



Discoveries in  
Cognitive Science

an open access journal



Citation: Niyogi, R. K., Breton, Y.-A., Solomon, R. B., Conover, K., Shizgal, P., Dayan, P. (2015). Optimal indolence: a normative microscopic approach to work and leisure. Open Mind 1(1): 1â€”12.

DOI:  
<http://dx.doi.org/10.1098/rsif.2013.0969>

Supplemental Materials:  
<http://dx.doi.org/10.1098/rsif.2013.0969>

Received: 20 October 2013  
Accepted: 7 November 2013  
Published: 26 January 2014

Competing Interests: The authors have declared that no competing interests exist.

Corresponding Author:  
Author Name  
Corresponding author email address

Copyright: © 2016  
Massachusetts Institute of Technology  
Published under a Creative Commons  
Attribution 4.0 International  
(CC BY 4.0) license



Title of Article: Subtitle Here

Author Names with affiliations<sup>1</sup>, Another Name<sup>2</sup>, Still another Name<sup>2</sup>,  
and Final Name<sup>1</sup>

<sup>1</sup>Department, Institution, City, Country

<sup>2</sup>Another Department, Institution, City, Country

Keywords: (a series of uncapitalized words, separated with commas)

ABSTRACT

Abstract text here.

SAMPLE SECTION

Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here.

Sample Subsection

Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here.

Sample Subsubsection Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here. Text here.

SAMPLE EQUATIONS

$$\rho^\pi = \frac{RI + \mathbb{E}_{\pi([L, \tau_L]|\text{post})} [C_L(\tau_{\text{Pav}} + \tau_L)] + \int_0^P dw \mathbb{E}_{\pi_{wL}} \left[ \sum_{n_L|[pre, w]} C_L(\tau_L) \right]}{P + \mathbb{E}_{\pi([L, \tau_L]|\text{post})} [\tau_L] + \tau_{\text{Pav}} + \int_0^P dw \mathbb{E}_{\pi_{wL}} \left[ \sum_{n_L|[pre, w]} \tau_L \right]} \quad (1)$$

As long as  $RI - K_L P > \frac{1}{\beta}$

$$\left. \begin{aligned} \rho^\pi &= \frac{\beta(RI + K_L \tau_{\text{Pav}}) - 1}{\beta(P + \tau_{\text{Pav}})} \\ \text{and } \mathbb{E}[\tau_L|\text{post}] &= \frac{P + \tau_{\text{Pav}}}{\beta(RI - K_L P) - 1} \end{aligned} \right\} \quad (2)$$

Simple code sample

```
procedure bubbleSort( A : list of sortable items )
  n = length(A)
  repeat
```

\*Current address: MacMurdo Sound, Antarctica

```

newn = 0
for i = 1 to n-1 inclusive do
  if A[i-1] > A[i] then
    swap(A[i-1], A[i])
    newn = i
  end if
end for
n = newn
until n = 0
end procedure

```

#### *Algorithm environment*

---

**Algorithm 1** A sample in an algorithm environment.

---

```

if  $i \geq \text{maxval}$  then
   $i \leftarrow 0$ 
else
  if  $i + k \leq \text{maxval}$  then
     $i \leftarrow i + k$ 
  end if
end if

```

---

#### JARGON DEFINITIONS

Symbol	Meaning
Term	Definition
Term	Definition

Symbol	Meaning
Term	Definition
Term	Definition

#### ITEMIZED LISTS

##### *Roman list:*

- (i) at high payoffs, subjects work almost continuously, engaging in little leisure in between work bouts;
- (ii) at low payoffs, they engage in leisure all at once, in long bouts after working, rather than distributing the same amount of leisure time into multiple short leisure bouts;
- (iii) subjects work continuously for the entire price duration, as long as the price is not very long (as shown by an analysis conducted by Y-AB, to be published separately);
- (iv) the duration of leisure bouts is variable.

##### *Numbered list:*

1. at high payoffs, subjects work almost continuously, engaging in little leisure in between work bouts;

2. at low payoffs, they engage in leisure all at once, in long bouts after working, rather than distributing the same amount of leisure time into multiple short leisure bouts;
3. subjects work continuously for the entire price duration, as long as the price is not very long (as shown by an analysis conducted by Y-AB, to be published separately);
4. the duration of leisure bouts is variable.

