Less A, More I:
Using Psychology in Game AI

Dave Mark – Intrinsic Algorithm
Brian Schwab – Blizzard

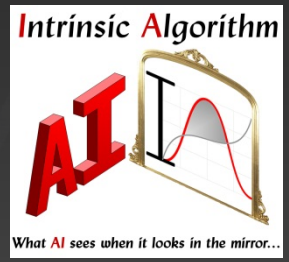
AI GAME PROGRAMMERS GUILD

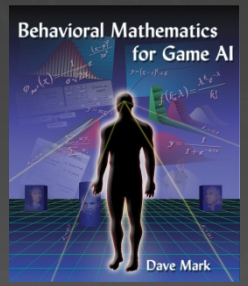
"Reducing the world to mathematical equations!"

Intrinsic Algorithm

Dave Mark

- President & Lead Designer of Intrinsic Algorithm LLC
  - Independent Game Studio
  - AI Consulting Company
- Author of *Behavioral Mathematics for Game AI*
- Contributed to:
  - *AI Game Programming Wisdom 4*
  - *Game Programming Gems 8*
  - *Game Developer Magazine*





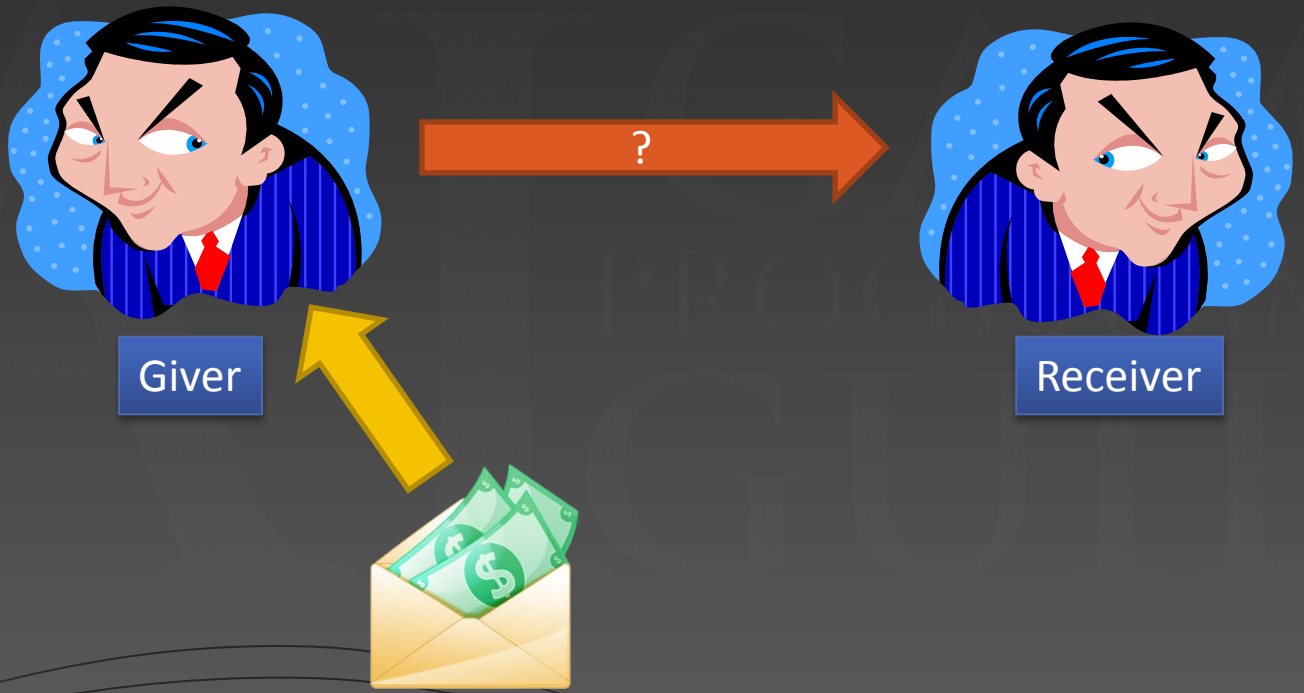
What We're Covering

- Could involve animation
  - Not necessarily an "AI and animation" talk
- Could involve character design
  - Not necessarily a design talk
- Could involve level design
  - Not necessarily a level design talk
- Aspects and tools that AI programmers need to be aware of to create more expressive characters

