Learning & Conditioning

PSYC 423/523 – Research in Aging

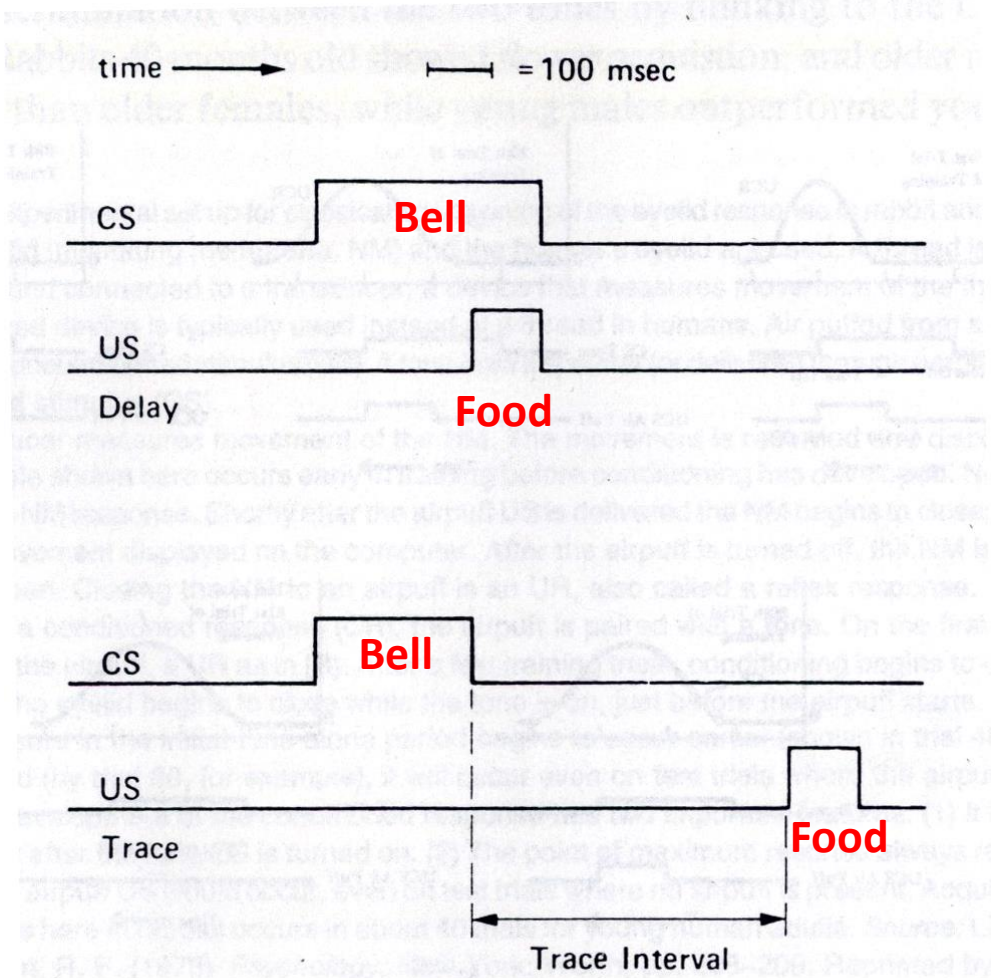
Classical Conditioning

- One of the most basic forms of learning
- A process that establishes an association between a reflexive response and a neutral (arbitrary) stimulus
- Initial conditions:
  Food → Salivation
  Identify an existing or innate **UCS** → **UCR** pairing
- Conditioning process:
  Bell
  Repeatedly present the neutral stimulus (**CS**) concurrently with the **UCS**
- Conditioning outcome:
  Eventually the **CS** will elicit the targeted response in the absence of the **UCS**

Bell → Salivation

UCS = Unconditioned Stimulus **UCR** = Unconditioned Response **CS** = Conditioned Stimulus

Variations of the Classical Conditioning Paradigm

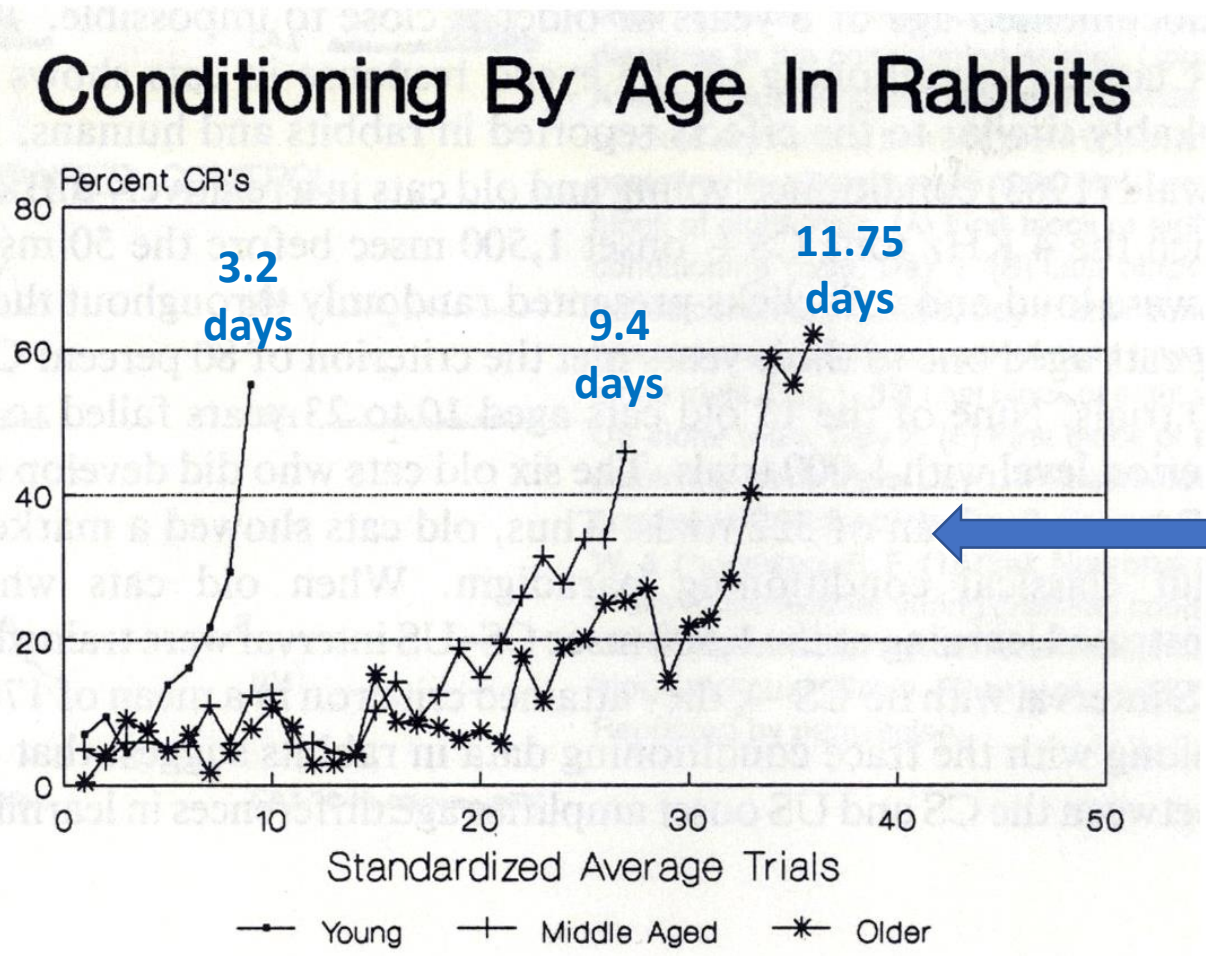


Delay Paradigm:

Onset of CS precedes and overlaps UCS
(Most efficient procedure)

Trace Paradigm:

CS precedes UCS
CS terminates before UCS
(Efficiency drops with longer trace intervals)