**Bulleted list:**

- at high payoffs, subjects work almost continuously, engaging in little leisure in-between work bouts;
- at low payoffs, they engage in leisure all at once, in long bouts after working, rather than distributing the same amount of leisure time into multiple short leisure bouts;
- subjects work continuously for the entire price duration, as long as the price is not very long (as shown by an analysis conducted by Y-AB, to be published separately);
- the duration of leisure bouts is variable.

**SAMPLE CITATIONS**

For general information on the correct form for citations using the APA 6 format, see the following sites: [APA 6, In-text citations](#), [The Basics](#) and [APA 6, In-text citations](#)

**NATBIB CITATION MARK UP**

*Single citations*

Type	Results
<code>\citet{jon90}</code>	Jones et al. (1990)
<code>\citet[chap. 2]{jon90}</code>	Jones et al. (1990, chap. 2)
<code>\citep{jon90}</code>	(Jones et al., 1990)
<code>\citep[chap. 2]{jon90}</code>	(Jones et al., 1990, chap. 2)
<code>\citep[see][]{jon90}</code>	(see Jones et al., 1990)
<code>\citep[see][chap. 2]{jon90}</code>	(see Jones et al., 1990, chap. 2)
<code>\citet*{jon90}</code>	Jones, Baker, and Williams (1990)
<code>\citep*{jon90}</code>	(Jones, Baker, and Williams, 1990)

For example, some citations from the OpenMindSample bibliography: `citet:Anderson (1983)`, `citep:(G. Baggio, Stenning, & van Lambalgen, in press)`, and `cite*: Anderson (1983)`.

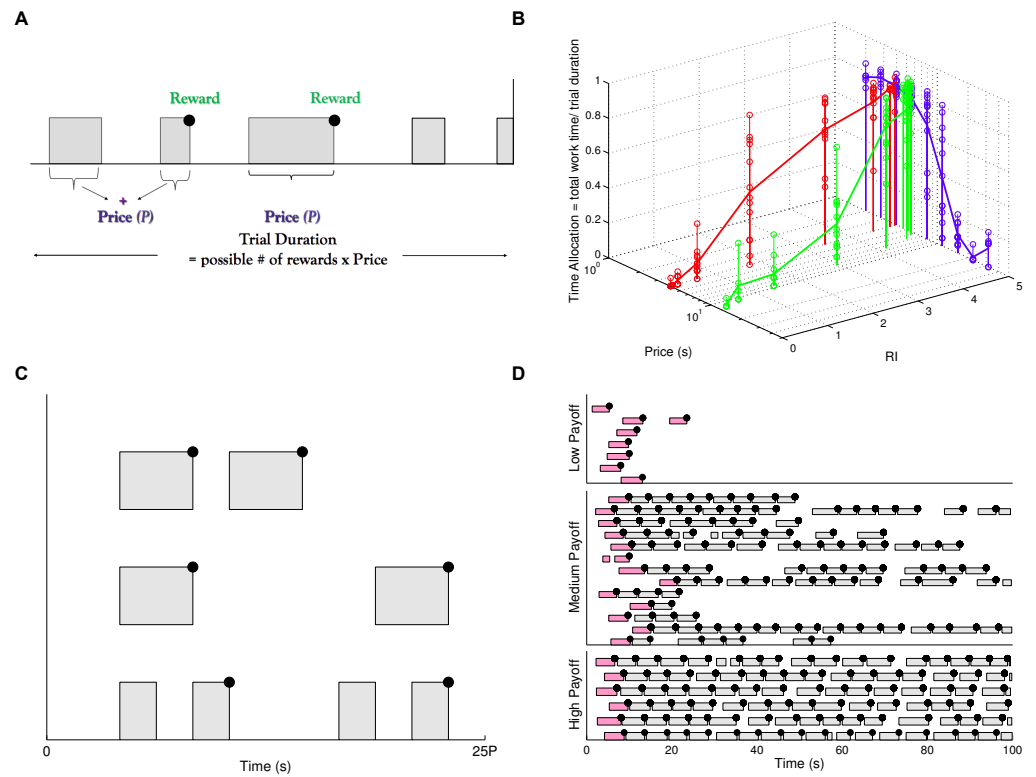
*Multiple citations*

Multiple citations may be made by including more than one citation key in the `\cite` command argument.