Let's Play a Game, Mr. Bond

- Ultimatum Game
  - I hand you $100
  - You must offer a portion of it to the person next to you
  - If the person *accepts* your offer, you both keep your amounts
  - If the person *rejects* your offer, I take the $100 back and you both get nothing.
- How much do you offer?

Ultimatum Game



Ultimatum Game

- "Fair" offer is $50
- Typical offer is about $30 (Giver keeps $70)
- Optimal offer is $1
  - Receiver gets $1 instead of $0
  - Giver maximizes what he keeps ($99)

Perfectly Rational

Perfectly Rational

How a Computer Does It

```
Offer = 0;
MineNow = 100;
MineSoon = 100;
YoursNow = 0;
YoursSoon = 0;

While !( YoursSoon > YoursNow) {
    Offer++;
    MineSoon--;
    YoursSoon++;
}
```

Result found:
Offer = $1

Emotions in Charge

Giver

- Desire (greed)
- Fear of Rejection
- Generosity
  - "This wasn't mine to begin with."
- Altruism
  - Still give when it is fake money (?)
- Pride/Shame
  - "I want the receiver to think of me as a good person."

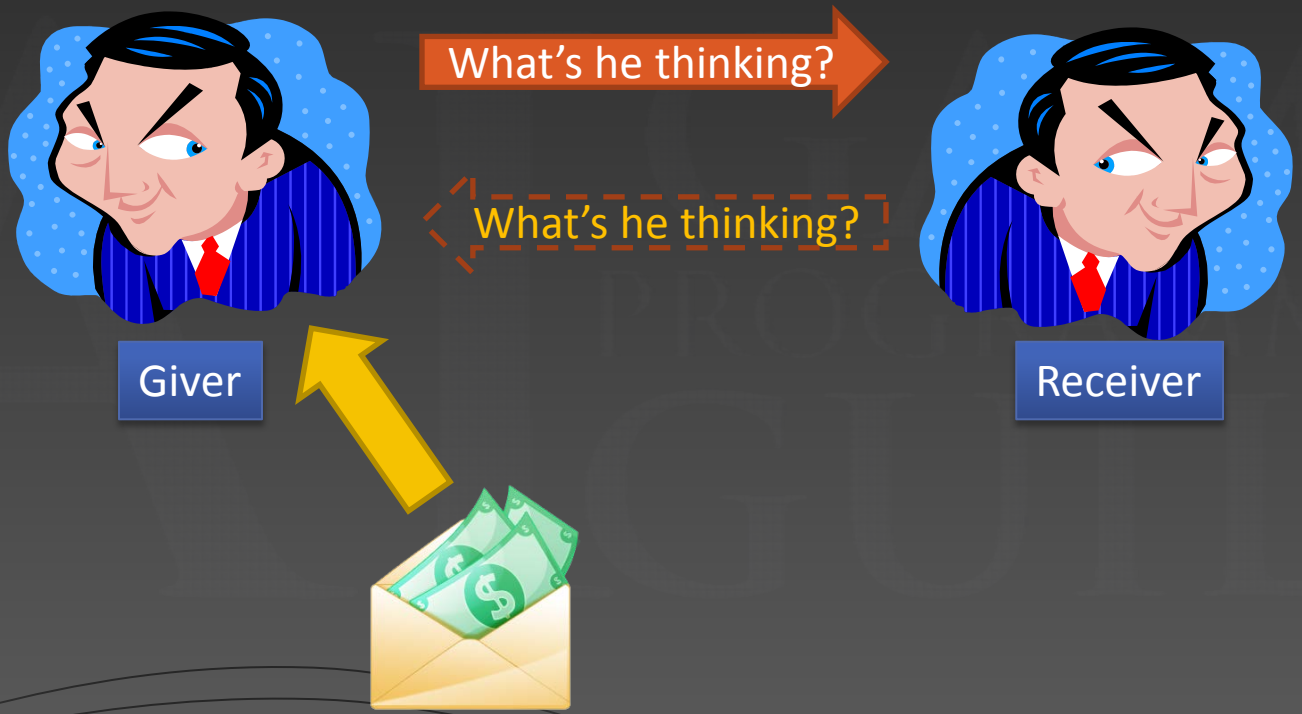
Receiver

- Desire (greed)
- Sense of Fairness
  - "There should be a split."
- Gratitude
  - "It's nice that he gave me some."
- Jilted/Slighted/Hurt
  - "What's wrong with me?"
- Spite
  - "If he won't give to me, I won't let him have his!"

Even Less Logical…