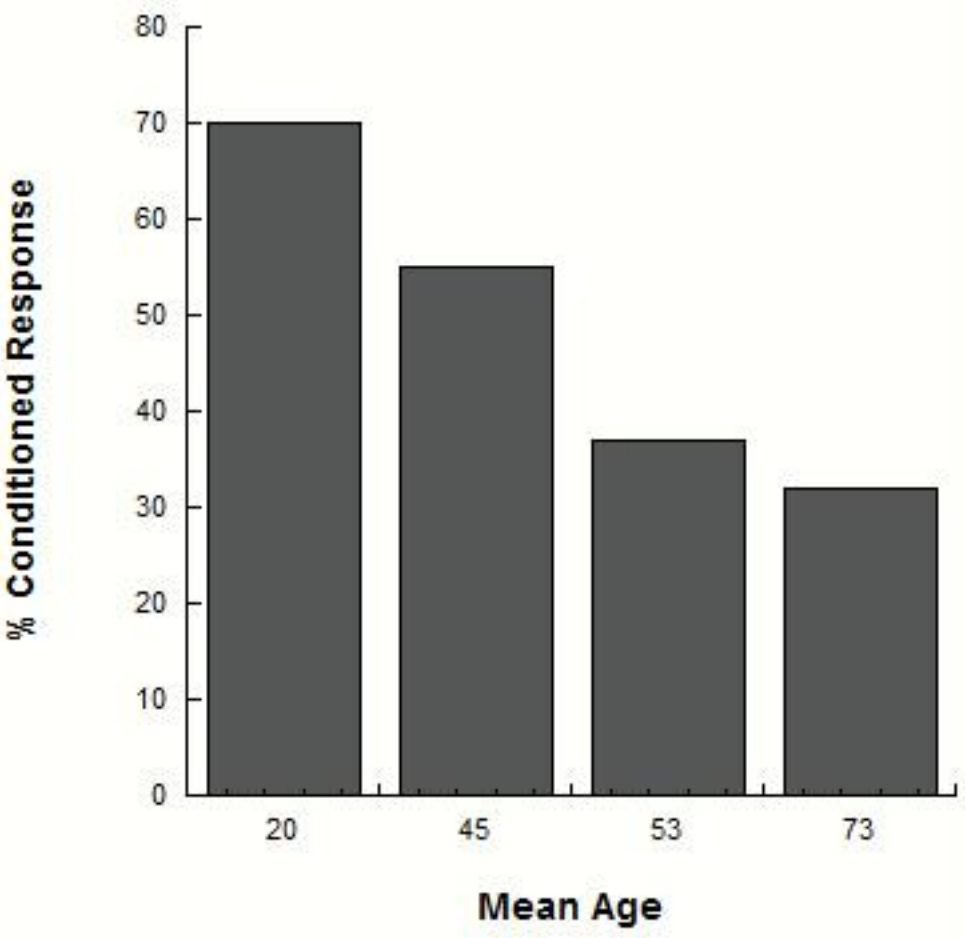
"Eyelid" conditioning; 500 msec trace interval
126 conditioning trials per day
[Woodruf-Pak et al., 1987]

Almost all research regarding classical conditioning and aging relies upon animal models

Older mammals (cat, rats, rabbits) demonstrate very poor acquisition using the trace paradigm

Older mammals can be classically conditioned using the delay paradigm … but acquisition of the conditioned response requires many more trials

Classical Conditioning in Older Human Adults



Woodruff-Pak & Thompson (1986)

UCS → UCR = Corneal Air Puff → Eye Blink

CS = Tone; Delay Paradigm

108 trials; CS-only prompt every 9th trial

Significantly weaker acquisition

Reductions in conditioning efficacy begin in middle-age

Some studies also reveal **less resistance to extinction** following initial acquisition

Speculation:

Older adults less susceptible to phobia

(Consistent with classical conditioning models)

Instrumental Conditioning

- Instrumental conditioning refers to the modification of voluntary behavior via its environmental consequences **[Thordike's Law of Effect]**
- Reinforcements are environmental stimuli that increase the probability that the associated behavior will be emitted in the future
- Punishments are environmental stimuli that decrease the probability that the associated behavior will be emitted in the future
- Efficiency of instrumental learning is usually reported in terms of acquisition rate
- Strength of instrumental learning is related to its rate of extinction

Effects of Aging upon Instrumental Conditioning

- **Acquisition rates are moderately slower**
- **Extinction rates tend to be comparable to young**

Special Factors Modulating Instrumental Learning:
(1) Reductions in the general **base rate of behavior**
(2) **Response perseveration** (Behavioral Rigidity)

The Behavioral Base Rate Problem

- **Behaviors must occur before they can be shaped** via instrumental conditioning measures
- The more behaviors emitted per unit time, the more opportunity there is to implement schedules of reinforcement
- The fewer behaviors emitted per unit time, the less opportunity to exert instrumental controls
- The number of behaviors emitted per unit time is known as the **behavioral base rate**

The Behavioral Base Rate Problem

- For a variety of reasons, the **behavioral base rate is significantly reduced in older organisms** – including humans
  [general behavioral slowing; cautiousness; etc.]

- As a result, older adults experience fewer opportunities to be rewarded (or punished) in a given period of time

- Much of the age-related **decrease in the acquisition rate** for instrumental learning appears to be due to such lost opportunities

Modified Schedules of Reinforcement
(Designed to Offset the Base Rate Problem)

- One simple schedule of reinforcement is to reward "correct" responses and withhold reward for incorrect responses
- **Leech & Witte (1971)** set up a learning experiment where young and older participants could make 3 types of responses:
  (1) correct response, (2) commission error; (3) omission error
- They modified the schedule of reinforcement in an unusual way in order to increase the base rate of responding among the older folks

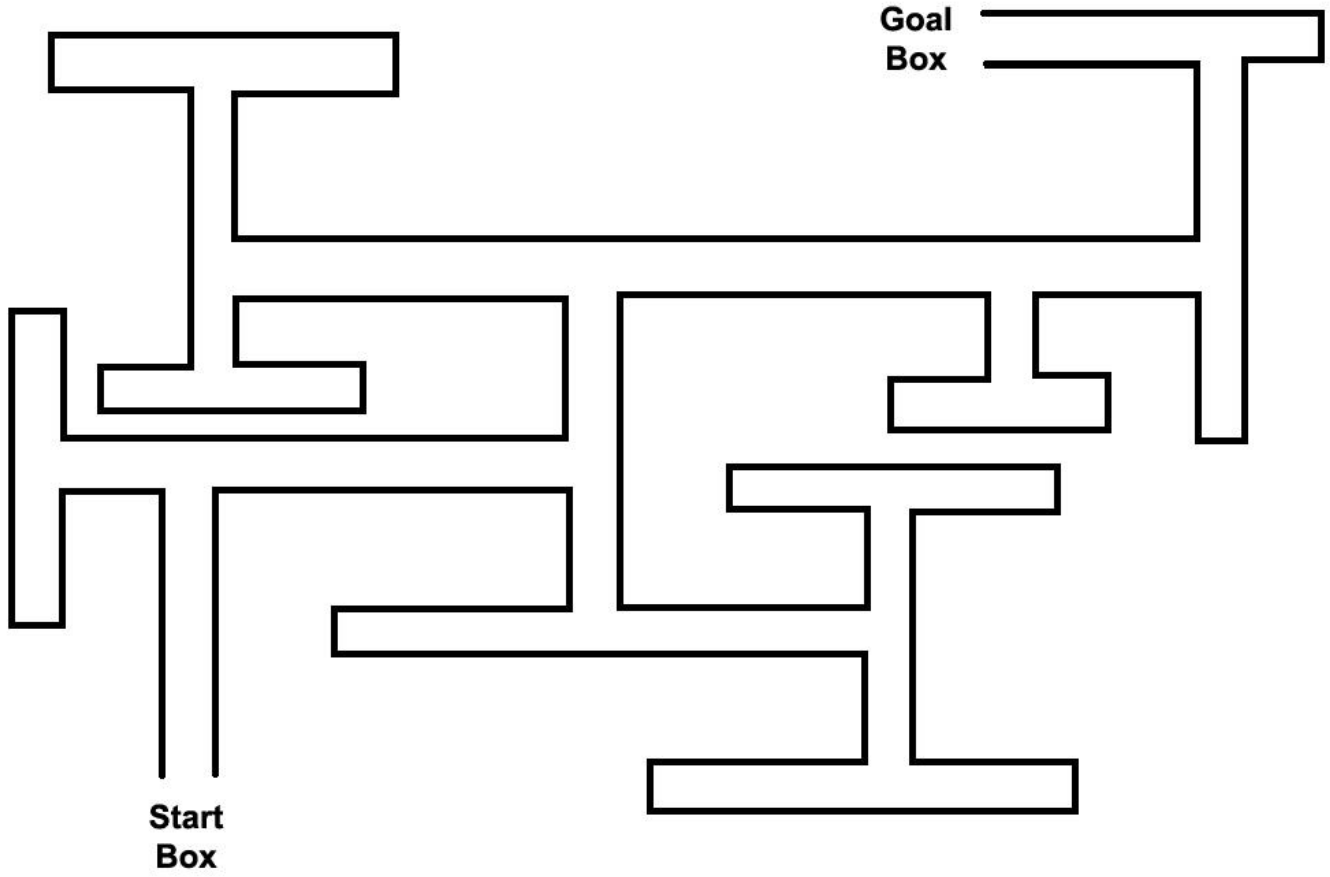
Schedule of Reinforcement

Response Type	Reward Value	
correct	1	
commission error	1/3	[This is the "unusual" manipulation]
omission error	0	

- Results: **Old group increased their overall rate of responding and paradoxically demonstrated faster acquisition**

