Mousetracking

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Today's outline

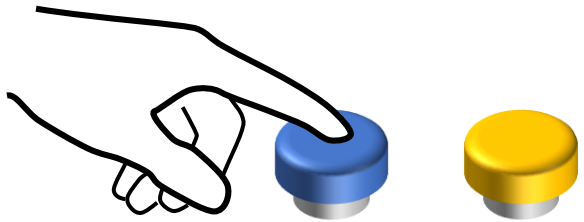
- Why mousetracking?
- Theories of cognitive processes
  - How can mouse-tracking be used to study theories
- Examples
- Examples beyond theories
- Combining measures
- Future
- Recap

Behavior and cognitive processes

Eye-tracking

Reaction Time (RT)

Neural measures



Psychophysiology

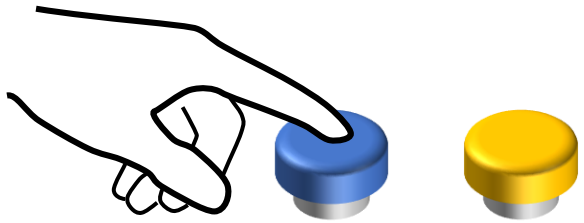
Spatiotemporal features of the action itself

Behavior and cognitive processes

Eye-tracking

Reaction Time (RT)

Neural measures



Mousetracking

Psychophysiology

Why mousetracking?

Why mousetracking?

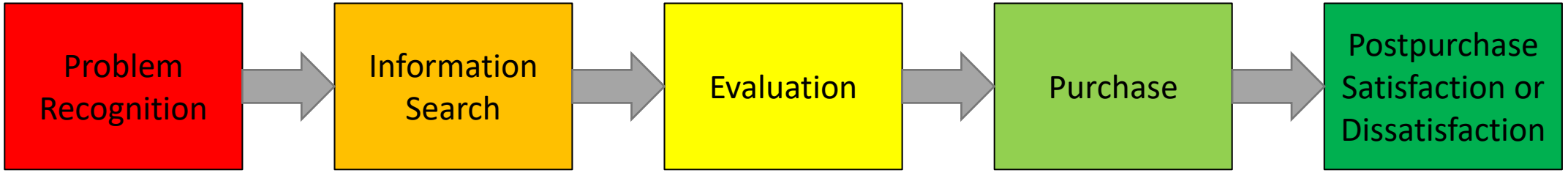
- Freely available and easy to use
  - You need a computer and a mouse
  - Freeware (for both running and analyzing)
  - Neurophysiological support for hand movements as valid index of evolving decisions
- Fine-grained measure of behavior
  - Decision microstructure
  - Capture in-between states