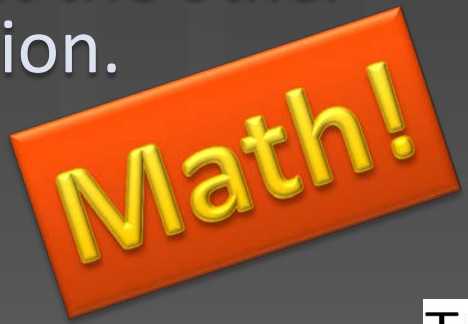
- Neurology too!
  - Increased oxytocin increased generous offers
  - Lower serotonin increased rejections
- Not all about the other human
  - People still give when they know it is a computer
  - (Being judged by the scientist?)
  - (Being judged by themselves?)

Mental Models



Mental Models

- Our decision must take into account the *other* player's situation.
  - What does he have now?
  - What will he have after?
- Our decision must take into account the *other* player's mental model of the situation.
  - He knows what I have now
  - He knows what I will have after



Empathy

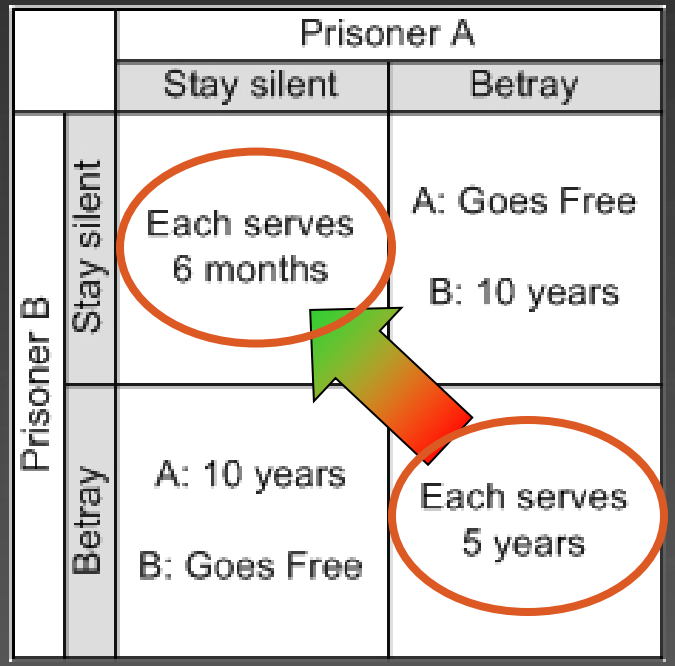
- How is he going to *feel* about this situation?
- How are those feelings going to affect his decision?
- How do I balance my desires with his?

“Terrible Twos”

- Developed a sense of self
- No awareness of other people’s mental models or emotions
- 2-year-olds are sociopaths
- (So are most AI agents.)

Psychology over Rationality

- Ultimatum Game
- Prisoner's Dilemma
- Poker
- Sports
  - Baseball
  - Basketball
  - Football



Artificial Psychology?

- Our agents don't really *have* psychology
- Our *players* have psychology
- How can we leverage our players' innate psychology to create the illusion of it in our agents?

What is he feeling?

