Learning in a Digital World

Plenary Session

"Applications of Psychological Science to Learning Using Technology"

Victor A. Benassi

Learning in a Digital World
Washington, DC • September 13-16, 2014

Center for Excellence in Teaching and Learning

University of New Hampshire

Applications of Psychological Science to Learning Using Technology

http://www.unh.edu/teaching-excellence/resources/Multimedia%20learning.html

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American Psychological Association, 2014 Education Leadership Conference:
Learning in a Digital World, September 15, 2015

Acknowledgments

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- This work is also supported by the University of New Hampshire (UNH) Office of the Provost and Vice President for Academic Affairs.

- Special thanks to Catherine Overson for developing and designing the UNH-based research described in the presentation and to Elizabeth Tappin for her work on the assessment components of the projects. Thanks also to Lou Ann Griswold, Adam St. Jean, Michael Melville, Barbara White, Rosemary Caron, Charlie Putnam, and Trish Cox, teachers of and collaborators on the projects described in this presentation.

BDA

Before the Digital Age

(Circa 1954 – 1975)

B.F. Skinner's Teaching Machines

B.F. Skinner's Teaching Machines

https://www.youtube.com/watch?v=jTH3ob1IRFo

Educational Public Television: "Watch Mr. Wizard"

http://www.youtube.com/watch?v=Z1avfr6llzs

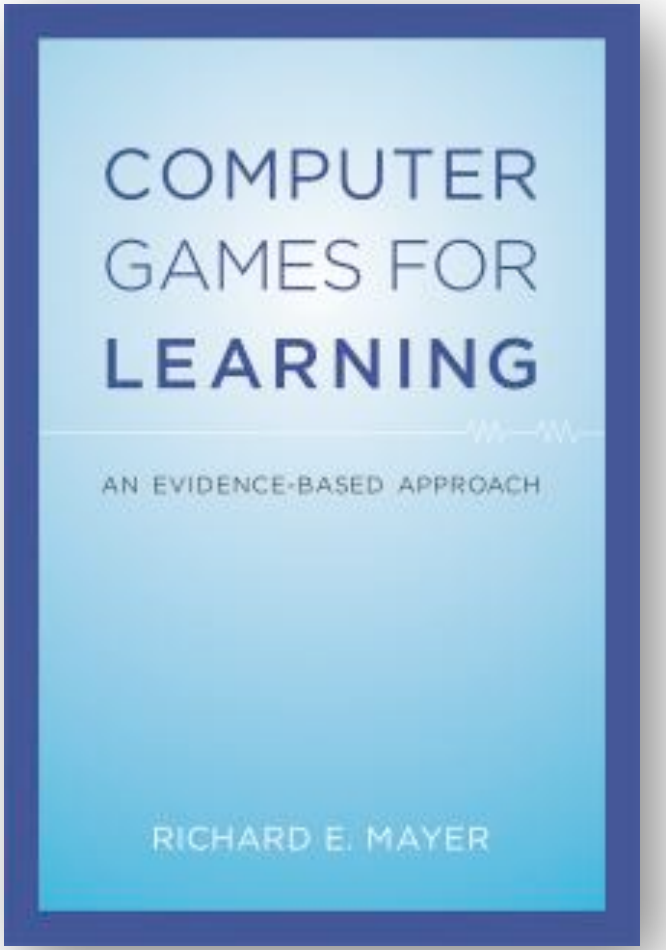
PLATO

https://www.youtube.com/watch?v=rf5_ivobNb4

DA

In the Digital Age

Computer Games:
Do they facilitate student learning?



Video: More and fancier video production does not necessarily facilitate learning

Firing Neurons | Cell Dance 2010, Public Outreach Video Winner

http://www.biotechniques.com/multimedia/videos/?pager.offset=48

Leonard Bosgraaf, Ph.D., Molecular Shots, Inc, of Groningen, The Netherlands, for "Firing Neurons," a movie created entirely by computer animation

What YouTube viewers say:

"Incredible Science Animation About Neurons!"

"What is name of the music please?"

" This video helped me in understanding how neurons communicate. Please make more. Very informative. Thank you."

Followed by:

"Wow, no f-----g kidding!

http://www.biotechniques.com/multimedia/videos/?artId=307463

45% of the video with violins, but no words.

Only images of neurons that do not inform.

http://www.youtube.com/watch?v=haNoq8UbSyc

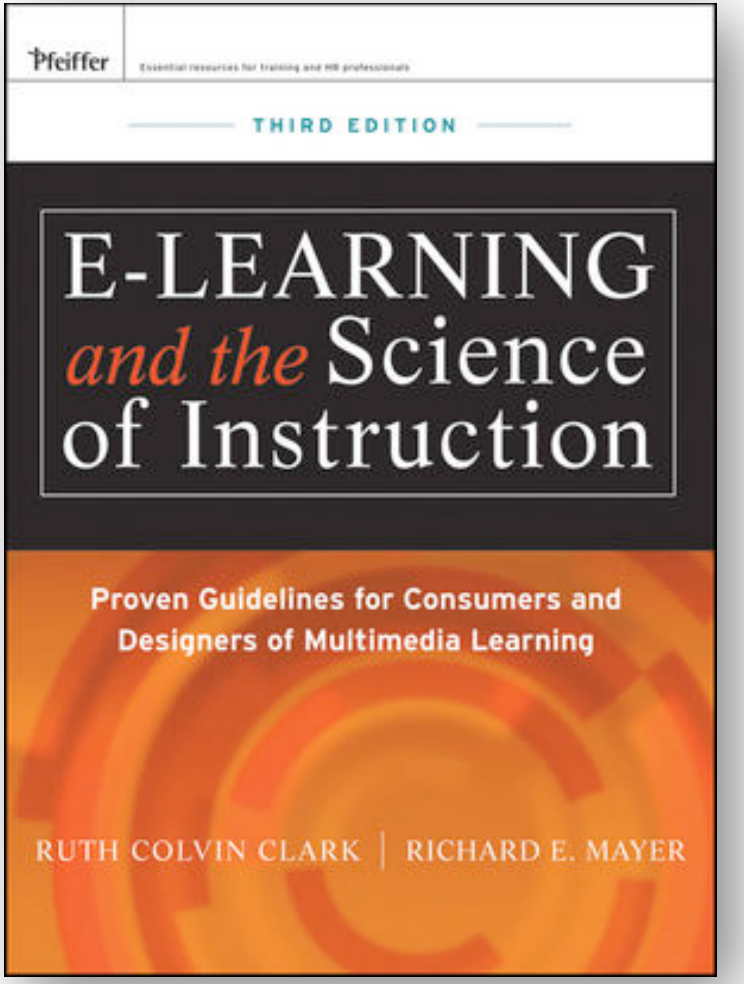
Contrast the previous with this. Not so cool, but effective?

http://www.youtube.com/watch?v=d648WiEchtQ

Carnegie Mellon University Open Learning Initiative

Ruth C. Clark and Richard E. Mayer (2011, 3rd edition)

e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning



Intelligent Tutoring Systems

Auto-Tutor (PI: Arthur Graesser, University of Memphis)

"AutoTutor is a computer tutor that helps students learn by holding a conversation in natural language. AutoTutor tracks the cognition and emotions of the student and responds in a manner that adapts to the student. AutoTutor has been developed to help students learn about physics and computer literacy. Emotions are recognized by the dialogue patterns, facial expressions, and body posture of the student."

http://www.memphis.edu/iis/projects/autotutor/

Cognitive Tutors

Another type of Intelligent tutor.

Development based on John Anderson's ACT-R theory.

http://ies.ed.gov/ncee/wwc/interventionreport.aspx?sid=87

The Power of Learning Analytics

Yesterday, Linda Baer called learning analytics "The Game Changer."

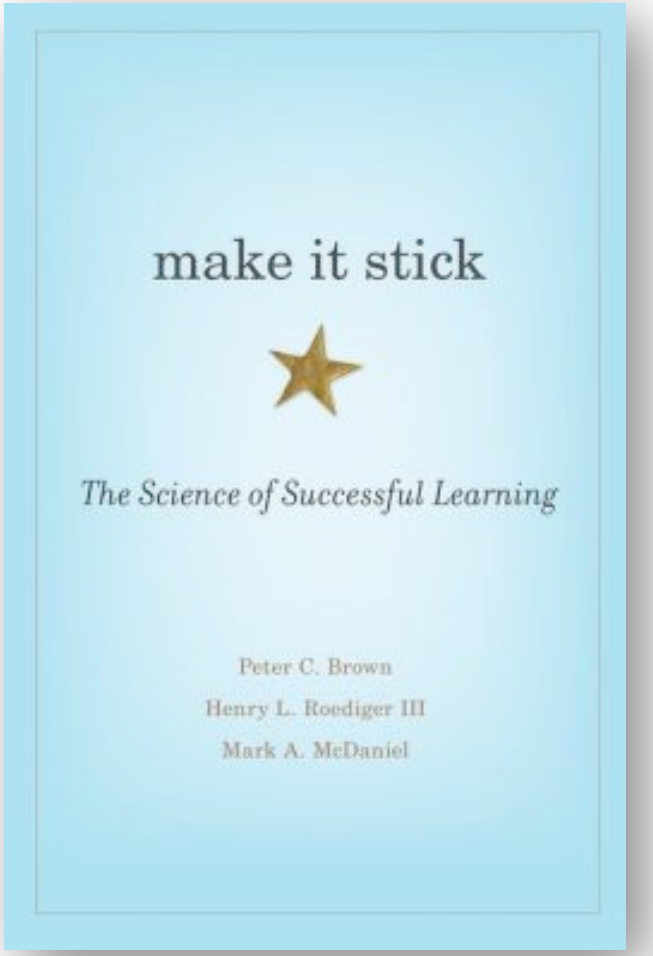
Remainder of this presentation will focus on how my colleagues and I have used data to assess the impact of instructional interventions and to make course adjustments, based on principles of psychological science.

