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Our Brains

- The human brain is
 - Wonderfully complex
 - Amazingly resilient
 - Easily fooled

But how? And why?

EMPIRICISM

CONJECTURE

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Ways We Fool Ourselves

Types of errors that we make

1. Problems in scientific thinking
2. Problems in pseudoscientific thinking
3. Logical problems in thinking
4. Psychological problems in thinking
5. Misperception & misinterpretation of random data
6. Misinterpretation of incomplete or unrepresentative data
7. Biased evaluation of ambiguous & inconsistent beliefs


Gilovich (1991), Shermer (2002) | science versus pseudoscience

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Problems in Scientific Thinking

- Theory influences observation
 - Perceptions of events are colored by our thoughts about them
 - E.g., "Why does someone become depressed?"

Internal conflicts between the id, ego, and superego!



Lack of proper reinforcement in the environment!





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Problems in Scientific Thinking

- The observer changes the observed
 - Studying a thing can have an impact on the thing studied





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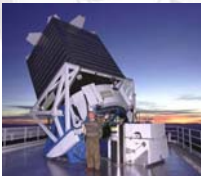
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Problems in Scientific Thinking

- Equipment constructs results
 - Our measuring devices impact what we see and how we theorize



VS.




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Probs in Pseudoscientific Thinking

- Anecdotes do not make a science

"I have an uncle who...."
"It worked for me!"



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Probs in Pseudoscientific Thinking

- Scientific language does not make a science

Energy fields, frequencies, vibrations, etc. are useless without an operational definition

"Many crystals have **healing properties** that you can discover. Crystals **vibrate at different frequencies** to **enhance** healing. Quartz crystals have excellent healing properties. Quartz also has the **ability to transform an imbalanced energy field**. When you feel stressed the crystal can **balance your energies** and **revitalize you**. Other minerals beside quartz crystals display healing properties. Small quartz crystals left in water will **ionize the water** and are a good drink for healing."

http://www.crystalinks.com/crystal_healing.html


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Probs in Pseudoscientific Thinking

- Bold statements do not make claims true

Extraordinary statements require what?



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Probs in Pseudoscientific Thinking

- Heresy does not equal correctness
"Oh yeah? Well, they laughed at...."

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Probs in Pseudoscientific Thinking

- Burden of proof
Those making claims must prove them, not the majority position

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Probs in Pseudoscientific Thinking



- Rumors do not equal reality
"I heard from someone that..."

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Probs in Pseudoscientific Thinking

- The unexplained is not inexplicable
"Well, I can't think of an answer, so it must be magic!"

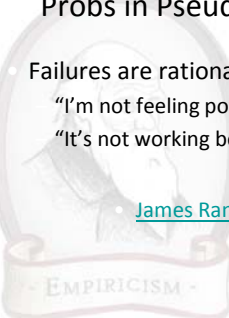
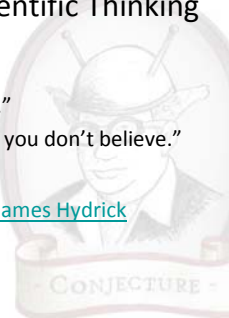
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Probs in Pseudoscientific Thinking

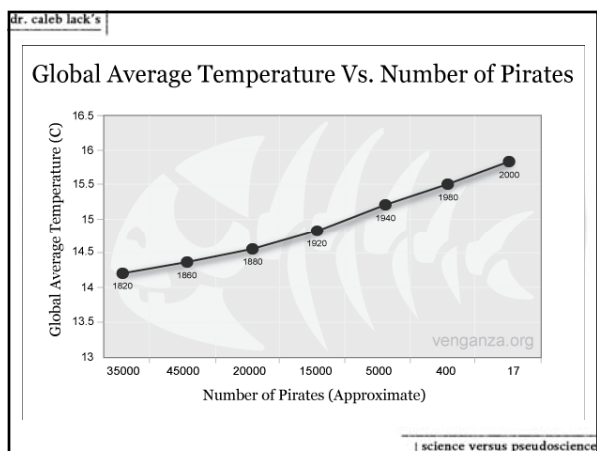
- Failures are rationalized
"I'm not feeling powerful."
"It's not working because you don't believe."

[James Randi vs. James Hydrick](#)

Vs



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Probs in Pseudoscientific Thinking

- Coincidence
 - "I'm on a roll!" or "He's got the hot hand!" greatly misunderstand statistics (more on this later)

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Probs in Pseudoscientific Thinking

- Representativeness
 - We forget the misses and remember the hits
 - Psychic Predictions for the Year 2005***

Romantic drama ahead for Chelsea Clinton. Every major disease will be cured. Terrorists start World War III by shooting a nuclear missile into China. World hunger ends when scientists developed a tasty crossbreed between a camel and an iguana. Communications will be disrupted when Earth's magnetic field reverses. A California inventor will cause earthquakes in Los Angeles and San Francisco. NASA astronomers will find a ruined city on Mars. Israel and the U.S. will invade Syria and Iran. Edible furniture will have to be recalled because of a sanitation problem. Millions of dollars in divorce fees will be saved when disgruntled couples were allowed to play a new computer game where the loser dies in real life. There will be a new Pope.