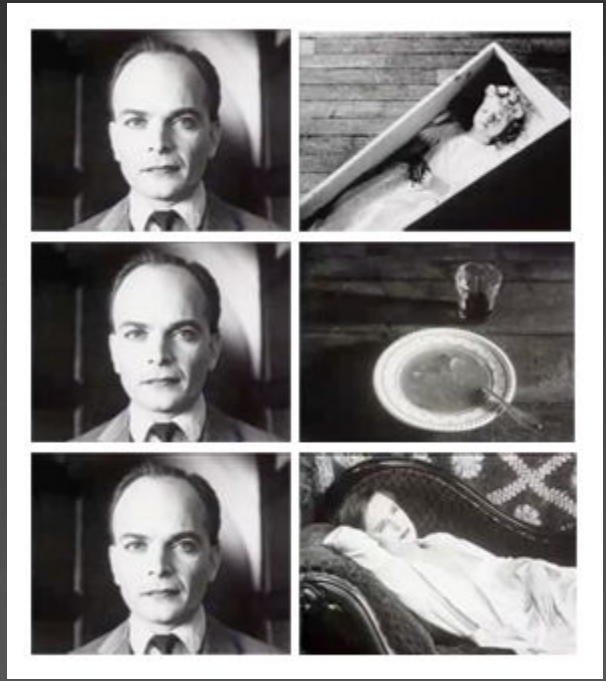
"Reducing the world to mathematical equations!"

Kuleshov Effect

- People project their own feelings onto the actor.
- What *should* the actor be feeling?
- What am *I* feeling?

People Project

- In the absence of any defining information, people project what they believe *should* be there.
- Their projections might be right or wrong.
- Let's help them out some!

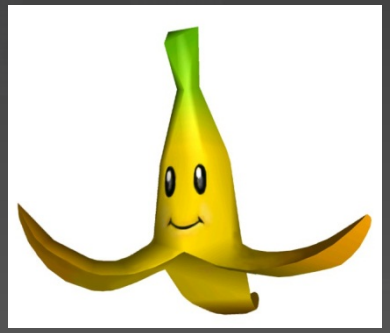


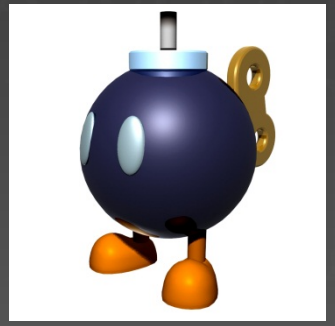
Face it…

- Biologically wired to recognize faces
  - Faces = fusiform gyrus
  - Objects = inferior temporal gyrus
- Babies will detect and follow faces
- Faces express most of our emotions
  - FACS, Paul Ekman

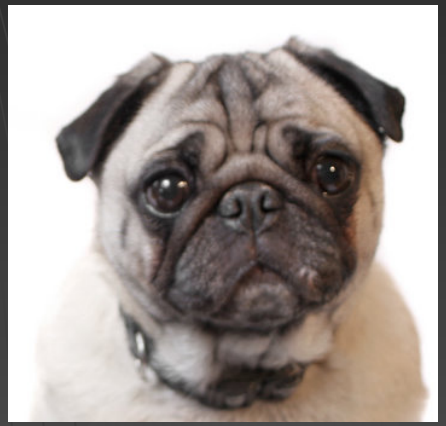
And the eyes have it…

- Biologically wired to detect eyes
- Biologically wired to feel *connection* to eyes