An Interesting Demonstration of Response Perseveration (in Older Rats)

(Goodrick, 1968)

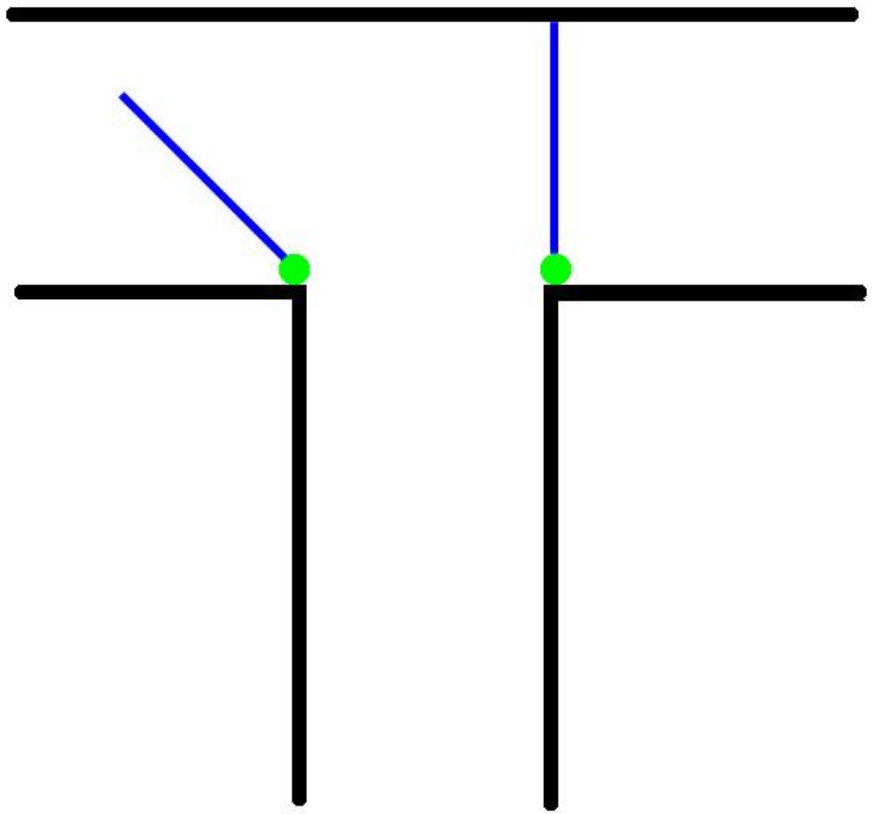


Older rats have a strong tendency to **perseverate previous behaviors** during maze learning

This type of behavioral "inertia" is called **response rigidity** in the gerontological literature

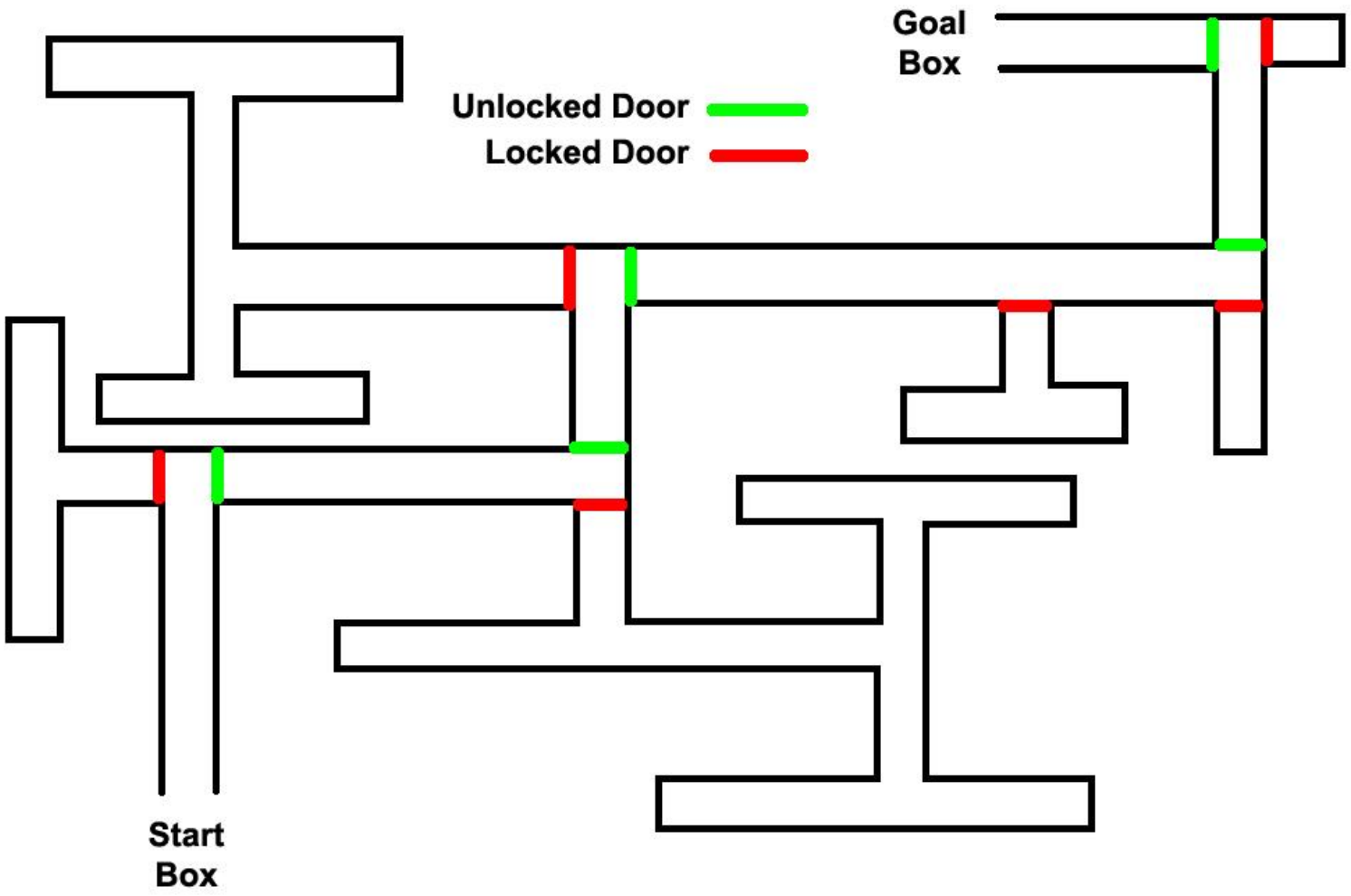
Goodrick (1968) devised an intriguing study designed to translate age-related increases in response rigidity into an advantage

Young and old rats learned to find the goal box in a **special multiple T-maze** designed to manipulate their experience on the initial maze learning trial.



Each choice-point in the T-Maze was fitted with special spring-loaded doors that could be locked or unlocked by the experimenter

First trial conditions



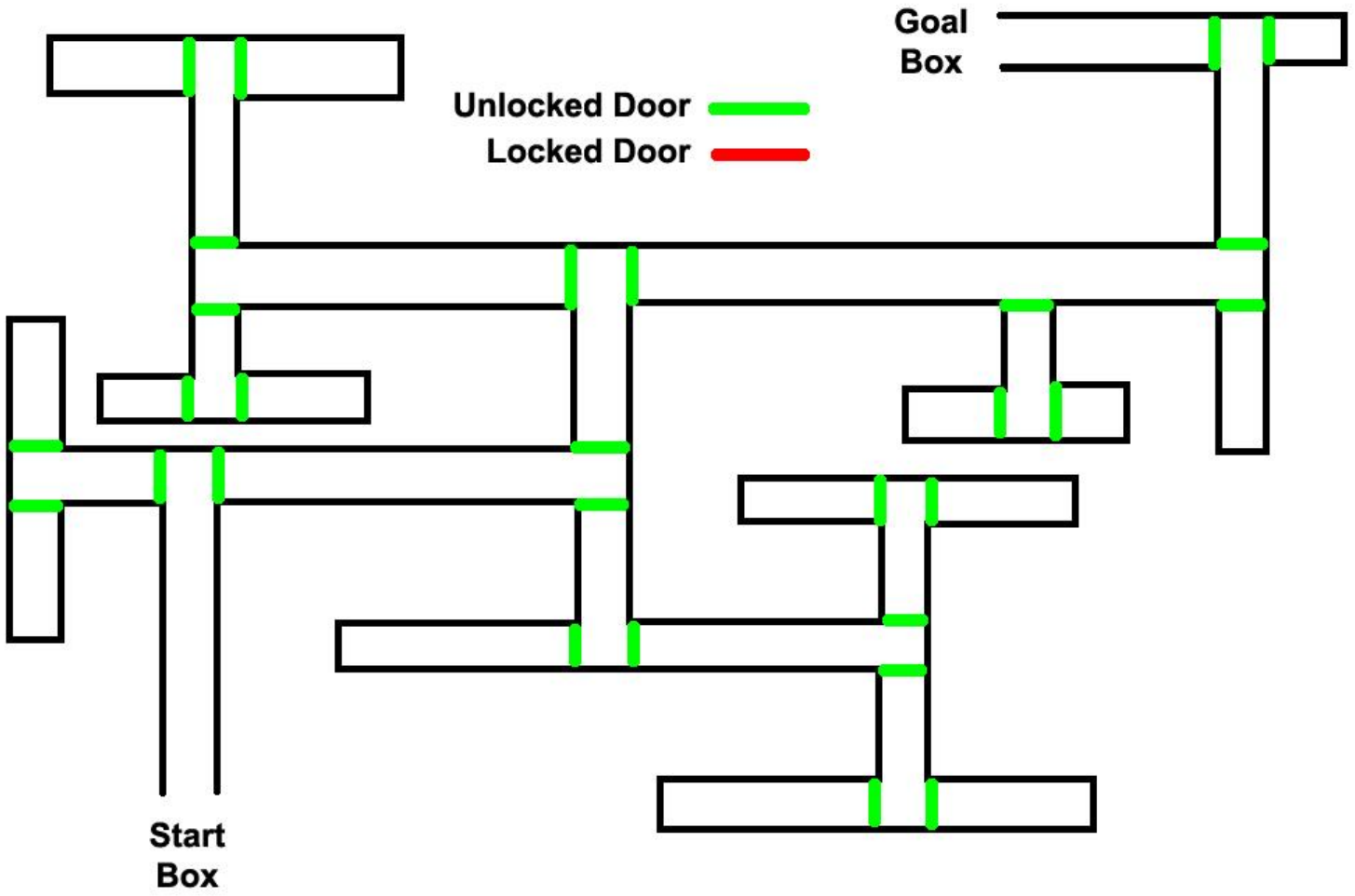
On the first trial through the T-Maze, all of the doors associated with a wrong turn (i.e., an error) were locked

