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Using Cognitive Modeling to Study Behaviour Moderators: Pre-task Appraisal, Anxiety, and Later, Caffeine

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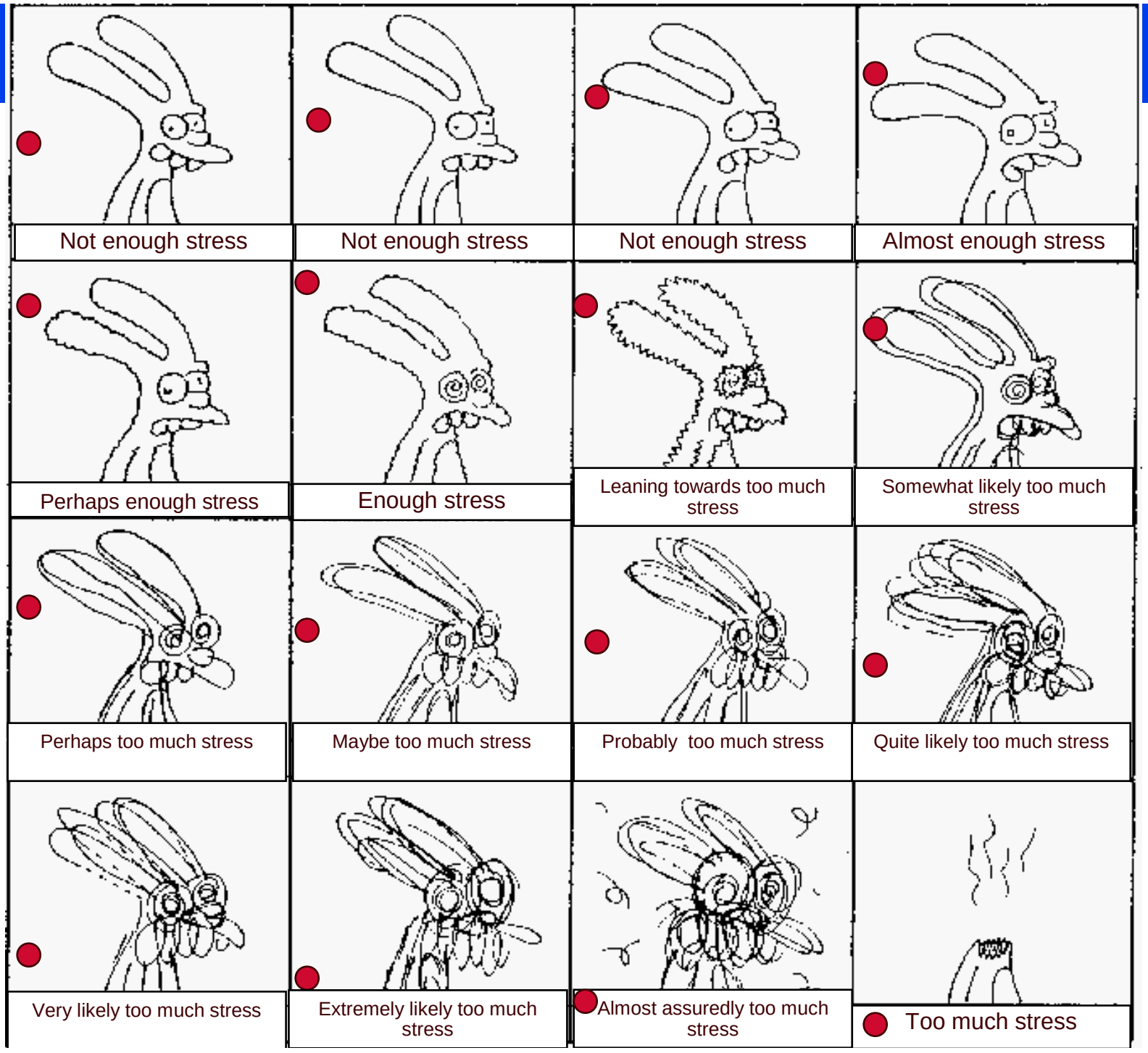
Motivation for Modeling Moderators

- Modeling cognition and affect including stress (multiple behavioral moderators that influence architecture processing)
- Important for modeling aspects of human-computer interactions
- Extending computer-generated forces
- Example validated model


Not enough stress
Not enough stress
Not enough stress
Almost enough stress
Perhaps enough stress
Enough stress
Leaning towards too much stress
Somewhat likely too much stress
Perhaps too much stress
Maybe too much stress
Probably too much stress
Quite likely too much stress
Very likely too much stress
Extremely likely too much stress
Almost assuredly too much stress
Too much stress

Our Approach

- Cognitive architecture (ACT-R)
- Biopsychology models and data
- Validation of model's behavior
- Displays to explain model to
  - > analysts
  - > readers

ACT-R Model of Serial Subtraction

- Create goal to serial subtract
  - > Subgoal to do current column
    - Two strategies: count-down and subtract
    - Get column answer
  - > Repeat across columns
  - > Report result
- 28 rules
- 15 state chunks + 230 math facts (~250 total chunks)