Theories of cognitive processes

- Stage-based models
- Dual-systems models
- Dynamic models

Stage-based models

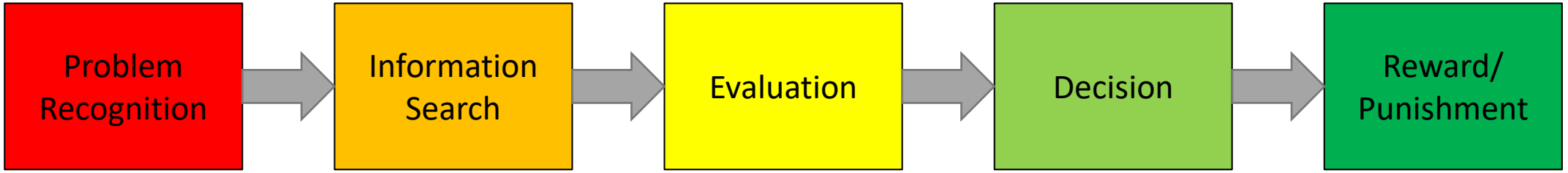
Consumer decision-making process



John Dewey, 1910, *How we think*

Stage-based models

Applied to more general decision-making processes



John Dewey, 1910, *How we think*

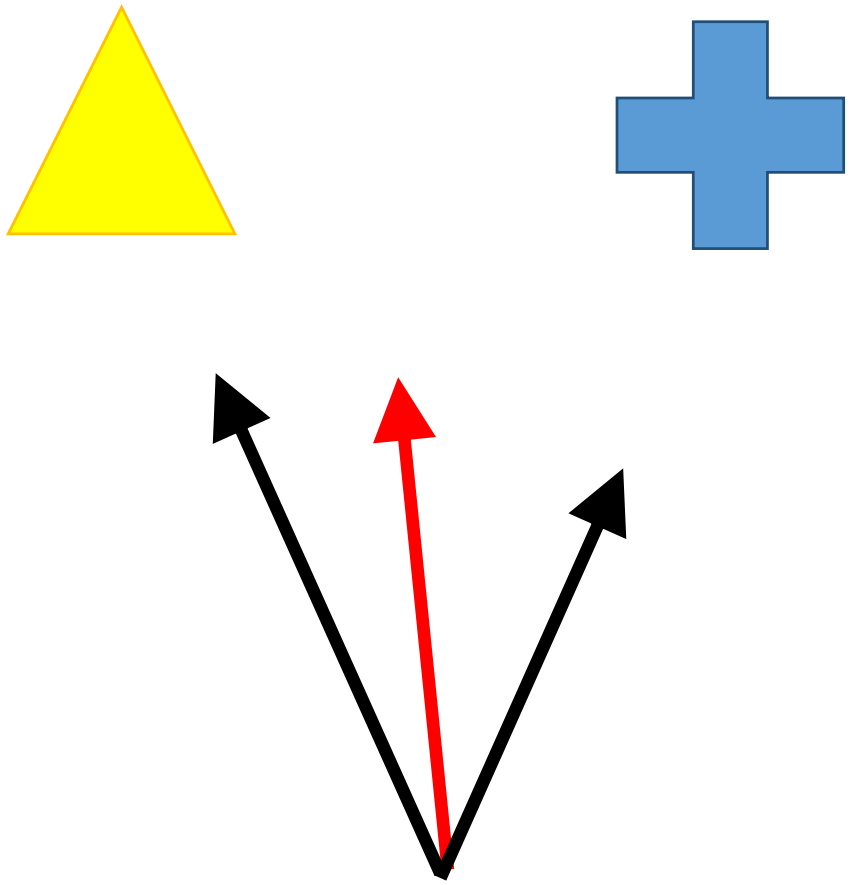
Dual-systems models

System 1
Fast, Automatic,
Non-consious,
Emotional,
Implicit

System 2
Slow, Controlled,
Conscious,
Logical, Rational

Kahneman, 2011, Thinking Fast and Slow

Dynamic models



PARALEL PROCESSING - MEANS OUR PATH PROB IS LIKE THE RED ARROW

From theory to prediction

Stage-based:

Dual-systems:

Midflight corrections

Flip-flopping

2 movement components (dual-systems)

SUDDEN CHAGNE

Dynamic:

Continuous attraction

Coactivation

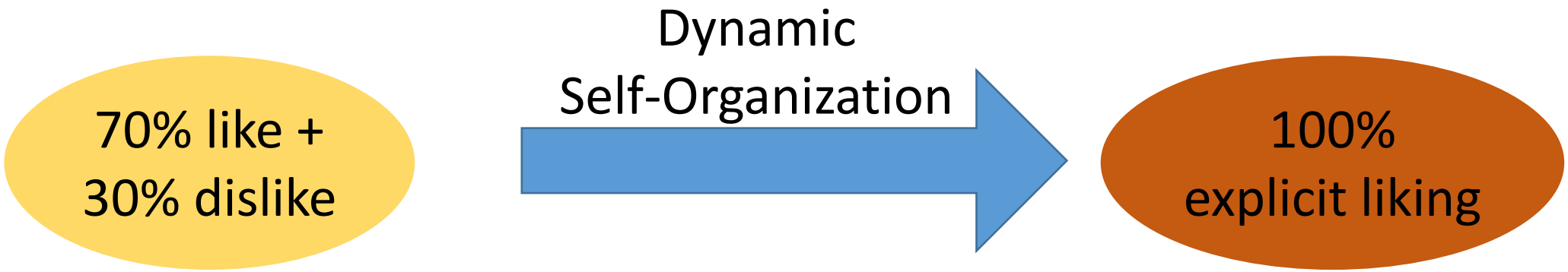
PREDICT A MORE SMOOTH MOVEMENT

Stereotypes & Attitudes

- How are attitudes formed?