All of the doors associated with a correct turn were unlocked

Hence, the special conditions in place for the first trial eliminated the possibility of errors and allowed only correct turning behaviors while traversing the maze

HYPOTHESIS:
When all the doors were then unlocked for subsequent maze learning trials, the older rats would learn the maze faster due to perseveration of their behavior from trial #1.

Trials 2 through N…



After the first run through the maze, all of the doors were unlocked….and the number of trials necessary to learn the maze to criterion (no errors) was determined.

Older rats outperformed the young rats

Response perseveration from the first run through the maze carried-over to influence subsequent performance

When the same experiment is conducted without the special conditions seen on the initial trial, older rats take many more trials to learn the maze

Inference and speculation:
If such response perseveration (or, rigidity) generalizes to older humans, then "trial and error" learning techniques would be counter-indicated.

Does Response Rigidity characterize behavior in Older Humans?

While the use of T-Mazes is probably not appropriate for human studies, evidence from several learning and problem solving domains has accrued to support the Response Rigidity hypothesis

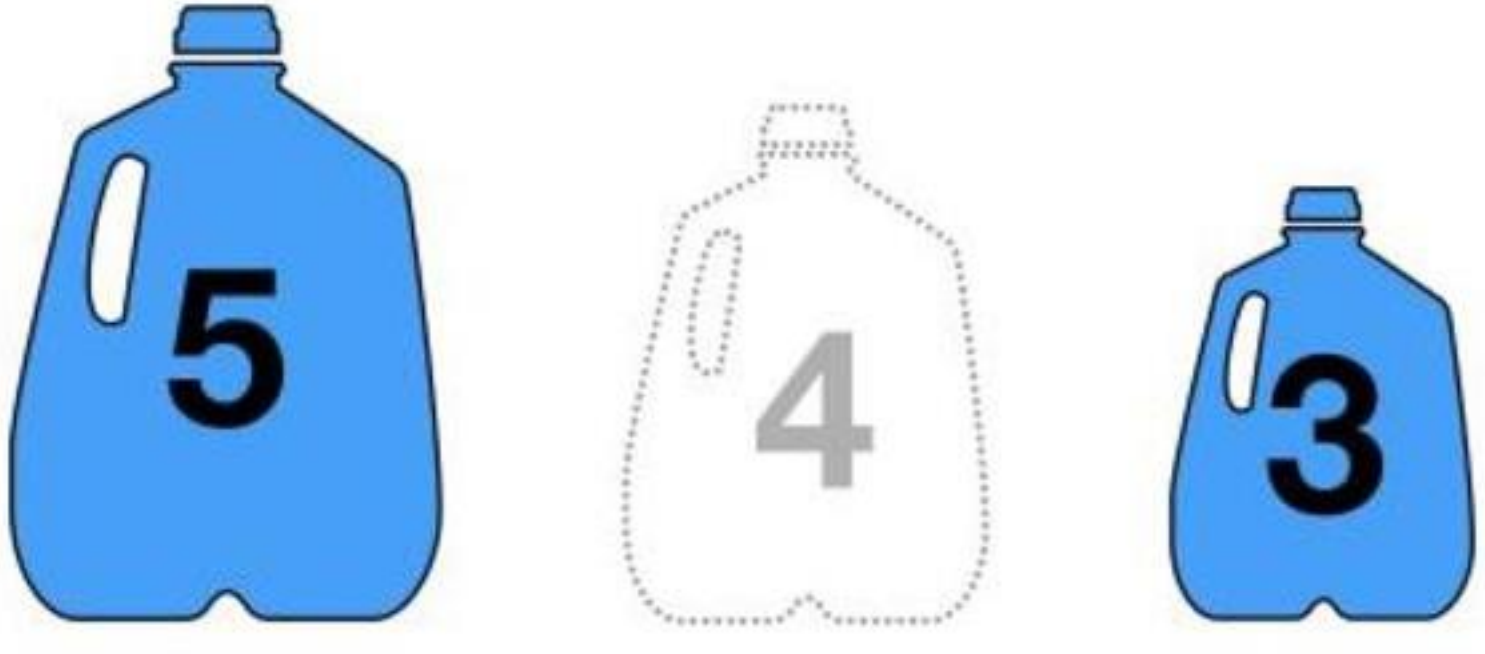
We will exam some findings from Heglin's Water Jug Problem Experiment…

But…..What is a Water Jug Problem ???

Let's explore a difficult Water Jug Problem encountered in a famous Hollywood film… https://www.youtube.com/watch?v=6cAbgAaEOVE

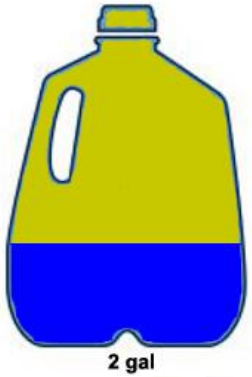
The "Die Hard 2" Water Jug Problem

Given a 5 gallon jug, a 3 gallon jug and an unlimited supply of water, measure out exactly 4 gallons of water

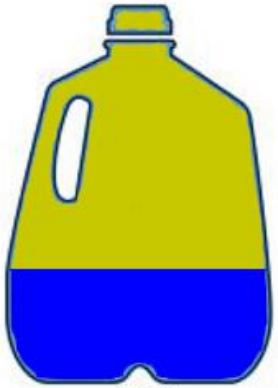


Die Hard Water Jug Problem "Solution"

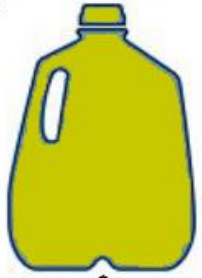
Fill 5 gal jug using external water source

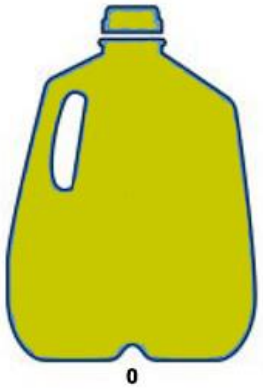


Fill 3 gal jug using contents of 5 gal jug



Empty contents of 3 gal jug

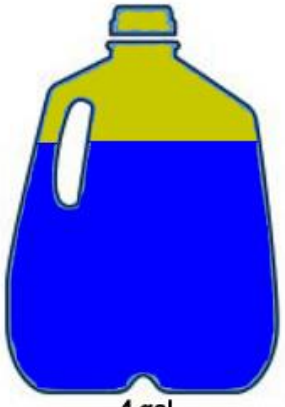




Transfer contents of 5 gal jug to 3 gal jug

Fill 5 gal jug from external water source

Q.E.D



Top-off 3 gal jug using contents of 5 gal jug

Response Rigidity in Older Adults
(Cognitive "Set" or "Inertia")

Numerous studies have demonstrated that older problem solvers (learners) are much less flexible with regard to changing cognitive strategies….Consider the case of Heglin's Water Jug Problem experiment:

