Consciousness and Cognition xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Consciousness and Cognition

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

Review article

Merging with the path not taken: Wilhelm Wundt's work as a precursor to the embedded-processes approach to memory, attention, and consciousness

Nelson Cowan[a,*], Nikolay R. Rachev[b]

[a] Department of Psychological Sciences, University of Missouri, USA
[b] Department of General, Experimental, and Developmental Psychology, Sofia University "St. Kliment Ohridski", Bulgaria

ARTICLE INFO

Keywords:
Wundt
Embedded processes
Working memory
Focus of attention
Activation
Long-term memory
Activated long-term memory
Introspection
History of psychology

ABSTRACT

Early research on memory was dominated by two researchers forging different paths: Hermann Ebbinghaus, interested in principles of learning and recall, and Wilhelm Wundt, founder of the first formal laboratory of experimental psychology, who was interested in empirical evidence to interpret conscious experience. Whereas the work of Ebbinghaus is a much-heralded precursor of modern research on long-term memory, the work of Wundt appears to be a mostly-forgotten precursor to research on working memory. We show how his scientific perspective is germane to more recent investigations, with emphasis on the embedded-processes approaches of Nelson Cowan and Klaus Oberauer, and how it is in contrast with most other recent theoretical approaches. This investigation is important because the embedded-process theorists, apparently like most modern researchers, have recognized few of Wundt's specific contributions. We explore commonalities between the approaches and suggest that an appreciation of these commonalities might enrich the field going forward.

1. Introduction

We tend to think of consciousness as only recently open to empirical investigation but the director of the first formal laboratory of experimental psychology, Wilhelm Wundt, discussed consciousness in a theoretical framework that seems remarkably similar to some modern concepts of working memory, the small amount of information temporarily accessible to consciousness. The modern work rarely has cited Wundt. In the domain of memory research, it is worth tracing what happened to the work of Wundt because it contains, as it were, important messages for us regarding our scientific attitude to the topic.

The topic of this paper may seem long overdue but, in important ways, it is timely. The voluminous work of Wundt has been difficult to obtain, and mostly not translated into English. Scientific historians have examined Wundt from multiple perspectives (for a good compendium see Rieber & Robinson, 2001) and there is at least one new reinterpretation of much of Wundt's work (Araujo, 2016). As Araujo documents at length, the views of Wundt himself changed from one in which unconscious inference played an important role in his view of the mind, to one in which only conscious aspects of the mind were deemed worthy of study. There are still disagreements between investigators; as just one example, Araujo states (p. 103) that "David Robinson (1987) speculates that the increasing popularization of the language of the unconscious in German philosophy led Wundt to abandon it, but he fails to offer convincing evidence for this."

* Corresponding author at: Department of Psychological Sciences, University of Missouri, Columbia, MO 65211, USA.
E-mail address: CowanN@missouri.edu (N. Cowan).

https://doi.org/10.1016/j.concog.2018.06.001
Received 10 February 2018; Received in revised form 23 May 2018; Accepted 1 June 2018

In some ways, we are far from the ideal investigators to wade into the controversy of the meaning of Wundt's work. We are not leading experts on the history of psychology, and we do not speak or read German fluently enough to try to read Wundt in original form. However, unlike the other investigators who have discussed Wundt, we are cognitive psychologists with a modern-day theoretical view that we think recaptured much of the spirit of Wundt's original enterprise (unbeknownst to Cowan until Rachev pointed it out). Given our new appreciation of Wundt's philosophical orientation and how thoughtful and penetrating his approach was, we see a possibly unique opportunity to explain how the field may now be positioned to benefit more from Wundt. For although Wundt has long been recognized as the originator of the first laboratory of experimental psychology, the historians seem to agree that the field went off in other directions and largely ignored or improperly simplified much of what Wundt had to say (as in the famous poem by Keith Douglas, *Simplify Me When I'm Dead*).