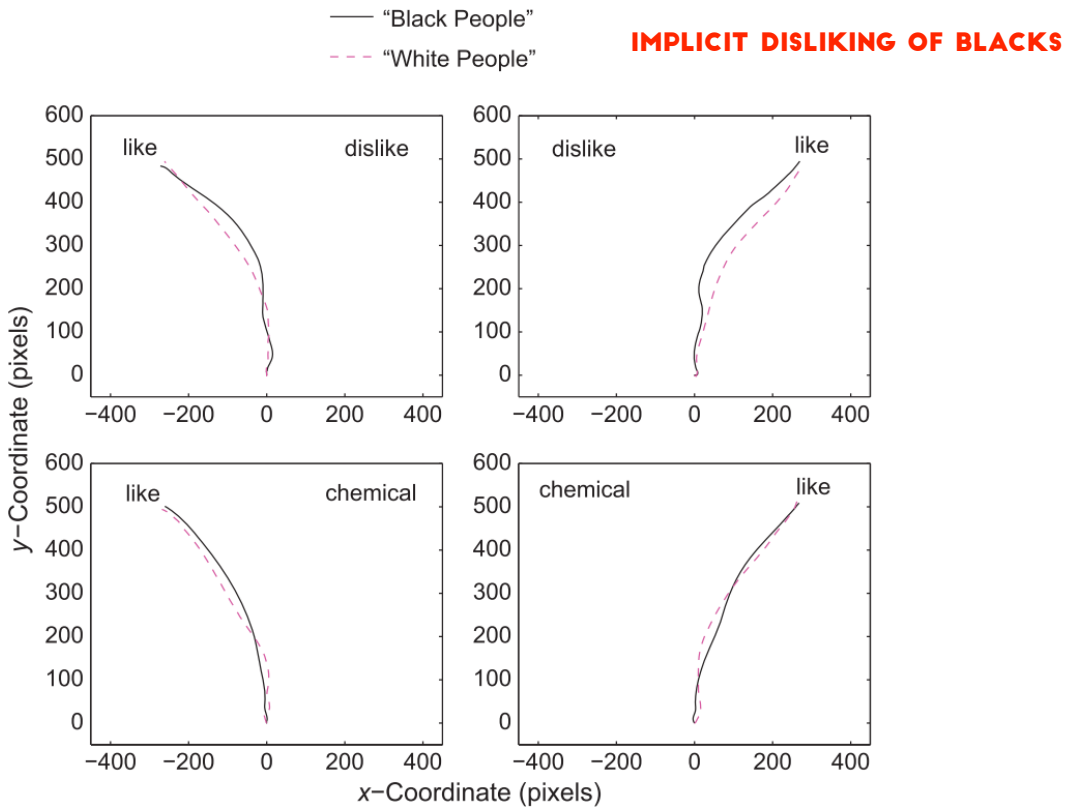
  Explicit & Implicit attitudes

- Coexistence of multiple attitudes



Wojnowicz et al, 2009, *The Self-Organization of Explicit Attitudes*

Stereotypes & Attitudes



Wojnowicz et al, 2009, *The Self-Organization of Explicit Attitudes*

Language comprehension

Understanding structurally ambiguous sentences:

“The adolescent hurried through the door tripped.”

- Activation of one vs multiple syntactic representations?
- Influence of non-syntactic information?

Farmer et al, 2007, *Tracking the Continuity of Language Comprehension : Computer Mouse Trajectories Suggest Parallel Syntactic Processing*

Language comprehension

Syntax-first models (stage-based):

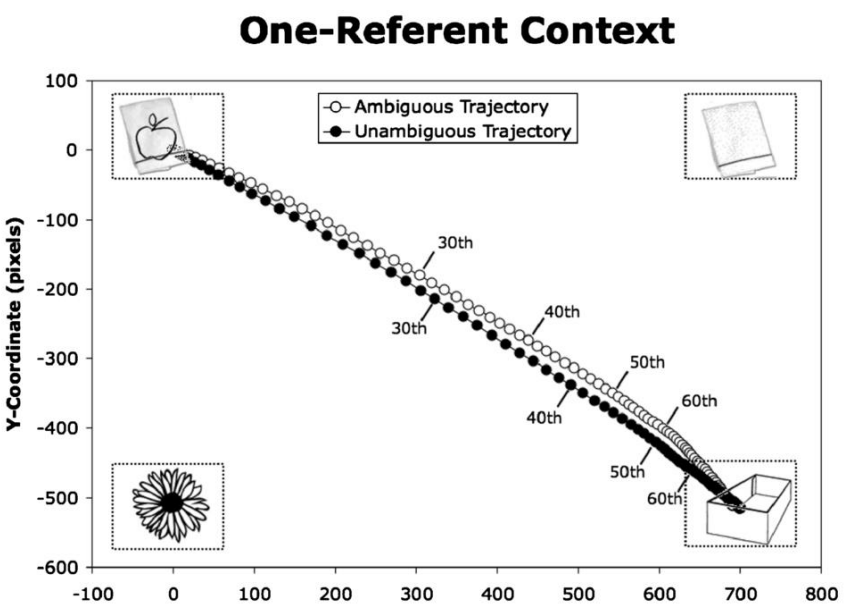
- One representation at any given time
- Misanalysis -> separate reanalysis
- Non-syntactic information comes in late