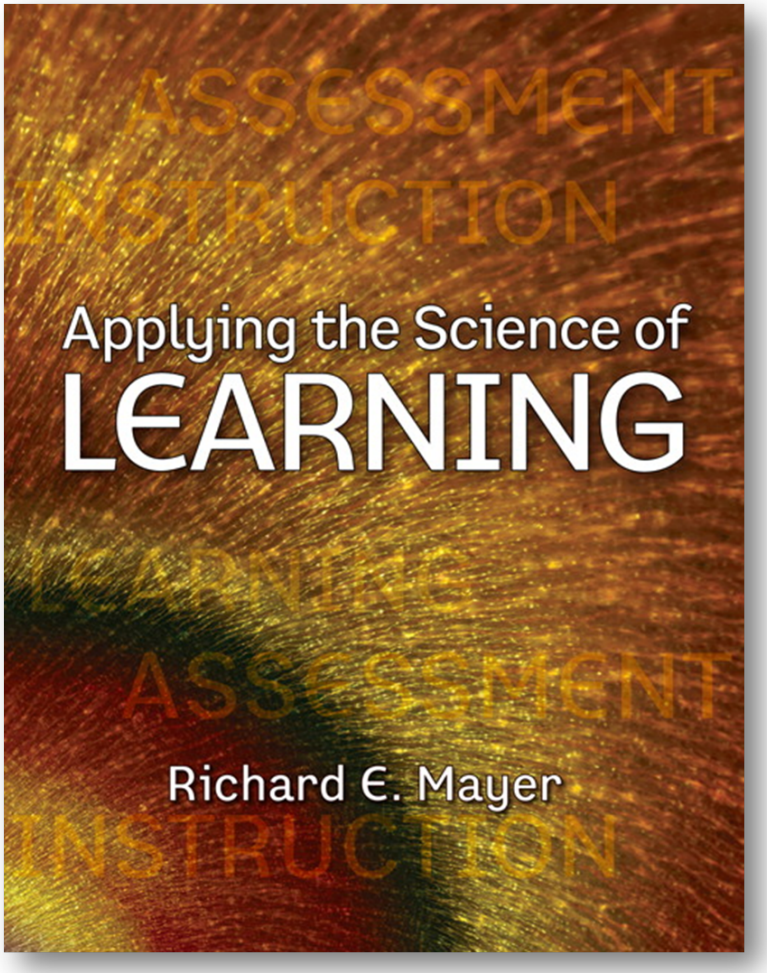
Overview of Remainder of Presentation

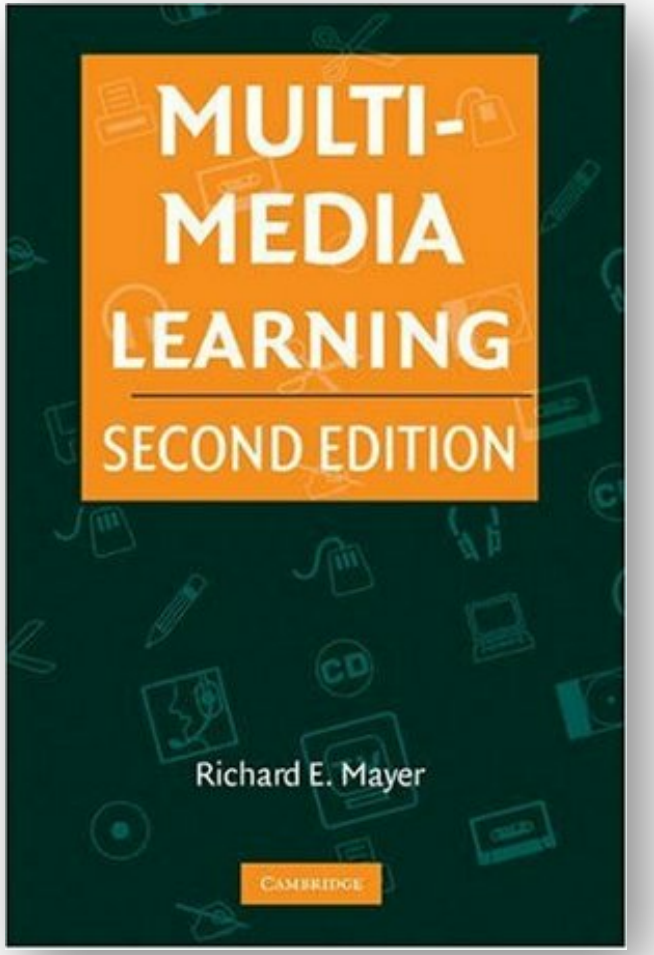
1. **Using Personal Response Systems** (*i*Clicker) in the Classroom to Promote Student Learning in a Lower-Division Course on Energy and Environment.

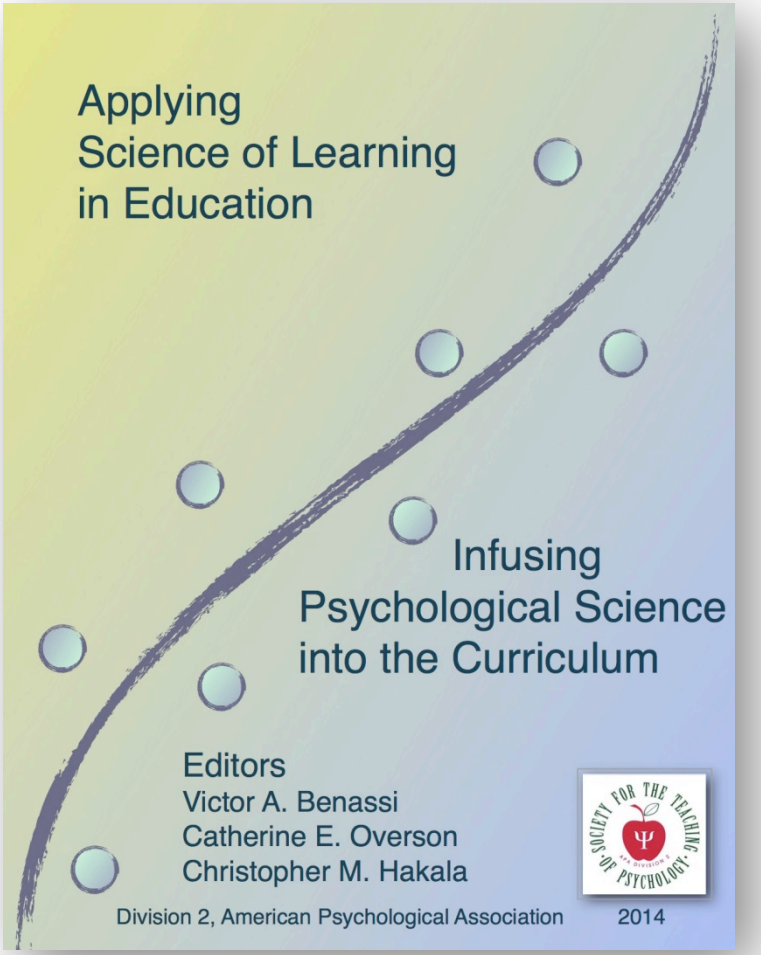
2. **Embedding Questions** in Online Video Lectures in a Graduate-Level "Flipped" Course on Occupational Therapy for Children.

3. **Applying Multimedia Principles** with Face-To-Face and Online PowerPoint Presentations.


make it stick
The Science of Successful Learning
Peter C. Brown
Henry L. Roediger III
Mark A. McDaniel


ASSESSMENT
INSTRUCTION
Applying the Science of
LEARNING
LEARNING
ASSESSMENT
Richard E. Mayer
INSTRUCTION


MULTI-
MEDIA
LEARNING
SECOND EDITION
Richard E. Mayer
CAMBRIDGE


Applying
Science of Learning
in Education
Infusing
Psychological Science
into the Curriculum
Editors
Victor A. Benassi
Catherine E. Overson
Christopher M. Hakala
SOCIETY FOR THE TEACHING OF PSYCHOLOGY
Division 2, American Psychological Association
2014

Using Personal Response Systems

Using Personal Response Systems (*i*Clicker) in the Classroom to Promote Student Learning in a Lower-Division Course on Energy and Environment.

Course: Energy and Environment

Enrollment: > 200

Question: Does "clicking" make a difference?

Partial Assessment of a Peer Instruction Method

http://mazur.harvard.edu/research/detailspage.php?ed=1&rowid=8

- Presentation of in-class questions – three clicker conditions
- Teacher presented some material followed by a question using a particular presentation strategy.
- Repeated 3 times per class period.
- On different class days, teacher either:
  1. Click/peer-to-peer discussion/click
  2. Click/think/click
  3. Think/ peer-to-peer discussion/think
- After each condition, teacher provided correct response

An In-Class Question

If you were asked to convert 12 in^2 into m^2, which conversion factor would be the correct one to use?

A $\dfrac{1\ in}{0.0254\ m}$

B $\dfrac{0.0254\ m}{1\ in}$

C $\left[\dfrac{1\ in}{0.0254\ m}\right]^2$

D $\left[\dfrac{0.0254\ m}{1\ in}\right]^2$

A Related Exam Question

During the solution of a problem you decide to use the unit conversion factor $\frac{1\ yr}{8{,}760\ hr}$. What conversion are you most likely trying to accomplish?

A. hours to years
B. years to hours
C. years to days
D. days to years

Inserting Embedded Questions into Lecture-Capture Presentations May Promote Learning and Long-Term Retention

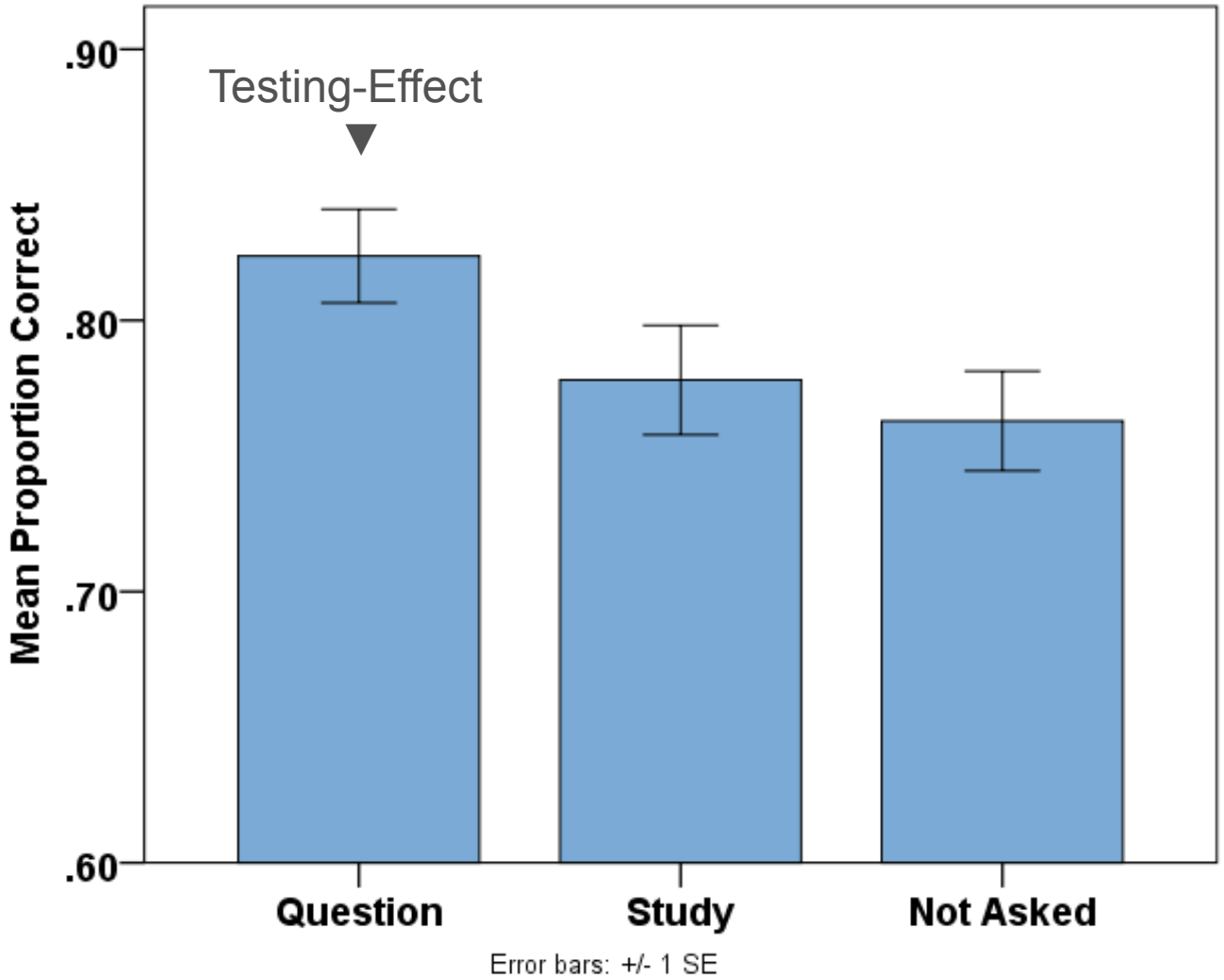
Embedding Questions in Online Video Lectures in a Graduate-Level "Flipped" Course on Occupational Therapy for Children

- Master's Level Course:
  Occupational Therapy for Children
- Flipped Class
- Enrollment = 60+

Project Intervention

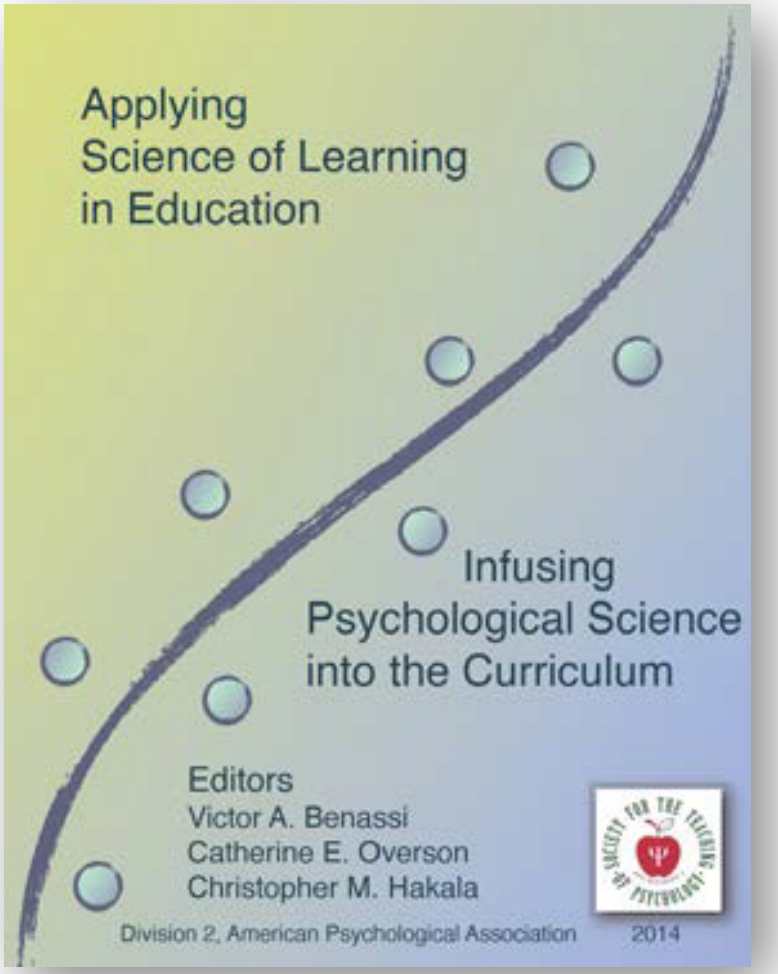
- Generation of specific objectives (advance organizers)
- Presentation of base materials (Pre-training)
- Embedded questions in pre-training presentations
- Questions were either:
    1. Multiple-choice (quiz condition)
    2. Summary Statement (study control)
    3. Not-asked (not-asked control)

Mean proportion correct on midterm exam questions for each of the three experimental conditions.