Problem N:

Given: 3 water jugs (A=21, B=127, C=3 quarts)
Measure out: exactly 100 quarts
Solution: B – A – 2C (i.e., 127 – 21 – 3 – 3)

Problem N+1:

Given: (A=23, B=49, C=3 quarts)
Measure out: exactly 20 quarts

Older adults were much more likely to perseverate the solution from the previous problem (B – A – 2C) despite the obvious and more efficient solution given by (A – C) (i.e., 23-3=20)

Verbal Learning

- Verbal learning is the process of acquiring associations between verbal stimuli (e.g., words, numbers, CVC trigrams)

- Most studies of human learning processes have employed verbal stimulus materials

Age-Differences in Verbal Learning

- It has been conclusively demonstrated that as people get older their performance on verbal learning tasks becomes deficient
- However, the magnitude of these age-related deficits in learning performance is very situation specific
- Much of the classical work on aging and learning has focused upon understanding the nature of these situation-specific factors that modulate the magnitude of age-related declines

Some Factors that Modulate Age-Differences in Learning Performance

- **“Pacing” Effects**
  (Stimulus presentation speed and time available to make a response)
- **Over-Arousal** during experimental evaluations
  (Situational anxiety)
- **Stimulus meaningfulness** for older learners

Stimulus Pacing Effects

Pacing Effects

- Canestrari compiled evidence that the external pacing of stimulus presentations might not give older people sufficient time to response in typical assessment situations
- Their upper limit on performance was constrained by response speed instead of actual learning
- Evidence included:
  universal slowing in reaction time
  increased proportion of errors of omission [commission vs. omission errors]
- Canestrari devised a classic **paired-associates learning protocol** that could be used to assess the effects of pacing on age differences in verbal learning performance

We'll need to review the nature of the paired-associates procedure first…

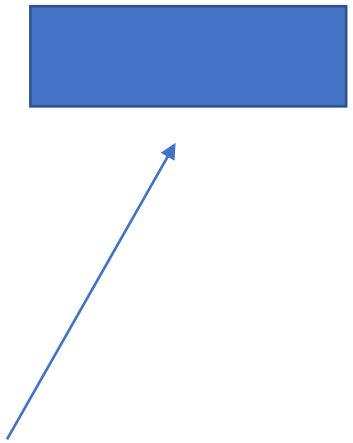
Paired-Associates Procedure

List of Paired-Associates to be learned:

MOOSE	LASER
OFFICE	FRAME
PHONE	LICENSE
CLINIC	EDITOR
METER	CHART
Etc., etc.., etc.	

Response Interval:

MOOSE



What word is associated with “moose”?

Study Interval:

MOOSE LASER

Opportunity to “refresh” or strengthen the association between stimulus pair prior to next trial

Response Interval:

OFFICE 

Study Interval:

OFFICE FRAME

Response Interval:

PHONE 

Study Interval:

PHONE LICENSE

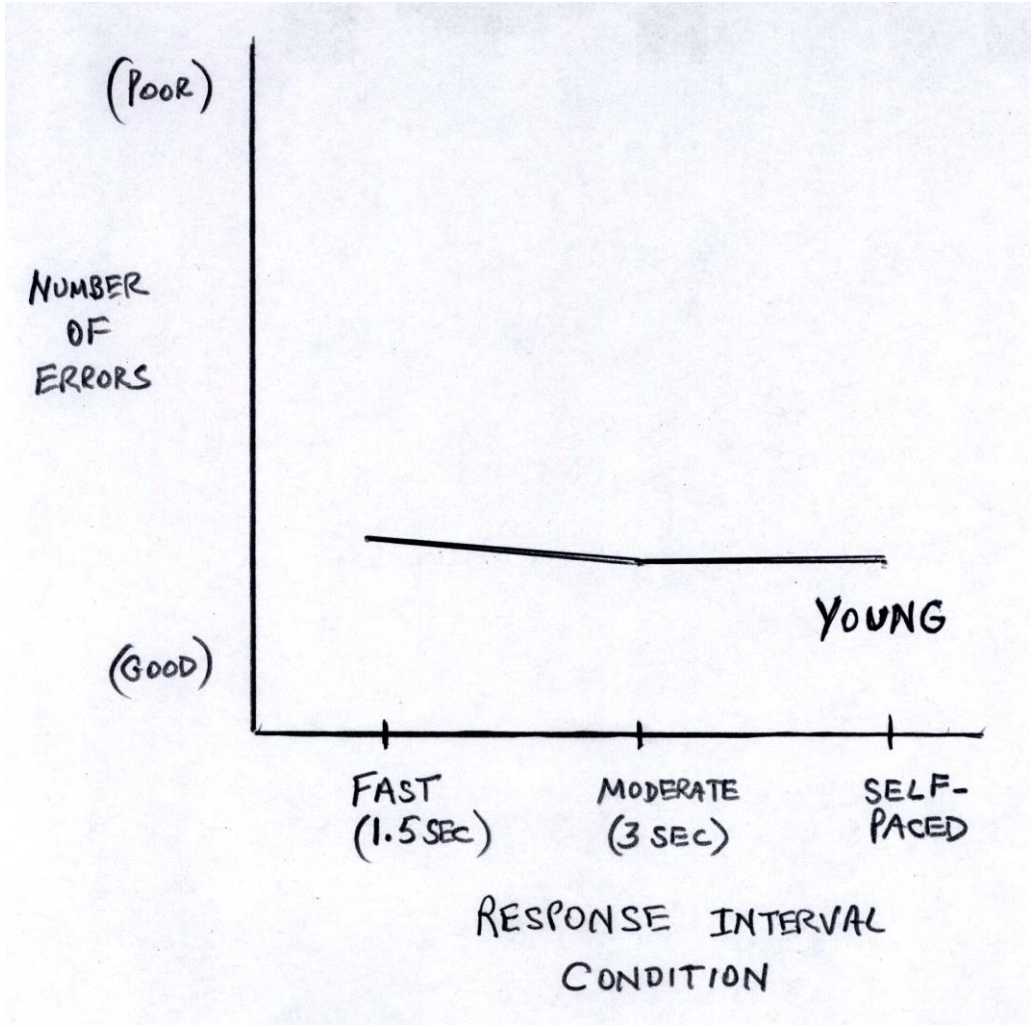
Stimulus Pacing and Paired-Associates Learning

(Canestrari Experiment)

- Young vs. Old group
- List of 16 paired-associates stimuli
- Study interval held constant at 3 sec
- **Response interval varied experimentally:**
  - **1.5 sec (fast)**
  - **3.0 sec (typical)**
  - **self-paced**
- What happens to the magnitude of age-related declines in learning performance as a function of variations in the response interval?

Stimulus Pacing and Paired-Associates Learning

(Canestrari Experiment)



Variations in the response interval did not affect the learning performance of the young participants

Stimulus pacing effects were not setting limits on the learning performance of the young group

Stimulus Pacing and Paired-Associates Learning

(Canestrari Experiment)

Experimental manipulation of the response interval had a **profound effect for the old participants**

The older group made significantly more errors in the fast (1.5 sec) condition (especially errors of omission)