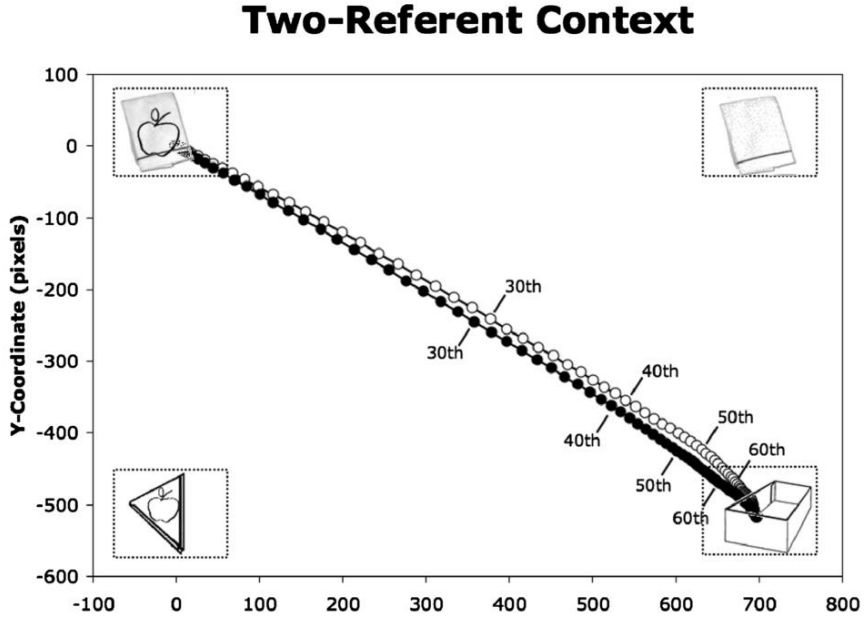
Multiple constraints-based models (dynamic):

- Simultaneous active representations
- All information integrated immediately

Farmer et al, 2007, *Tracking the Continuity of Language Comprehension : Computer Mouse Trajectories Suggest Parallel Syntactic Processing*