2. How the early field spawned modern approaches to memory

Today's memory research has been built primarily on the work of Ebbinghaus (1885/1913), who turned himself into a research participant to be tested on the acquisition of strings of nonsense syllables of various lengths after various retention intervals and various numbers of repetitions. Although he found a precursor of what we now term working memory in the "first fleeting grasp" of short lists that could be recalled immediately after only a single viewing, for the most part his forgetting curves served as the basis of a behaviorally-based science of learning and memory, which later flourished in the fields of verbal learning (e.g., Kausler, 1974) and then cognitive psychology (e.g., Crowder, 1976).

The modern field, however, is recognized not only as a science of behavior, in keeping with the approach of Ebbinghaus, but also as a science of the mind (e.g., Gardner, 1985). Wundt's work, while thoroughly empirical in nature, was carried out within a theoretical framework in which the subjective aspects of the mind were the objects of study, not just behaviors.

The focus on behavior versus conscious experience can lead to strikingly different graphic representations of memory processes. If the emphasis is primarily on behavior then the graphic representation that may seem most suitable is one in which there is a discrete progression from one process to the next, as in Sternberg's (1969) stimulus encoding, memory search, decision-making, and motor response processes or (stated in modern terminology) Broadbent's (1958) sensory memory, working memory, and long-term memory stores. Sometimes from a behavioral approach there is also recurrent entry into a process earlier in the stream after a later one is reached, as in the computer-flowchart-inspired representation of processing by Atkinson and Shiffrin (1968), or a model with multiple, separate but interacting components (e.g., Baddeley, 1986; Baddeley & Hitch, 1974; Logie, 2016). If, however, the emphasis is directly on the mind and consciousness, a better representation may be one that depicts processes more organically, as it were, with a limited focus of attention and awareness as central to other memorial processes and embedded in them, providing a flow of information from up to several sources in parallel into, and out of, this focus of attention.

The latter, experience-based graphic representation of processing is a fair description of the embedded-processes modeling framework of Cowan (1988; later elaborated upon by Cowan, 1999, 2005) and of the framework with an additional embedded layer described by Oberauer (2002). In Cowan's (1988) framework, the focus of attention can contain several well-integrated object representations at once and is embedded in a currently-activated portion of long-term memory. The latter can contain an unlimited number of separate feature representations, often not fully integrated into objects, subject to their mutual interference and decay; in turn, activated long-term memory is embedded within the wealth of knowledge of the individual, the memory system at large. Oberauer modified Cowan's focus of attention, calling it a capacity-limited region of direct access and proposing that the focus of attention is actually a mechanism embedded within this capacity-limited region, with the focus holding just a single item in a more privileged status.

The embedded-processes type of model has been popular among some brain researchers because it seems to mesh with assumptions based on brain research indicating that attention processes involved in working memory operate as a subsystem embedded within more general, sometimes autonomously-functioning information processing systems in the brain (e.g., Chein & Fiez, 2010; D'Esposito, & Postle, 2015; Ruchkin, Grafman, Cameron, & Berndt, 2003). Several articles on embedded-process approaches (Cowan, 1988, 1999, 2001, 2005; Oberauer, 2002), taken together, have been cited about 13,000 times.

Cowan (1988) attributed his model to the fusion of some important concepts underlying the embedded processes and their graphic representation. The most important precursors included (1) a proposal of some access to items outside of attention upon arrival of an important, related stimulus such as one's name, the attenuation theory (e.g., Treisman, 1964); (2) attentional orienting to information discrepant with the current neural model of the environment (Sokolov, 1963); and (3) the models of processing mentioned above (Atkinson & Shiffrin, 1968; Baddeley, 1986; Baddeley & Hitch, 1974; Broadbent, 1958). What Cowan was not aware of was a related precursor to his approach in the work of Wilhelm Wundt.

A depiction of the Wundt approach and that of Cowan (1988) appear for comparison in Fig. 1. Below, we elaborate on Wundt's approach to memory and then ask which aspects of it have been overlooked and might still be important to incorporate into modern approaches to the topics of attention and memory, and especially the embedded-processes approach.

3. Wundt's approach to memory, attention, and consciousness

Wundt's approach can be examined by starting with his model and then exploring the philosophical underpinnings of the approach leading to that model.