The Whites of their Eyes




- Humans have the highest % of visible sclera

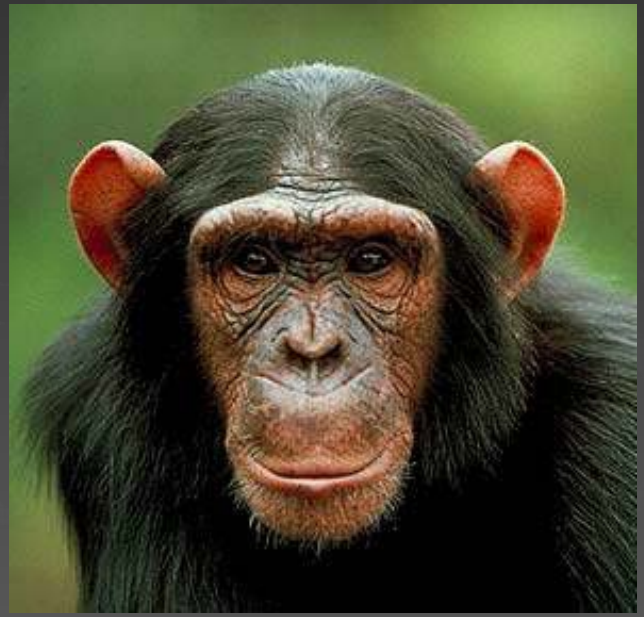
The Whites of their Eyes

- Easier to detect eye direction
  - Looking at a teleprompter instead of the camera
  - “Felt someone was looking at me”

The Whites of their Eyes

- Attention
  - "Where am I looking?"
  - Primates don't follow eye direction, only head direction
- Emotion
  - Interest
  - Surprise
  - Alarm
  - Fear
  - Desire

How does this help us?



Meet Egg Boy

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People Infer

- Given minimal physiological clues, people infer what they believe is causing them.
- Often this is done subconsciously
- This can be correct or incorrect
- The more information we can give them, the better.

Heider-Simmel

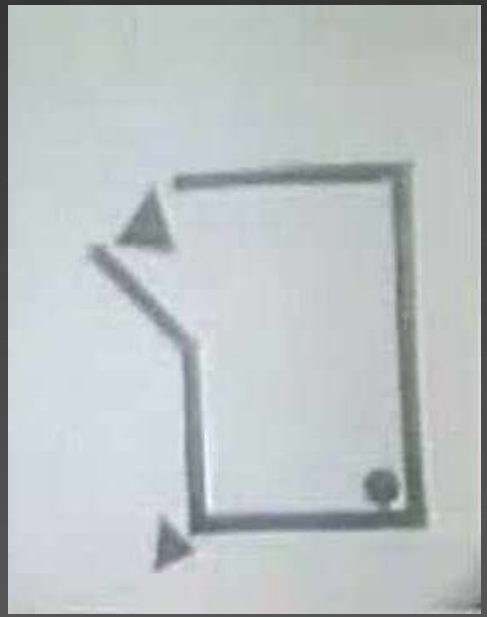
- Fritz Heider and Marianne Simmel,
  Smith College
- "An Experimental Study of Apparent Behavior"
  – American Journal of Psychology, 1944

Heider-Simmel

What did you just see?

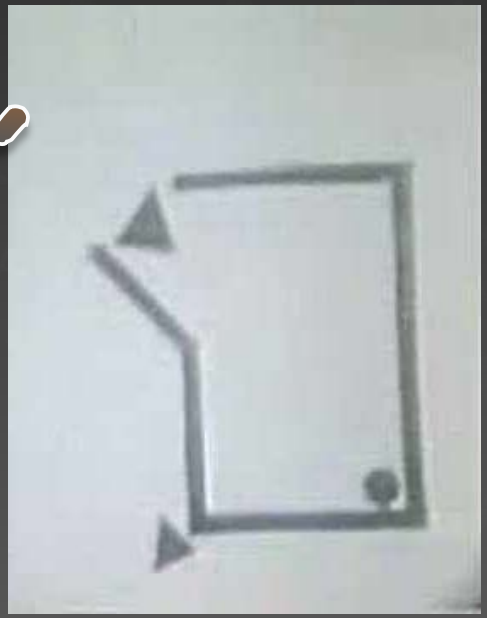
What most people say

- Young couple + big bully
- Young couple + angry father
- Mother and child + [bad guy]
- Drug deal gone bad?



What It Really Is...

IT'S 2 TRIANGLES,
A CIRCLE AND
SOME LINES!



