

Brain Fitness and Motor Learning

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Understanding and Improving Motor Learning

Motor control

- The process of regulating and directing the mechanisms essential to movement

Motor Control & Motor learning

- Learning a new skill, or relearning motor control that has been lost, follows a science known as motor learning

Motor learning defined

- A set of processes associated with practice or experience leading to relatively permanent changes in the capability for producing skilled action*

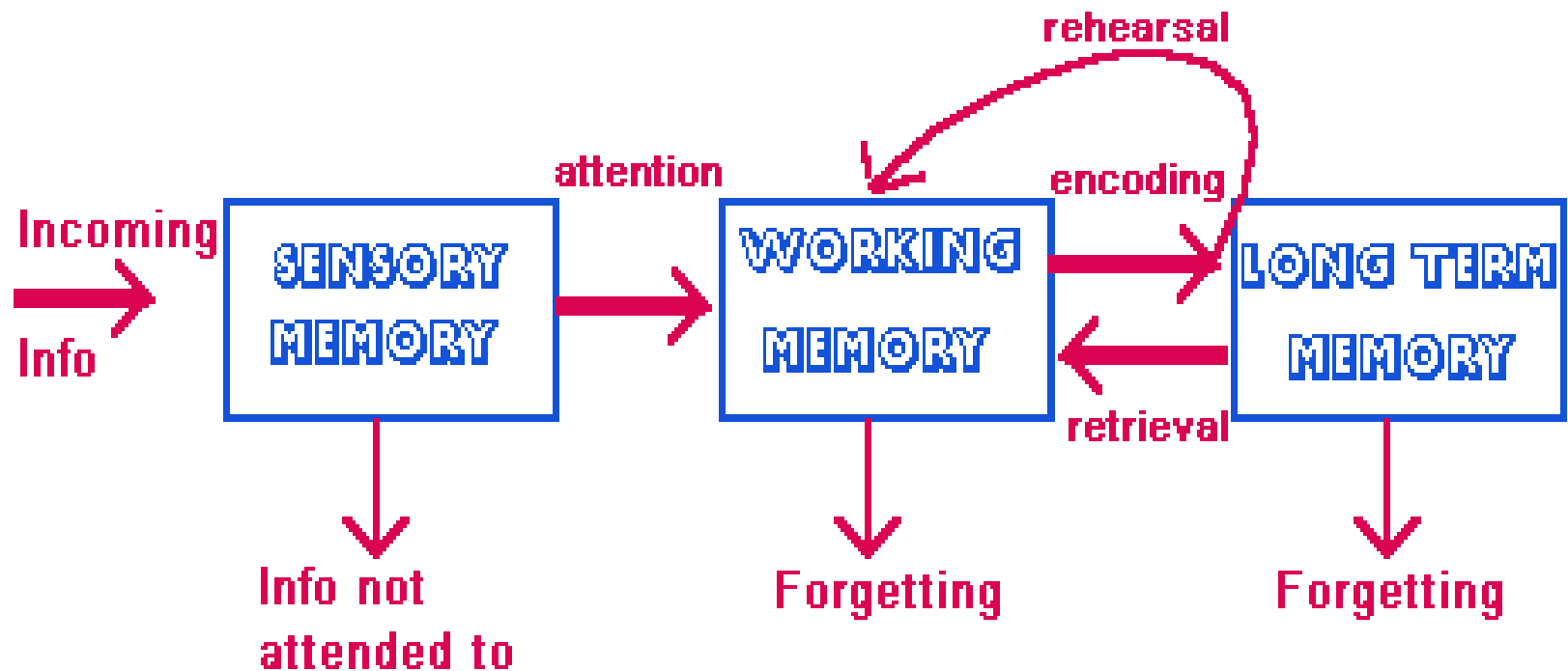
Motor performance (MP)

- Benefiting from practice and feedback, we can improve within a session, across repetitions. These gains are known as motor performance.

