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Overview
• Individual Learner Characteristics
• Expertise Reversal
• Design of Adaptive Learning Environments
• Research on Individual Differences

Example
• Intelligence
• Ability
• Preferences
• Learning Style
• Personality Type

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Individual Differences

Examples
• Demographic
• Physiological
• Experience
• Learning Style
• Aptitude
• Knowledge

Group Discussion

You are asked to develop an adaptive learning environment for teaching the History of the Gulf War.

How would you approach this project?

Effect of Individual Differences

Assumptions:
• Good design supports learners' individual characteristics
• If learner preferences or abilities are not supported, learning suffers

=> Is that always so? Can you name examples?
You are asked to develop an adaptive learning environment for teaching the History of Space Travel. How would you approach this project?

1. Identify relevant individual differences that affect the cognitive processes involved in instructional strategies

**Categories of Individual Differences**
- Intelligence (General Mental Ability)
- Second Order Abilities (Fluid, Crystallized, Visual)
- Cognitive Abilities (Primary)
- Cognitive Styles
- Learning Styles
- Personality Types

**Cognitive Abilities**
- Content and level of cognitive activity
- Competencies, maximal performance
- Unipolar measures, value directional
- Affected by content domain, nature of task
- Enable people to perform tasks
- Examples: spatial ability, verbal ability

**Verbal Ability**
- Ability to learn vocabulary and comprehend text
- Vocabulary tests correlate with capacity of verbal WM (Gathercole & Baddeley, 1993)
- Relationship with vocabulary learning in second language (Atkinson & Baddeley, 1998)

**Spatial Ability**
- Ability to generate, maintain and manipulate mental visual images (Carroll, 1993)
  - Visualization (Cards, Figures, Flags)
  - Spatial relations (Card rotation)
  - Spatial Orientation (Paper Folding)
- Spatial relations ability expected to affect processing of visual information

**Cognitive Styles**
- Manner and form of learning
- Propensities, typical performance
- Bipolar measures, value differentiated
- Control way in which tasks are performed
- Stable over time and content
- Examples: visual/haptic, holist/serialist
Learning Styles
- General tendencies to prefer to process information in different ways
  - Kolb (1975) (perceiving, processing)
  - Dunn & Dunn (1974) (environmental, sociological, emotional, physical variables)
  - Gregorc (1982) (perceiving, processing)

Individual Differences
- Personality Types
  - Aristotle: sanguine, melancholic, choleric, phlegmatic
  - Freud: ego, id, super ego
  - Jung's personality types
  - Miller (1981) (analytic - objective - holistic - subjective; emotional stability/instability)

Group Discussion
- You are asked to develop an adaptive learning environment for teaching the History of Space Travel.
  - How would you approach this project?
  1. Identify relevant individual differences that affect the cognitive processes involved in instructional strategies
  2. Identify their expected effect.

Multimedia Learning
- Media Effects
  - Is one medium better than another?
- Multimedia Effects
  - Is multimedia instruction effective?
    - Single vs. multiple representations
- Interaction Effects
  - For whom is multimedia effective?
    - (Mayer, 1997)

Presentation
- Expertise Reversal Effect
  - Expertise Reversal – a treatment that is effective for less knowledgeable learners becomes ineffective for more knowledgeable learners
  - Information required by novices to comprehend the material may generate high load in more advanced learners who need to relate that information to existing knowledge structures.
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**Expertise Reversal**

Integration of textual information in visuals

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**Expertise Reversal**

Separation of textual information in visuals

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Attempts to reduce *Extraneous* load for low-prior knowledge learners:
- Integrate important textual explanations into visuals
- Replace on-screen text with audio narration
- Use worked-out examples
  
  But: this can result in higher extraneous load for high-prior knowledge learners

Examples?

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Attempts to manage *Intrinsic* load for low-prior knowledge learners:
- Present isolated concepts before instruction
  
  But: this can result in higher extraneous load for high-prior knowledge learners

Examples?

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**Conclusion**

- Educational Design must take learners’ prior knowledge into account
- Also important: Consider change of learners’ knowledge as part of the learning process

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**ATI Research**

**Attribute x Treatment Interaction**

- Interaction between alternative attributes, traits, or aptitudes and alternative treatments

- Examples
  - Low- vs. high-structured environment for low vs. high-prior knowledge learners
  - Visual vs. Verbal treatment for Visualizers vs. Verbalizers
  - Direct Instruction vs. Exploration for low vs. high executive function learners
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ATI Research

Acceptable Evidence (Pashler, McDaniel, Rohrer, & Bjork, 2008)

Unacceptable evidence (Pashler, McDaniel, Rohrer, & Bjork, 2008)