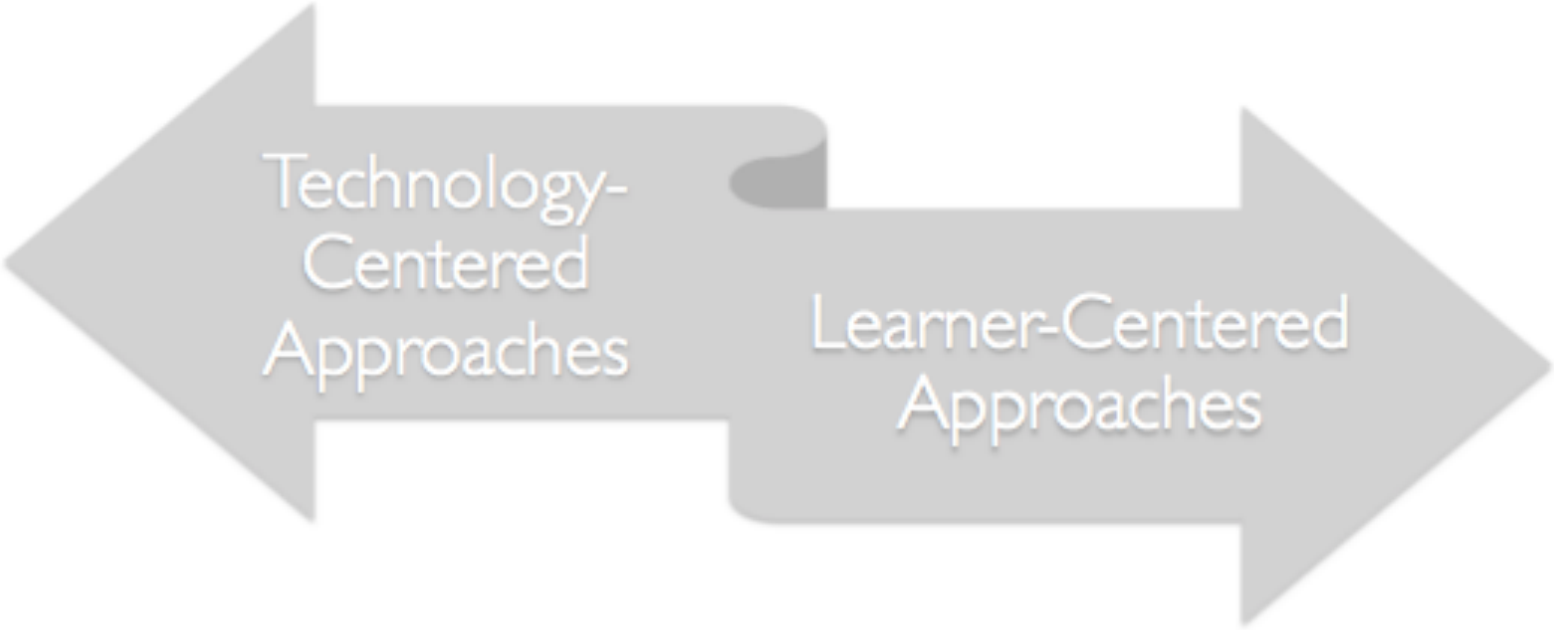


Multimedia Learning

Mayer, R. E. (2014). Research-Based Principles for Designing Multimedia Instruction. In V.A. Benassi, C.E. Overson, & C.M. Hakala (Eds.). *Applying science of learning in education: Infusing psychological science into the curriculum.* Retrieved from the Society for the Teaching of Psychology web site: http://teachpsych.org/ebooks/asle2014/index.php



Multimedia Design
Two Approaches



Mayer, R. E. (2011). Applying the science of learning. Upper Saddle River, NJ: Pearson

Our Approach

Science of Learning	Science of Instruction	Science of Assessment
Cognitive Load Theory	Multimedia principles of instruction	Use of authentic measures of student performance • Learning • Retention • Transfer

Mayer, R. E. (2011). Applying the science of learning. Upper Saddle River, NJ: Pearson

Cognitive Load

Extraneous Cognitive Load

- ✓Does not serve the instructional goal
- ✓Poor instructional design

Essential Cognitive Load

- ✓Represents essential material in working memory
- ✓Load depends on Complexity of material

Generative Cognitive Processing

- ✓Required for deep understanding of material (e.g., construction of schemas)
- ✓Good instructional design—increases student motivation to learn

Goals of Multimedia Instruction

Minimize Extraneous Load

Manage Essential Load

Foster Generative Processing

Minimize Extraneous Load

Table 2, Mayer, 2014 (page 62)

Principle	Description
Coherence	Delete extraneous material
Signaling	Highlight essential material
Redundancy	Don’t add onscreen captions to narrated graphics
Spatial contiguity	Place printed words near corresponding part of graphic
Temporal contiguity	Present spoken words at same time as corresponding graphics

Manage Essential Load

Table 3, Mayer, 2014 (page 64)

Principle	Description
Segmenting	Break lesson into learner-paced parts
Pre-training	Present characteristics of key concepts before lesson
Modality	Use spoken words rather than printed words

Foster Generative Processing

Table 4, Mayer, 2014 (page 66)

Principle	Description
Personalization	Put words into conversational style rather than formal style
Voice	Put words into human voice rather than machine voice
Embodiment	Have onscreen agent use human-like gestures and movements
Image	Do not necessarily put an image of agent on the screen

Multimedia Projects

1. In-Class *PowerPoint* Projects
   - Mixture of multimedia principles
2. Out of class *PowerPoint* Projects

In-class PowerPoint projects

Experimental Design

Multimedia Principle

"People learn better from words and pictures than from words alone."

Mayer, page 223

Example 1

ORIGINAL

Descriptive vs. Analytic Epidemiology

- *Descriptive studies*--used to identify a health problem that may exist. Characterize the amount and distribution of disease.
- *Analytic studies*--follow descriptive studies, and are used to identify the cause of the health problem.

MODIFIED

Descriptive vs. Analytic Epidemiology

Descriptive Studies	Analytic Studies
Used to identify a health problem that may exist. Characterize the amount and distribution of disease.	Follow descriptive studies, and are used to identify the cause of the health problem.

Signaling Principle

"People learn better when cues that highlight the organization of the essential material are added"

Mayer, page 108

Example 1

ORIGINAL

Cardiovascular Disease and Chronic Stress Pathway

1. Increased stress produces stress hormones that pump the heart more and increase wear and tear

2. Blood pressure increases to pump blood faster during the stress response

3. Increased blood pressure forces the body to produce stronger vessels to handle the pressure, lead to increased pressure

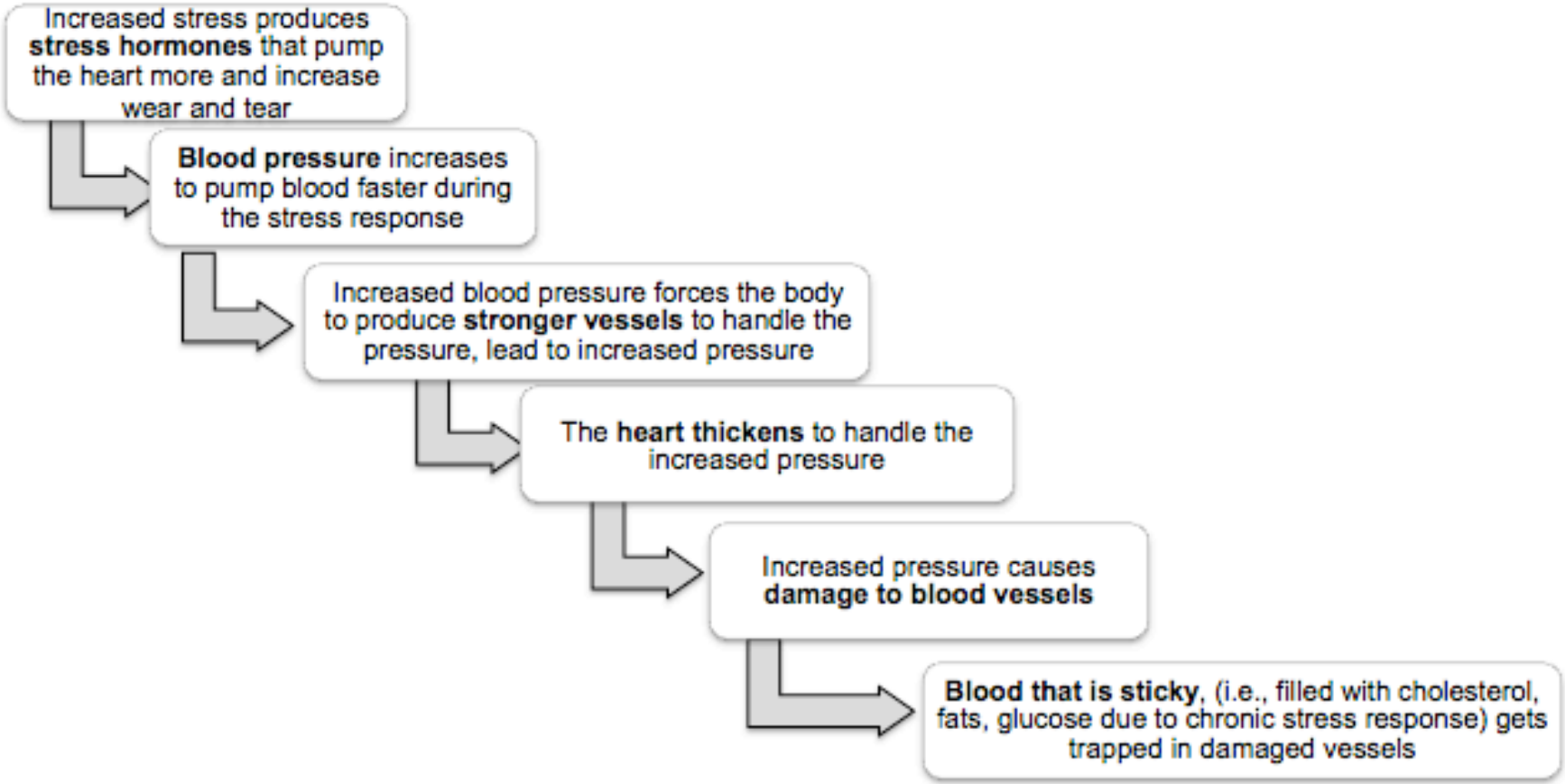
4. The heart thickens to handle the increased pressure

5. Increased pressure causes damage to blood vessels

6. Blood that is sort of sticky and filled with cholesterol, fats, glucose
   - This can happen anywhere but when it happens to actual heart vessels a person is at even greater risk

MODIFIED

Cardiovascular Disease and Chronic Stress Pathway



Coherence Principle

"People learn better when extraneous material is excluded rather than included"

Mayer, page 89

Example 1

ORIGINAL

Positivist Approach

Positivist Approach

- Donald Black: perspective & method of natural ***sciences***
  - Form & test hypotheses empirically

Positivist Approach

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- Some hypotheses:

Positivist Approach

- Some hypotheses:
  - Law varies inversely w/ other social control
  - > stratification = more law
  - > "downward law" than "upward law"
  - > law as intimacy decreases [most law where people interact a lot w/ little intimacy]

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MODIFIED

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Learning Outcomes

Experiment 1:

Learning

Mean Percent Correct Responses to
Questions Asked at End of Class During
Which Modified or Original PowerPoint Slides
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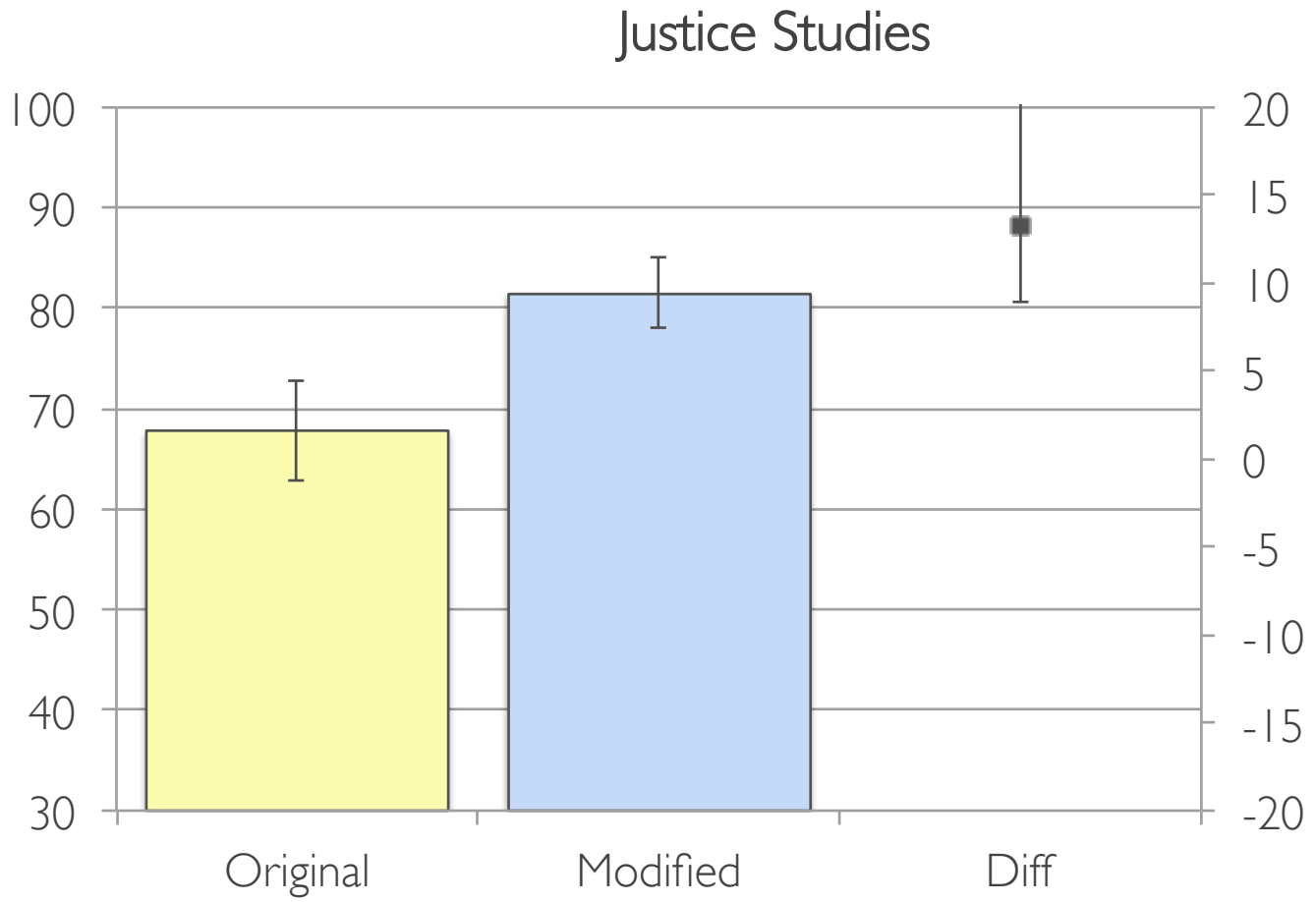

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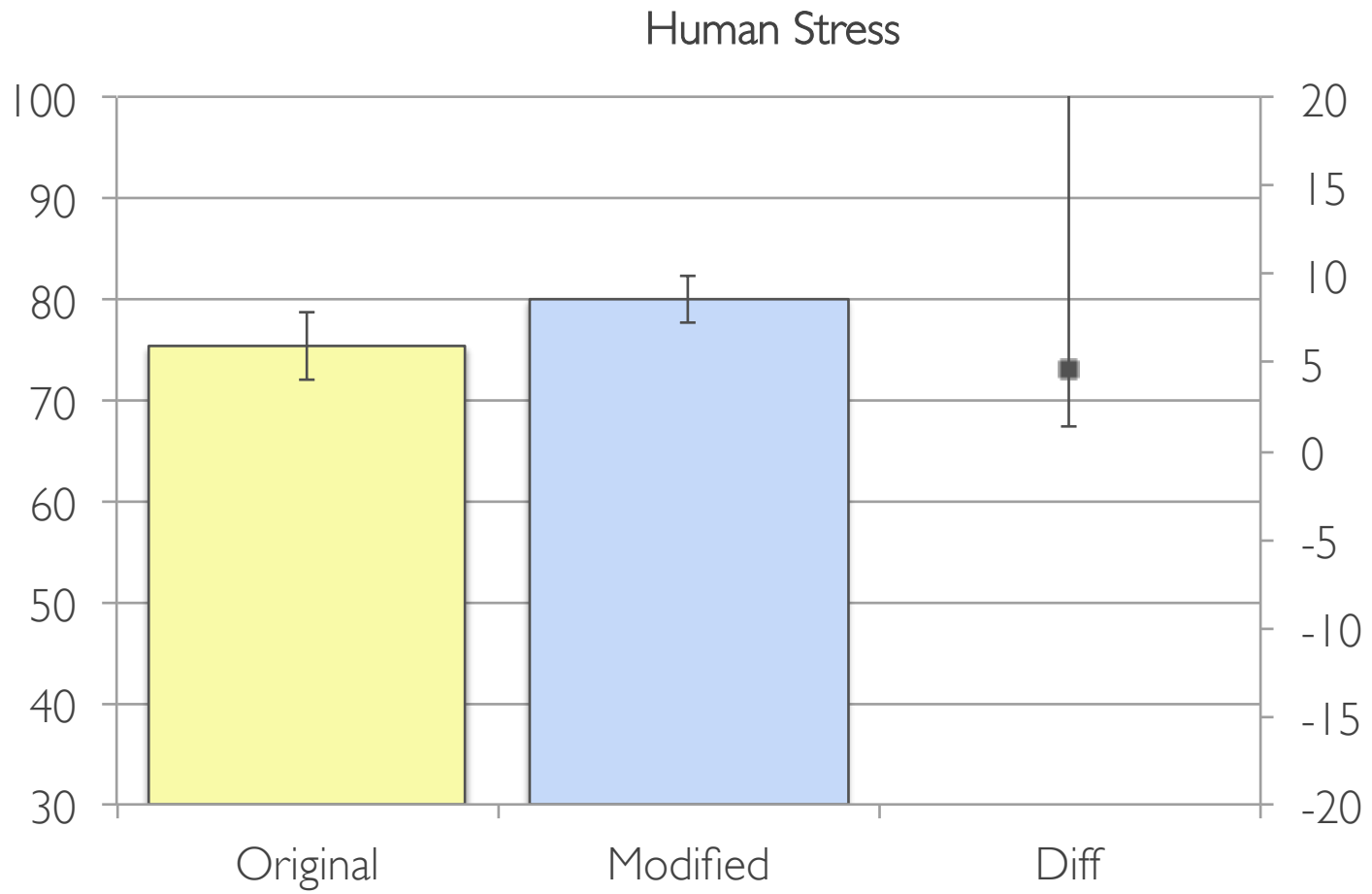

Experiment 2:

Long-Term Retention

Mean Percent Correct Responses to Midterm Exam Questions Based on Information in Modified or Original PowerPoint Slides

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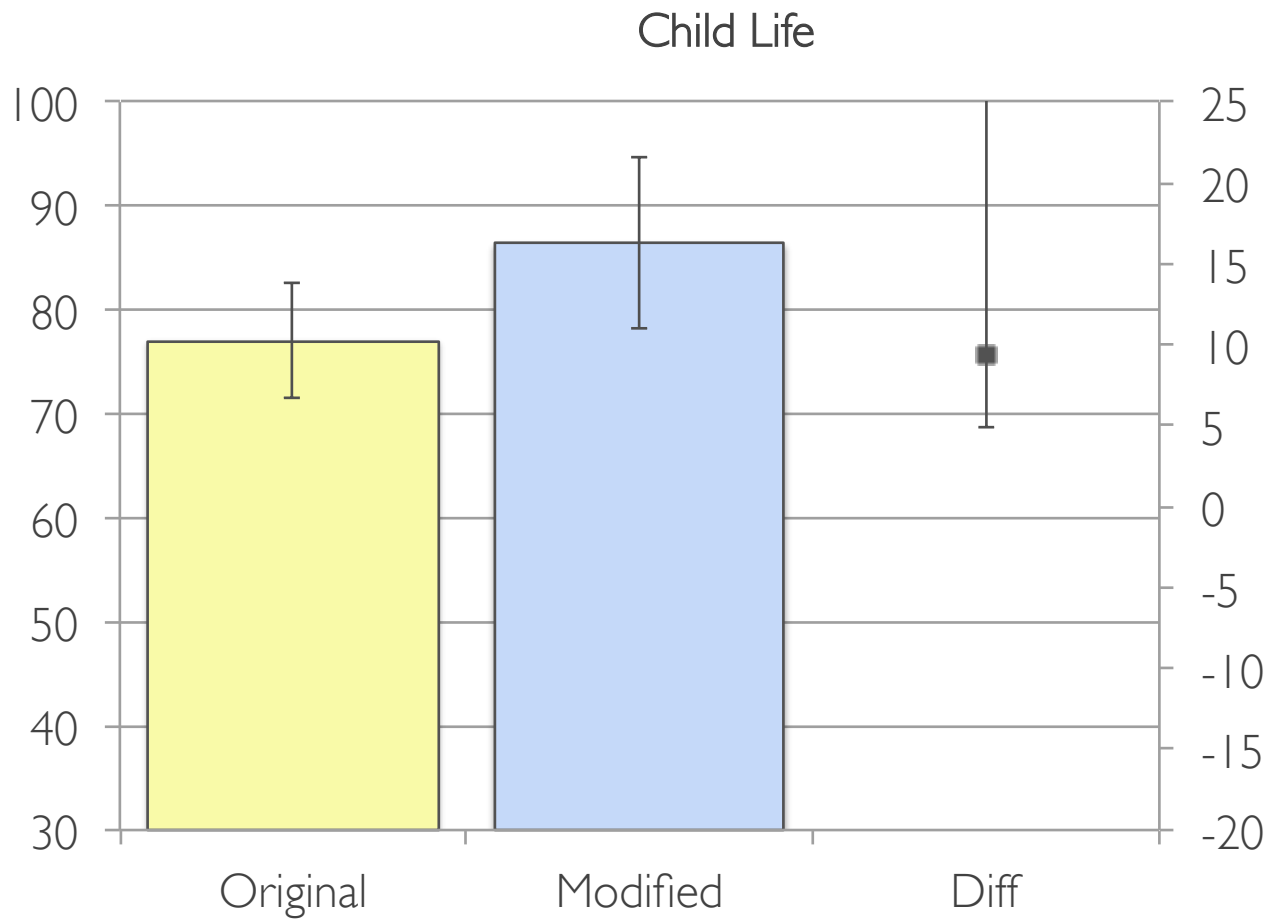