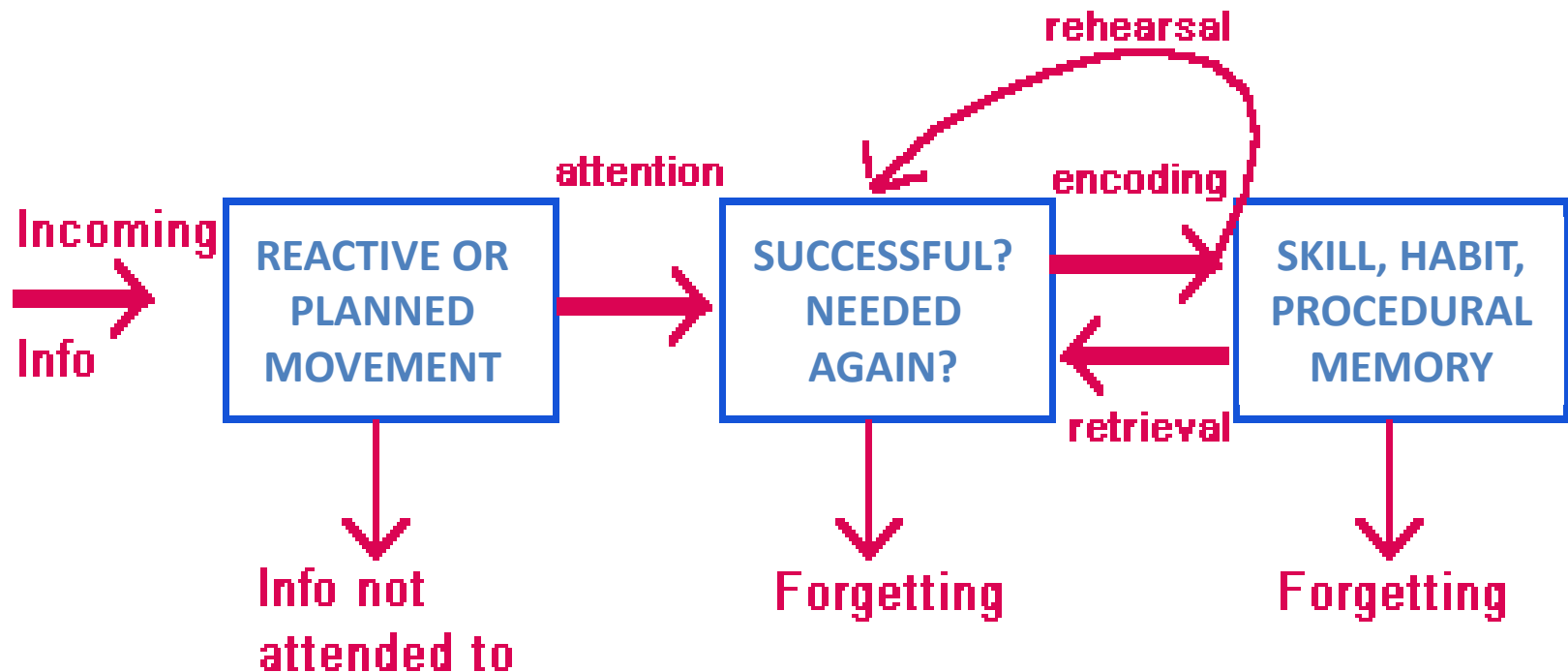
Motor performance defined

- Temporary changes in the capability for producing skilled movement that are dependent on recent feedback, practice, or experience