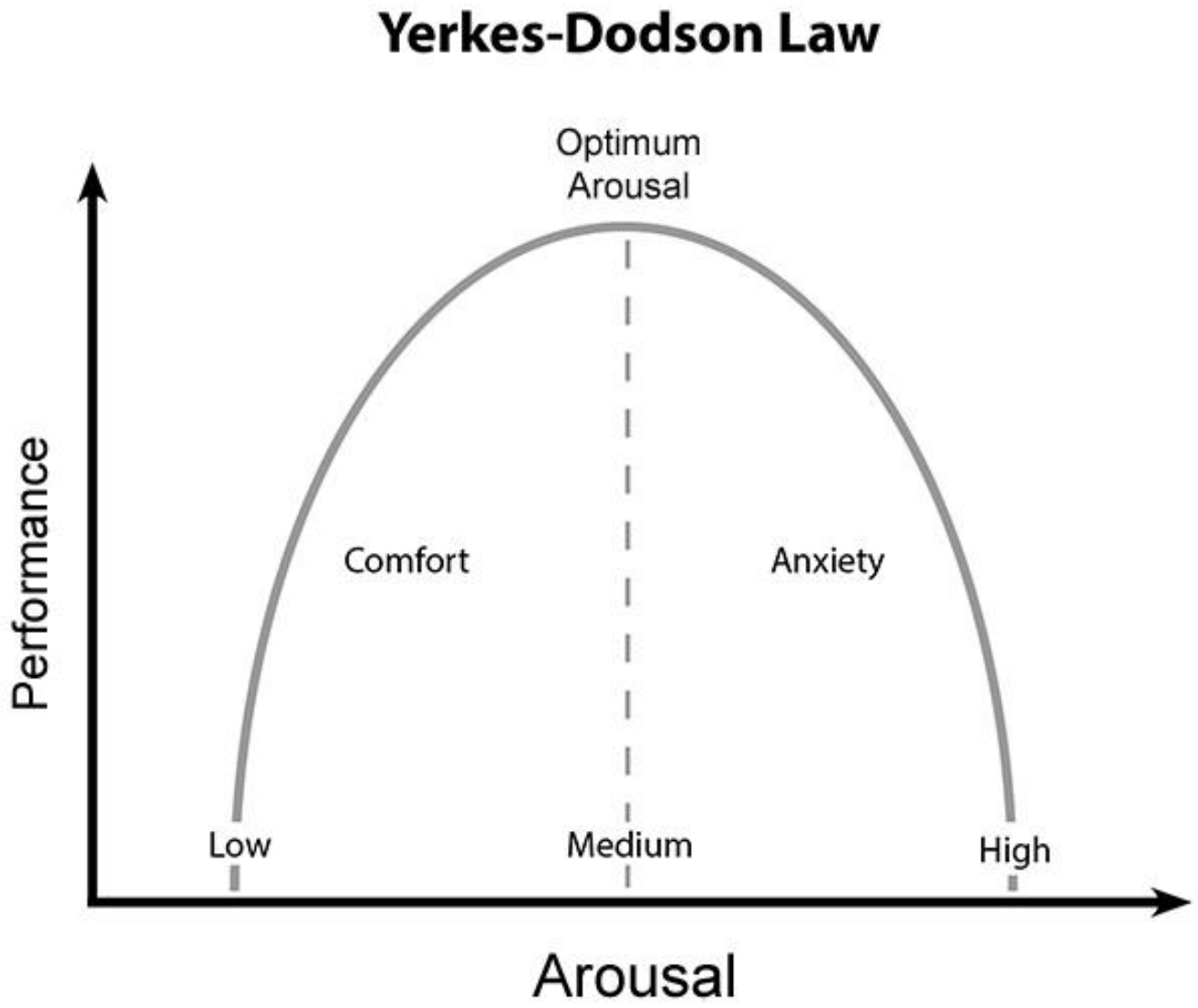
The age decrement in performance became quite small in the self-paced condition

The mean response latency in the self-paced condition did not differ from that observed in the 3 sec condition….**Suggesting some fundamental difference between externally paced vs internally paced cognitive processes.**

Under-Arousal versus Over-Arousal

Mediators of Learning Performance

Performance as a function of Physiological Arousal



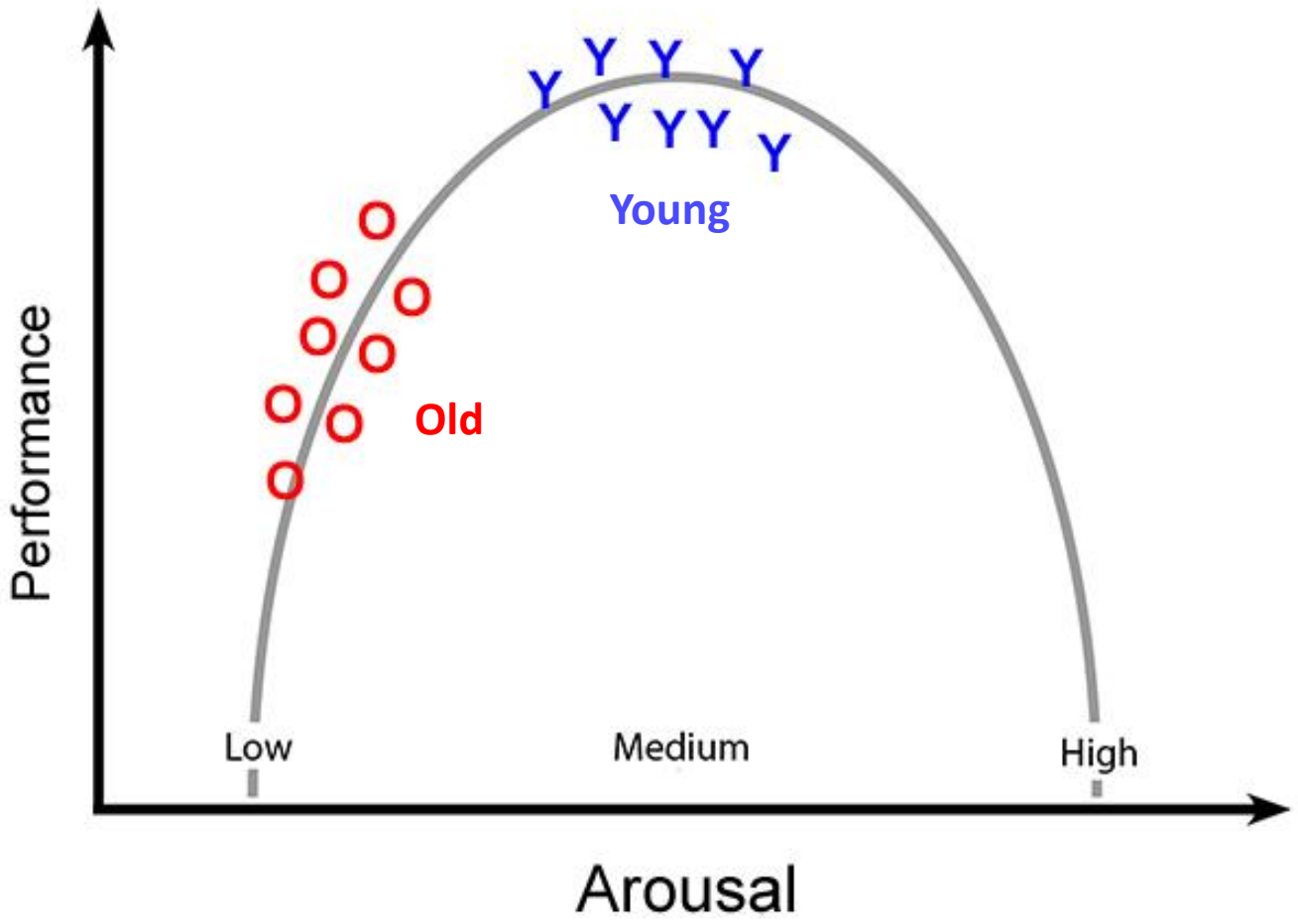
Arousal is a psychological construct used to capture physiological activation and related processes such as motivation

If arousal is too low, performance suffers (i.e., under motivation; boredom; fatigue)

If arousal is too high, performance suffers (e.g., test anxiety)

Performance is optimal at the "sweet spot" ("Goldilocks Effect")

Aging and the Under-Arousal Assumption



Historically, researchers assumed that compared to young college students….

Older participants in laboratory studies were less motivated to achieve high performance scores

Less motivation means less arousal

and…

Lower arousal contributes to sub-optimal performance

Over-Arousal Hypothesis of Aging
(Eisdorfer et al.)