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Subtraction Data: Neutral and Non-neutral Appraisal

- Subtask of many military tasks
- Relevant data to hand
  % correct and attempts from article
- Problem is that we will need more detailed data with moderators active
  - > Typically, with moderators active only gross performance measures are taken

Data to Be Modeled: Challenge Appraisals

- Pre-task appraisal and Caffeine
  - » Important effects in humans

- "Challenge" pre-task appraisal:
  - > incr. heart rate, incr. sympathetic arousal, vascular dilation: good energy mobilization (fight-or-flight)
  - > incr. subtraction attempts
  - > incr. percent correct responses

Data to Be Modeled: Threatening Appraisals

- "Threatening" pre-task appraisal
  - > modest incr. heart rate, modest incr. sympathetic arousal, vascular constriction, poor energy mobilization
  - > decr. subtraction attempts
  - > decr. percent correct responses

	Its **Effect**	Overlay **Implementation**
Pre-task appraisal	Challenge leads to more attempts, less errors	Decrease Expected-Gain-Noise (0.1) Increase circulation, generally *
	Threat leads to fewer attempts, more errors	Increase Expected-Gain-Noise (1.0) Complex changes in circulatory system *
Anxiety	Same as threat	Rule fires, using time and decreasing working memory activation
Caffeine	Increased alertness with inverted U-shaped curve	Affects threshold at end of 4 min. run for Challenging post-task appraisal*
	At moderate doses decreased RT	Indirect through task appraisal*
	Exacerbate the effects of anxiety	Decrease error threshold needed for post-task appraisal being "threat"*

* Indicates not in released version.

Subtraction Model (challenge)

QuickTime™ and a
Graphics decompressor
are needed to see this picture.

Subtractions: Predicted and Actual

		Cognitive Appraisal Overlay: Threat (EGN=1)		Challenge (EGN=0.1)		Neutral (Default) (EGN=0)
Model	Attempts	46.8 (3.6)	<	54.5 (3.5)	<	70.9 (1.3)
(N=100)	Correct	42.5 (5.1)	<	50.2 (5.1)	<	70.9 (1.3)
	% correct	91%		92%		100%
Model with math anxiety	Attempts	36.8 (2.6)	<	40.6 (2.6)	<	58.8 (1.0)
(N=100)	Correct	32.2 (4.3)	<	36.0 (4.2)	<	58.8 (1.0)
	% correct	88%		88%		100%
Human data	Attempts	46		61		
(N=22)	Correct	42		56		
	% correct	91%		92%		

Ritter, F. E., Avraamides, M., & Councill, I. G. (2002). An approach for accurately modeling the effects of behavior moderators. In *Proceedings of the 11th Computer Generated Forces Conference*. 29-40, 02-CGF-002. Orlando, FL: U. of Central Florida.

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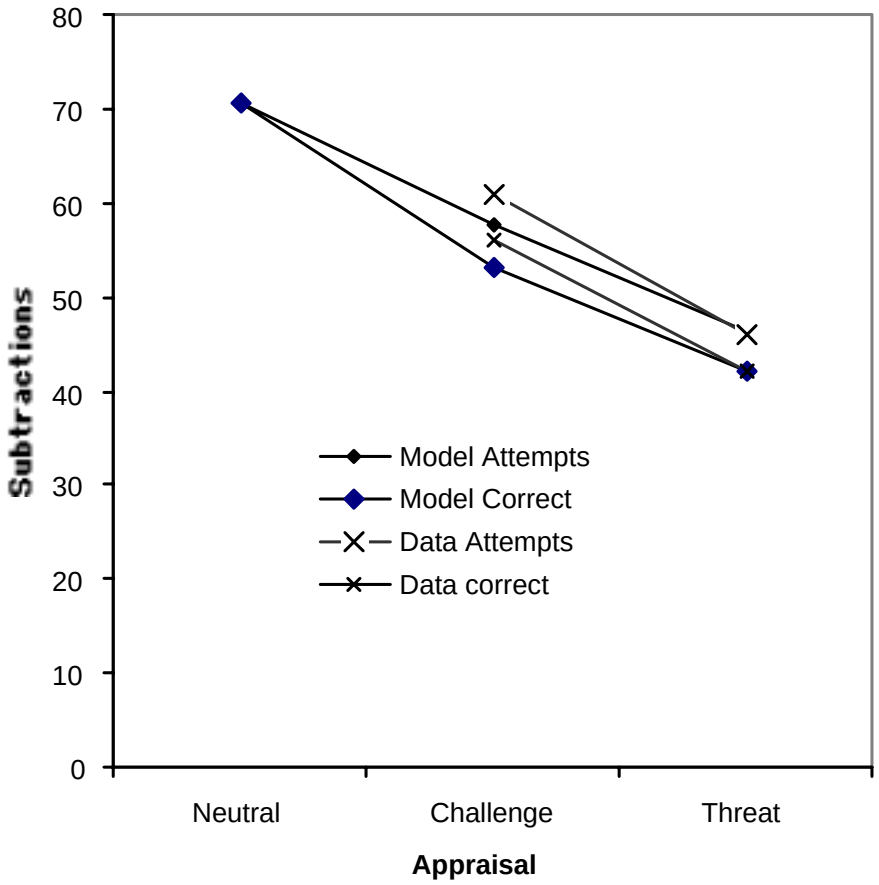
Answers: Predicted and Actual