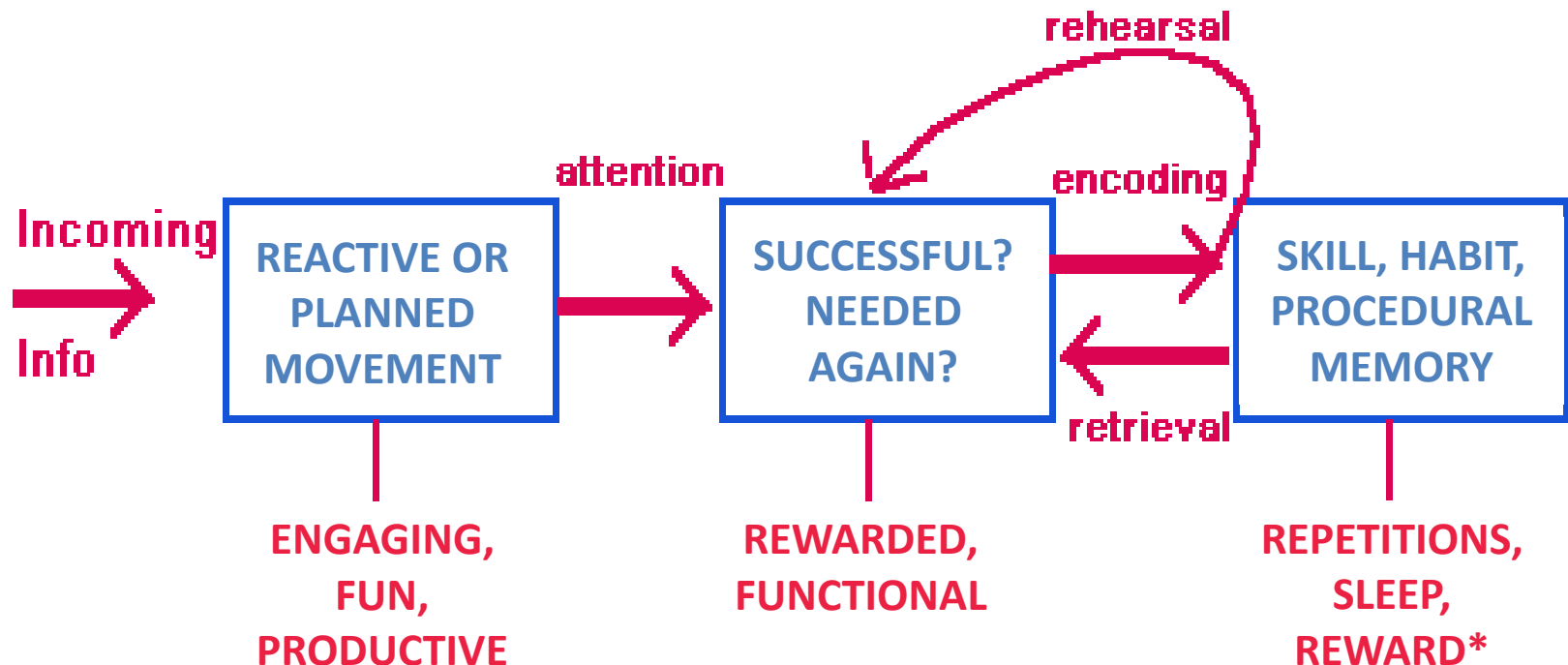
Is this the same for **motor** learning?



