Baddeley's working memory model

A wide range of research in short term memory was conducted in the 1950s, with the development of new techniques and advanced theoretical approaches based on previous concepts of information processing. Psychologists attempted to find a link between short term memory and working memory. Working memory is defined as being part of long term memory, which also encompasses short term memory. This perspective suggests that working memory holds only the most recently stimulated portion of long term memory, and transfers it into and out of brief, temporary memory storage. “ According to Baddeley and Hitch (1974) the working memory plays an important role in supporting a whole range of complex everyday cognitive activities including reasoning, language comprehension, long-term learning, and mental arithmetic” (p. 33), this definition has evolved from the model of a unitary short-term memory system. “ Baddeley and Hitch (1974) in particular were concerned with the question of whether short term memory acted as a working memory (p. 2).” This essay will present an account of the origins and development of the working memory; briefly covering the history of alternative models and their relationship to the framework; followed by issues of the models. A brief discussion of previous working memory models proposed by Baddeley et al will be assessed, followed by issues of the past models. Baddeley’s 2000 model will be introduced and then a brief outline of past experiments conducted will be described in order to help prove the existence of components in the 2000 model that could not be explained by the past models. Using current studies, the 2000 model will be critically evaluated, analysing the strengths and weaknesses of the model, making a clear distinction between the overall theoretical frameworks. Finally, the

conclusion will outline speculations on further developments and comments on the value of attempting to apply the 2000 model of working memory beyond the laboratory studies, to everyday life.

In 1968, Atkinson and Shiffrin proposed the multi-store model; “ the model depicts memory as entailing the flow of information between three interrelated stores (p. 10).” It proposed that human memory involves a sequence of three stages; sensory store, short-term store and long-term store. Sensory memory is when a form of a stimulus remains unchanged in the mind for a brief time; it is rapidly lost through spontaneous decay. Evidence of sensory memory was conducted by Sperling (1960); he presented participants with visual displays containing three rows of four random letters for very brief periods (50 milliseconds). In the whole array condition, participants could recall 33% of items, in one row condition participants could recall 75% of items, suggesting information decays quickly after presentation. Short term memory is when information receives minimal processing, it is relatively limited in capacity (it holds about seven items). Evidence of short term memory was conducted by Peterson and Peterson (1959); they studied the recall of trigrams. If participants had to wait three seconds before recalling the trigram they could remember 80%. But if they had to wait 18 seconds, recall was reduced to 10%. Participants did an interference task, counting backwards between presentation and recall to prevent rehearsal. Long term memory is when information is stored permanently and has unlimited capacity. Different types of long term memory have been identified such as; procedural memory (knowing how), declarative memory (knowing that), sematic memory (storage for language

and general knowledge) and episodic memory (memory for personal events and people). Evidence for long term memory was conducted by Bahrick et al (1975), he demonstrated the existence of ‘ very long term memories’ (VLTMs). 400 adults were asked to identify individuals from their high school yearbooks; they found that even after 34 years, ex-students were still able to name 90% of their classmates. This shows that people have accurate VLTTMs. The multi-store memory model has well supported research and provides an alternative explanation of memory. However, one of the reasons why the model fell into disfavour was because its explanation of short term was oversimplified. The multi-store model presents a passive view of memory and cannot explain active processes such as reconstruction, which is when memories are altered because of expectations; an example of this would be the accuracy of eye witness testimony which is affected by misleading information. The validity of the model has been questioned as research studies have tended to concern only semantic memory, therefore the results and the model may be relevant to only this kind of memory rather than explaining memory for events in the past as well. The model is no longer regarded as an adequate representation of memory processes. However, historically, it is an important theory.

Baddeley and Hitch (1974) tested the hypothesis that the short-term store also functioned as a working memory. They did this by asking participants to perform reasoning, comprehension or learning tasks at the same time as they were holding in short term memory between 0 and 8 digits for instant recall. If short term memory does function as a working memory, then filling it to capacity should interfere with cognitive processing. It did cause

disruption and effected performance, but the effect was not huge. Therefore abandoned the modal model was deposed of, according to which short term memory is a unitary store. “ The idea that short term storage involves a number of subsystems has been most actively developed by Alan Baddeley and his colleagues (Baddeley and Hitch 1974; Baddeley, 1986, 1990, 1992, 2000)” (p. 121) argued that the concept of the short-term store should be replaced with that of working memory. The original consists of three components; central executive, phonological loop and visuo-spatial sketchpad. The model defines working memory as composed of a central executive, which is a modality free component of limited capacity, and controls the other two modules through limited attention. A phonological loop that holds and manipulates acoustic and speech based information; and a visuo-spatial sketchpad that is responsible for visual information. McLeod (1977) showed that performance was impaired when participants played the piano and sang at the same times (both tasks auditory), this is due to competition within one component. Evidence for the central executive was provided by Bunge et al (2000), he used fMRI (functional magnetic resonance imaging) to view which parts of the brain were most active when participants were going two tasks at the same time; reading a sentence and recalling the final word in each sentence. There was more activation in the dual task condition, showing that increased attention leads to greater brain activity which is a central executive function. Evidence for the visuo-sketchpad was provided by Baddeley et al (1975); he gave participants the task of visualising a matrix of digits. When this task was combined with tracking a moving light, the ability to visualise was impaired. Evidence for the phonological loop was provided by Baddeley et al (1988), the study of a

patient with a phonological short term memory insufficiency, who found it extremely hard to learn to link new words to their meaning, while learning to link pairs of words in her native language.