Language comprehension



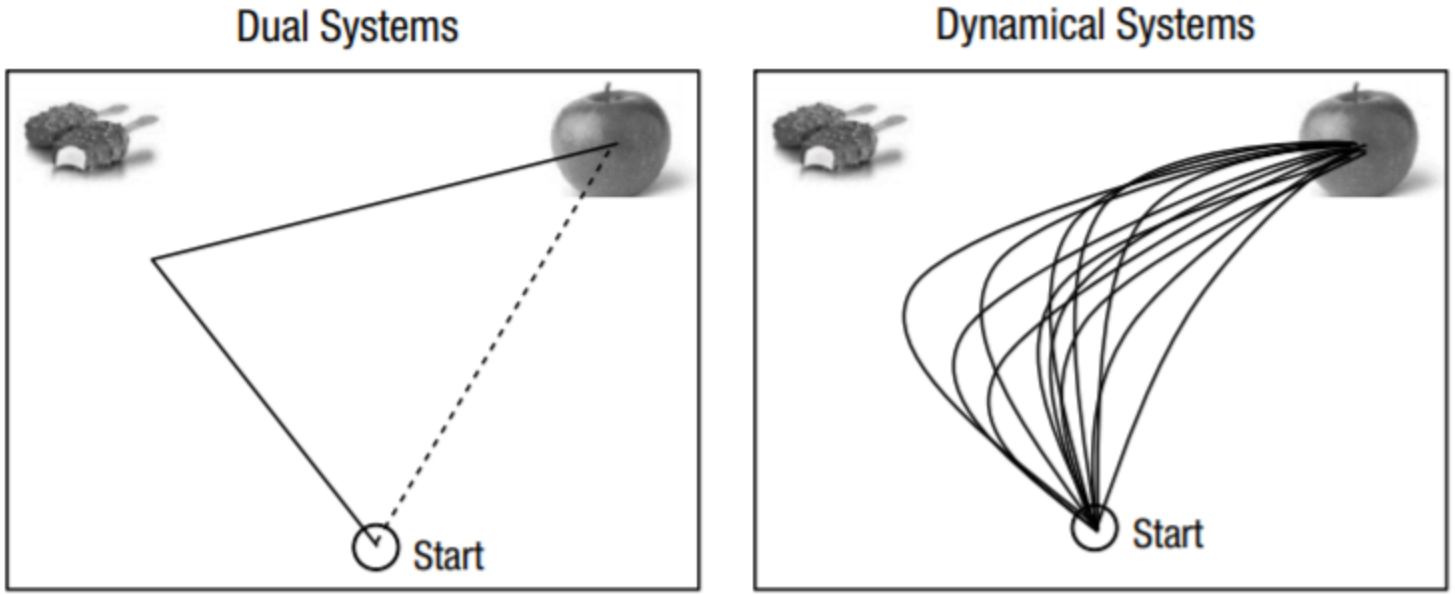


Ambiguous: *Put the apple on the towel in the box.*

Unambiguous: *Put the apple that's on the towel in the box.*

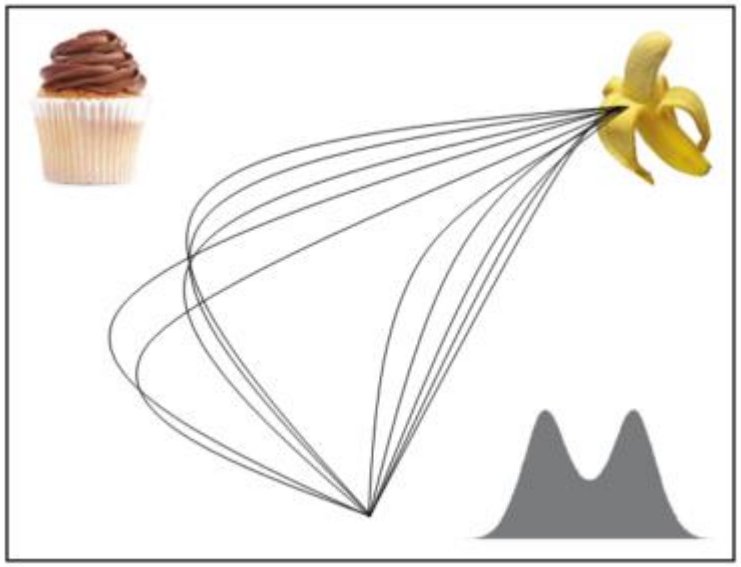
Farmer et al, 2007, *Tracking the Continuity of Language Comprehension : Computer Mouse Trajectories Suggest Parallel Syntactic Processing*

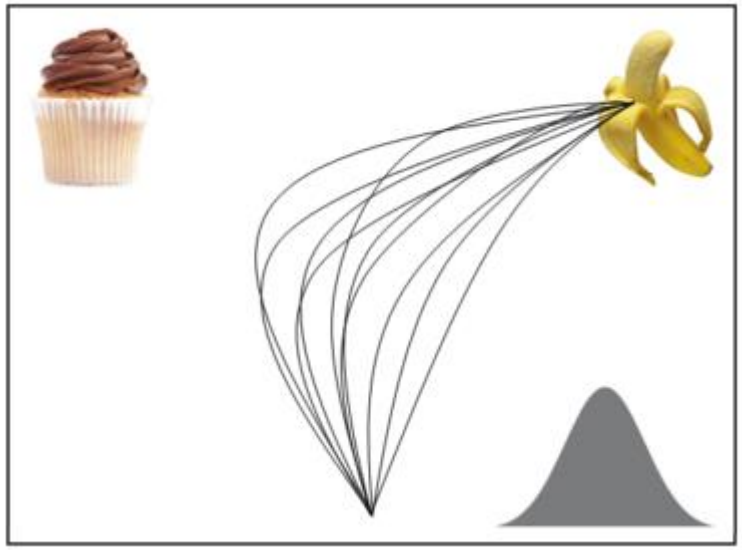
Dual-systems & Self-control?



Stillman et al, 2017, *Resisting temptation: Tracking how self-control coflicts are succesfully resolved in real time*

Dual-systems & Self-control?





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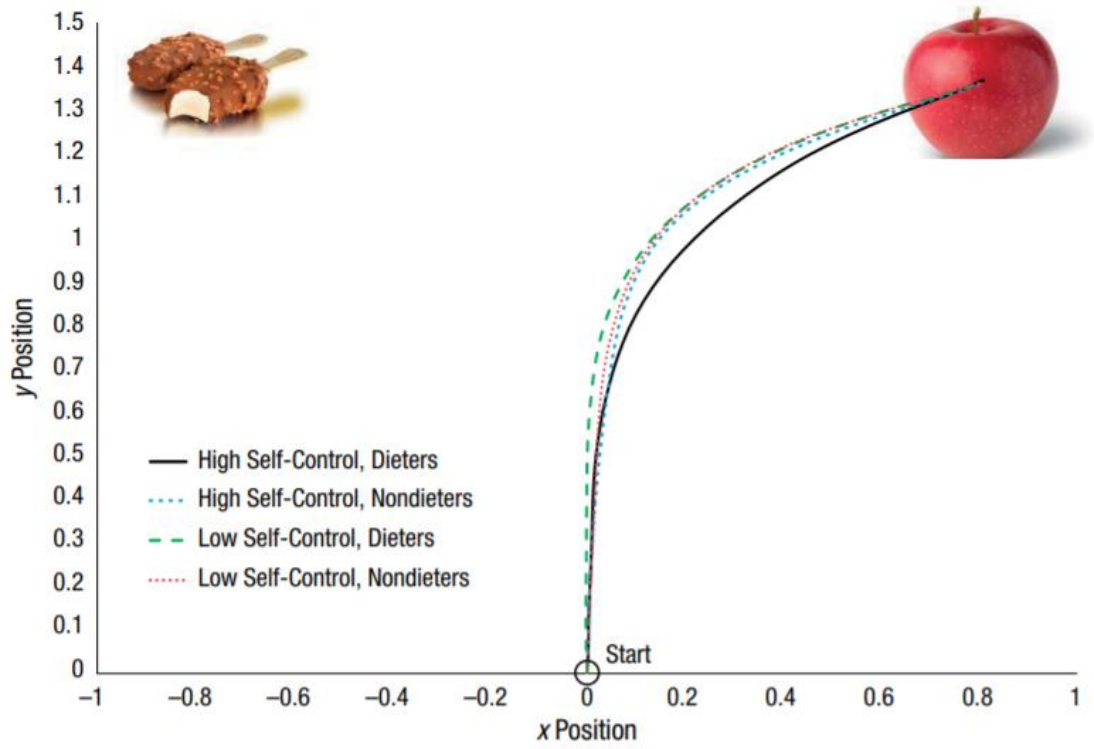
Dual-systems & Self-control?