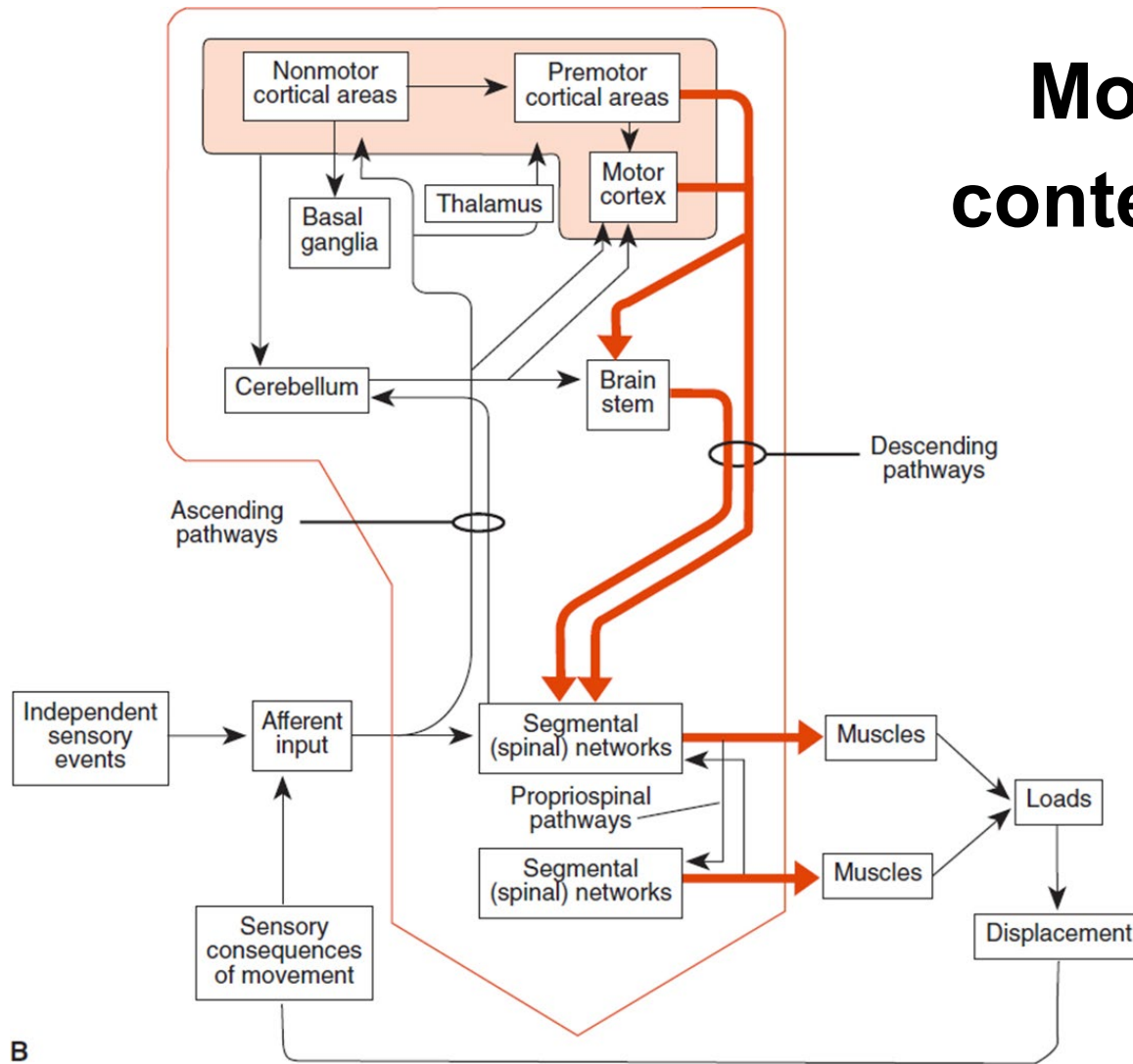
Similar for motor learning...



