Expert Performance and Deliberate Practice

An updated excerpt from Ericsson (2000)

EXPERTISE refers to the mechanisms underlying the superior achievement of an expert, i.e. "one who has acquired special skill in or knowledge of a particular subjects through professional training and practical experience" (Webster's dictionary, 1976, p. 800). The term expert is used to describe highly experienced professionals such as medical doctors, accountants, teachers and scientists, but has been expanded to include any individual who attained their superior performance by instruction and extended practice: highly skilled performers in the arts, such as music, painting and writing, sports, such as swimming, running and golf and games, such as bridge and chess.

When experts exhibit their superior performance in public their behavior looks so effortless and natural that we are tempted to attribute it to special talents. Although a certain amount of knowledge and training seems necessary, the role of acquired skill for the highest levels of achievement has traditionally been minimized. However, when scientists began measuring the experts' supposedly superior powers of speed, memory and intelligence with psychometric tests, no general superiority was found --the demonstrated superiority was domain specific. For example, the superiority of the chess experts' memory was constrained to regular chess positions and did not generalize to other types of materials (Djakow, Petrowski & Rudik, 1927). Not even IQ could distinguish the best among chessplayers (Doll & Mayr, 1987) nor the most successful and creative among artists and scientists (Taylor, 1975). In a recent review, Ericsson and Lehmann (1996) found that (1) measures of general basic capacities do not predict success in a domain, (2) the superior performance of experts is often very domain specific and transfer outside their narrow area of expertise is surprisingly limited and (3) systematic differences between experts and less proficient individuals nearly always reflect attributes acquired by the experts during their lengthy training.

In a pioneering empirical study of the thought processes mediating the highest levels of performance, de Groot (1946/1978) instructed expert and world-class chessplayers to think aloud while they selected their next move for an unfamiliar chess position. The world-class players did not differ in the speed of their thoughts or the size of their basic memory capacity, and their ability to recognize promising potential moves was based on their extensive experience and knowledge of patterns in chess. In their influential theory of expertise, Chase and Simon (1973; Simon & Chase, 1973) proposed that experts with extended experience acquire a larger number of more complex patterns and use these new patterns to store knowledge about which actions should be taken in similar situations.

According to this influential theory, expert performance is viewed as an extreme case of skill acquisition (Proctor & Dutta, 1995; Richman, Gobet, Staszewski & Simon, 1996; VanLehn, 1996) and as the final result of the gradual improvement of performance during extended experience in a domain. Furthermore, the postulated central role of acquired knowledge has encouraged efforts to extract experts' knowledge so that computer scientists can build expert systems that would allow a computer to act as an expert (Hoffman, 1992).

Among investigators of expertise, it has generally been assumed that the performance of experts improved as a direct function of increases in their knowledge through training and extended experience. However, recent studies show that there are, at least, some domains where "experts" perform no better then less trained individuals (cf. outcomes of therapy by clinical psychologists, Dawes, 1994) and that sometimes experts' decisions are no more accurate than beginners' decisions and simple decision aids (Camerer & Johnson, 1991; Bolger & Wright, 1992). Most individuals who start as active professionals or as beginners in a domain change their behavior and increase their performance for a limited time until they reach an acceptable level. Beyond this point, however, further improvements appear to be unpredictable and the number of years of work and leisure experience in a domain is a poor predictor of attained performance (Ericsson & Lehmann, 1996). Hence, continued improvements (changes) in achievement are not automatic consequences of more experience and in those domains where performance consistently increases aspiring experts seek out particular kinds of experience, that is deliberate practice (Ericsson, Krampe & Tesch-Römer, 1993)--activities designed, typically by a teacher, for the sole purpose of effectively improving specific aspects of an individual's performance. For example, the critical difference between expert musicians differing in the level of attained solo performance concerned the amounts of time they had spent in solitary practice during their music development, which totaled around 10,000 hours by age 20 for the best experts, around 5,000 hours for the least accomplished expert musicians and only 2,000 hours for serious amateur pianists. More generally, the accumulated amount of deliberate practice is closely related to the attained level of performance of many types of experts, such as musicians (Ericsson et al., 1993; Sloboda, et al., 1996), chessplayers (Charness, Krampe & Mayr, 1996) and athletes (Starkes et al., 1996).

The recent advances in our understanding of the complex representations, knowledge and skills that mediate the superior performance of experts derive primarily from studies where experts are instructed to think aloud while completing representative tasks in their domains, such as chess, music, physics, sports and medicine (Chi, Glaser & Farr, 1988; Ericsson & Smith, 1991; Starkes & Allard, 1993). For appropriate challenging problems experts don't just automatically extract patterns and retrieve their response directly from memory. Instead they select the relevant information and encode it in special representations in working memory that allow planning, evaluation and reasoning about alternative courses of action (Ericsson & Lehmann, 1996). Hence, the difference between experts and less skilled subjects is not merely a matter of the amount and complexity of the accumulated knowledge; it also reflects qualitative differences in the organization of knowledge and its representation (Chi, Glaser & Rees, 1982). Experts' knowledge is encoded around key domain-related concepts and solution procedures that allow rapid and reliable retrieval whenever stored information is relevant. Less skilled subjects' knowledge, in contrast, is encoded using everyday concepts that make the retrieval of even their limited relevant knowledge difficult and unreliable. Furthermore, experts have acquired domain-specific memory skills that allow them to rely on long-term memory (Long-Term Working Memory, Ericsson & Kintsch, 1995) to dramatically expand the amount of information that can be kept accessible during planning and during reasoning about alternative courses of action. The superior quality of the experts' mental representations allow them to adapt rapidly to changing circumstances and anticipate future events in advance. The same acquired representations appear to be essential for experts' ability to monitor and evaluate their own performance (Ericsson, 1996; Glaser, 1996) so they can keep improving their own performance by designing their own training and assimilating new knowledge.

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