Type	Results
<code>\citet{jon90, jam91}</code>	Jones et al. (1990); James et al. (1991)
<code>\citep{jon90, jam91}</code>	(Jones et al., 1990; James et al. 1991)
<code>\citep{jon90, jon91}</code>	(Jones et al., 1990, 1991)
<code>\citep{jon90a, jon90b}</code>	(Jones et al., 1990a,b)

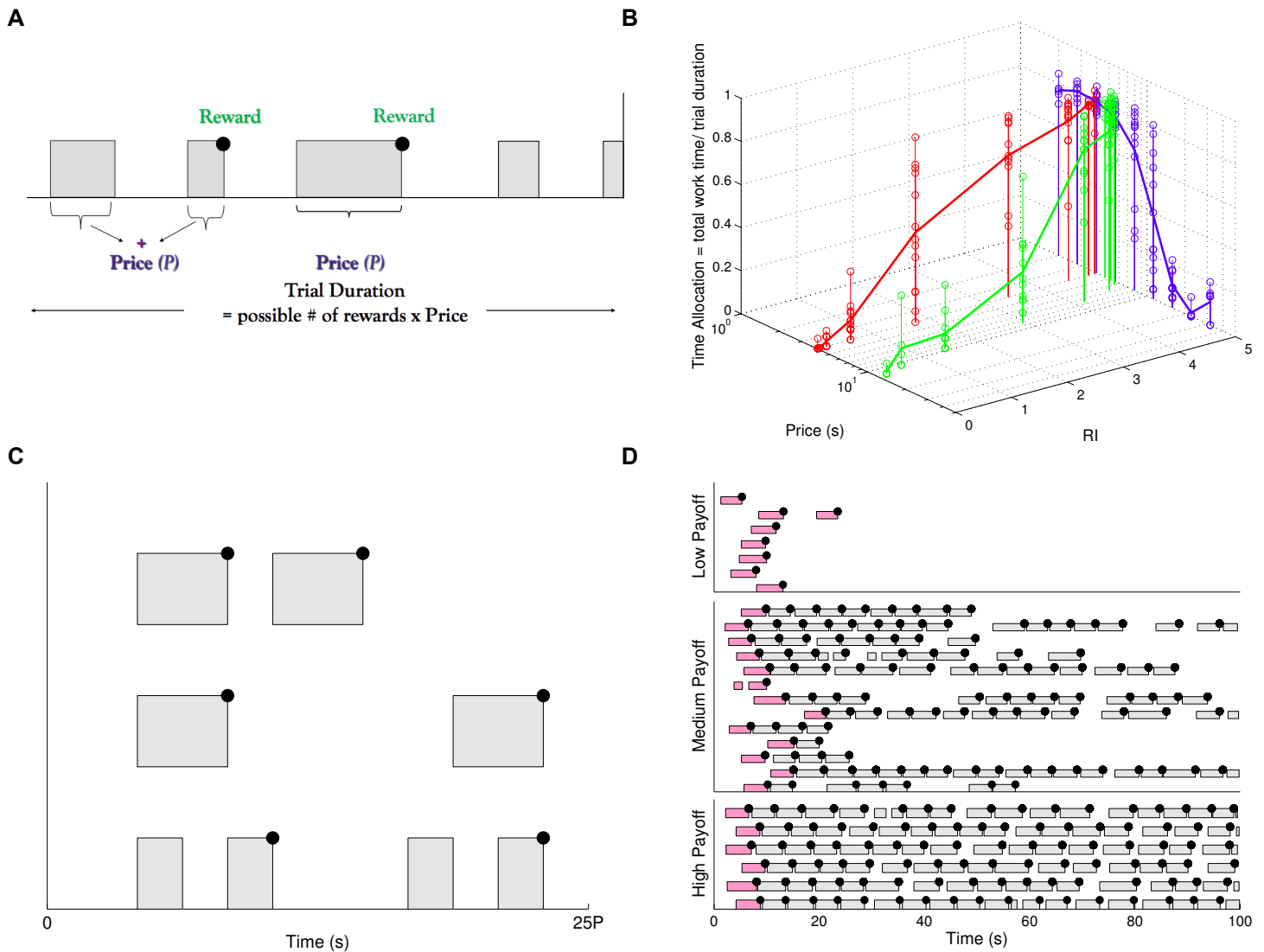
For example, multiple citations from the OpenMindSample bibliography: `citet:Anderson` (1983); G. Baggio et al. (in press), `citep:(Anderson, 1983; G. Baggio et al., in press)`. As you see, the citations are automatically hyperlinked to their reference in the bibliography.

