

Manufacturing Exceptional Performance: A Review of Skilled Memory Theory

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Abstract

Skilled memory theory explains how exceptional performance can be developed in any area of academic study, profession, vocational skill, and sports; long-term working memory explains about the cognitive structures and their attendant processes that form the underlying basis for the development of exceptional performance; and the framework of deliberate practice describes the systematic methods for development of skilled memory and long-term working memory in any domain.

Ericsson and his colleagues show that normal adults, with consistent practice over the duration of some years, can achieve exceptional performance in a particular domain, and that they are not endowed with some extraordinary cognitive structures and processes, but share the same that are common to all the populace. Expert memory is demonstrated as an outcome of expert performance in a domain of expertise which is called the skilled memory.

These three interrelated theoretical constructs have inspired and guided a number of researchers and practitioners in many areas to investigate their respective domains in a systematic and empirical manner and design and implement interventions to improve the students and participants performances.

Key words: *skilled memory theory; Long-term working memory; deliberate practice; exceptional performance, learning*

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I. INTRODUCTION

Exceptional performances in various fields elicits awe and ambiguity about its causes and it is a common assumption that such performers are endowed with some special ability which sets them apart from other people, and they are 'natural performers'. Ericsson and his colleagues set out to unravel the mysteries of expert performers and to investigate if it can be manufactured in the lab, and their empirical findings have demystified expertise, its developmental methods, and the cognitive structures and functioning of working memory and long-term working memory that underpin it.

II. THEORETICAL ANALYSIS AND EMPIRICAL RESEARCH OF EXPERTS AND EXPERTISE

Expertise research (Ericsson & Lehmann, 1996) provides a broad framework to situate exceptional performances as falling within the purview of universal cognitive processes shared by all and not confined to a few memory experts and demonstrates that expertise can be developed with hard work. The expertise researchers focus on superior performance that can be investigated under laboratory conditions. They have identified mechanisms that are domain specific cognitive structures and skills that performers have acquired to overcome the limits on the processing and functioning capacity of working memory.

Skilled Memory Theory (Chase & Ericsson, 1980), deliberate practice (Ericsson, Krampe, and Tesch-Romer, 1993) and long-term working memory (LT-WM) (Ericsson & Kintsch,

1995) have had a tremendous influence on the development and implementation of scheduled interventions to improve knowledge, skills and behaviours in various fields like the office, factory, academic institutes, and other social settings, and consequent investigations and solutions to attendant problems are practical, empirical and replicable. Research conducted by them (Chase & Ericsson, 1980; Ericsson, Chase, & Faloon, 1980; Ericsson & Chase, 1982; Ericsson & Polson, 1988 b; Ericsson, Krampe, & Tesch-Romer, 1993; Ericsson & Charness, 1994; Ericsson & Lehmann, 1996) has moved the study of people with exceptional memory and expert performances from the anecdotal to an empirical and systematic study. Prior to these studies, any exceptional performance in most fields was accounted for by associating it with inborn talent or natural predisposition. Exceptional performance was rare in most domains. So, Ericsson and his associates' series of experimental studies account for exceptional performance in terms of deliberate practice, and efficient use of memory and other cognitive structures and processes. Moreover, these researchers have accumulated empirical evidence in many domains of expertise through systematic study and greatly influenced many researchers in various domains to develop their domain-specific criteria for expertise and its development. Their theoretical formulations regarding development of exceptional performance in varied fields including memory, are conceptually concise and logical. They utilize and offer support to cognitive psychology constructs including working memory, encoding, storage and retrieval from long term memory.

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They validate their theoretical constructs with empirical support through systematic investigations and replicable procedures. Ericsson (1985) analysed various memory experts and mnemonists for the structure of their memory skill and techniques used in memorizing and concluded that memory skill is acquired through extensive practice.