*as made in *The Sun*

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Logical Problems in Thinking

- Emotive words and false analogies

"Sup

"The

"New

"Peo

"Clini

"For a

"You'


"Pro-choice versus Pro-life

I'M A CHILD

NOT A CHOICE

IF YOU CAN'T TRUST ME WITH A CHOICE

HOW CAN YOU TRUST ME WITH A CHILD



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Logical Problems in Thinking

- *Ad ignorantiam*
An appeal to ignorance
"We can't prove that there isn't, so there must be!"

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Logical Problems in Thinking

- *Ad hominem* and *tu quoque*
"To the man" and "you also"

"Oh yeah? Well...you're a communist!"

"Sure, I did it...but everyone else did too!"

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Logical Problems in Thinking




- Hasty generalization
Improper induction / prejudice

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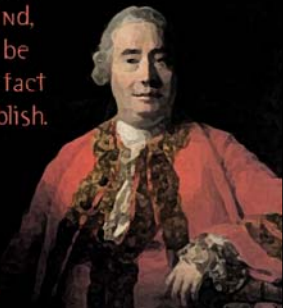
Logical Problems in Thinking

- Over reliance on authorities

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No testimony is sufficient to establish a miracle, unless the testimony be of such a kind, that its falsehood would be more miraculous than the fact which it endeavors to establish.




David Hume

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Logical Problems in Thinking

- False dilemma


"It's *either* this *or* that...and here are some arguments against that...so it must be this!"




"He who is not with me is against me..." Luke 11:23



"Every nation has to either be with us, or against us." Sept. 13, 2001



"Either you are with us, or you are with the terrorists." Sept. 20, 2001



"If you're not with me, you're my enemy."

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Logical Problems in Thinking

- Circular reasoning

The conclusion is a restatement of the premise


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Logical Problems in Thinking

Reductio ad absurdum and the slippery slope

"Why are you smoking?"
 "All my friends do."
 "If they all jumped off of a cliff, would you too?"



Eating ice cream will make you gain weight.
 Gaining weight will make you fat.
 Soon you will weigh 500 pounds and die of heart disease and diabetes.
 So, eating ice cream kills you. Don't do it.

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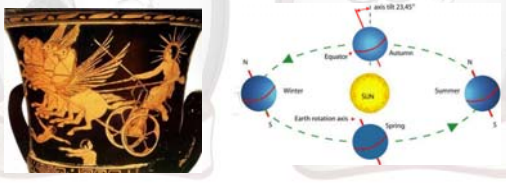
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Psychological Problems in Thinking

- Need for certainty, control, and simplicity
- Why does the sun rise and set?



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Psychological Problems in Thinking

- Problem-solving inadequacies

1. We quickly form hypotheses and look for confirmation only, not disproving evidence
2. We are very slow to change the hypothesis, even if obviously wrong
3. If information is too complex, we over simplify hypotheses or solutions
4. If not the right solution, we still form hypotheses about relationships due to coincidences

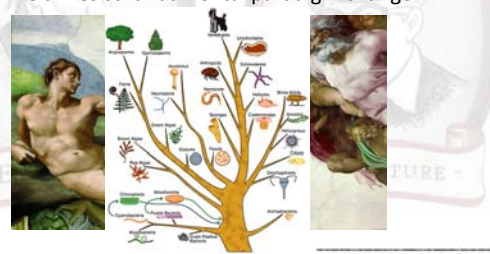
Singer & Abell (1981)

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Psychological Problems in Thinking

- Ideological immunity
- We all resist fundamental paradigm change



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Something from Nothing



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Something from Nothing



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Something from Nothing



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Something from Nothing



[Satan loves Rock 'n Roll](#)

Vs


- CONJECTURE -

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Something from Nothing

- Pareidolia – the tendency to interpret an ambiguous stimuli as something meaningful



- EMPIRIC -

- CONJECTURE -

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The “Hot Hand”

- In sports, the tendency for a player to get “hot” (making shots) after making 2-3 shots in a row

“Success breeds success”

- You get “cold” (missing shots) after missing 2-3 shots in a row

“Failure breeds failure”

But does it exist, or is it pareidolia?