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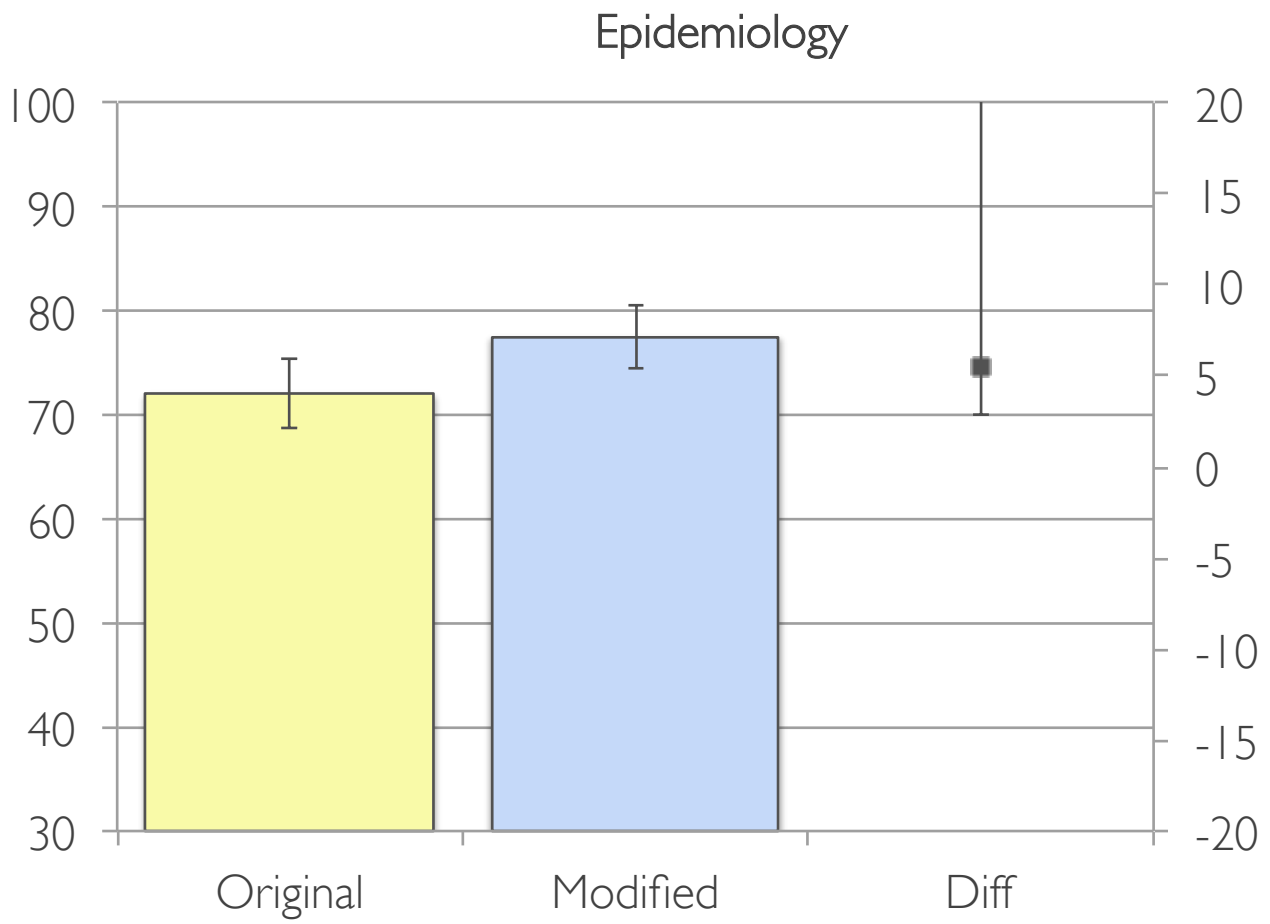

Out-of-class PowerPoint projects

Introduction to Psychology Course

Experiment Design

Attitudes
(Word Version)

Attitude Change by Our Own Behavior

- We hold many cognitions (for example: beliefs, feelings, and our behavior) about ourselves and the world around us
- We expect our cognitions to be in harmony with one another – that is, we expect that our attitudes and our behaviors are consistent/ compatible
- Sometimes we behave in ways that are inconsistent with our attitudes. These conflicting cognitions produce an unpleasant psychological state – cognitive dissonance – that we strive to reduce
- Because we cannot change our past behavior, one way to reduce the dissonance is by changing our attitudes so that they are more in line with our behavior

Attitudes
(Multimedia Version)

Attitude Change by Our Own Behavior

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We hold many cognitions about ourselves and the world around us, which we expect to be consistent/compatible with one another

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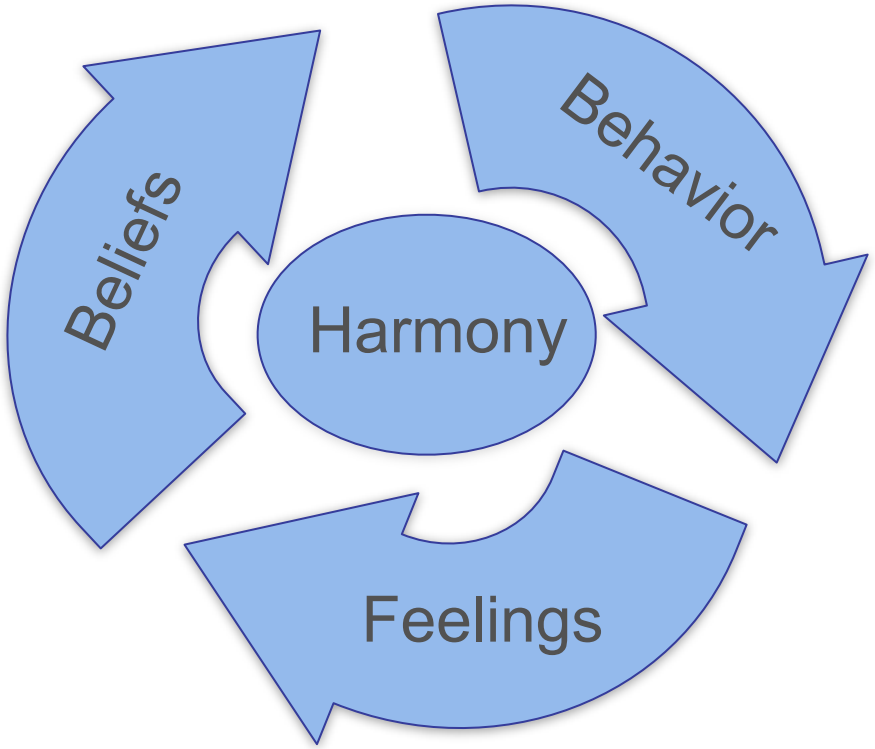

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When we behave in ways that are inconsistent with our attitudes, we experience an unpleasant psychological state that we strive to reduce

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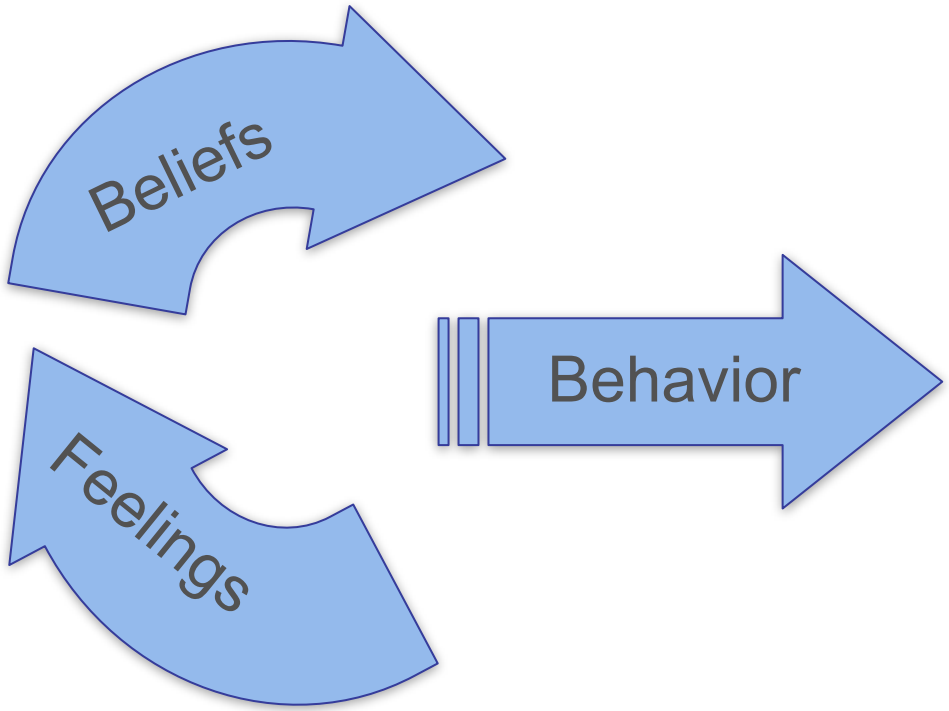

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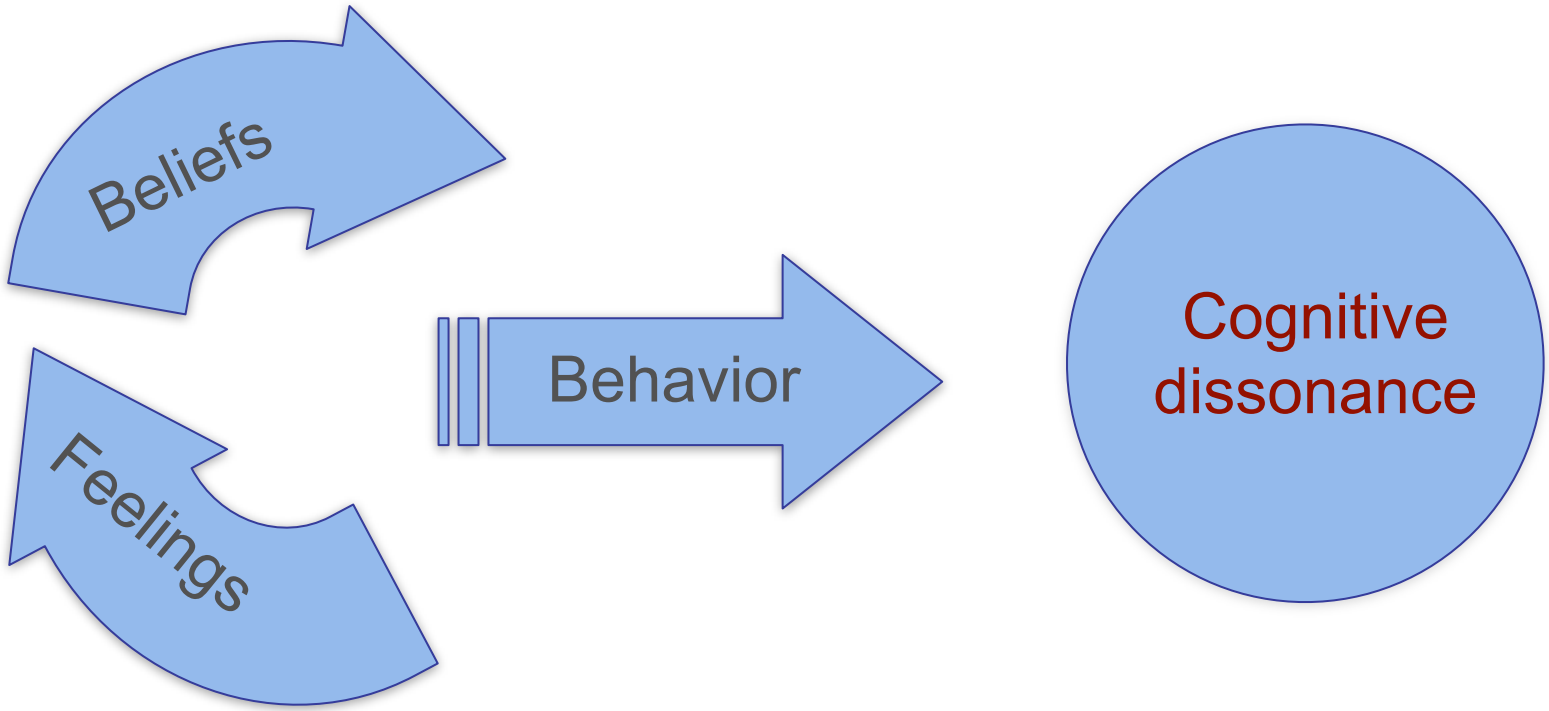

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Because we cannot change past behavior, we reduce dissonance by changing our attitudes to align with our behavior

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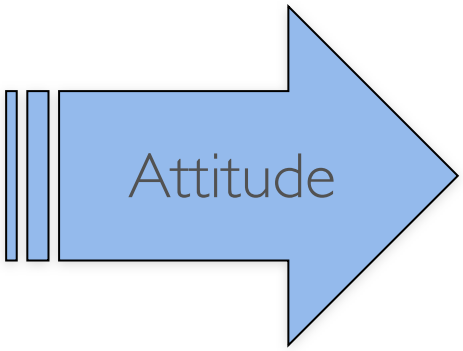