Enhancing motor learning



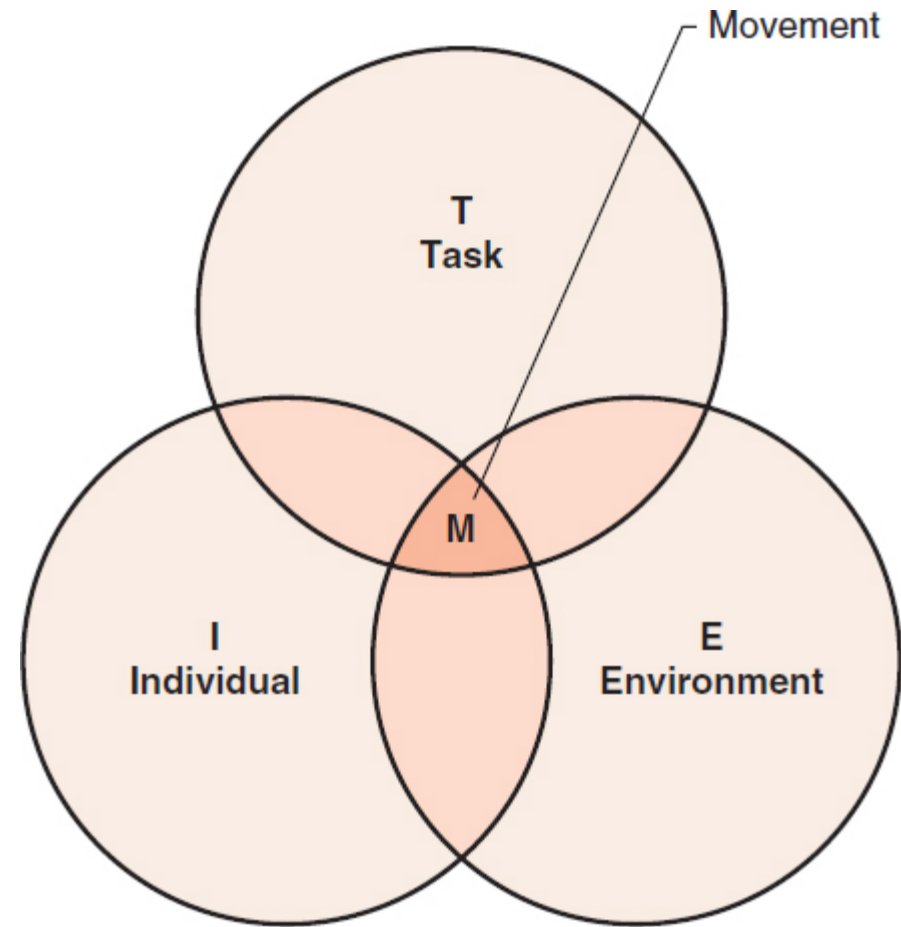
Motor Control: A contemporary model



(Shumway-Cook, 2022)

Motor “memories”

- Procedural Memory Centers (PMCs)
Overlearned movements “stored” and automated
- Central Pattern Generators (CPGs)
Rhythmic movements “stored” brain and spinal cord
- Motor synergies
Efficient combinations of movement : Biomechanical
and neuromuscular coordination



Individual- Environment-Task Interaction

**An equation to be
solved anew with
each experience**

Individual-Environment-Task Interaction

- An equation to be solved anew with each experience
 - **My resources** (skill, coordination, flexibility, power, endurance/fatigue, sensation)
 - **This task** (expectations, accuracy, history, consequences)
 - **This environment** (distractions, surface, temperature, obstacles)

Motor learning principles

- Feedback
- Practice

Motor learning principles

- Feedback
- Practice
- Intensity
- The role of errors
- Personalizing activities and difficulty
- Enhancing engagement

Stages of learning

Cognitive: Novice learner experiments with strategies. Movement is variable and requires concentration.

Associative: Strategy selected. Refining skill. Less variability. Verbal/cognitive aspects of learning are not as important.

Autonomous: automaticity in skill. Limited attention required

(Fitts & Posner, 1967)

Variables of Feedback

Relative frequency of feedback

Knowledge of Results vs. Knowledge of Performance

Internal vs. External Focus (means vs. ends)

Bandwidth Feedback

Source of feedback: Patient, instructor, or the goal outcome (result)

Concurrent vs. Summative (Summary, Terminal)