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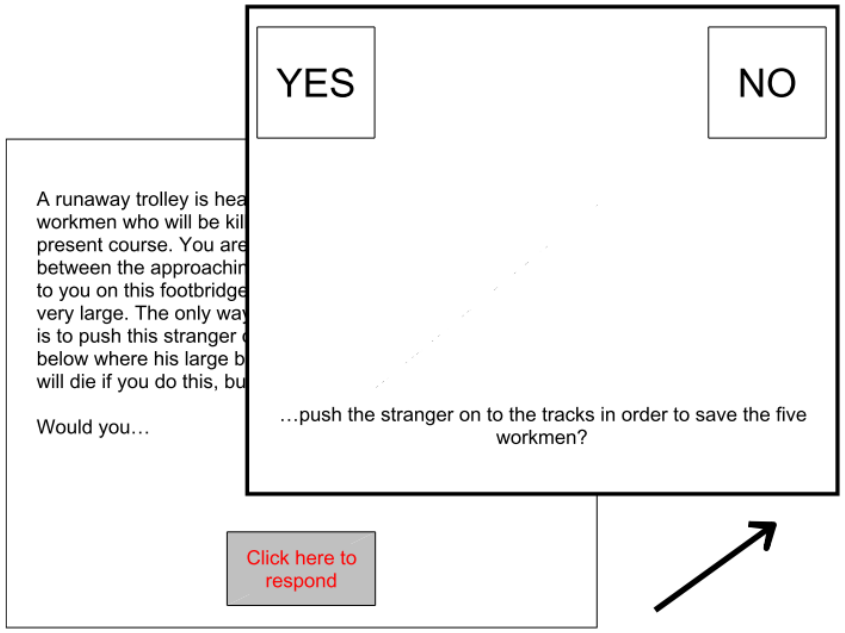
Moral decision making

- Emotion vs Deliberation
  - ”Default-interventionist” (DI) process (Evans, 2008)
  - Emotion = moral laws & rules / Deliberation = utalitarian concerns



