

Development of Expertise

General Empirical Results:

Stages of skill learning (Fitts & Posner '67)

cognitive

declarative, verbal

slow

associative

errors detected & eliminated

connections strengthened

autonomous

automated and rapid

Power Law of Practice

Aspects of Development of Expertise

1. Proceduralization

compiling declarative knowledge into specific rules

2. Tactical Learning

sequences as chunks

computation -> retrieval

3. Strategic Learning

Physics

backward -> forward search
(also seen in geometry)

problem categorization by deeper principles
(seen also in math, programming, and medicine)

Programming

no change to working forward
depth first -> breadth first
deeper representation
language independence

4. Problem Perception

Physics (see above)

problem categorization by deeper principles
(seen also in math, programming,
and medicine)

Chi, Feltovich & Glaser 1981
classification

"angular speed" -> conservation of energy

Medicine

Lesgold et al. 1988
x-rays

5. Pattern Learning and Memory

de Groot 1965, 1966 memory for chess
(seen in other domains since)

Chase & Simon, 1973

chunking

more patterns, larger patterns

Simon & Gilmarin 1973 ~50k chunks

Newell & Simon 1972

Human Problem Solving

chunks = productions

~50K productions for expertise

6. Long Term Memory and Expertise

(patterns are basis for memory recording)

Chase & Simon, 1973

chunk define by 2 sec. pause

master:	3.8 pieces
	7.7 patterns / board
	= 29.26 total (ceiling?)
beginner:	2.4 pieces
	5.3 patterns / board
	= 12.72 total

Charness 1976

chess patterns after 30 sec.
interference task

Chase & Ericson 1982

digit spans