Visual (demonstration), auditory, tactile/manual

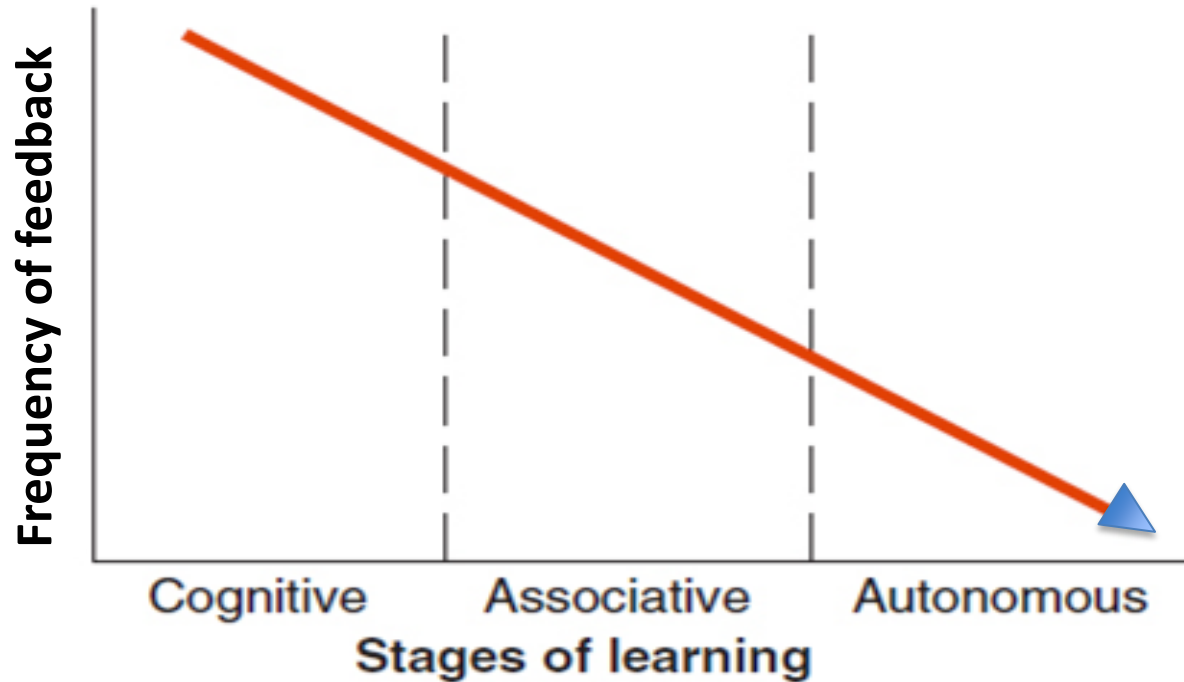
Motor learning: Feedback variables

- Frequency
- Mode – fact-based, auditory, visual, manual,
- Bandwidth – feedback delivered as a function of performance
- Source – intrinsic v. extrinsic
- Focus – body parts (internal) v. goal/task (external)

Practical considerations: Presence of video or mirrors, situational or environmental pressure, preferences, stage of learning

Examples: A first driving lesson, parent + crowd + teammate advice, pain in limb

Progressing feedback



Motor learning: Practice variables

- Repetitions – volume
- Structure – relative consistency (blocked) v. variety (random)
- Variability – how similar each repetition is to the previous
- Specificity – how similar practice is to the intended behavior

Practical considerations: Level of interest, gamified features (points, levels, rewards), fatigue, stage of learning

Examples: carnival games, golf putting, hitting a pitched ball, tying shoes

Essentials of practice

Role of errors

Intensity

Attention

Repetitions

Task specificity

Difficulty

Salience, time, interference

Kleim, Jones 2008

Error-Driven v. Errorless Learning

Consider personality

Patient preference, self efficacy

Competitive preferences

Stage of learning

Frequency of success

Neurologic resources (awareness, working memory, attention)