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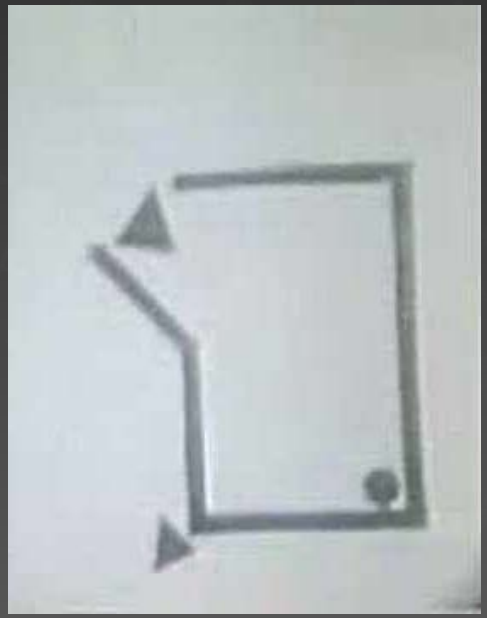
Intrinsic Algorithm

Male vs. Female?

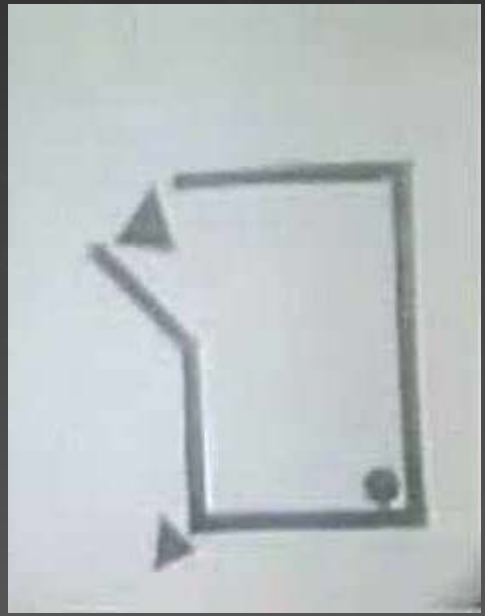
People Bring their own Narrative

- We do this with animals, right?
  - Dogs, cats, birds, fish, bears
  - Anthropomorphism is a cartoon staple
- Even on non-anthropomorphic objects, people can't help but interpret actions
  - Relationships
  - Causality
  - Intent
  - Mood, emotion



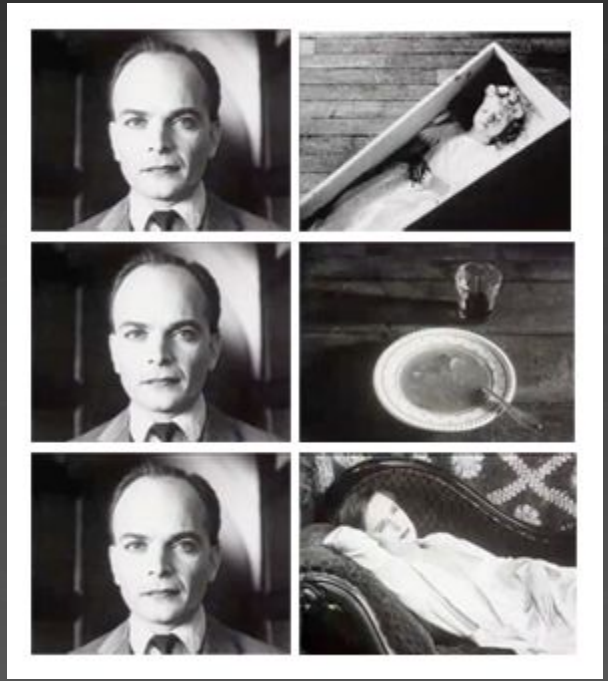
How do we tell?

- Movement Speed
  - Fast movement – joyful or angry?
  - Slow movement – menacing or sneaking?
- Spatial Position
  - In corner – resting or cowering?
  - Close together – loving or aggressive?



