Breaking Through the Breakthrough Myth

Lecture Goals

• Explain the Breakthrough Myth

• Explain scientific ideas

• Explain scientific principles for progress

Misunderstanding Scientific Ideas

• 2006 – Is America Flunking Science?

Scientific Breakthrough Myth

• False belief that science creates ________________ answers to ____________ questions

• A.K.A. The “_________________________ Syndrome”

• Headlines
  • “Biological Experiment Reveals the Key to Life”
  • “New Breakthrough in Mind Control”
  • “California Scientist Discovers How to Postpone Death”

Scientific Ideas

• Everyday “theories” & “hypotheses”
  • Unverified ideas, mere guesses, ______________________________
• Based on _______________________________ observations, intuition, reasoning

• Scientific “hypotheses”
  • Predictions about specific changes or __________________ observed in
    ____________________ studies
    • I predict that people will bike faster when racing another instead of the clock
    • I predict that the ball will come back down after I throw it up into the sky

• Come from observing the world or thinking about the results of

• Scientific “theory”
  • Grows when similar results are found from testing

  • Bike races
  • Children’s fishing-reel competition
  • Throwing balls up into the sky
  • Throwing paper air planes
  • Sky diving
  • Slides

• Is an explanation about ______________________________________________

  • ___________________________ = explanation for pattern of symptoms

  • Theory of crime = explanation for pattern of ______________________________
• Theory of gravity
• Early social facilitation -- Human competition elevates motivation & performance

4 Broad Principles Drive Scientific Progress

• Principle of Connectivity
• Principle of Falsifiability
• Principle of Convergence
• Principle of Public Verification

Principle of Connectivity

• Gist – scientific ideas (hypotheses/theories) must connect to ____________________________

  • Not based on ____________________________ - a hunch, intuition, opinion
  • True with doctor’s diagnoses
  • True with theories of a crime

• Formally - scientific ideas must be connected to

  ____________________________

  • This is why theory of ____________________________ is not considered scientific

Principle of Falsifiability

• Gist – a scientific idea (hypotheses/theories) must be ____________________________ and
  ____________________________ enough that it could be wrong (false)
• Formally – Scientific ideas must predict an expected _______________ of empirical results…

• ____________________________ (can’t change ideas to match the results after-the-fact)

• That can be measured _____________________________ (not subjectively)

• That could be wrong (false)

• Limits questions science can address

• Science can only address _______________ questions, not general or essentialist ones

• Only some important questions are _______________________________ given current methods & technologies

**Principle of Convergence**

• Gist – ____________________________ that something is true increases when different researchers find the same thing

• ____________________________ or experiment

• Many potential problems (________________________)
  • Fisherman casts net and gets…only large fish
• “Perfect” study only rules out ______________________________ possible explanations

• Perfect ______________________________ only rules out some possible illnesses/causes

• ~__________________________ published results = wrong!!

• ______________________________ that are confirmed go on to further testing & replication in other studies

• ______________________________ in a finding when it is replicated across studies with different…
  • Researchers (or doctors)
    • Second opinions

  • ______________________________

  • ______________________________

  • Methodologies
    • Multiple medical tests = same illness

  • ______________________________ evidence

  • ______________________________ replication failure? ______________________________ was different?
    • Characteristics of sample?
• Methodological differences?

• Calls for more research, revision ________________________________

• _______________________________ /evidence suggest current diagnosis is wrong

• _______________________________ (suspect has air tight alibi) suggests current theory of crime is wrong

• In 20 questions, ________________________________ suggests that your current guess is wrong

• Spectator effects/Cockroach races/Poorer public performance

• New theory replaces old theory if it provides a better connection to the ________________________________

• A better explanation for the pattern of new and old ________________________________

• New diagnosis must account for new and ________________________________ symptoms

• New theory of crime must account for new and ________________________________

• Social facilitation/impairment & evaluation apprehension

• Once a new theory is in place (Evaluation Apprehension), seek more converging evidence revealing…. 
• _______________ of theory (biological predispositions)

• _______________ of theory (public speaking)

• _______________ for other theories (theories of coaching, education)

**Principle of Public Verification**
• Gist – Public knowledge and debate of results is important

• Publicizing work is ________________

  • Promotes replication & ________________

  • Promotes debate and ________________
    • Peer review process

  • Promotes ________________ focus

• Publication allows for ________________
  • 20 Questions with announced answers

**Anatomy of Scientific Articles**
• Principle of Connectivity

  • ________________

• Principle of Falsifiability
• Wherever hypotheses are discussed

• Principle of Convergence

• Principle of Public Verification