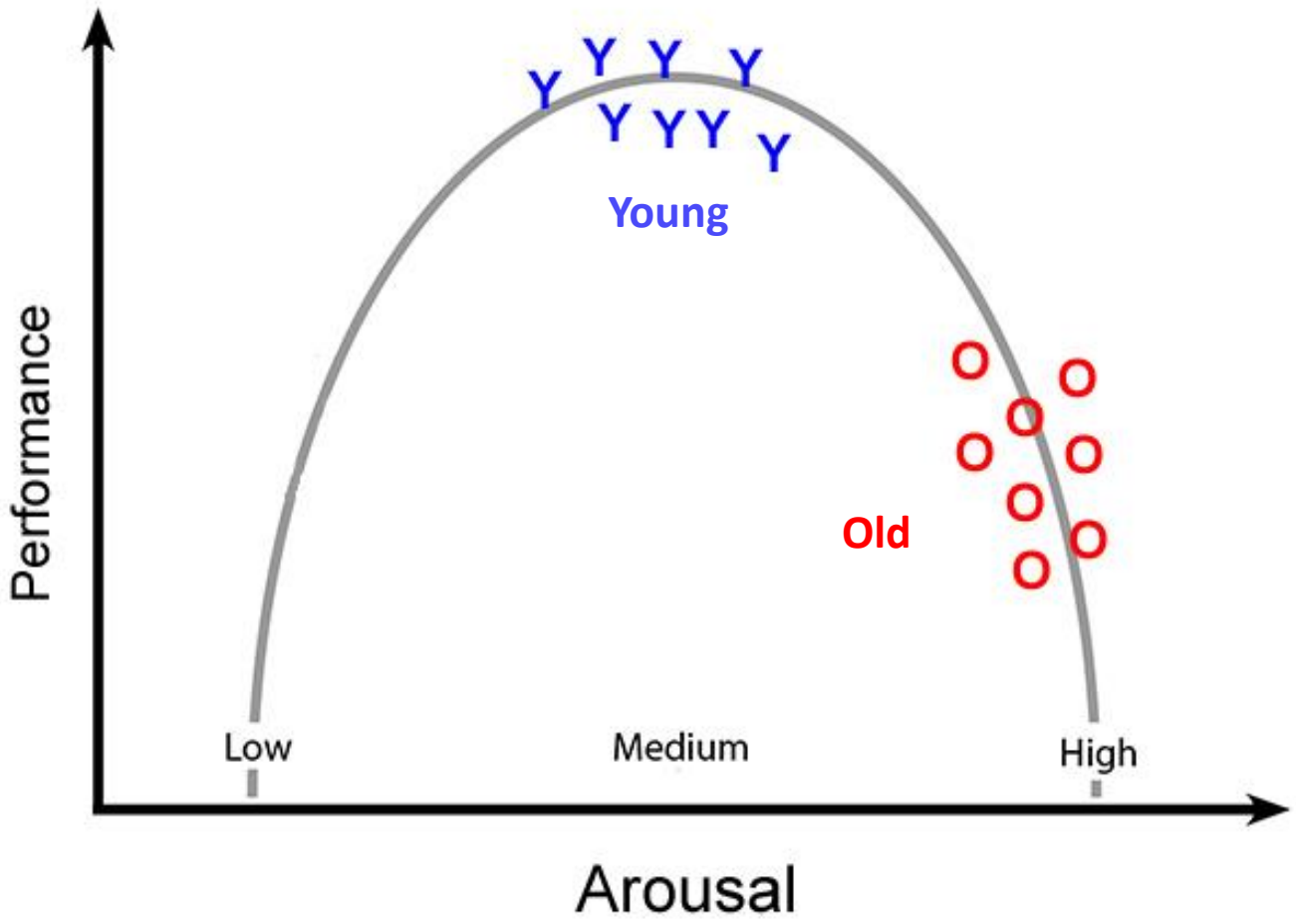
- Carl Eisdorfer (Duke University) and his associates described many characteristics of age-related performance in learning studies that suggested that older participants were over aroused in the laboratory rather than under aroused

  e.g., many omission errors; anxiety; etc.

- Eisdorfer conducted several "classic" experiments designed to demonstrate and manipulate the effects of over-arousal upon age-differences in learning performance

Age, Learning Performance and Physiological Arousal

(Eisdorfer Experiment I)



Measures of physiological arousal were collected during participation in a serial learning task

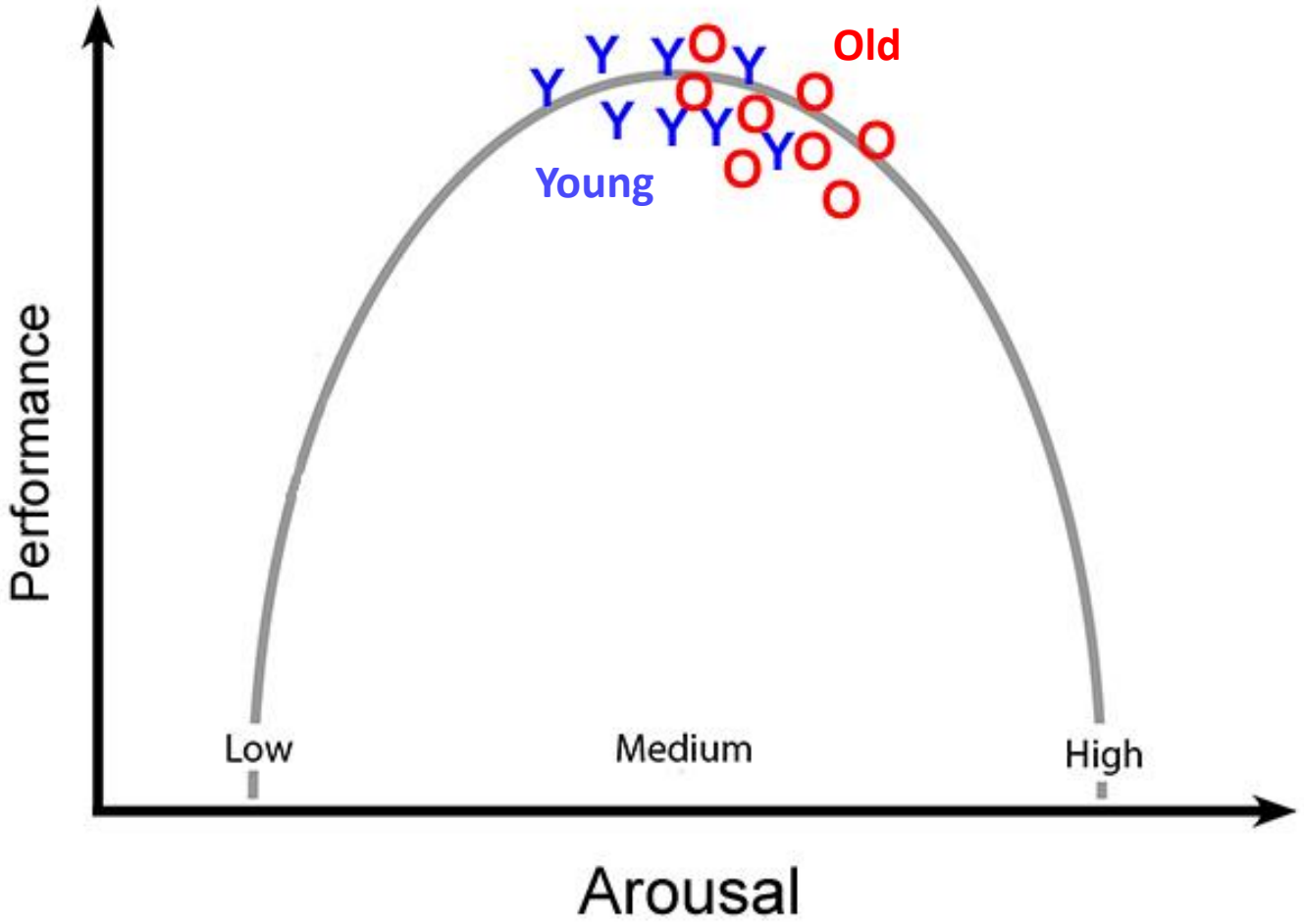
As predicted, **high levels of physiological arousal were strongly associated with both increased age and decreased performance**

Findings were consistent with the over-arousal hypothesis

In a clever follow-up study, Eisdorfer was able to strengthen the case for the over-arousal hypothesis via direct experimental manipulation (rather than mere correlational evidence)

Reducing Physiological Arousal Moderates Age-Related Learning Decrements

(Eisdorfer Experiment II)



Older participants demonstrated excessive physiological arousal in experiment #1

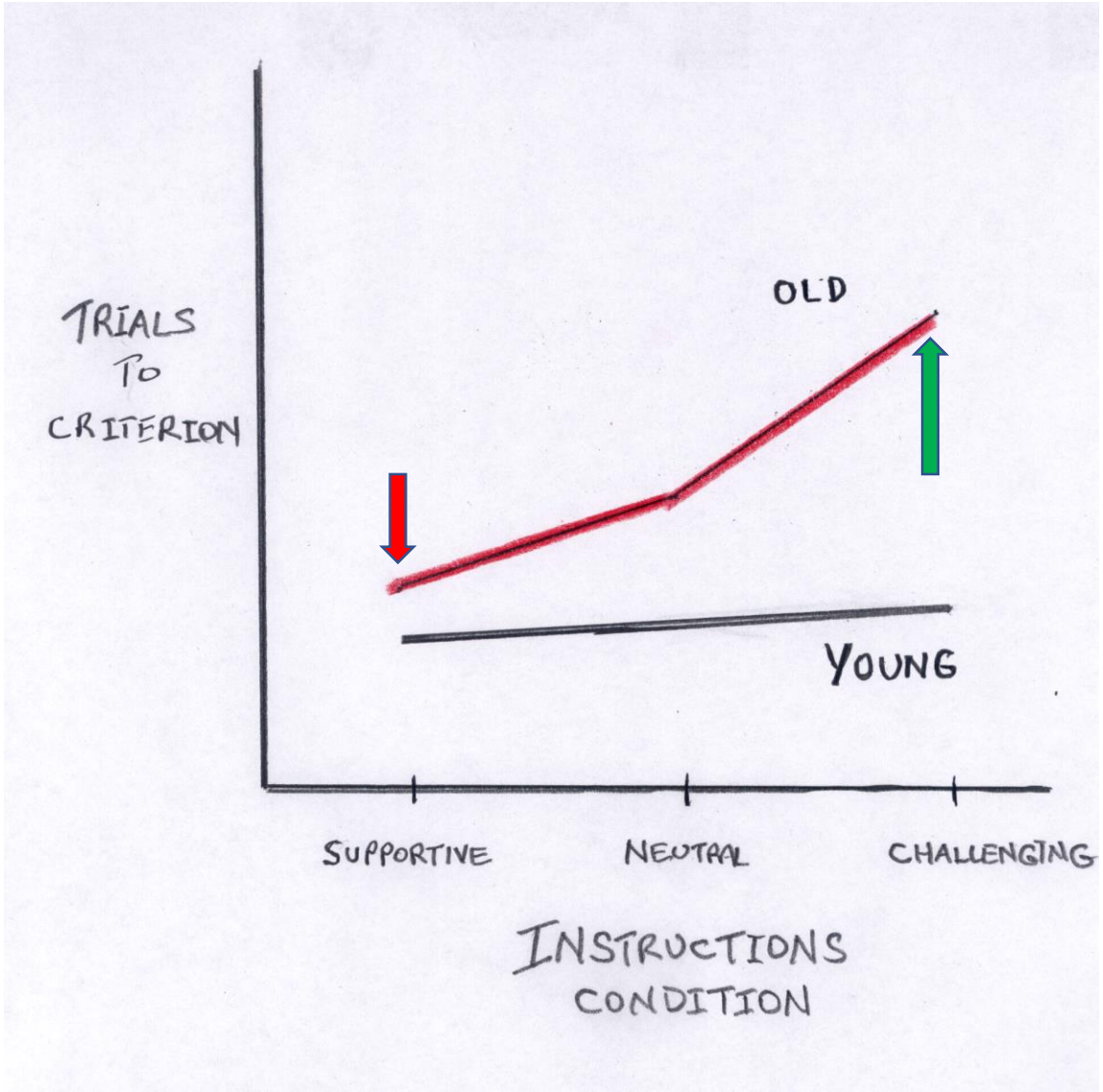
Excessive arousal was highly correlated with poor learning performance