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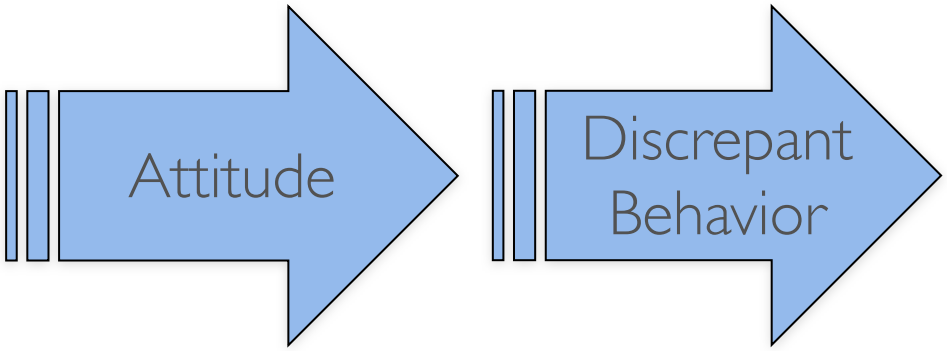

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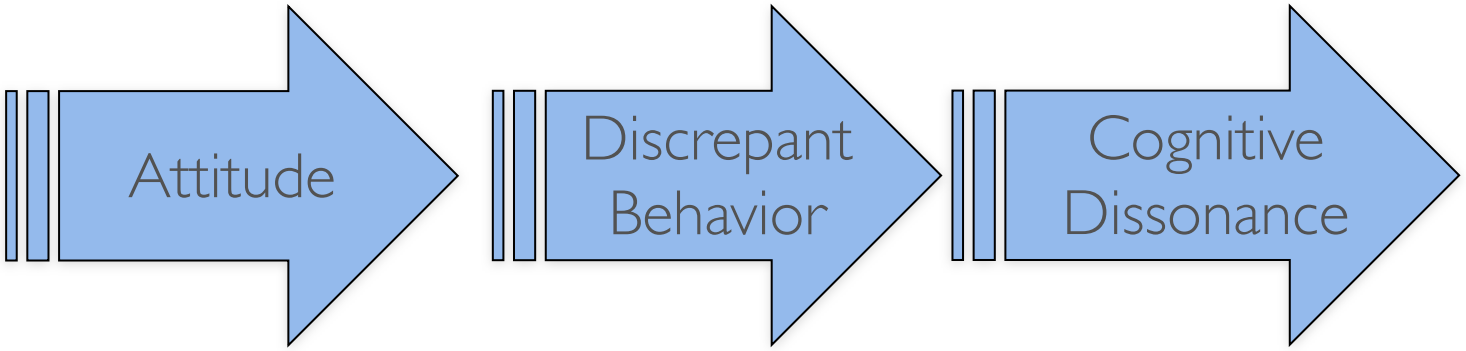

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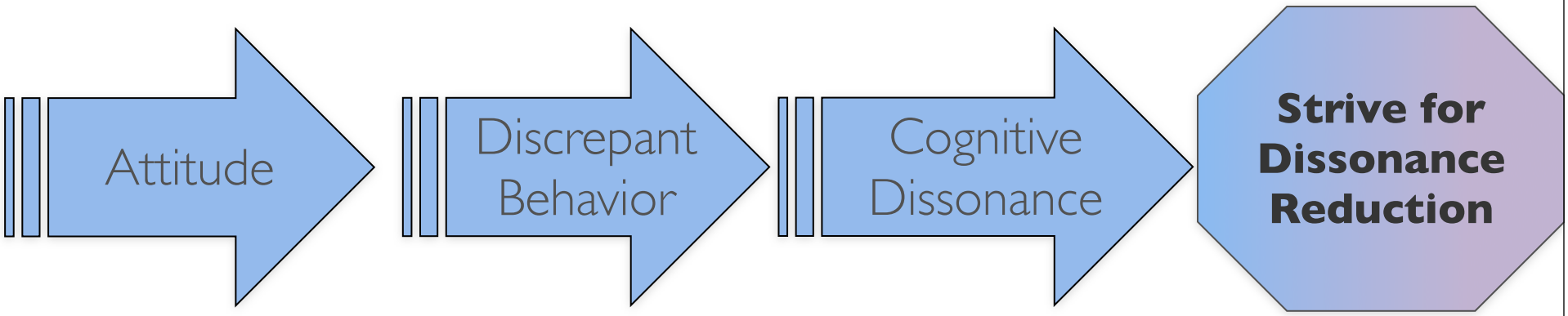

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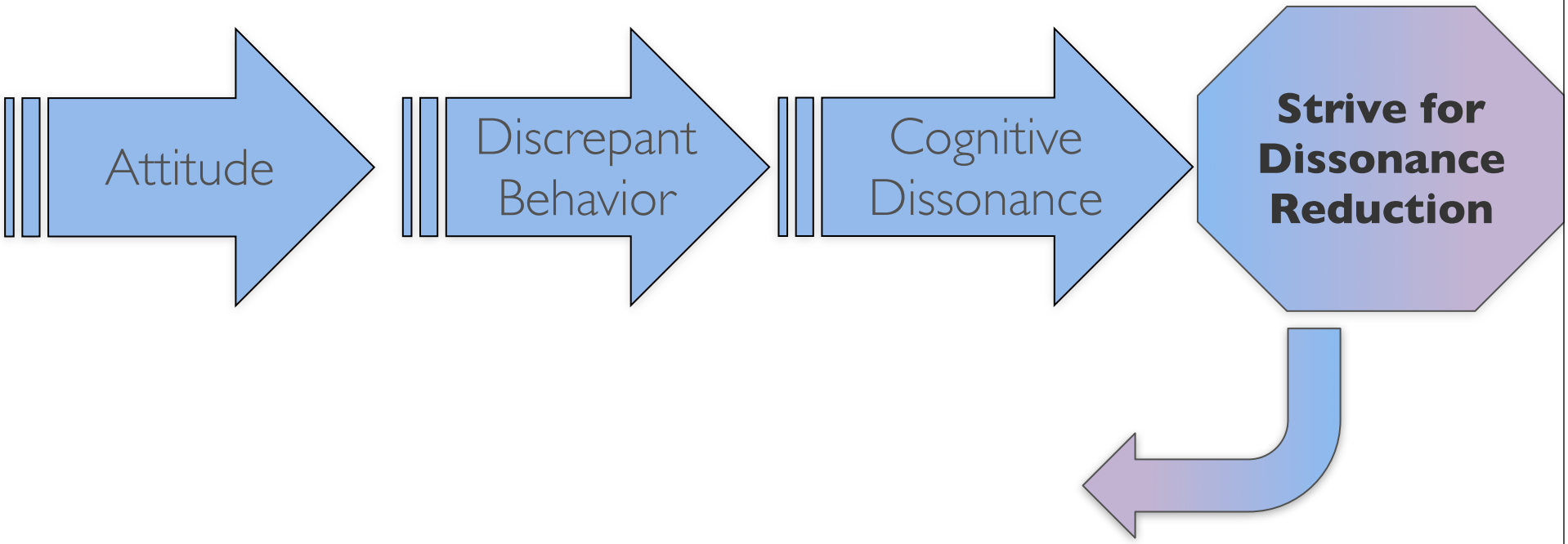

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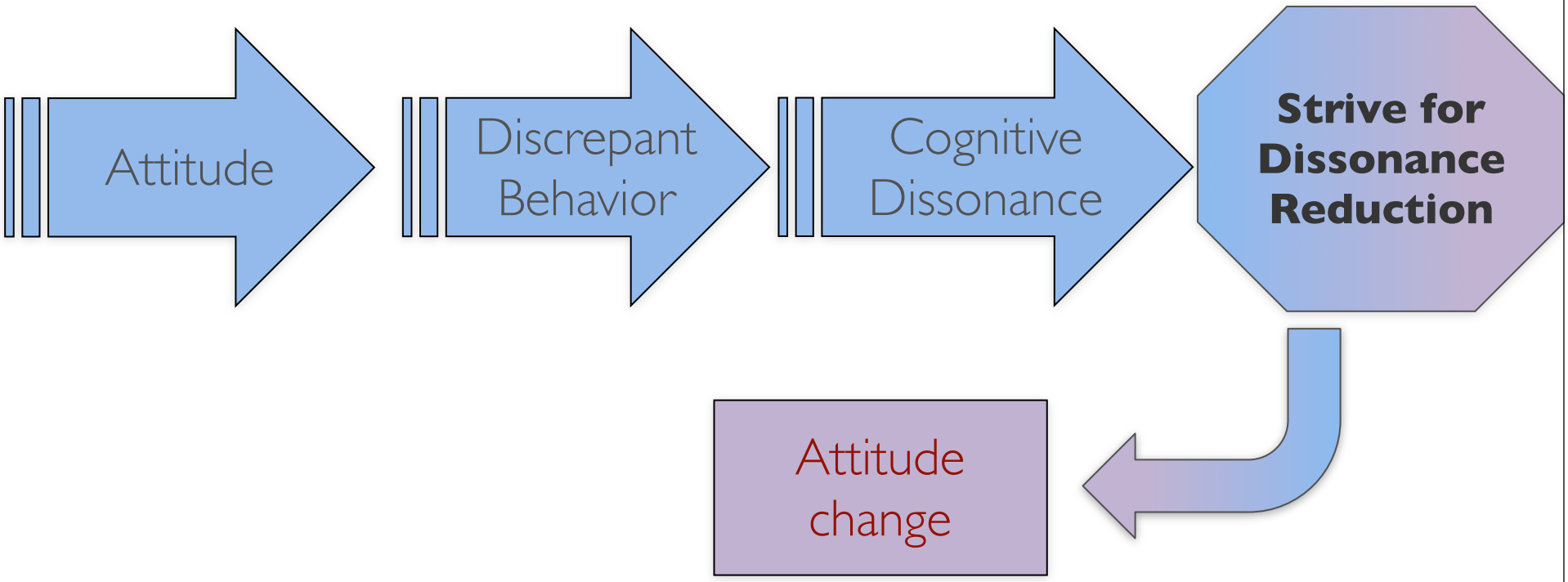
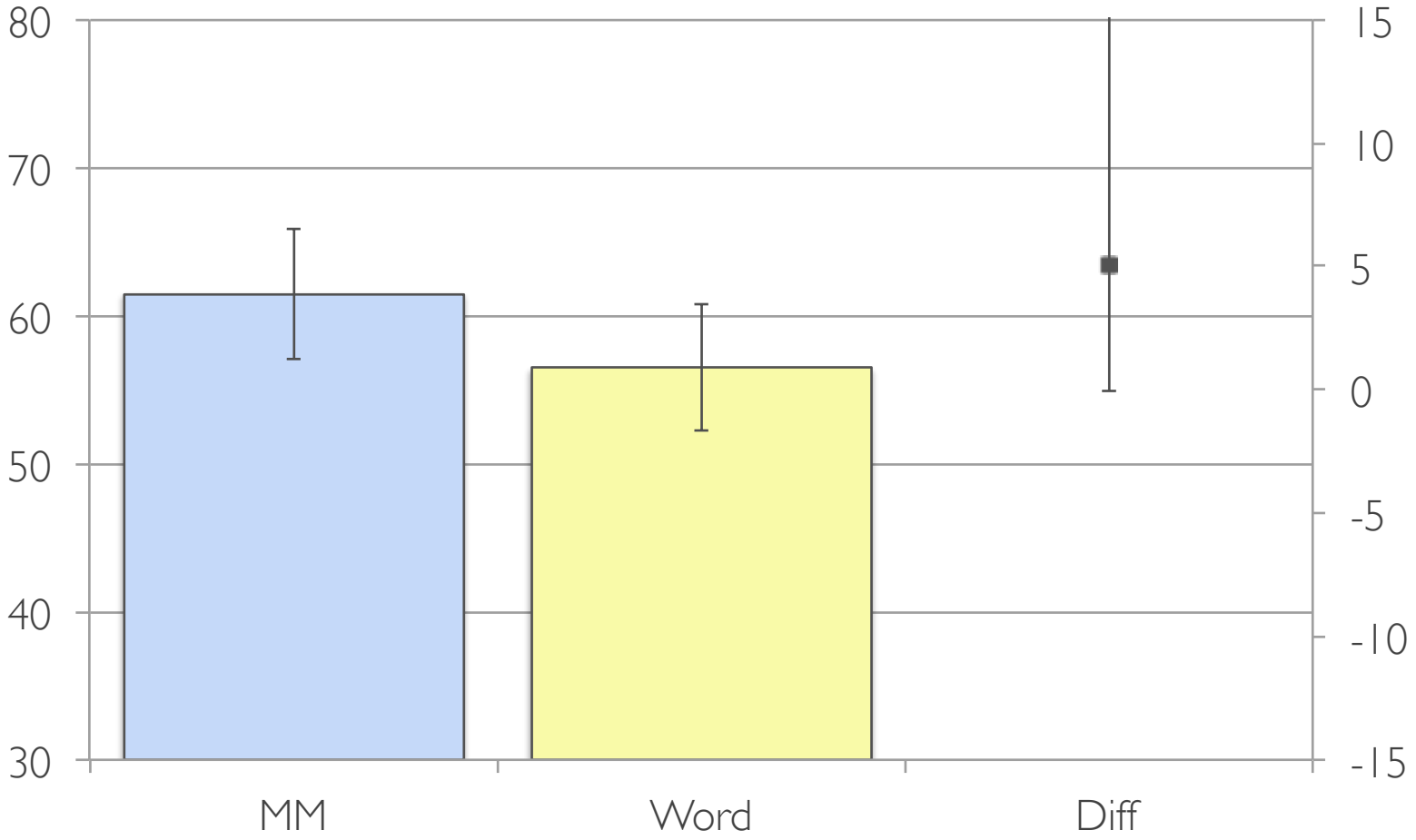
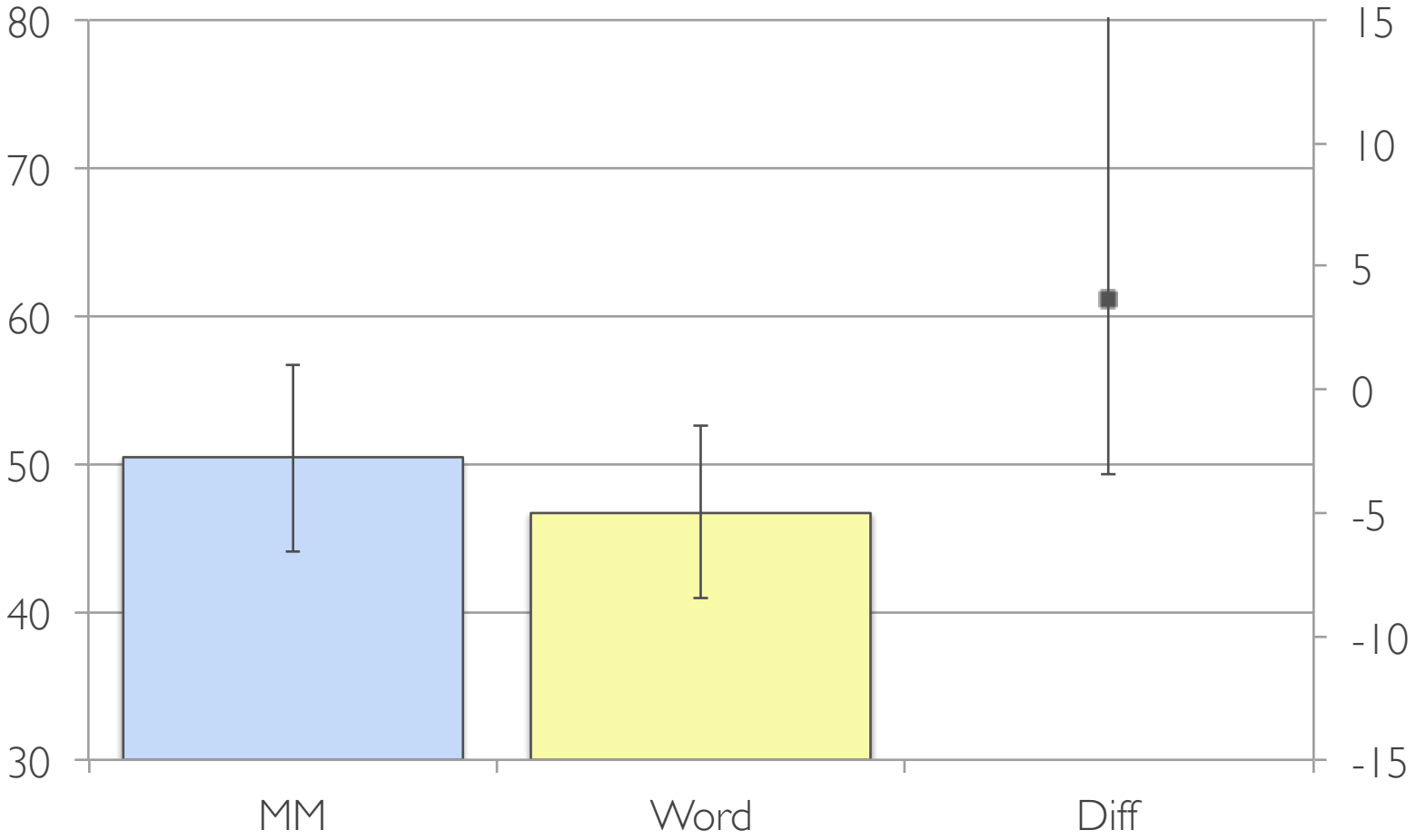