The previous working memory models did not explain how information from different subsystems with different codes could be combined and how it communicates with the long term memory. 26 years later, Baddeley decided to add a 4th component known as the episodic buffer. The purpose of the episodic buffer is to bind together all of the information from other components of working memory with information about time and order; because there is nowhere for information that is both visual and acoustic to be stored. The episodic buffer integrates information from the central executive, the visuo-spatial sketchpad and the phonological loop. The episodic buffer is seen as a solution to problems of the previous working memory model eg: articulatory suppression, recall of prose, and the binding problem. The main incentive for introducing this component was the observation that some patients with amnesia, who seemingly have no ability to encode new information in long-term memory, but have good short-term recall of stories, recalling much more information than the phonological loop can hold.

The solution to the problems such as articulatory suppression and recall of prose of working memory is the episodic buffer, which has the following features; controlled by the central executive through conscious awareness, it has limited capacity, temporary storage system, integrates information from a range of sources into a single complex structure or episode. Baddeley et al (1984) did a study on articulatory suppression, where participants repeat the

word ‘ the’ while learning a visually presented list of numbers; the model predicted that there will be no recall. This prediction is made on the assumption that visual information has indirect access to the phonological loop and articulatory suppression should prevent visual information from gaining access to the phonological loop. However, the data showed that articulatory suppression only resulted in a small reduction in recall typically from 7 to 5 digits. This shows that binding does not stop even when interference is caused in the central executive, but performance is reduced. In studies of brain-damaged patients, individuals with impaired short term memory show better recall for visually presented digits than for auditory presented digits. This shows that there is a ‘ back up’ store for temporary information to pass through, which is explained by the episodic buffer. Hulme et al (1991) found that remembering lists of nonwords (different language) was much more difficult than remembering lists of familiar words. They showed that if participants learnt the ‘ meanings’ of nonwords (Italian words), memory for them improved. These results illustrated the role of ‘ semantic’ information, knowledge of the meanings of the words, on short-term recall. The mechanism through which this information can improve recall is assumed to be by the episodic buffer.

Baddeley et al did a study on where the episodic buffer located within the anatomy of the brain. Baddeley’s initial hunch was that the episodic buffer was located in the hippocampus, but recent studies with an amnestic individual (John) with severe hippocampal damage has shown that tasks requiring the episodic buffer were unimpaired in this individual. He suffered from anoxia (lack of oxygen at the birth), therefore has half a hippocampus.

In Baddeley’s opinion it seems unlikely that science will identify a single area responsible for the episodic buffer. Instead, it might be in a number of different brain areas working together which give rise to the episodic buffer. A recent fMRI study by Prabhakaran et al (2000) “ compared the retention of verbal and spatial information held in an integrated or unintegrated form. The results showed greater right frontal activation for integrated information, with unintegrated retention showing more latter activation of areas previously implicated in verbal and spatial working memory.” Prabhakaran et al (2000) concluded that “ the present fMRI results provide evidence for another buffer, namely, one that allows for temporary retention of integrated information.” (p. 421-422)

In conclusion, the episodic buffer is a valuable addition to the working memory model and increases the models ability to predict behaviour in many situations, such as in amnestic individuals. There is much research supporting the model, including psychological lab experiments and neurophysiological research, such as brain scans showing the differences in brain activity during tasks. However, as the episodic buffer was added 26 years after the original model was published, it suggests that the original model was unfinished; therefore the model may not serve as an explanation of the working memory. The model doesn’t account for all senses (it only relies on sound and sight), and much of the lab support for the model uses artificial tasks which lack validity because the tasks are not true to life, you cannot guarantee that the other senses might have been used in real life such as touch or smell. The working memory view has recently been challenged by many psychologists including Cowan (2001) “ who proposed a

model that specifies the interaction between the central executive and the episodic buffer" (p. 87). Depoorter and Vandierendonck (2009): " they found evidence that verbal serial order memory tasks interfered with visuo-spatial serial order memory tasks and vice versa. This is not predicted by the working memory model, as these two tasks should be carried out by separate slave systems, so should not interfere with each other. Depoorter and Vandierendonck (2009) suggested that memory for serial order is not modality specific as previously thought, but carried out by a modality independent system. Depoorter and Vandierendonck (2009) argued that the episodic buffer may be ' the ideal medium to maintain a modality-independent order code'. Therefore, research continues to reveal new ways in which the episodic buffer may contribute to the working memory system." (p. 34)

Baddeley's 2000 working memory model can be applied to real life situations such as patients with amnesia and Alzheimer's disease. However the model should be developed further by analysing the true measurement of its capacity. Although the model has faced many criticisms it has still formed a productive basis for the systematic growth of knowledge about important cognitive functions.