Physiological arousal in older adults was experimentally attenuated using medication (propranolol; β-adrenergic blocker)

Experimental manipulation mitigated the physiologically over-arousal in the older adults and simultaneously eliminated much of the decrement in learning performance

Ross' Confirmation of the Over-Arousal Hypothesis

(Mitigating Over-Arousal through Situational "Calming")



Administering prescription drugs to mitigate over arousal might be appropriate for a laboratory study. However, it is neither safe nor practical for everyday applications.

Ross attempted to modulate age-differences in learning performance by using specially prepared experimental instructions designed to either increase or decrease sympathetic arousal

EXPERIMENTAL INSTRUCTION TYPES:

Supportive (reduce over-arousal)
Neutral (typical instructions)
Challenging (exacerbate over-arousal)

As predicted, instructions designed to decrease arousal reduced the size of the age-difference while instructions designed to aggravate over-arousal served to increase the age-difference in learning performance

Stimulus Meaningfulness

Stimulus Meaningfulness is Cohort-specific

(Barrett & Wright)

- It is well known that highly "meaningful" stimuli can be learned more quickly
- Barrett & Wright noticed that many studies of age-differences in learning tended to use verbal stimuli more commonly spoken by younger cohorts (i.e., stimuli more familiar to the young cohort)
- They devised a study to assess the potential impact of such age-by-cohort confounds
- In addition to comparing young vs. older participants…..they also compared the effects of using **"young" vs. "old" stimulus words**

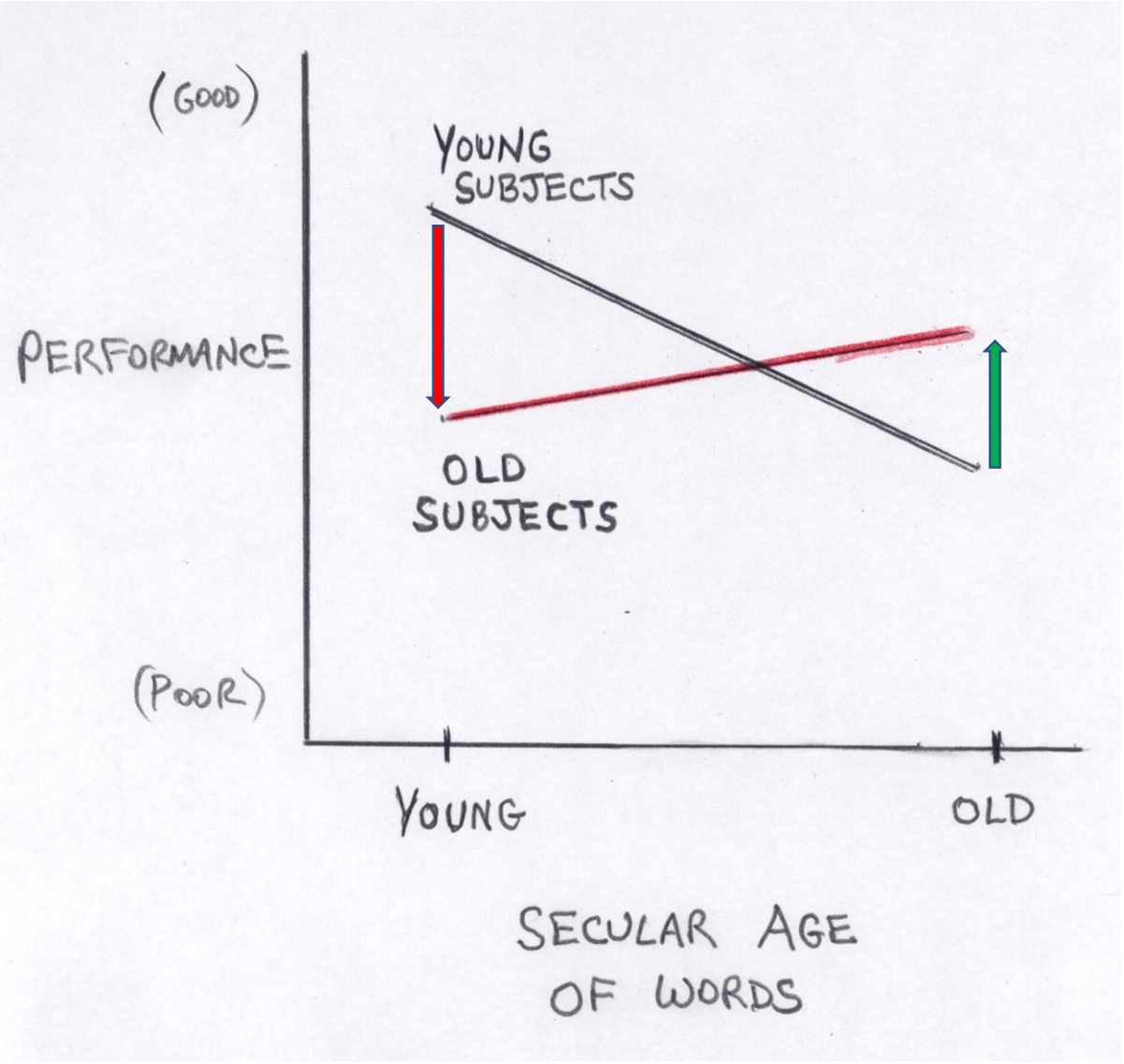
Table 17.3 The young and old word lists

Young List	*Old List*
afro	drugget
tweeter	poultice
bummer	gooseberry
ripoff	phaeton
gig	slate
spa	slacker
freon	crony
sunspot	counterpin
turntable	panteloons
terrarium	pompadour
denim	flitters
disco	settee
synthesizer	fedora
dude	petticoat
foreplay	blotter
cassette	parasol
communes	bungalow
narc	teacakes
readout	flivver
decoupage	gramophone
reefer	davenport
stereo	hollyhock
calculator	flapper
bellbottom	bolster
gauchos	bloomers
pinball	doily
frisbee	victrola
orgy	vamp

Source: Barrett & Wright, 1981, pp. 194–99. Reprinted by permission of the *Journal of Gerontology*, 36, pages 194–199, 1981.

Stimulus Meaningfulness is Cohort-specific

(Barrett & Wright)



Young participants demonstrated superior learning performance when contemporary stimuli for their birth-cohort were used.

Remarkably,
The **typical pattern of age-related decline in learning performance was reversed when stimuli more familiar (and more meaningful) for the older birth-cohort were employed.**

Mitigating Age-Related Declines in Learning and Memory

(Some parting comments)

- Many studies have shown the older adults with mild cognitive impairment can be trained to improve their learning and memory performance

  e.g., visual imagery; mnemonic devices (HOMES = Great Lakes);
  Method of Loci; narrative story construction, etc.

- **Universal problem**….People find these techniques to be too effortful and do not spontaneously use their training in daily life

- However, older learners benefit immensely from **Modeling** approaches
  e.g., observing other people solve problems or follow complex procedures, etc.

  Video sites such as **YouTube** may prove to be extremely effective in supporting the life-long learning needs of all of us as we grow older