Chapter VI
Nous:
Cognitive Models of Working Memory

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ABSTRACT

The path to the study of cognition has to take into account working memory, as it is a key process of thinking operations in the human cognitive system. Naturally, this also holds for cognitive operations in the Web. The chapter introduces readers to current trends regarding models of working memory. The major models proposed in the literature are discussed here: Baddeley and Hitch's multi-component model, Daneman and Carpenter's account, Cowan's embedded-process model, Kane and Engle's executive attention model and long-term working memory model by Ericsson and Kintsch. The chapter focuses on the Baddeley and Hitch model, and the author argues that this specific model offers a more theoretically sound account of working memory operations. Unresolved issues and inefficiencies are also discussed and research directions are proposed.

INTRODUCTION

In order to explain how learning occurs, we have to thoroughly investigate phenomena like memory, language and thinking. Learning and memory provide the theoretical substratum for the study of education. Therefore, research in cognition, from perception to memory and from problem solving to higher-order interactions, is of great importance. That evidently applies to learning in the Web because, as Wolfe (2001) stresses, the web is basically based on cognitive technology. Recent advances in the psychology of learning point towards four dimensions of importance in web learning: a) individual differences that are provided for in a web environment, b) learning as a social process, c) the learning context, which web learners seem to be very sensitive to, and d) fundamental cognitive processes, such as perception, memory and metacognition.

In order to introduce memory structures and operations, we should at this point refer to the

most basic distinction proposed in the literature, the distinction between short-term memory (STM) and long-term memory (LTM) (see Atkinson & Shiffrin, 1968). Short-term memory is the part of memory that deals with our "psychological present"; it receives and retains stimuli for very short periods of time. It is a fragile system of very limited capacity (typically 7 ± 2 items of information at any given time) and duration (information is retained there for approximately 20 seconds). When short-term memory capacity becomes overloaded, information is very susceptible to loss, because it either decays or is replaced by new items. Loss of information also occurs when stimuli remain in the system longer than approximately 20 seconds. After 20 seconds elapse, items must either be transferred to a permanent memory system, long-term memory, or they are cleared from short-term memory. Long-term memory deals with our "psychological past". It is viewed as a huge store of practically unlimited capacity and duration. Information from short-term memory is transferred there and can remain for long periods up to a lifetime. Everything we know about ourselves and the world is stored in this system.

In the past 30 years, the concept of working memory has appeared to challenge the traditional view of short-term memory. Working memory is, no doubt, one of the "hottest" and most exciting areas in cognitive psychology and cognitive neuroscience. It also is one of the most researched areas, as it serves as a backbone to cognitive processes. Various working memory models have been developed, quite diverse in their scope and emphasis. As Miyake and Shah (1999, p. xiii) rightly point, existing models account for certain aspects of processes and functions in a sophisticated manner, nevertheless they tend to omit specifying in detail some other aspects.

This chapter is concerned with the ways working memory plays a major role in information processing. The objective set is to present the main theoretical frames of working memory and to describe its structure and organization. The chapter also aims at demonstrating how the system is intertwined to learning and academic performance. It introduces working memory accounts by Daneman and Carpenter (1980), Cowan (1995; 2005), Kane and Engle (2000), Ericsson and Kintsch (1995) and focuses on the multicomponent model by Baddeley and Hitch (1974; Baddeley, 2000). I will argue that the Baddeley and Hitch model is better equipped to offer a theoretical explanation of how working memory operates and how it is connected to higher-order cognitive functions.

BACKGROUND

The working memory (WM) framework was proposed to replace the traditional STM concept. Since the new framework was introduced, about 30 years ago, research has exploded. However, the bridging has not been achieved to a significant extent. Although the concept of WM has invaded cognition research, in everyday life much uncertainty is related to its nature and functions. Among this voluminous research, the chapter will inevitably present selective work in the area, based on the author's theoretical views. However, an effort has been made to include the main approaches to the WM concept.

Elaborating on the distinction mentioned in the Introduction, between STM and LTM, let us point that memory was initially conceptualized as a tri-partite structure (see Figure 1). This structure comprises a sensory register (receiving and identifying all environmental stimuli), a limited capacity short-term store (holding information temporarily and at the same time processing that information for the needs of the task to be executed) and an essentially unlimited capacity long-term store, which is fed by the elements that remained long enough in the short-term store (Atkinson & Shiffrin, 1968). Keeping memory traces active in STM (mainly by using rehearsal) was considered to achieve transfer to LTM and,