



Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Consciousness and working memory: Current trends and research perspectives



Boris B. Velichkovsky*

Department of Psychology, Moscow State University, Russia

ARTICLE INFO

Keywords:

Consciousness
Working memory
Visual masking
Attentional blink
Implicit working memory

ABSTRACT

Working memory has long been thought to be closely related to consciousness. However, recent empirical studies show that unconscious content may be maintained within working memory and that complex cognitive computations may be performed on-line. This promotes research on the exact relationships between consciousness and working memory. Current evidence for working memory being a conscious as well as an unconscious process is reviewed. Consciousness is shown to be considered a subset of working memory by major current theories of working memory. Evidence for unconscious elements in working memory is shown to come from visual masking and attentional blink paradigms, and from the studies of implicit working memory. It is concluded that more research is needed to explicate the relationship between consciousness and working memory. Future research directions regarding the relationship between consciousness and working memory are discussed.

1. Introduction

The problem of consciousness is a central problem in philosophy, psychology, and neurosciences. Today, attempts are made at the empirical study of consciousness while theoretical approaches to consciousness flourish as well. A concept closely related to consciousness is working memory (WM). WM is thought to be a cognitive system for on-line storage and processing of information in the service of the current task (Baddeley, 1986, 2012). Usually, WM is assumed to be capacity-limited and associated with the functioning of the general-purpose processor responsible for cognitive processing per se. While there are several conceptions of WM today (D'Esposito & Postle, 2015; Miyake & Shah, 1999), it holds that WM is responsible for short-term maintenance of goal-relevant information and its processing. A very general understanding like this gives WM a special status in the cognitive system – it may be understood as the medium (or “workspace”) in which thinking and cognition takes place (Baars & Franklin, 2003). This special role of WM is supported empirically by the findings of a strong association between WM capacity and higher-order cognitive activities (Engle, 2002), including general intelligence (Ackerman, Beier, & Boyle, 2005). WM is also a major construct in current cognitive architectures (Kieras & Meyer, 1997), in which its alleged role as the workspace of cognitive processing (“thinking”, in a general sense) is made fully explicit. In a similar vein, evolutionary studies ascribe WM an important role in the development of human intelligence (Carruthers, 2013; Haidle, 2010).

WM is usually thought to be closely linked to consciousness (Andrade, 2001; Baddeley, 1992; Jacobs & Silvanto, 2015). This is evident, for instance, in Baddeley's multicomponent WM model which dominated WM research in the recent past. For instance, it is typically assumed that the content held in WM is conscious. This means that WM operates on consciously accessible information and, in some sense, that WM and consciousness are the same. This is a very strong conjecture which may lead to a stronger

* Address: Mokhovaya 11/9, 125009 Moscow, Russia.
E-mail address: velitchk@mail.ru.

operationalization of the consciousness research (consciousness being defined as the content of WM). However, there are still doubts whether consciousness can be equated to WM, especially given that consciousness as well as WM are not homogenous entities but may appear in several varieties (Cowan, 1999; Block, 1995). Recent evidence suggests that there are unconscious WM content and WM processes which renders the relationship between WM and consciousness even more complex. Below, we consider two major approaches to the understanding of the relationship between consciousness and WM – the understanding of WM as a conscious process and the understanding of WM as an unconscious process (the two views may, of course, overlap). It will turn out that there is a strong evidence for there being unconscious elements of WM. Considering the reviewed results on the conscious/unconscious processing in WM in the last section we propose some research directions which may advance the understanding of WM/consciousness relationship.

2. WM as a conscious process

2.1. The multicomponent WM model

A standard view in cognitive science is that WM is closely related and even equal to consciousness, although this relationship has been often assumed only implicitly (Baddeley, 1992, 2000). Baddeley's WM model suggests a hierarchical organization of WM in a supervisory system – the central executive – and several “slave” systems for on-line storage of information (Baddeley, 1986). The slave systems are there for the transient storage of modality-specific information: verbal/symbolic (phonological loop), visual and spatial (visual-spatial sketchpad), tactile, etc. For the slave systems, the idea that WM processes are conscious is intuitively evident. Indeed, we are usually aware of verbal rehearsal of items held in the phonological loop and of visual imagery associated with the visual-spatial sketchpad. At least, this is so when we are given explicit retention instructions. The storage systems thus provide phenomenal consciousness (Block, 1995).

