MENTAL LABOUR

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Introduction → Research question → Economics

Evidence of the effort cost → Effort cost described by functions → Rewards

Strategy → Cost → Conclusion
Outlining:

- Introduction
- Research question
- Economics
- Evidence of the effort cost
- Effort cost described by functions
- Rewards
- Strategy
- Cost
- Conclusion
INTRODUCTION

Mental effort analogy with economics

The development of this association
MENTAL EFFORT

“Subjective intensification of mental activity,” which “mediates between how well an organism can potentially perform on some task and how well it actually performs on that task”.

MENTAL EFFORT

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RESEARCH QUESTION

• When people invest in mental effort?
• What regulates the intensity of mental effort?
Introduction

Research question

Economics

Evidence of the effort cost

Effort cost described by functions

Rewards

Strategy

Cost

Conclusion
• Mental effort is like physical effort — people dislike both

• If behavioral sequences involve a different amount of energy, then organism will lean towards less laborious

• We like to solve problems easily. Why? Well, it takes less effort, and effort, except in the area of our most intense interests, is disagreeable
ECONOMICS

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THE EXPERIMENT
THE DEMAND SELECTION TASK

Low-demand (10% task switching)

High-demand (90% task switching)

Low-demand choice rate vs. Trial number in run

- Low-demand choice rate increases over the trials.
- The trend indicates a gradual increase in the choice rate from the first to the last trials of the run.

The graph shows the relationship between the trial number and the low-demand choice rate, highlighting the observed trend over the run.
Take your time and choose carefully!

$1.00 for black

or

$2.00 for red

DYNAMIC

FIXED
Offer for black on iteration 1

Take your time and choose carefully!

- High effort/amount chosen
- Low effort/amount chosen

$1.00
$1.50
$1.38
$1.75
$0.50
$0.25
$0.12
$0.06
$1.88
$1.94
$1.44
$1.32
$1.12
...

$1.00 for black
$2.00 for red

DYNAMIC
FIXED
Offer for black on iteration 2
IF red was chosen

Offer for black on iteration 1

Take your time and choose carefully!

$1.00 for black  or  $2.00 for red

DYNAMIC  or  FIXED

High effort/amount chosen
Low effort/amount chosen
Offer for black on iteration 1

Offer for black on iteration 2
IF red was chosen

Offer for black on iteration 3
IF black was chosen

Offer for black on iteration 5
IF red was chosen

Take your time and choose carefully!

$1.00 for black

$2.00 for red

DYNAMIC

FIXED
Level of cognitive demand involved (increasing to the right)
UTILITY FUNCTIONS
1. Linear
2. Convex
3. Concave

Adequate performance in some studies
1. Linear
2. Convex
3. Concave
1. Linear
2. Convex
3. Concave
1. Hyperbolic: increase in effort affects more rewards when effort is low

2. Exponential: similar to hyperbolic

Recent study showed that the data were **best described** by a hyperbolic cost function.
1. Hyperbolic: increase in effort affects more rewards when effort is low

2. Exponential: similar to hyperbolic
A JOINT REWARD–EFFORT UTILITY FUNCTION

- Given available wage
- Given the choice of how many hours to work
- Balance is favored
A JOINT REWARD–EFFORT UTILITY FUNCTION

- Given available wage
- Given the choice of how many hours to work
- **Balance is favored**

More coherent results than other functions have
A JOINT REWARD–EFFORT UTILITY FUNCTION

• Wage increase will trigger increases in work
• Wage reduction will lead to reductions in work
• Mental effort is dependent on how much is already invested and received
Income-compensated wage reduction

Income-compensated wage increase

Baseline

After decrease

After increase
Income-compensated wage reduction results in a more horizontal budget constraint.

Initial budget constraint: 

\[(T - \text{total available time})\]
EXPERIMENTAL RESULTS

[Graphs showing income vs. leisure time with baseline and after decrease/increase points indicated.]
SWITCHING TIME BETWEEN TASKS

Magnitude task

3 s

Correct!

Parity task

3 s

Oops! Wrong

0.5 s
Effect of monetary incentive?

Increased incentives enhanced effort for those who scored low on scale

Inclination to engage in demanding cognitive activity
STROOP TEST

Congruent

Incongruent

2 s

Incongruent

2 s

Green or green?
Participants with low in cognitive control capacity displayed a larger incentive effect.
REWARDS

1. Stable individual differences in effort sensitivity
2. Mental effort can carry rewards
3. Subjective value of reward can increase when it is obtained with effort
REWARDS: FUTURE RESEARCH

Can reward as inner value cancel out the cost of the effort?
STRATEGY
REWARD BASED DECISION-MAKING

1. Model-free system (habit)
2. Model-based system (search through scenarios)
TWO-STEP TASK

• First-stage states
• Choice triggers a transition
• The second-stage yields a monetary reward
• Independent probabilities change randomly (slowly across trials)
MODEL-FREE SYSTEM (HABIT) OR MODEL-BASED SYSTEM?
Probability of choosing the same goal
(if the previous trial was positive)

Model-based (non-habit) control yielded higher reward
(Increased stakes triggered reliance on model-based control)
THE EFFECT OF PLANNING DEMANDS

- Weighing the increased accuracy of planning against its effort costs
A reduction in model-based control in the case of a more complex planning
MODEL-FREE SYSTEM (HABIT) OR MODEL-BASED SYSTEM?

• Model-based decision-makers are able to transfer experiences
• Model-free (habit) learners by definition rely on directly experienced reward associations.
• More model-based (non-habit) control when higher rewards at stake
COST

• Metabolic energy consumption
  • Real time-on-task effects on effort
  • Limited resource that is cognitive or computational in nature
  • Evolution discourages wasteful allocation of cognitive
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MULTI-TASK LEARNING

• Neural network architecture that learns a generic response policy with a set of task-specific policies
• This favors maximally useful default policy
• Simulation confirmed more stability and reliability than other architectures
MULTI-TASK LEARNING
Allow habits to be overridden
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CONCLUSION

• When people invest in mental effort?
• What regulates the intensity of mental effort?
• Rewards (could be inner)
• A joint reward–effort utility function