III. DEVELOPING EXCEPTIONAL PERFORMANCE

Ericsson, Chase and Faloan (1980) conducted an intervention under controlled laboratory conditions on a university student, S.F. who had average memory ability and average IQ. He was given 230 hours of practice to increase his digit span which he did from 7 digits to 79 digits. His exceptional performance was equivalent to memory experts with lifelong training. Retrospective verbal data from S.F. showed that he had developed a mnemonic system of associations during the course of the practice that facilitated the storage, retention and retrieval recall of the random digits. The second important component of his skill was development of retrieval structures that organized the inputs into a methodical arrangement for ease of access and speed of recall. Chase and Ericsson (1980) in their technical report in Anderson (1985) mention the details of the development of skilled memory of S.F. that on Day 5 of the intervention, he showed a dramatic improvement of 4 S.D. (standard deviations) from the previous day, and in his retrospective reports he detailed the use of his mnemonic device. He maintained and improved on his digit span as he developed his mnemonic system based on existing knowledge of running times and its control structure. They also mention the revaluation of levels-of-processing theory by researchers who were trying to define what is meant by 'deeper level of processing' with its emphasis on encoding operations. However, further research made it apparent that retrieval operations were equally crucial to recall retrieval cues that were generated during encoding.

Chase and Ericsson (1982, as cited in Bower, 1982) present evidence for the efficient use of working memory involving a mnemonic system of running times by both their subjects, SF and DD as both of them running athletes. The researchers conclude that SF and DD were using a 'generate-and-test' strategy to search their long-term semantic memory to recall timings of various categories of running races.

An important point to note in these skilled memory articles is the fact that verbal reports of the subjects are taken as authentic evidence to monitor their cognitive processes. Ericsson and Chase (1982) corroborate that a 'single model of memory is sufficient to explain all aspects of memory and its functioning in adults, and there is no need to construct a separate memory model to explain instances of exceptional memory cases'. Many researchers subscribing to the information processing models of cognition (Richman et al., 1996, as cited in Ericsson, 2014, (ed.) have demonstrated that the same basic information processing structures and mechanisms that are utilized to explain about cognition and its functions, can be used to explain about expertise and its cognitive requirements. The difference in the outcomes of experts and non-experts is that the former deploys the information processes elements to higher degree of skill in

their expertise domain compared to non-experts and they have vast knowledge of their domain.

Ericsson and Charness (1994) list a number of reasons for studying memory skills in specific domains. They opine that researchers who investigated expertise development in various domains have discovered that such experts overcome the normally accepted limits on the speed, storage and processing limits of memory. Expert performers can display their superior performance effortlessly, as they have gained mastery on all domain relevant factors including motivation. Therefore, they reproduce their expert performance under controlled conditions, and their performance can be studied scientifically and analysed (Ericsson & Lehmann, 1996). The three characteristics of expert performance (Ericsson & Delaney, 2005, as cited in Logie & Gilhooly, 2005) are that a large amount of information in domain-relevant tasks is available in accessible form during its processing; effortless resumption of the expertise level activity after an interruption; and accurate recall of domain-related information during unexpected tests. Researchers (Ericsson & Charness, 1994) can identify instructional methods and the contribution of social and motivational factors from the study of experts and their instructors.

Chase and Ericsson (1980) define 'skilled memory as the rapid and efficient utilization of memory' in a particular knowledge domain in order to perform a task at an expert level. Chase and Ericsson (1980, 1982) formulated three principles of skilled memory: meaningful encoding by using knowledge structures of the concerned domain; using a retrieval structure to organize information, make associations, store cues and sequence of information, and retrieve quickly; and systematic practice to increase the speed of recognition, encoding and retrieval. Chase and Ericsson (1980) conclude that 'no special abilities are necessary for the development of memory skill. Systematic practice, an appropriate mnemonic system and retrieval structure are sufficient to develop memory skill'.