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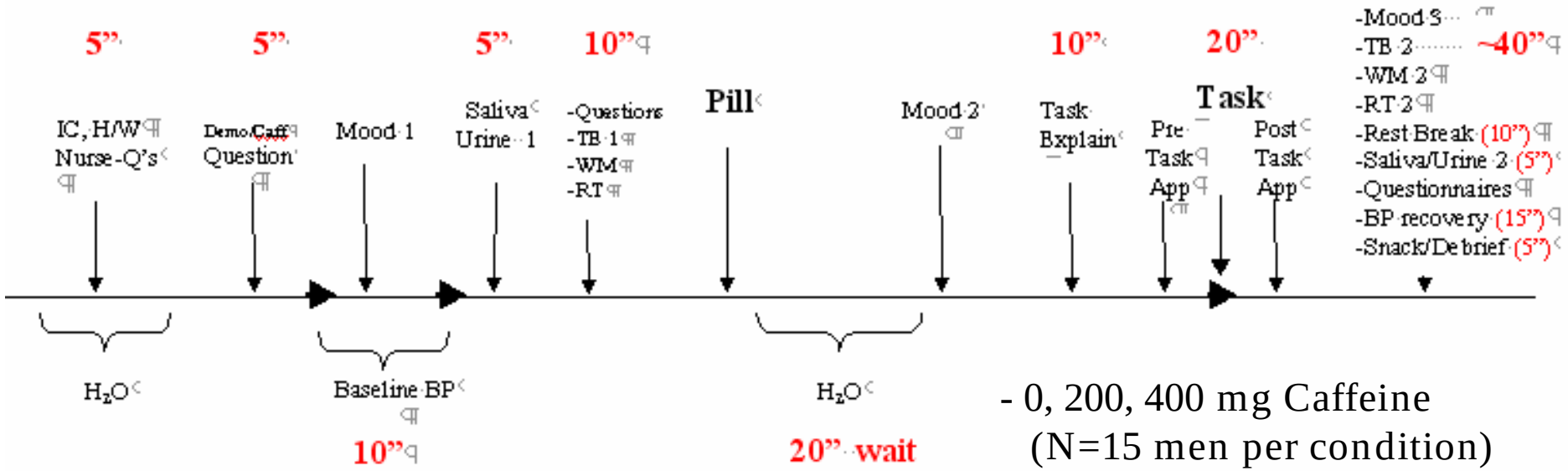
Data to Be Modeled: Caffeine

- Qualitative performance: an inverted U-shaped curve:
  - > Low and high levels of caffeine --> poor performance
  - > Moderate levels of caffeine --> optimal performance
- Quantitative measures with this task needed from future study
- Also need a mapping from data to theory

CaféNav Session Timeline

CAW 6/18/03

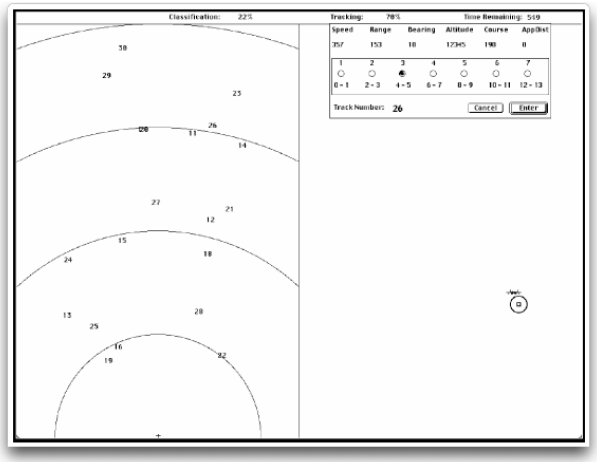


- 0, 200, 400 mg Caffeine
  (N=15 men per condition)
- Median split on appraisal
- X Serial sub, driving, Argus'

IC = Informed Consent
H/W = Height Weight measurements
Demo/Caff = demography and Caffeine use questionnaires
WM = working memory
RT = Reaction time
BP = Blood pressure
TB = Time Estimation
Baseline BP= taken every 2 minutes

Total time:
130 minutes

Application to Existing Interfaces: 3D Driving and Argus



- Direct interface
  - With “Inside-out” driving
- Driving behavior
  - Real-time
  - Interactive environment
- Extensible code
  - Environment
  - Interface
  - Works with unmodified 3D Driving Game

» Perception influences task, and also task appraisal

Distributed Code

- acs.ist.psu.edu /ACT-R_AC
- Overlay includes: model, worry dual-task, interfaces, traces, pictures, movies
- Leaves out internal, physiology variables

Open Questions / Conclusions

- ACT-R's model library is not yet large enough to cover tasks
  (about 1/4 of published 'available')
- ACT-R at 'normal' is too good, rule choice is perfect
- How to overlay multiple overlays?