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Method

- Authentic German Reading Text (Heinrich Böll)
- Within-subject design: Choice of Annotations (Visual or Verbal) for Vocabulary Words
- Preferences: VV-BOS (Visualizer/Verbalizer Behavioral Observation Scale)
- Vocabulary Test (Recognition)
- Comprehension Test (Recall Protocol)
- 103 Participants (college students)

Cognitive Load, Multimedia, and Abilities

Study 1 (Plass, Chun, Mayer, Leutner, 1998)
- Choice of Multimedia Annotations in Second-Language Reading Text
- Visualizer and Verbalizer Preferences

Study 2 (Plass, Chun, Mayer, Leutner, 2003)
- Four Treatment Groups: Visual x Verbal Annotation, use of annotations required
- Spatial and Verbal Ability

Cognitive Load, Multimedia, and Abilities

Vocabulary Acquisition

- No main effect of treatment or preference
- Multimedia Effect for Vocabulary Acquisition
- Significant interaction of learning preferences and annotation type
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Multimedia Effect

- Significant Interaction of Learning Preferences and Annotation Type, F(1,72) = 45.9, MSE = 90.40, p<.001

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Attribute x Treatment Interaction
- Significant Interaction of Learning Preferences and Annotation Type, F(1,72) = 45.9, MSE = 90.40, p<.001

Study 1–Results (Comprehension)

Text Comprehension
- No main effect of learning preferences
- Main effect of annotation type (annotated verbally only or visually and verbally)
- Interaction of learning preference and annotation type used to annotate a proposition

Significant Interaction of Learning Preferences and Annotation Type, F(1,72) = 4.42, MSE = 429.20, p < .05

Study 1–Summary

- Lookup choice supports learning preferences for Visualizers and Verbalizers for vocabulary acquisition
  - Same performance
  - Different lookup pattern
  - Different access routes for retrieval
- Absence of visual information leads to lower text comprehension for Visualizers
- Overall multimedia effect for vocabulary acquisition

Study 2–Lookup Required

- Visual annotations led to lower scores in vocabulary acquisition for low-ability learners
  - Insufficient cognitive resources to process visual information and build referential connections
  - Detrimental effects on vocabulary learning
- Visual annotations led to lower comprehension for all learners
  - Additional cognitive resources required to translate ambiguous visual information into verbal information
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Study 2–Lookup Required

- Forced lookup results in attention shift from text comprehension to vocabulary acquisition
- In high cognitive load situations: Only high-ability learners able to shift attention from vocabulary acquisition to text comprehension
- Overall multimedia effect for vocabulary acquisition

Discussion

- Lookup choice
  - Supports preferences of learning with visual v. verbal material
  - Results in equal performance but different processing patterns and retrieval cues used
- Forced lookup
  - Results in higher cognitive load for low-ability learners
  - Leads to shift of attention from text comprehension to vocabulary acquisition

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Instructional Format

- Comparison of exploratory learning vs. direct instruction:
  Interaction of instructional format and learners level of executive functions

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Representation of Information

- Comparison of iconic vs. symbolic representations:
  Interaction of representation type and learners level of prior knowledge

Implications

- Multimedia Information is not helpful for all learners under all conditions
- Instructional Application: Choice of presentation mode of information needed

Multimedia Learning

Interaction Effects

- Low vs. High Knowledge (Mayer, 1997; Plass et al., 2009)
- Low vs. High Spatial Ability (Mayer, 1997)
- Low vs. High Spatial/Verbal Ability (Plass et al., 2003)
- Verbalizer/Visualizer Preferences (Plass et al., 1998)
- Low vs. High Executive Functions (Plass et al., 2009)
Learning Outcome
• Can learners’ characteristics be used to predict learning outcomes?
  - Need for cognition
  - Locus of Control
  - Online Course activity (Wang & Newlin, 2000)

Approach
• Prediction of success v. Design for differences

Indiv. Differences and Learning

Salomon’s (1972) Heuristics

Approaches to Adaptive Learning

Compensation/Enabling Approach
• Compensate for shortcomings

Preference/Facilitating Approach
• Support Strengths

Remediation Approach
• Identify and address shortcomings

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Group Discussion

You are asked to develop an adaptive learning environment for teaching the History of Space Travel. How would you approach this project?

1. Identify relevant individual differences that affect the cognitive processes involved in instructional strategies
2. Identify their expected effect.
3. Design intervention to address this effect.

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Group Activity

How can the Cognitive Theory of Multimedia Learning be used to inform the design of effective multimedia instruction? Use your own example or one of these scenarios for your answer:

- Multimedia software to improve freshmen students’ Spanish vocabulary and to support the process of reading a text in Spanish.
- Multimedia software to introduce medical students to human anatomy.
- Multimedia instruction to train experienced Airline Pilots on the navigational instruments of a new type of airplane.
- Multimedia instruction in the history of the American civil war for university students