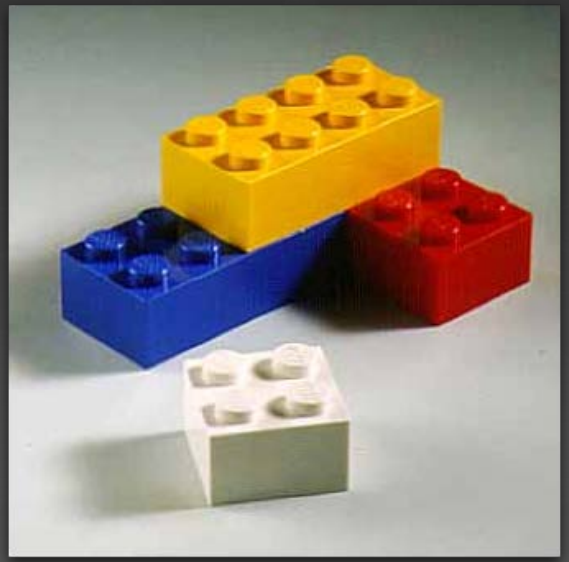
Inferences from Total Context

- Like Kuleshov effect, we put together *entire* montages
- Perception of one stimulus is affected by proximity to another stimulus



Crafting Meaning

- Numerous atomic actions
  - Facial
  - Postural
  - Barks
- Simultaneously or in serial
- “Assemble” different perceptions by the player



Crafting Meaning

- Random headlook
- Double-take at player
- Rapidly back up half-step
- Look around rapidly
- Rapidly look back at player
- Slowly back away from the player

- Random headlook
- Double-take at player
- Slowly back up half-step
- Glance around slowly
- Slowly look back at player
- Slowly move *toward* the player

Simple Things Make the Difference

- Speed of motion
- Fluidity
  - Smooth
  - Stutter-step
- Micro-motions
  - Flinches
  - Half-step forward
  - Half-step backward
- Headlook
  - Flinches
  - Double-takes (surprise!)
  - Relative Axis
    - Directly at
    - Partially towards
  - Eye-contact
    - With player
    - With other agents
    - With environment

The Power of Movement

- Changing speed of action
- Stopping and starting an action
  - Hesitation
  - Uncertainty
- Pausing
  - Preparing to do something (e.g. run away)
  - Restraining themselves

The Power of Headlook

- Looking for cover
  - Look at various cover points
  - Double look at one just before moving to it
- Looking at other agent's
  - Agents looking at each other are "working together"
  - Agents looking at the same agent show he's "the boss"

Big Motions vs. Small Motions

Early Silent Movie Actors

- Exaggerated body and facial actions
- Used music to add emotion
- Project over a distance (from stage)
- Looks campy, overblown, and out of place now
- Eventually learned that subtlety works

Early Game Characters

- Exaggerated body movements
- Used barks to reveal emotions and intentions
- Poor resolution and/or animation techniques
- Looks campy, overblown, and out of place now
- Time to learn how to be subtle?

Why Subtlety Matters

- People “sense” things that they are not directly focusing on
- People physiologically “feel” things even when we can’t explain why.
- Takes a shorter time that we realize

Pick a Card… Any Card

- University of Iowa “Gambling Task”
- 4 decks of cards – 2 red, 2 blue
  - Blue cards = generally better (net +)
  - Red cards = big payouts, *bigger* losses (net -)
- Pick one card at a time
- ???
- PROFIT!!

Pick a Card... Any Card...

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Pick a Card… Any Card

- After 80 cards:
  - Explain exactly what was going on
- After 50 cards:
  - Had a hunch *something* was amiss
- After 10 cards:
  - Exhibited physiological stress responses
  - Had already started *changing their behavior* (subconsciously)

Why are we doing this again?

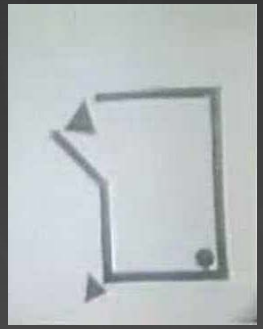
- Average character = 7 seconds
- Not a lot of direct interaction
  - Dialog
  - Cutscenes
- So does this really matter?