IV. COGNITIVE STRUCTURES OF EXCEPTIONAL PERFORMANCE

Ericsson and Kintsch (1995) proposed the LT-WM theory to extend the Chase and Ericsson (1982) skilled memory theory to demonstrate the mechanisms that support 10-fold increase in the experts' performances as it increases their WM capacity. LT-WM theory updated skilled memory theory similar to how theories of working memory updated theories of STM (Delaney, 2018). The proposed mechanisms were shown to expand the skilled performers' working memory capacity and control proactive and retroactive interferences. Experts utilize retrieval structure and retrieval cues to encode, store and retrieve information about their expertise domain from LT-WM efficiently. The authors stress on the importance and use of acquired knowledge to construct and use a retrieval structure.

LT-WM is not a generalizable capacity that can enhance WM in any cognitive activity. It is acquired and utilised in particular domains only, and it is an outcome of the domain's specific storage and retrieval requirements. Its defining features are that it can be accessed rapidly after a pause as it has become automatised and concurrent tasks can be

performed without decrement in performance. They propose two types of mechanisms of LT-WM: generation of new structures and use of retrieval structures. In the case of expert memory which is developed as a consequence of developing expertise in a particular domain, generation of new structures is important as knowledge is applied in varied settings to solve problems. Proactive and retroactive interferences in encoding and retrieval is controlled and eliminated with cued recall of the retrieval structure.

V. SYSTEMATIC METHODOLOGY OF EXCEPTIONAL PERFORMANCE

Ericsson et al., (1993) elucidate on the role of 'deliberate practice' in expertise. They assert that since superior performance is domain specific, it implies that knowledge and skill are important and are acquired, and not inborn. They list the characteristics of deliberate practice which begins with an individual's motivation to work on the domain specific tasks continually, develop related skills and knowledge steadily, systematically collect data about their performance, and analyse it and get prompt feedback and then plan and execute subsequent tasks to improve their efficacy. Experts maintain consistent practice schedules over a significant duration to improve performance, and studying them reveals information that can be utilised to improve performance in other domains. Deliberate practice facilitates an exponential increase in the information processing ability of skilled performers, it is exhibited in seemingly enhanced WM capacity, and it improves the performance with the help of structured and individualized learning activities under the guidance of a qualified coach (Ericsson & Charness, 1994). The authors quote four studies that show poor predictability and generalization of simple psychometric tests with later expert performance in related domain as expert memory skill is not transferable to other skills.

Ericsson and Lehmann (1996) have shown that the duration and intensity of the experts' training in their domains is sustained for prolonged periods. And their theoretical framework of deliberate practice can explain the development and maintenance of exceptional performance in many domains empirically. Deliberate practice interventions and schedules are planned and implemented by qualified teachers with in-depth knowledge of the domain (Ericsson & Kintsch, 1995; Ericsson et al., 1993; Ericsson & Lehmann, 1996).

There are some differences between experience in a domain and acquiring expertise in it with the help of deliberate practice: the former is passive, in which a variety of learning experiences might occur and the individual is left to learn from them by himself, while the latter is active, in which a large variety of representative learning activities are identified and practiced, and the individual is enabled to learn from them with help from a coach. So, it is more structured and controlled, as against experience which might or not lead to better learning.

VI. APPLICATIONS

The constructs of skilled memory theory LT-WM and deliberate practice have inspired researchers in multiple

domains to systematically study their domains and develop useful interventions and effectively implement them. Plant, Ericsson, and Hill (2005) conducted research on study time by college students and concluded that the study time should have features of 'deliberate practice' to be effective, as also shown by Anderson (2011) for mathematical ability, and Roring (2008) for chess.

VII. CONCLUSIONS

Development of skilled memory is facilitated through deliberate practice, and results in the formation of a specialised LT-WM which leads to the development of customised solutions, and practical problem solving. The solutions are domain specific and cannot be generalised from one domain to another one, and they must be implemented under the guidance of a coach for attaining optimum outcomes.

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