Learning Outcomes

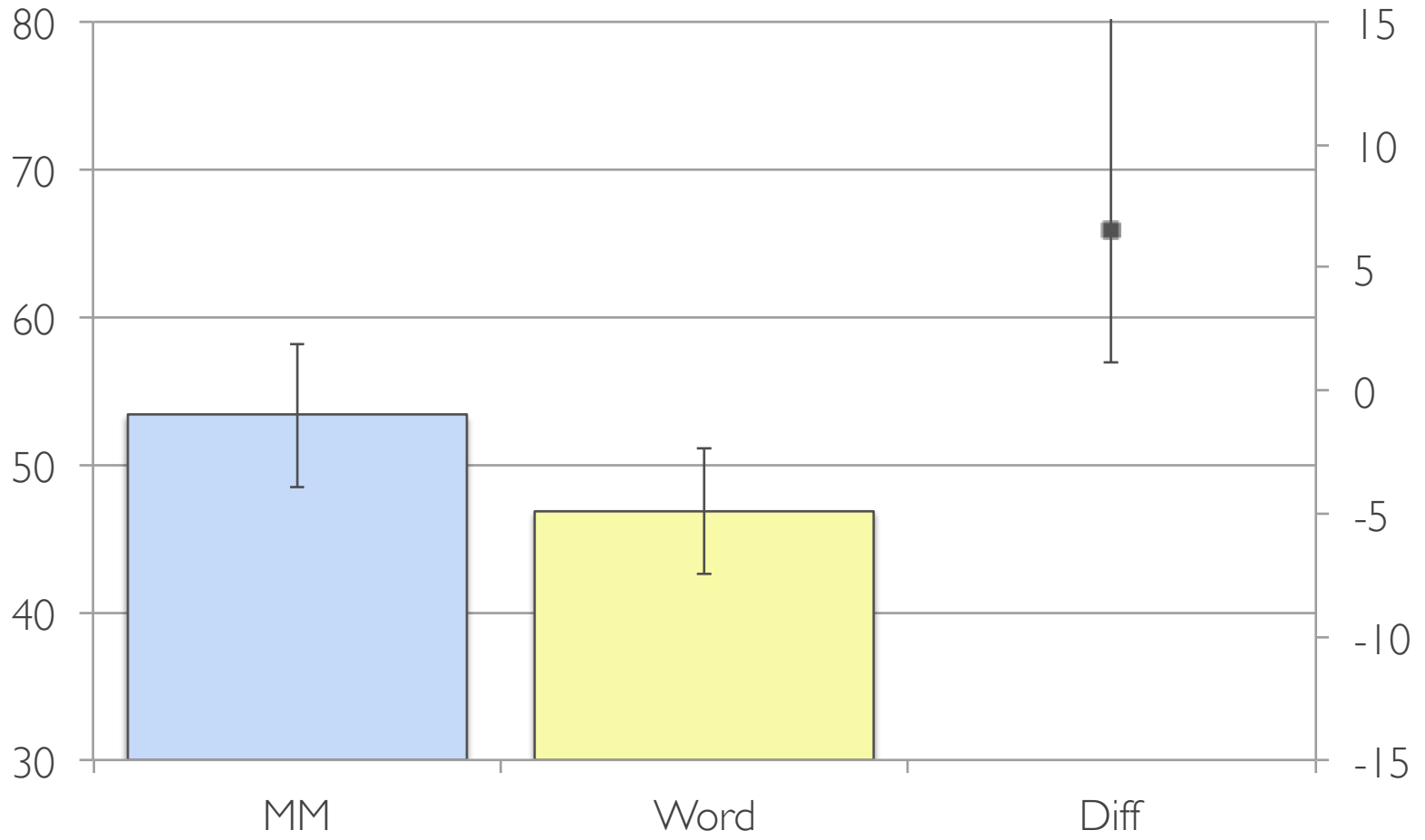
Quiz Performances Following Multimedia and Word Formats: Learning