- EMPIRIC -

- CONJECTURE -

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The "Hot Hand"

- Analyzed all shots taken by members of the 76er's in the 1980-1981 season
- No statistical relationship was found between the probability of making a shot and the outcome of the previous shots
- Examination of free-throws found that you were 75% likely to make a free-throw after missing the previous one *or* making it

Gilovich, Vallone, & Tversky (1985)
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The "Hot Hand"

- People believe in the hot hand because...
 - Our theories bias our observations
 - We don't know what chance looks like

If you flip a coin 20 times,
 how many will be heads?
 50% chance of 4 in a row
 25% chance of 5 in a row
 10% chance of 6 in a row

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Gambler's Fallacy

If you have a run of bad luck, you are "due" for a run of good luck

- This is another example of the *clustering illusion*



"Who is this guy? So he makes a study. I couldn't care less."

Red Auerbach

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Why Do We Still Believe?

- Judgment by representativeness
"Like goes with like"

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Why Do We Still Believe?

- Misperceptions of random distributions
It's all in how you divide it
- OXXOXOXOXOXOXOXOXOO

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Why Do We Still Believe?

- Humans are pattern recognition machines – especially for human forms

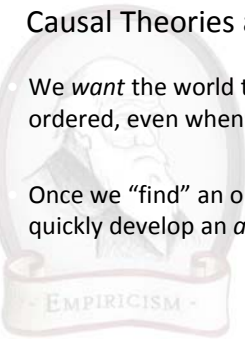
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Causal Theories and Misperceptions

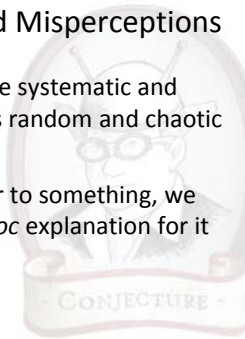
- We *want* the world to be systematic and ordered, even when it is random and chaotic

Once we "find" an order to something, we quickly develop an *ad hoc* explanation for it



- EMPIRICISM -

Vs



- CONJECTURE -

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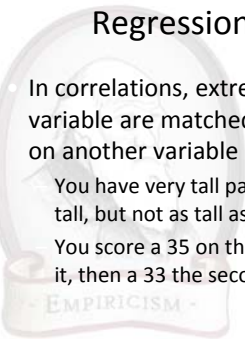
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Regression to the Mean

- In correlations, extreme values on one variable are matched by less extreme values on another variable

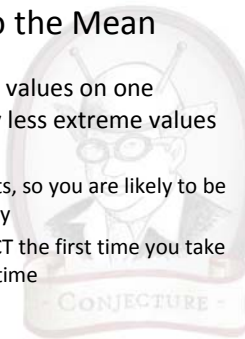
You have very tall parents, so you are likely to be tall, but not as tall as they

You score a 35 on the ACT the first time you take it, then a 33 the second time



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Vs



- CONJECTURE -

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Regression Fallacy



- EMPIRICISM -

Vs



- CONJECTURE -

[Sports Illustrated "jinx"](#)

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Too Much from Too Little

- Infertile couples who adopt often get pregnant right afterwards
- Dreams can predict future events
- Natural cures can sometimes cause cancer to go into remission
- These are often based on data from our real life, but not the right kind of data

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Does Adoption Impact Conception?

	Conceive	Do not Conceive
Adopt	A a	b
Do not Adopt	c	D d

Probability of conception after adoption = $a/(a+b)$

Probability of conception after non-adoption = $c/(c+d)$

We over-rely on cells A and D, skewing results

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Why?

- It's easier to deal with cognitively
- Non-confirmatory information is often framed negatively
- "All male UCO students are Bronchos" vs. "All male non-UCO students are non-Bronchos"

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Quick Quiz

- Each card has a letter on one side and a number on the other. Determine whether all cards with a vowel on one side have an even number on the other side by flipping one or two cards. Which do you flip?

A

B

2

3



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Example

- I'm thinking of a number between 1 and 10,000. You have 20 questions to guess it.

When I said "Yes" to a guess, were you more excited than when I said "No"? Why?

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Confirmatory Bias

- "It is the peculiar and perpetual error of the human understanding to be more moved and excited by affirmatives than negatives."

We don't objectively evaluate information, but focus on the positives – even in situations when we don't care if the hypothesis is true

Bacon (1620)
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Exercise #3

Quiz Maker II

Now that you know that people seek confirmatory information, how can you improve your quiz?

- Rework your original quiz over the next 10 minutes.

