

## Chapter 3

# Multimedia Design of Assistive Technology for Those with Learning Disabilities

**Boaventura DaCosta**  
*Solers Research Group, USA*

**Soonhwa Seok**  
*Center for Research on Learning - eLearning Design Lab,  
University of Kansas, USA*

### **ABSTRACT**

*This is the final of three chapters serving as the introduction to this handbook which addresses the relationship between human cognition and assistive technologies and its design for individuals with cognitive disabilities. In this chapter the authors build upon the last two chapters and focus specifically on research investigating the visual and auditory components of working memory. The authors present the cognitive theory of multimedia learning, a learning theory proposing a set of instructional principles grounded in human information processing research that provide best practices in designing efficient multimedia learning environments. Much like the last chapter, the instructional principles presented are grounded in empirically-based study and consolidate nearly twenty years of research to highlight the best ways in which to increase learning. Altogether, the authors stress the common thread found throughout this three chapter introduction—that technology for learning should be created with an understanding of design principles empirically supported by how the human mind works. They argue that the principles emerging from the cognitive theory of multimedia learning may have potential benefits in the design of assistive technologies for those with learning disabilities.*

DOI: 10.4018/978-1-61520-817-3.ch003

## INTRODUCTION

### **Multimedia, Assistive Technology, and Those with Learning Disabilities**

Unlike early theories which viewed short-term memory as a single store capable of performing numerous operations (Sweller, 2005a), working memory is assumed to be composed of multiple stores (Baddeley, 1986, 1998, 2002; Paivio, 1990; Penney, 1989; Sweller, 2005). Baddeley's model of working memory portrays numerous operations by handling visual and acoustic information individually with the visuospatial sketchpad and phonological loop subsystems. Making use of partial autonomy for processing visual and auditory information is believed to be a way in which to address the limitations of working memory. For example, Frick (1984) had investigated the idea of separate visual and auditory memory stores, showing how digit-span recall could be increased; Penney (1989), in a review, had provided evidence that appropriate use of the visual and auditory stores can maximize working memory capacity. Although researchers seem to disagree on a common nomenclature, using terms such as *stores*, *channels*, *bisensory*, *dual-coding*, and *dual-processing* (e.g., Allport, Antonis, & Reynolds, 1972; Baddeley, 1986, 1998; Jones, Macken, & Nicholls, 2004; Mayer & Anderson, 1991; Paivio, 1971; Penney, 1989) to represent the components of working memory, they do seem to agree with the premise that dual-processing is vital towards overcoming the limitations of working memory.

This dual-processing assertion is best represented in Paivio's *dual-coding theory* (Clark & Paivio, 1991; Paivio, 1971, 1990), which proposes that cognition is composed of verbal and non-verbal subsystems. These two subsystems are considered distinct, but interrelated. The verbal subsystem favors organized, linguistically-based information, stressing verbal associations. Examples include words, sentences, and stories. The

non-verbal subsystem, organizes information in nested sets, processed either synchronously or in parallel. Examples include pictures and sounds (Paivio, 1971, 1990; Paivio, Clark, & Lambert, 1988). Multimodal instructional material, which can be coded in both subsystems, rather than just one, is more easily recalled. By leveraging both the verbal and non-verbal subsystems, more information can be processed.

Studies examining dual-coding have shown greater performance can be achieved when learners are presented with instructional material that takes advantage of both the verbal and non-verbal subsystems (e.g., Frick, 1984; Gellevij, Van Der Meij, De Jong, & Pieters, 2002; Leahy, Chandler, & Sweller, 2003; Mayer & Moreno, 1998; Moreno & Mayer, 1999). These findings are promising, as they suggest the limited capacity of working memory can be addressed by presenting instruction in a verbal and non-verbal manner (Mayer, 2001, 2005e; Sweller, van Merriënboer, & Paas, 1998). More importantly, the converse has also been shown. The verbal and non-verbal subsystems are believed to pool from the same processing resources. As such, multimodal information that is not interrelated can negatively impact working memory performance (Morey & Cowan, 2004). Thus, the non-verbal presentation of information should be relational to the verbal (textual), for it has a significant impact on working memory and learning.

This is the final of three chapters serving as the introduction to this handbook which addresses the relationship between human cognition and assistive technologies (ATs) and its design for individuals with cognitive disabilities. In this chapter we build upon the last two chapters and focus specifically on research investigating the visual and auditory components of working memory. We present the *cognitive theory of multimedia learning* (CTML), a learning theory proposing a set of instructional principles grounded in human information processing research that provide best practices in designing efficient multimedia learn-

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

[www.igi-global.com/chapter/multimedia-design-assistive-technology-those/42827](http://www.igi-global.com/chapter/multimedia-design-assistive-technology-those/42827)

## Related Content

---

### DRGs and the Professional Independence of Physicians

Lorraine Frisina and Mirella Cacace (2009). *Handbook of Research on Information Technology Management and Clinical Data Administration in Healthcare* (pp. 173-191).

[www.irma-international.org/chapter/drgs-professional-independence-physicians/35777](http://www.irma-international.org/chapter/drgs-professional-independence-physicians/35777)

### Computational Modelling in Epidemiological Dispersion Using Diffusion and Epidemiological Equations: Epidemiological Dispersion Modelling

George I. Lambrou, Kyriaki Hatzigiapiou, Petros Toumpaniaris, Penelope Ioannidou and Dimitrios Koutsouris (2019). *International Journal of Reliable and Quality E-Healthcare* (pp. 1-37).

[www.irma-international.org/article/computational-modelling-in-epidemiological-dispersion-using-diffusion-and-epidemiological-equations/237989](http://www.irma-international.org/article/computational-modelling-in-epidemiological-dispersion-using-diffusion-and-epidemiological-equations/237989)

### Interpreting Health and Wellness Information

Lena Mamykina and Elizabeth Mynatt (2010). *Health Information Systems: Concepts, Methodologies, Tools, and Applications* (pp. 510-526).

[www.irma-international.org/chapter/interpreting-health-wellness-information/49883](http://www.irma-international.org/chapter/interpreting-health-wellness-information/49883)

### Uncertainty in Clinical Knowledge: A Critical Dimension of Quality Evaluation

Vahé A. Kazandjian (2017). *International Journal of User-Driven Healthcare* (pp. 17-28).

[www.irma-international.org/article/uncertainty-in-clinical-knowledge/197793](http://www.irma-international.org/article/uncertainty-in-clinical-knowledge/197793)

### The ABC Approach and the Feminization of HIV/AIDS in the Sub-Saharan Africa

Lynette Kvasny and Jing Chong (2008). *Encyclopedia of Healthcare Information Systems* (pp. 10-15).

[www.irma-international.org/chapter/abc-approach-feminization-hiv-aids/12916](http://www.irma-international.org/chapter/abc-approach-feminization-hiv-aids/12916)