Chapter 9

Cognitive Load Aspects of Text Processing

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ABSTRACT

Cognitive load theory investigates instructional consequences of processing limitations of the human cognitive system. Because of these limitations, text processing may result in an excessive cognitive load that would influence comprehension and learning from texts, as well as change learner affective states. This chapter reviews basic assumptions of cognitive load theory, their consequences for optimizing the design of information presentations, and implications for processing written and spoken texts.

INTRODUCTION

Text processing could be a very cognitively demanding process due to general limitations of our cognitive system as well as to specific characteristics of written and spoken language. Research in applied natural language processing increases our knowledge of how the mind processes and represents language-related information. Determining essential characteristics of cognitive states involved in such processes may help in predicting potential comprehension gaps and corresponding affective states of human language processors.

Specific factors influencing cognitive load characteristics of learning and instruction have been investigated for several decades within a framework of cognitive load theory (for a recent comprehensive overview, see Sweller, Ayres, & Kalyuga, 2011). Most of this research has been conducted using well-structured technical (e.g., mathematics, science, or engineering) materials, although relatively recent studies have investigated cognitive load consequences of different instructional methods and presentation formats in language learning and other less structured
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domains. Also, the relations between experienced cognitive load and learner affective states have not yet been considered within this research framework.

This chapter reviews basic assumptions of cognitive load theory and major consequences of these assumptions for the design of information presentations, as well as their general implications for human language processing and affective states. A recently proposed evolutionary perspective on human cognitive architecture is outlined first as it may assist in making broader associations of natural language processing with an interaction between two types of information processing systems - natural (specifically, human) and artificial intelligent systems.

THE ARCHITECTURE OF NATURAL INFORMATION PROCESSING SYSTEMS

In its basic underpinning assumptions, cognitive load theory tries to rely on fundamental characteristics of information processing systems in general. For example, the established analogy between the information processing aspects of evolution by natural selection and human cognition (e.g., Sweller & Sweller, 2006) has particularly influenced this approach. Accordingly, the theory considers both biological evolution and human cognition as examples of a broader class of natural information processing systems. It is assumed that the operation of such systems is based on the following fundamental principles (Sweller, 2003; for an overview, see Sweller et al., 2011):

- **The information store principle**: all natural information processing systems include stores of information that govern their activities. In human cognitive architecture, long-term memory (knowledge base) provides this function.

- **The borrowing and reorganizing principle**: most information in the information store is borrowed and reconstructed from other information stores. In the case of human cognition, we build most long-term memory information structures by imitating people, listening to people, and reading or viewing materials produced by people.

- **The randomness as genesis principle**: all principally novel (not borrowed and reconstructed) information is acquired by a random generate-and-test process. In the absence of relevant information from other sources, we acquire it during problem solving by using general methods such as means-ends analysis.

- **The narrow limits of change principle**: there is a mechanism that prevents large and rapid random changes to the information store that could impair its functionality. Human cognitive architecture includes working memory as our major information processor. Working memory is severely limited in capacity and duration when dealing with novel information, thus reducing the risk of damaging long-term memory. That is, we can consciously process no more than a few items at a time for no longer than a few seconds at a time. If these limits are exceeded, information processing may be inhibited and information lost.

- **The environmental organizing and linking principle**: when information from the store is guiding specific environmentally appropriate activities of the system, the above limits are removed. In human cognition, the severe capacity or duration limits are lifted when organized information from long-term memory is processed in working memory while guiding specific activities (due to the “chunking” or “encapsulation” effect when many connected elements of information are treated as a single unit in working memory). While under the narrow
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