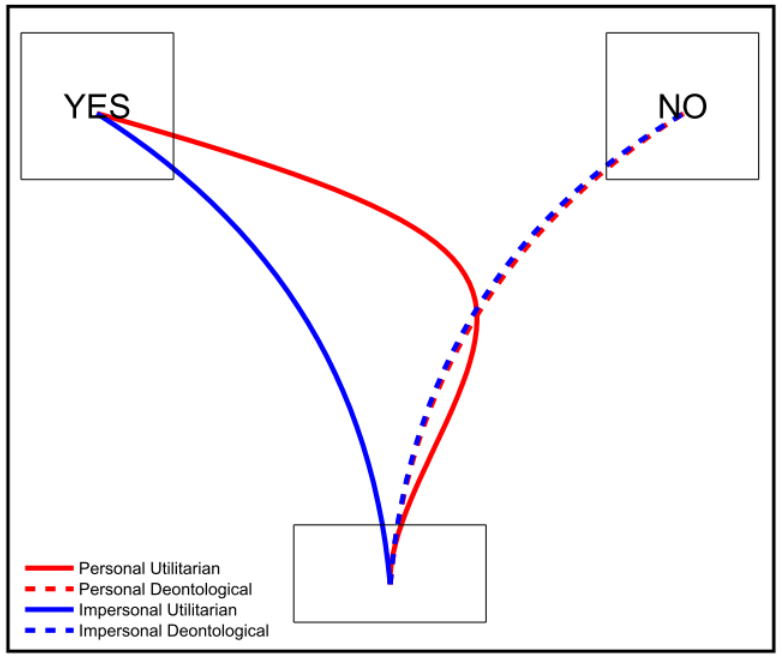
TROLLEY PROBLEM

Koop, 2013, Temporal dynamics of temporal decisions

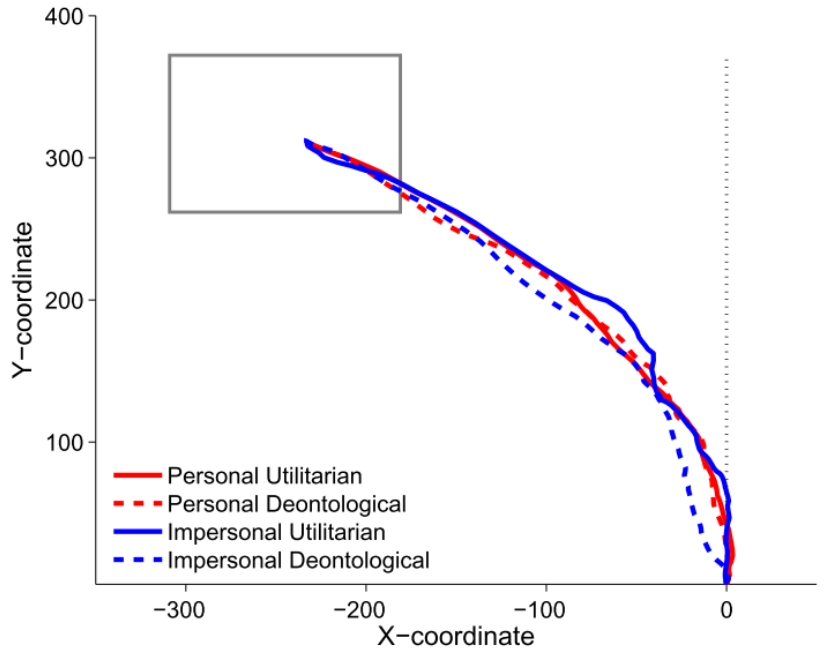
SHE TRIED TO FIND SOME ROBUST DUAL SYSTEM PREDICTIVE EXP., BUT NOO NO NO EVIDENCE FOR THIS GUTFEELING AND THEN MORE RATIONAL THOUGHT IN

Moral decision making

Dual-systems predictions



PERSONAL -> PUSHING IN FRONT
IMPERSONAL - PULL A LEVER



Koop, 2013, Temporal dynamics of temporal decisions

Beyond theories of cognitive processes

- Deception
- Value-based decision-making

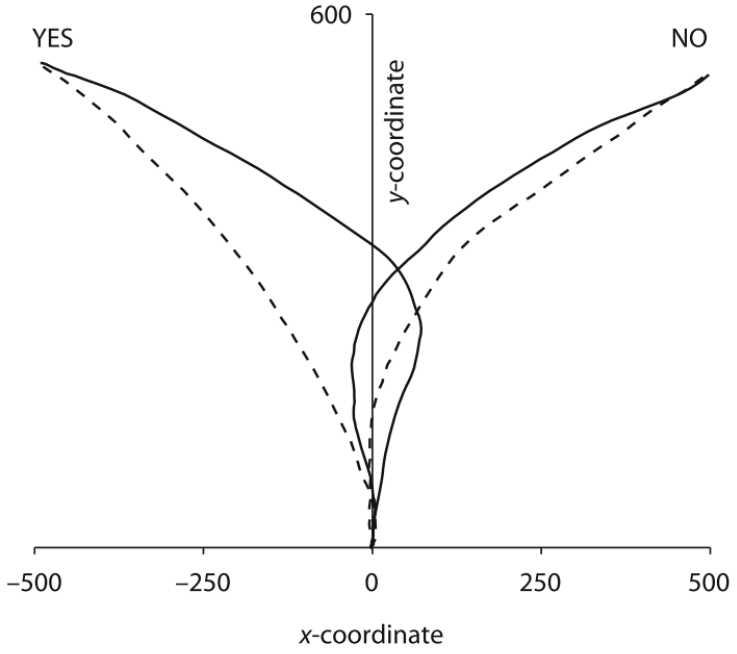
Temporal signature of deception

- False of truthful responses to autobiographical info (no/yes)
- Nintendo Wii Remote

Duran et al, 2010, *The action dynamics of overcoming the truths*

Temporal signature of deception

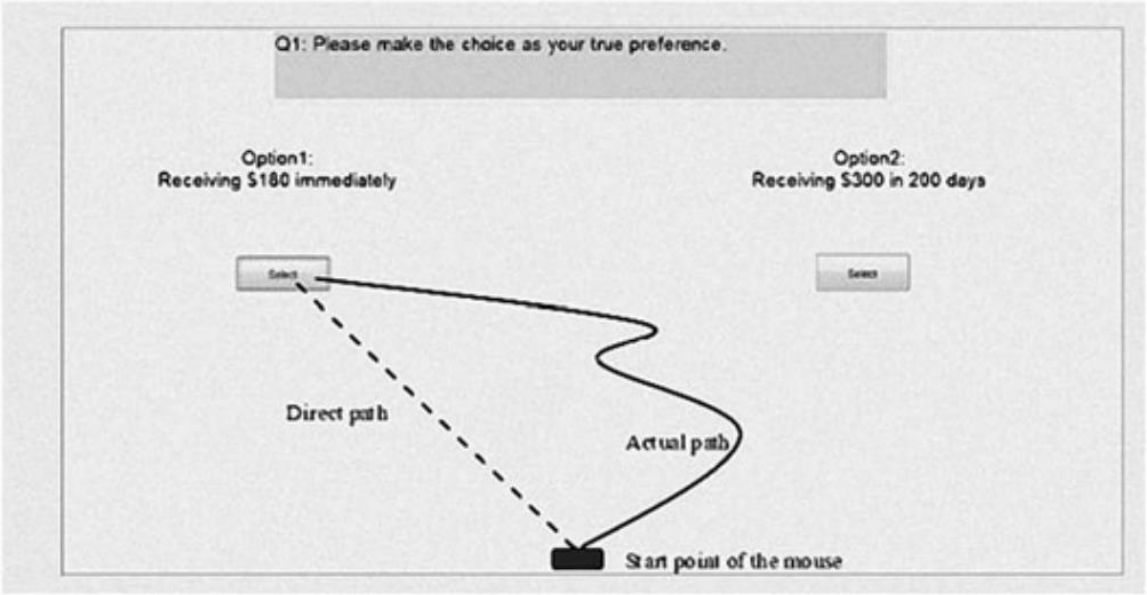
- False answers more complex (Yes greatest)
- Greater competition during false responding
- Deception detectable



