of working memory: putting long-term memory into context. Trends in cognitive sciences, 2005; 9(11):535-541.
4. O'Reilly RC; Biologically based computational models of high-level cognition, Science Magazine, 2006; 314 (5796):91-94.
5. Gaskell G; Language Processing, in Braisby, N. & Gellatly, A. (eds), Milton Keynes, The Open University. 2005.
6. Pike G, Edgar G; Braisby, N. & Gellatly, A. (eds), Cognitive Psychology, Milton Keynes, The Open University. 2005.
7. Hughes RG, Titler MG; The evidence for evidence-based practice implementation. 2008.
8. Hornof A; Cognitive Modelling, Eye Tracking and Human-Computer Interaction. 2003.
9. Stone T; Theoretical Issues in Cognitive Psychology, in Braisby, N. & Gellatly, A. (eds), Cognitive Psychology, The Open University. 2005.
10. Pike G, Brace N; Modelling in face recognition, in Braisby, N. & Gellatly, A. (eds), Cognitive Psychology, Milton Keynes, The Open University. 2005.