Basics of motor learning: Errors

Error frequency

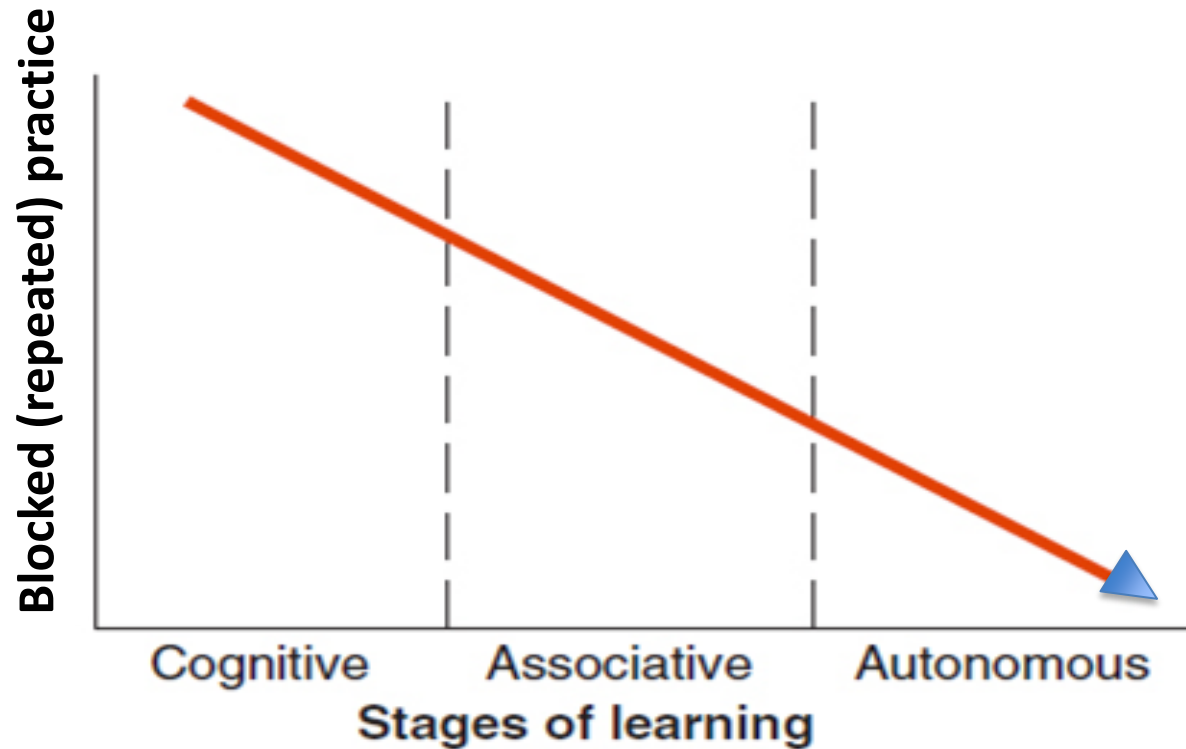
Consequences

Overload

Practical considerations: Tolerance of errors, frustration, pressure, consequences

Examples: Golf lesson, hula hoop, swimming

Progressing practice



How Can We Improve Memory?

- So how do we get information from short term memory into long term memory?
- Rehearsal, rehearsal, rehearsal....

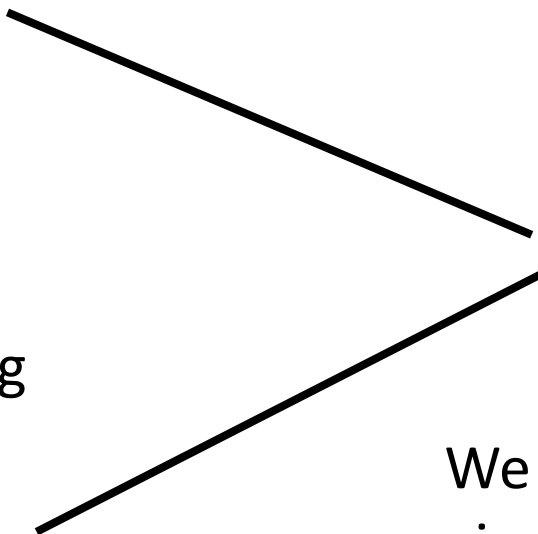
How Can We Improve Motor Learning?

- Repetitions, repetitions, repetitions....?
- Engagement (interest)
- Intensity (overload (dual task, pressure)
- Practice – delay (retention) – rehearsal
- Reward (success)
- External (goal) focus
- Attention (active, self-directed learner)

Motor control: Skill development

What gets a person to “expert” faster, from novice?

Pressure
Repetitions
Reward
Overload
Understanding
Dual task



PRROUD*

We will further personalize this and give consideration for timing in stages of learning...