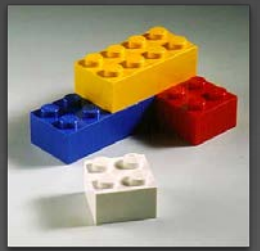
You only get one chance for that first impression…

- Nalini Ambady
- Students rated professors on teaching effectiveness over a whole semester
- Participants showed silent video clips of professors teaching
- Participants ratings aligned with that of the full-semester students' ratings
- Length of video:
  - 10 seconds
  - 5 seconds
  - 2 seconds

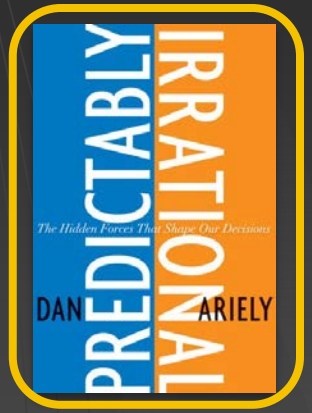
Simple Techniques – Lots of Mileage

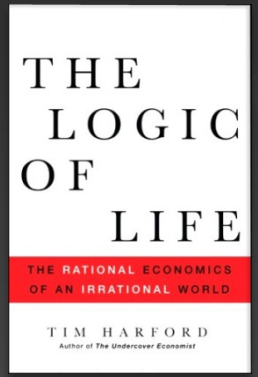
- People are *not* purely rational, they are emotional
- People want:
  - Engage with emotional characters
  - Engage their own psychology
- People will:
  - Assume causality
  - Infer narrative
- Leverage player's built-in assumptions and expectations
  - Adding simple building blocks (serial or parallel) will yank the player's psychological strings
  - Be subtle! Players will *feel* the changes before they even *realize* they are there.

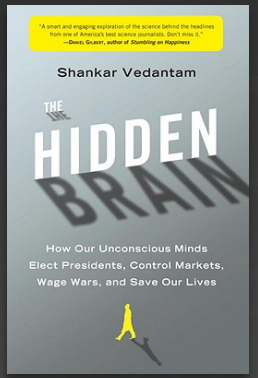


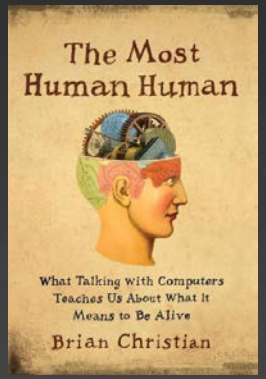


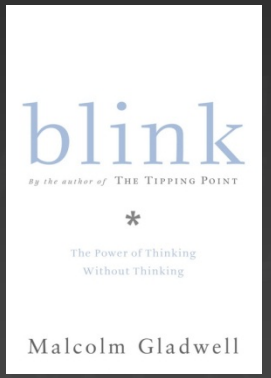
Further Reading

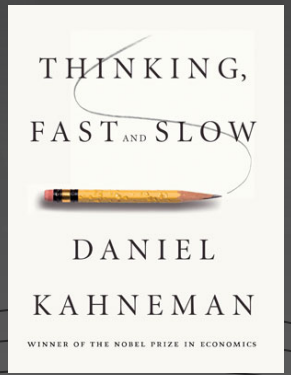


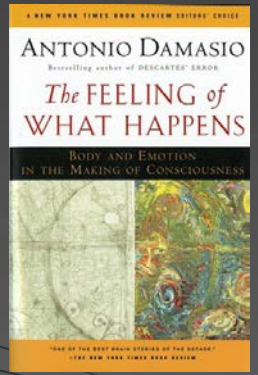


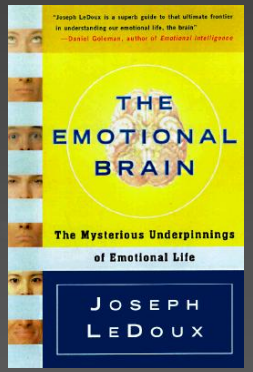












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