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Hidden Data

- Many times, we ignore certain parts of the data when making decisions

Other times, part of the data is unavailable, which can lead us to false conclusions

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Hidden Data

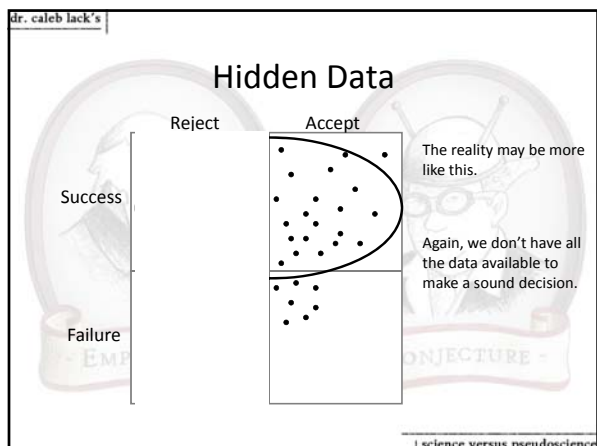
	Reject	Accept
Success		• • • • •
Failure		• • • • •

This shows all outcomes, both for accepted and rejected students.

We very rarely see this, though. Instead, we see only the "accepted."

This inflates the effectiveness of our "selection ability."

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Self-fulfilling Prophecy

- Our expectations lead us to act in ways that change the world that we observe
- We accept things as they are, with little consideration of how things might have gone differently if we had acted differently
- But for this to happen, mechanisms that translate expectations into confirmatory actions must be present

CONJECTURE - EMP

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Self-fulfilling Prophecy

- Negative prophecies are more easily fulfilled
- SFPs generally exaggerate a belief with at least a kernel of truth
- There are two kinds – true SFPs and seemingly-fulfilled prophecies
 - Expectations that limit another's responses, so that it is difficult to disconfirm the expectations

CONJECTURE - EMP

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Self-fulfilling Prophecy

- Seemingly-fulfilled examples
 - You think country music sucks, so you never listen to any of it
 - Someone who is thought to be a poor baseball player gets put in right field
- This is a special case of the hidden data problem

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Seeing What We Expect to See

- We make trade-offs in many situations
 - Large brain = long infancy
 - Quicker speed = less accuracy
- This is very apparent in our everyday use of judgment and reasoning skills
 - Ease of decision making = making systematic errors
 - E.g., the representative bias and...

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Seeing What We Expect to See

- Our expectations, preconceptions, and prior beliefs have a huge impact on how we interpret new information

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Appropriate and Inappropriate Bias

- When presented with new information
 - If consistent with our beliefs, it is accepted uncritically
 - If inconsistent with our beliefs, we carefully analyze and are critical of it
- Why are we like this?
 - COGNITIVE EFFICIENCY!

EMPIRICISM Vs CONJECTURE

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Is All Bias Bad?

- This goes back to scientific skepticism vs. pathological skepticism
 - Which should you more easily accept?
 -
 -

EMPIRICISM Vs CONJECTURE

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Ambiguous Information

Truly ambiguous information → **13**

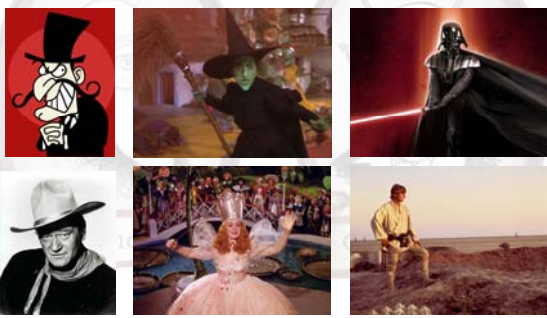
is perceived in a way that fits our preconceptions → **A13C**
→ **12 13 14**

EMPIRICISM Vs. COGNITIVISM

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Ambiguous Information



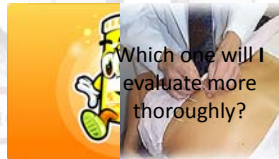
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Unambiguous Information

- Confirmatory evidence is accepted and not scrutinized; inconsistent information is put through the mental wringer




EMPIRICISM Vs. COGNITIVISM

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Unambiguous Information

- Gamblers have been shown to evaluate wins and losses in a similar way



Wins are seen as "sure things" or that they should have been more lopsided



Losses are seen as flukes or "near wins," with more time spent thinking about them

Vs

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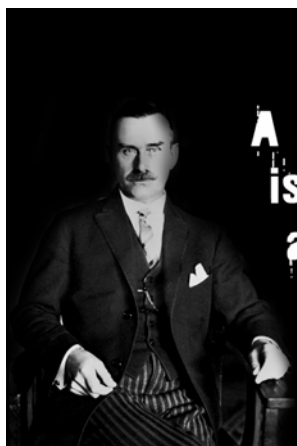
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Biased Science

- History is full of examples of grossly biased findings and interpretations
 - Broca's studies of brain size
 - Early intelligence testing
 - Lombroso's pain tolerance tests
- Past abuses point to the need for scientific skepticism and the scientific method

Vs

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A harmful truth
is better than
a useful lie.

Thomas Mann
