Chapter 7

Verbal and Visual Working Memory in Written Sentence Production

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During written sentence production, semantic content is planned and then encoded into a linguistic expression. Verbal working memory may enable these required computations by temporarily storing word representations. By contrast, visual working memory may only be needed when the semantic content activates imaginal as well as prepositional codes. College students wrote in longhand definitions of either concrete or abstract nouns, while concurrently performing either a visual or verbal working memory task. Both concrete and abstract nouns would disrupt the verbal task, but only concrete nouns would disrupt the visual task. The definitions were richer in detail for the concrete words, suggesting imagery was involved, compared to the abstract words. As predicted, only these image-evoking words slowed reaction times on the visual working memory task compared to baseline, control measurements. Both high and low imagery words interfered equally with the verbal working memory task. The results are discussed in terms of planning and translating ideas and processes involved in sentence generation.

7.1. Introduction

Working memory refers to a system for temporarily maintaining mental representations that are relevant to the performance of a cognitive task in an activated state. There have been a wide range of theoretical approaches to working memory proposed in the literature (Miyake & Shah, 1999), but in the present chapter we adopt the view that working memory comprises multiple components. The original Baddeley (1986) model postulated a phonological loop for storing and rehearsing verbal representations, a visuo-spatial sketchpad for visual object representations and their locations, and a central executive for attentional and supervisory functions. The evidence to date suggests that the visual and spatial components are distinct from one another and that the phonologically based verbal store is separate from...
a fourth semantic store (e.g., Jonides & Smith, 1997; Haarmann, Cameron, & Ruchkin, 2002; Martin, Shelton, & Yaffee, 1994). In writing, the central executive may be the most important component because it appears to be involved in planning ideas, translating ideas into text, and reviewing the ideas and text produced thus far (Kellogg, 1996). Only motor transcription operates effectively with minimal or no executive attention and this is true only when handwriting or typing is well practiced and automatized in adults. For young children, the attentional demands of even handwriting are a major impediment to fluent and effective composition (McCutchcen, 1996). When motor transcription is laborious, the central executive and possibly other components of working memory are diverted from planning, text generation, and reviewing (Bourdin & Fayol, 1994; Olive & Kellogg, 2002). A psychometric study of individual differences in children’s working memory indicated that only measures related to executive functions in the verbal domain accounted for a large source of variance in compositional quality and fluency (Swanson & Berninger, 1996).

What, then, might the roles be for the other components of working memory in text production? The role of verbal working memory in sentence comprehension has been extensively investigated (e.g., Caplan & Waters, 1999; Just & Carpenter, 1992). Because of the difficulties involved in studying production (Bock, 1996), it is not surprising that less is known about the working memory requirements of sentence generation and writing extended texts. For spoken sentence generation, it is necessary to translate the conceptual contents of the message to be communicated into a grammatically correct string of words and encode these words phonologically (Bock & Levelt, 1994). Is grammatical encoding modular or is it dependent on the general cognitive resources of working memory? For written sentences, there must also be a stage of orthographic encoding to spell each word. Phonological encoding may also be involved in written sentence production, because one route to word spelling is a conversion of phonemes to graphemes (Caramazza, 1991). Are the grammatical, phonological and orthographic encoding stages required in written sentence generation limited by the availability of working memory? What are the working memory demands of planning the conceptual content before it is translated into a sentence?

In the present chapter, we seek to take a preliminary step in addressing these fundamental, unanswered questions. Specifically, we tested the hypothesis that one or more aspects of translating the conceptual content of a sentence into a well-formed linguistic structure requires verbal working memory. It is not possible with our procedures to isolate the individual demands of grammatical, phonological, and orthographic encoding. Rather, we sought to measure whether all three of these taken together required verbal working memory. We further tested the hypothesis that the visual component of working memory is involved in planning the conceptual content of a sentence when the writer manipulates images of objects and events. Thus, our focus is on distinguishing between the working memory demands of planning conceptual content, on the one hand, and translating this content into a linguistic expression, on the other.

7.1.1. Background

A model of sentence generation: Sentence generation entails planning conceptual content and then linguistically encoding it into a grammatical string of words. Imaginal and propositional representations are translated into the ordered words of a sentence through grammatical and