Duran et al, 2010, *The action dynamics of overcoming the truths*

Value-based decision making

- Difference between decision uncertainty and decision conflict?
- Gain / Loss, Magnitude (Large / Small), Delay (Great, Small)



Cheng & González-Vallejo, 2017, *Action Dynamics in Intertemporal Choice Reveal Different Facets of Decision Process*

Value-based decision making

- Five measures (out approx 40 common)
  - X-flips HOW MANY TIMES SWITCH DIRECTION
  - Absolute average deviation (AAD) COMMON MEASURE OF DISTANCE FROM FASTEST PATH
  - Distance HOW LONG A PATH FOR THE CURSOR
  - Idle time TIME NOT DOING
  - Motion time TIME DOING
- PCA to derive components
  PRINCIPAL COMPONENT ANALYSIS

Cheng & González-Vallejo, 2017, *Action Dynamics in Intertemporal Choice Reveal Different Facets of Decision Process*

Value-based decision making

- Conflict
  - Increased Idle Time
  - Increased deviations from direct path

- Wavering (decision uncertainty)
  - Increased x-flips

Cheng & González-Vallejo, 2017, *Action Dynamics in Intertemporal Choice Reveal Different Facets of Decision Process*

Mouse-tracking & other measures

- Eye-tracking
  - MT continuous measure, ET discrete saccades
  - ET more sensitive to preattentive processes, before movement
  - Combining the two can be a good idea

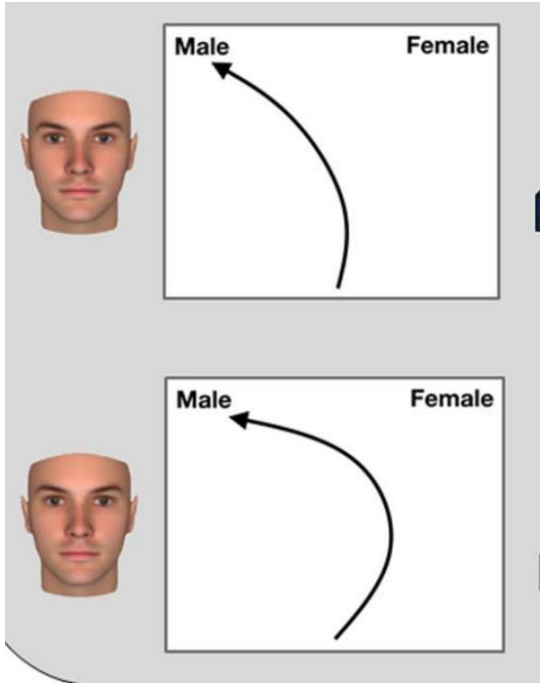
Mouse-tracking & other measures

- ERP
  - ERPs clear time lock, exact timing of interest
  - MT exact timing has no meaning, relative differences of interest
  - Combining both -> more meaningful interpretation of MT timing
  - Combining ERP with MT -> problem with ERP artifacts

Mouse-tracking & other measures

- fMRI or TMS
  - Allows for combining neural representational patterns with trajectories

- Categorizing gender & race (typical & atypical)
  - Multivoxel patterns in right fusiform gyrus in atypical trials more similar to oposing category



Stolier & Freeman, 2017, *A neural mechanism of social categorization*

The future of mouse-tracking

- Combining measures
  - Perhaps especially neuroimaging (fMRI, TMS)
- Investigating the implicit nature of MT
- Increased interest in motor processes

NOT JUST THE BRAAAAAAAAAAIN

The future of mouse-tracking looks bright!

Quick Recap

- Mouse-tracking is an easy to use method that captures the micro-structure of decisions
- Originally applied to distinguish between theories of cognitive processes
  - Stage-based / Dual-systems / Dynamic systems
- Applied in ”all” areas of research
  - Language processsing, value-based decisions, moral cognition, self-control
- A method that can easily be combined with other measures

Discussion, Questions, Comments?

Thank you!