The conscious status of central executive – which is a system for the control of slave systems and attention – is less clear. As a system responsible for controlled cognitive processing (Atkinson & Shiffrin, 1968), it has to be conscious. Conscious executive processes seem to be the voluntary initiation of item rehearsal in the slave systems, shifting of attention between tasks, or inhibition of distracting information. Baddeley (1992) also associates conscious experience with the central executive. Empirical evidence for this claim is seen in the fact that suppression of daydreaming is not modality-specific and thus seems to rely on the central executive. As daydreaming is the state where the conscious mind is “left to itself” the central executive may be the component of WM mainly responsible for conscious access (Baddeley, 1992). However, some executive processes – for instance, the formation and implementation of long-term memory search strategies – are not under conscious control. Thus, the workings of the central executive are only partially consciously accessible.

While the slave systems were initially thought to be modality specific (phonological loop, visual-spatial sketchpad), a new storage system – the episodic buffer – for the maintenance of polymodal episodes was introduced recently (Baddeley, 2000). The episodes contained in the episodic buffer can be a product of sensory integration, memory recollection, or imagination. The episodic buffer interacts with modality-specific storage system, on the one hand, and with episodic long-term memory, on the other hand. In its recent instantiation, the episodic buffer is considered to provide the interface between memory and conscious awareness (Baddeley, 2000). It is thought to be a passive store which holds chunks of integrated information (consider the binding problem below), to which the central executive provides conscious access (Baddeley, Allen, & Hitch, 2010).

Overall, there are several aspects to the relationship of the multicomponent WM model to consciousness. The storage system may hold representations which are consciously experienced. This is especially true for the episodic buffer which seems to hold integrated chunks of multi-modal items comprising conscious experience. However, the central executive seems to have a specially strong relationship with consciousness by being the system which provides conscious access to items held in WM (Baddeley, 2000; Baddeley et al., 2010). The multicomponent WM model thus seems to strongly suggest a very close link between consciousness and WM (if not equivalence). As explicated below, other WM model are more reluctant in suggesting such a close relationship.

2.2. Activation-based WM models

An alternative to Baddeley's multicomponent model of WM are the activation-based WM models (Cowan, 1999; Engle, 2002; Oberauer, 2002). These models concentrate on the presence of the various representational states of information held in WM (Öztekin & Cowan, 2015). For instance, the most differentiated model of Oberauer (2002) distinguishes three representational states in WM: focus of attention, region of direct access, and activated long-term memory. The focus of attention holds the single cognitive representation which is currently being processed, while the region of direct access stores several items which may be instantly “loaded” into the focus of attention. An intriguing property of the region of direct access is that items therein may be immune against interference and temporal decay (Cowan, Johnson, & Saults, 2005; Oberauer, 2002; Tehan & Humphreys, 1995; but see Ralph et al., 2011 for an opposing view). The activated part of long-term memory is not capacity limited and consists of LTM representations activated over the threshold due to their recent usage or through the spreading of activation. Information in the activated part of LTM is susceptible to interference and may be “refreshed” by bringing it to the focus of attention by a verbal or spatial rehearsal mechanism.

While activation-based WM theorists make no explicit claims about the consciousness/WM relationship in their models, some speculations on that topic seem possible. The content of the focus of attention and, to a lesser extent, of the region of direct access may be conscious. This corresponds to the subjective experience of only several items being separable in the focus of consciousness at

Download English Version:

<https://daneshyari.com/en/article/5041756>

Download Persian Version:

<https://daneshyari.com/article/5041756>

[Daneshyari.com](https://daneshyari.com)