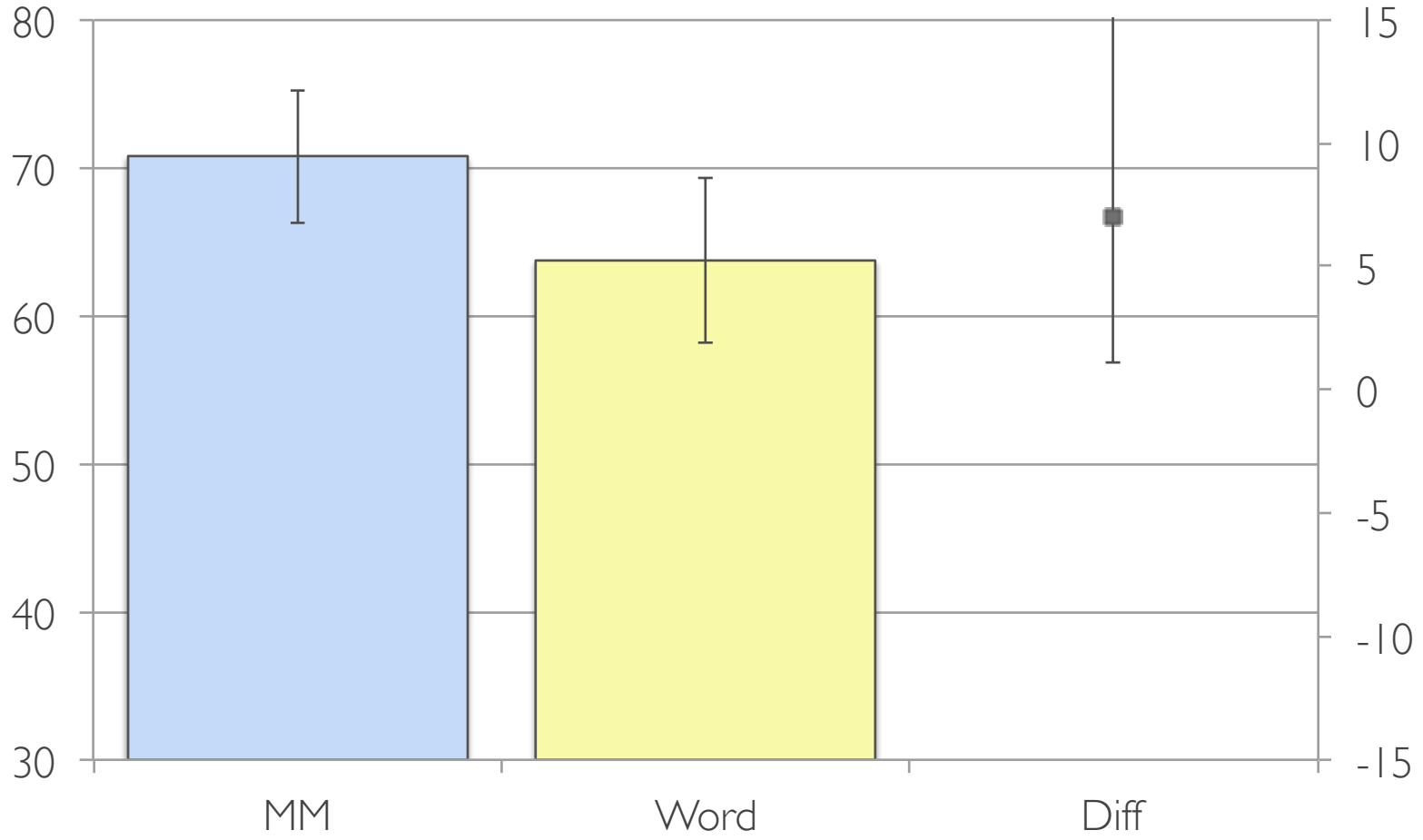
The Neuron



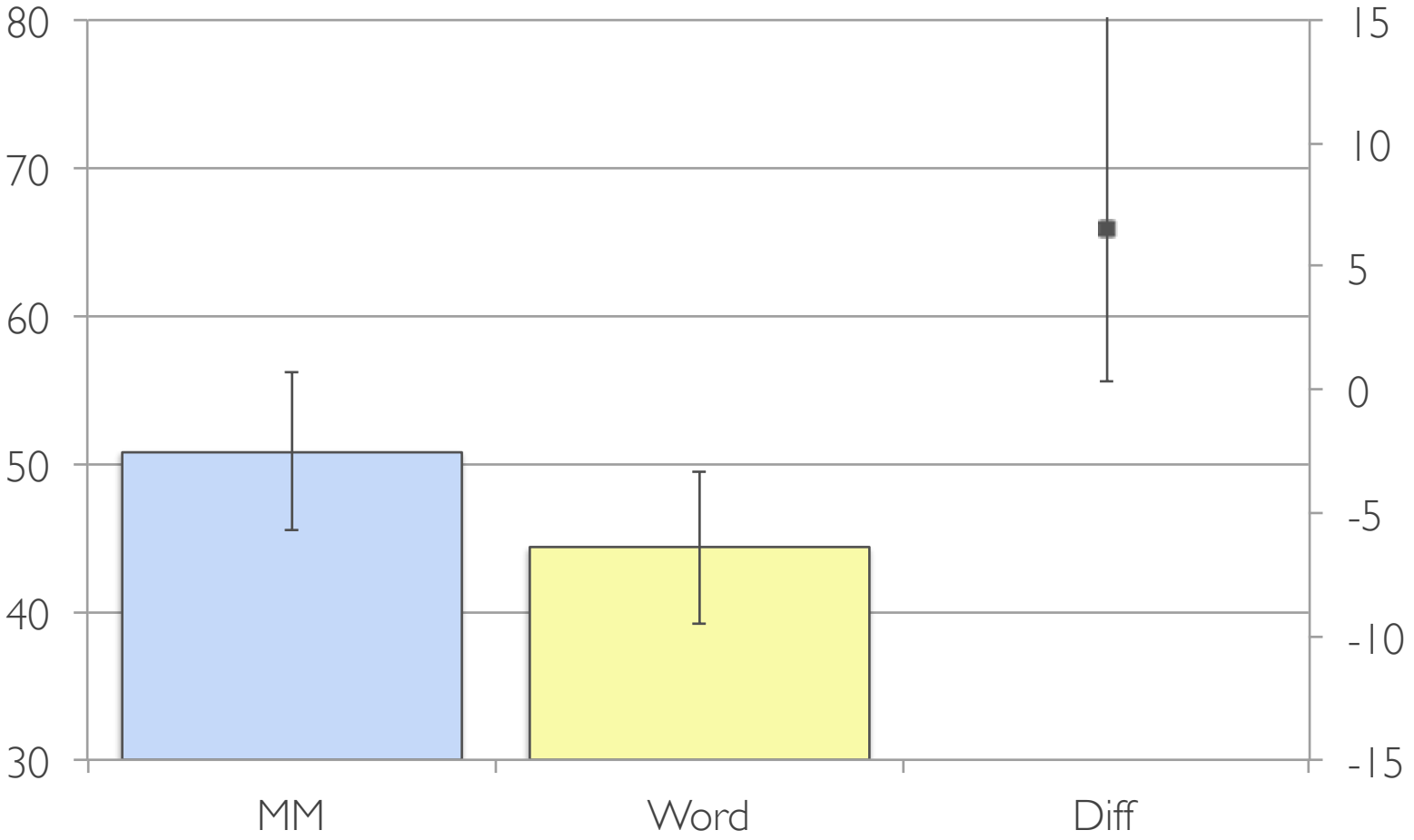
The Action Potential



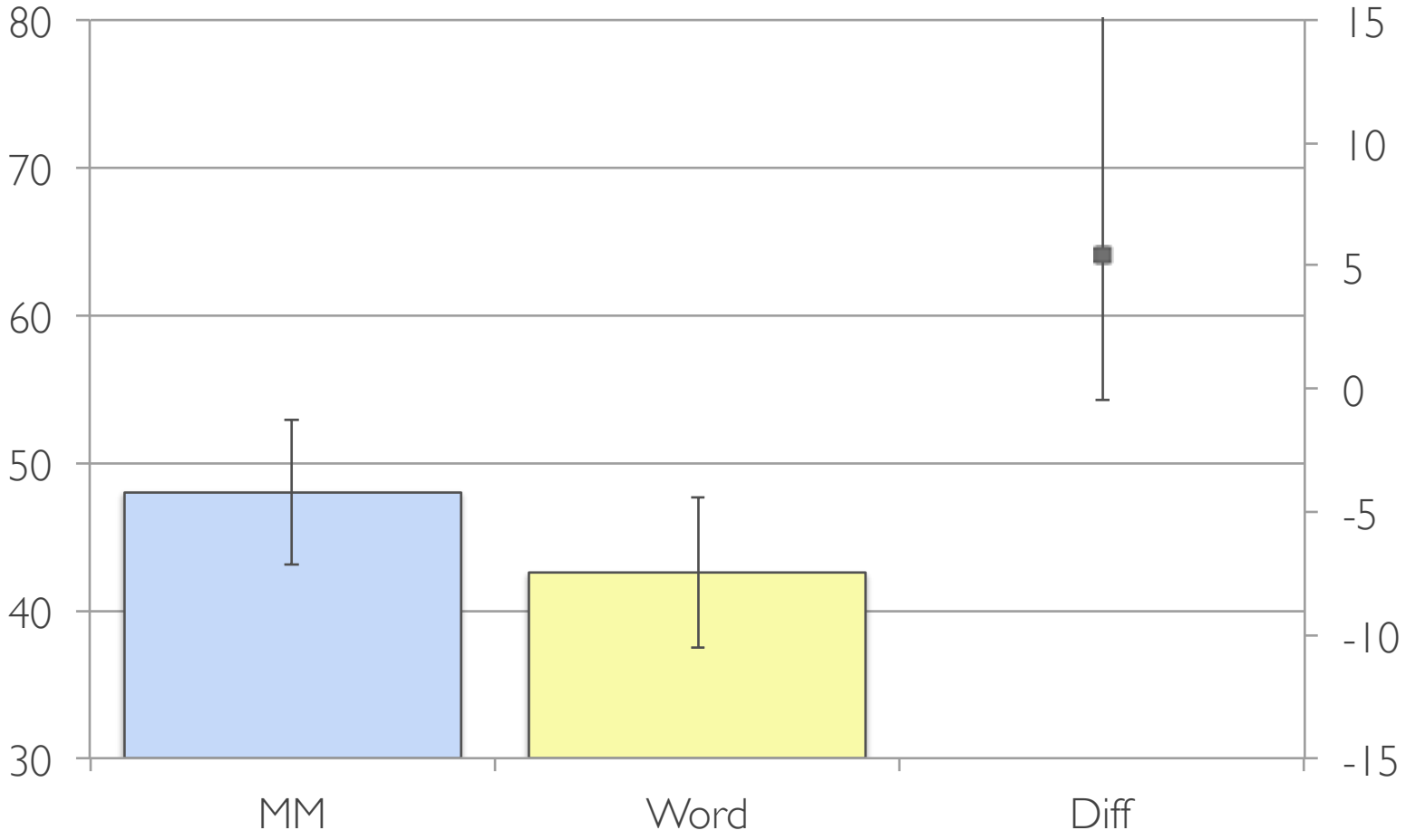
Classical Conditioning



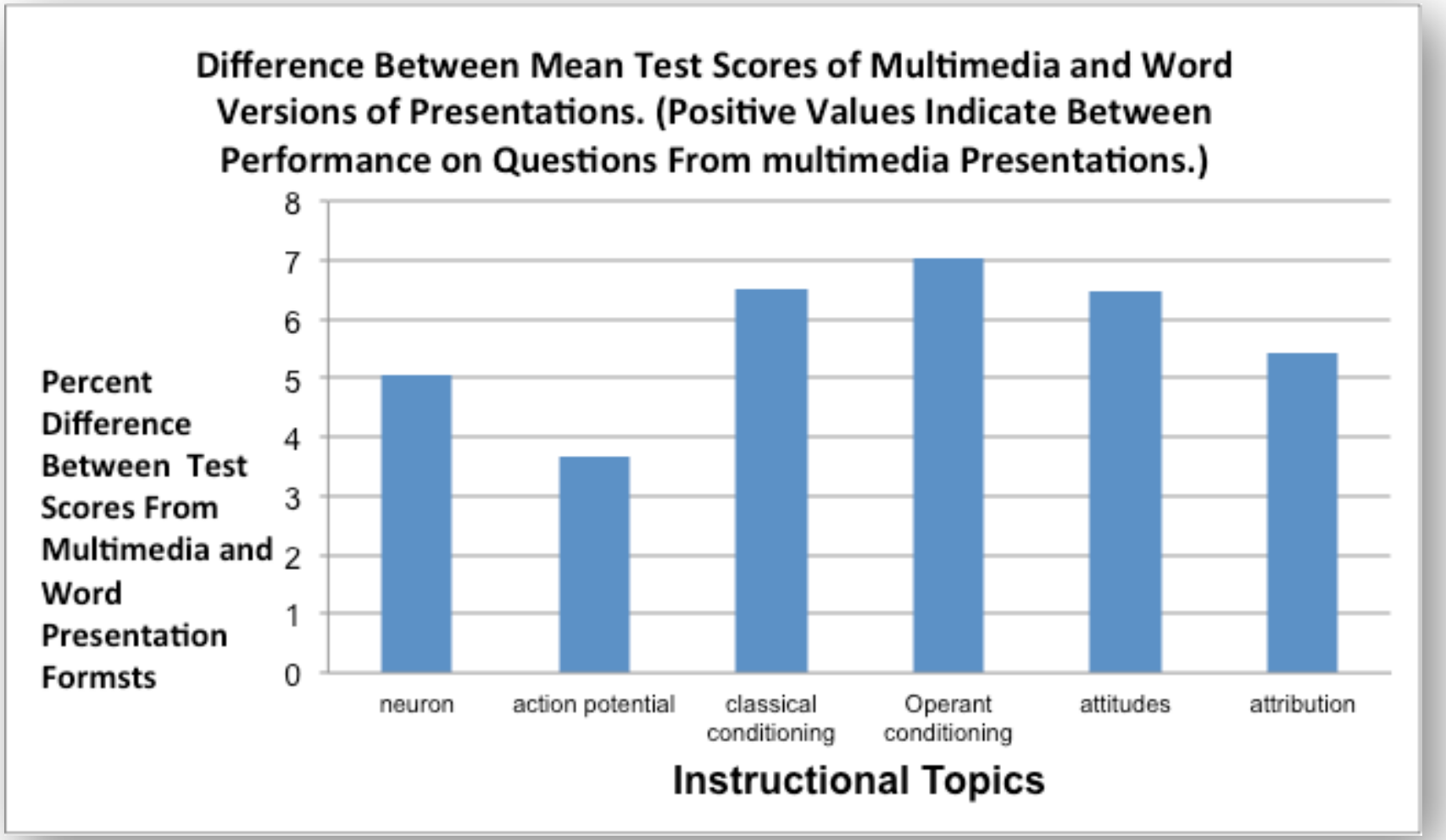
Operant Conditioning



Attitudes



Attribution


Difference Between Mean Test Scores of Multimedia and Word Versions of Presentations. (Positive Values Indicate Between Performance on Questions From multimedia Presentations.)
Percent Difference Between Test Scores From Multimedia and Word Presentation Formsts
8
7
6
5
4
3
2
1
0
neuron
action potential
classical conditioning
Operant conditioning
attitudes
attribution
Instructional Topics

Wrap Up

Three sets of studies demonstrate that authentic academic performance is positively affected by conditions of instruction:

1. Providing opportunities for deep processing *during lectures* facilitates learning, with or without clickers.
2. *Embedding* questions during online lectures produces a kind of "testing effect."
3. *Developing* PowerPoint slides that use multimedia instructional methods (science of instruction) can positively affect both initial learning and long-term retention of material presented during in-class lectures.

We use data from studies used to inform improvements in instruction and to develop "promising practices."

Thank You.