Basics of motor learning: Retention

Delay – time away from feedback and practice

Episodic and procedural memory relationship

Development of CPGs and automatization

Consolidation – degree of retention proven with delay

Spaced retrieval – programmed time from stimulus to recall

Practical considerations: Time between games, “playing time”/repetitions

Examples: Offseason, return from injury

Basics of motor learning: Transfer

Specificity - how similar practice is to the intended behavior

Familiarity – relative to this learner

Near/far transfer – how dissimilar is practice to the behavior

Migration – practice in one arena benefits another

Practical considerations: Novelty, interest, early success

Examples: Multisport athletes, swim strokes, cross-training

Serial Position Curve

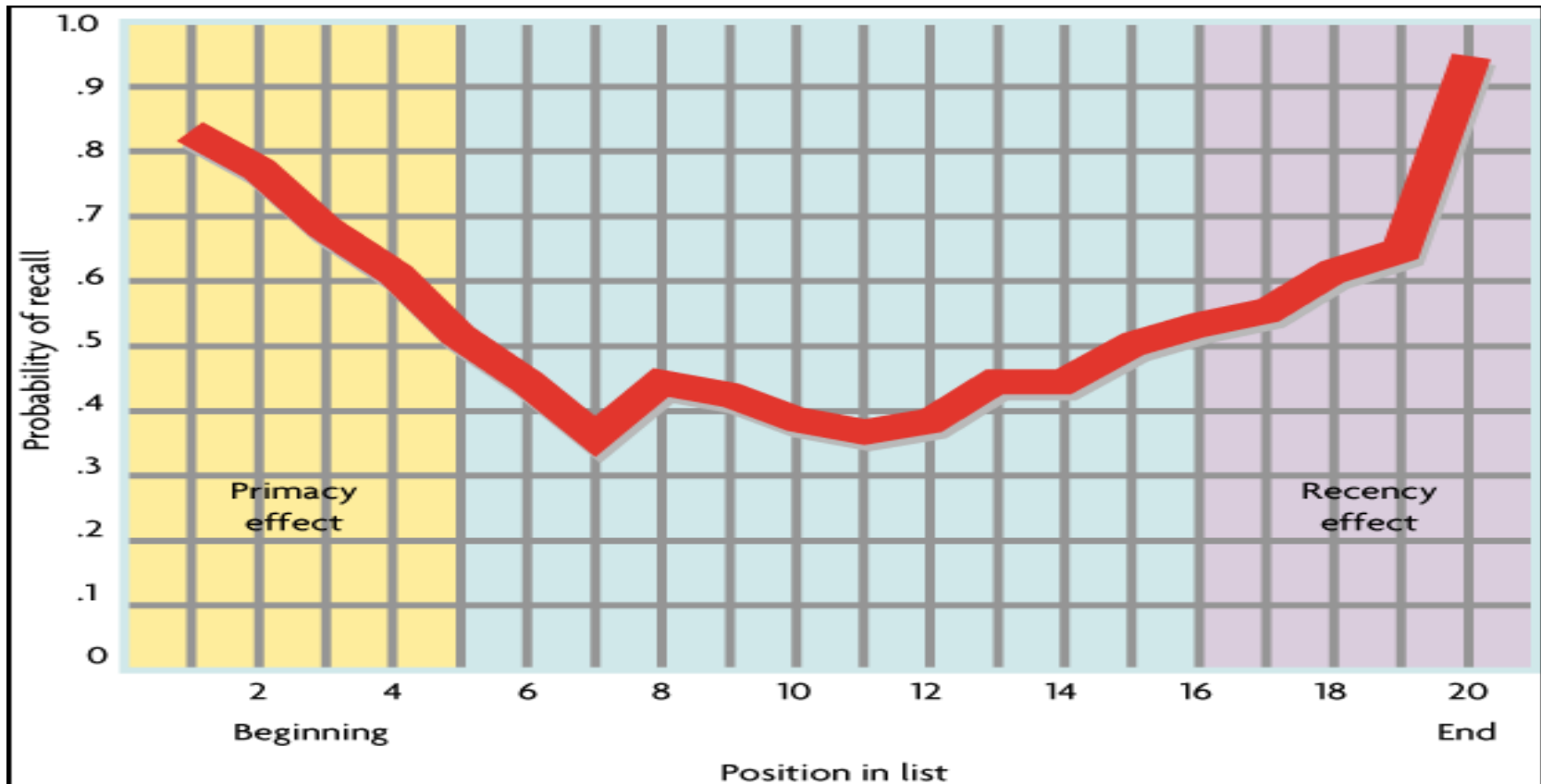


Image created by Rob Winningham

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Summarizing: Motor learning

Feedback: frequency, mode, bandwidth, source, and focus

Practice: structure, repetitions, variability, specificity

Success: Error frequency, consequences, overload

Transfer: Specificity, near/far migration of learning

Retention: Delay, familiarity, consolidation, spaced retrieval

Up Next

- Next, we will discuss ***Creating or Restoring Procedural Memories***