# The Transfer of Cognitive Skill

## by Mark K. Singley and John R. Anderson
## Cambridge, MA: Harvard University Press, 1989.

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Cognitive psychologists have only recently become more interested in the transfer of learning. This book is unique in that it consists of the most comprehensive study until now within the cognitive or information-processing approach to the transfer of skill.

Singley and Anderson (p.2) state that "in a world where rapid technological change often penalizes those who are narrowly skilled and inflexible,... educational questions interact with questions of technological design. ... in comparison with simpler machines like automobiles and copiers, transfer (of skill) among different kinds of computer systems is relatively difficult."

"As we move into an era when more and more people are acquiring knowledge of multiple information systems, transfer of training again looms as an important topic" [3]. Assessing the transfer of training is one way of choosing between proposed interface designs. What is evaluated is the transfer between the initial knowledge brought to the task by the learner and the knowledge required to master the alternative/competing designs. "Effective technology transfer may depend upon a technical understanding of transfer itself" [3].

The book starts with a historical perspective that not only presents recurring themes, both substantive and methodological, but also gives definitions needed for the understanding of the chapters that follow. Singley and Anderson try to distance themselves from the general approach to transfer (formal discipline to be transferred between domains, e.g., does a knowledge of Latin facilitate the learning of computer programming?). According to Singley and Anderson (p.25), besides negative evidence there has been no positive evidence of general transfer. For the authors, only in special situations where the knowledge is obviously relevant does transfer (situated learning, e.g., knowledge is transferred from an earlier lesson in LISP to a later lesson with the help of an intelligent tutor) have a chance (p.29). For different perspectives of the controversy between transfer within a domain (specific) and transfer between domains (general) see Salomon and Perkins [4] and Campione and Brown [2].

The central piece of Singley and Anderson's approach to modeling transfer of procedural knowledge is the use of productions — condition-action rules (IF-THEN pairs) — as defined in Anderson's ACT* (not an acronym) theory of cognitive skill acquisition [1]. An in-depth analysis of the process by which cognitive skill is acquired in ACT* through the use of production rules is supported through the analysis of a vertical transfer case, where knowledge from earlier lessons transfers to later lessons with the use of a LISP tutor.

Lateral transfer among various text editors is presented as a function of the number of productions they share. In another text-editing study, negative transfer is explained in terms of the positive transfer of non-optimal methods.

Analyzing experimental evidence from calculus and LISP programming domains, Singley and Anderson show that transfer is restricted to production rules shared between skills. The use specificity of procedural knowledge is made even more evident by the fact that transfer is not based on abstract characterization of the knowledge underlying the production rules.

To show that during the initial stages of learning (where weak problem solving methods like analogy are useful) the key to the transfer is declarative representation of operations, the use of a model of novice performance that simulates analogical transfer is described. Further proof is presented with another calculus experiment that isolates the declarative transfer of the model's components to the beginning stages of skill acquisition.

All the experiments brought up in this book are described to provide support for the identical production theory of the transfer of cognitive skill and the ACT* theory on which it is based. At the end, the authors focus on the main conceptual problem still remaining: the representation.

Singley and Anderson ask the reader not to conclude that "the representational issues pose a particular problem for the study of transfer. They are problems for the study of all cognitive phenomena, ... the transfer is less imperiled by representational indeterminism than the most phenomena because so many constraints can be applied to the representation before making behavioral predictions (p.274)."

In a time in which quality improvements are beginning to be demanded from the information technology management area, particularly in the end-user computing arena, developments such as the ones described in this book could

be used as the starting point to determine transfer as one of the areas to be measured. The identical production theory could be used to evaluate transfer to different interface designs, new versions of certain packages, or stages of a programming language training effort.

The book is designed for sophisticated students in the areas of cognitive psychology, educational psychology, and computer-aided instruction. This may well limit its usefulness in the area of human-computer interaction to practitioners and researchers in systems training, software development and test, and end-user support, all dealing with skill transfer and acquisition. From an applied artificial intelligence perspective, this book is suited for the study of intelligent tutors and other advanced training and testing systems. For researchers the appendix to Chapter 1 about transfer designs and formulas should be particularly useful.

Singley and Anderson's book may, therefore, be advanced even for graduate courses in end-user computing, user interface design, and expert systems. It is a theory-based book for a graduate course in intelligent tutoring systems. The authors' merit lies in their ground braking theoretical and empirical work that could lead us to quality improvement efforts not only in end-user computing but also in software development.

## REFERENCES

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