## SAMPLE FIGURES



**Figure 1.** (Colour online) Task and key features of the data.

A) Cumulative handling time (CHT) task. Grey bars denote work (depressing a lever), white gaps show leisure. The subject must accumulate work up to a total period of time called the *price* ( $P$ ) in order to obtain a single reward (black dot) of subjective reward intensity  $RI$ . The trial duration is  $25 \times \text{price}$  (plus 2s each time the price is attained, during which the lever is retracted so it cannot work; not shown).



**Figure 2.** (Colour online) Task and key features of the data.

A) Cumulative handling time (CHT) task. Grey bars denote work (depressing a lever), white gaps show leisure. The subject must accumulate work up to a total period of time called the *price* ( $P$ ) in order to obtain a single reward (black dot) of subjective reward intensity  $RI$ . The trial duration is  $25 \times \text{price}$  (plus 2s each time the price is attained, during which the lever is retracted so it cannot work; not shown).

SAMPLE TABLES

Table 1. Time of the Transition Between Phase 1 and Phase 2<sup>a</sup>

Run	Time (min)
<i>l</i> 1	260
<i>l</i> 2	300
<i>l</i> 3	340
<i>h</i> 1	270
<i>h</i> 2	250
<i>h</i> 3	380
<i>r</i> 1	370
<i>r</i> 2	390

<sup>a</sup>Table note text here.

Table 2. Sample table taken from [treu03]

POS	chip	ID	X	Y	RA	DEC	IAU± δ IAU	IAP1± δ IAP1	IAP2 ± δ IAP2	star	E	Comment
0	2	1	1370.99	57.35 <sup>a</sup>	6.651120	17.131149	21.344±0.006 <sup>b</sup>	2 4.385±0.016	23.528±0.013	0.0	9	-
0	2	2	1476.62	8.03	6.651480	17.129572	21.641±0.005	2 3.141±0.007	22.007±0.004	0.0	9	-
0	2	3	1079.62	28.92	6.652430	17.135000	23.953±0.030	2 4.890±0.023	24.240±0.023	0.0	-	-
0	2	4	114.58	21.22	6.655560	17.148020	23.801±0.025	2 5.039±0.026	24.112±0.021	0.0	-	-
0	2	5	46.78	19.46	6.655800	17.148932	23.012±0.012	2 3.924±0.012	23.282±0.011	0.0	-	-
0	2	6	1441.84	16.16	6.651480	17.130072	24.393±0.045	2 6.099±0.062	25.119±0.049	0.0	-	-
0	2	7	205.43	3.96	6.655520	17.146742	24.424±0.032	2 5.028±0.025	24.597±0.027	0.0	-	-
0	2	8	1321.63	9.76	6.651950	17.131672	22.189±0.011	2 4.743±0.021	23.298±0.011	0.0	4	edge

Table 2 is published in its entirety in the electronic edition of the *Astrophysical Journal*.

<sup>a</sup> Sample footnote for table 2.

<sup>b</sup> Another sample footnote for table 2.

Table 3. Here is a caption for a table that is found in landscape mode.

POS	chip	ID	X	Y	RA	DEC	IAU ± δ IAU	IAP1 ± δ IAP1	IAP2 ± δ IAP2	star	E	Comment
0	2	1	1370.99	57.35 <sup>a</sup>	6.651120	17.131149	21.344 ± 0.006 <sup>b</sup>	2 4.385 ± 0.016	23.528 ± 0.013	0.0	9	-
0	2	2	1476.62	8.03	6.651480	17.129572	21.641 ± 0.005	2 3.141 ± 0.007	22.007 ± 0.004	0.0	9	-
0	2	3	1079.62	28.92	6.652430	17.135000	23.953 ± 0.030	2 4.890 ± 0.023	24.240 ± 0.023	0.0	-	-
0	2	4	114.58	21.22	6.655560	17.148020	23.801 ± 0.025	2 5.039 ± 0.026	24.112 ± 0.021	0.0	-	-
0	2	5	46.78	19.46	6.655800	17.148932	23.012 ± 0.012	2 3.924 ± 0.012	23.282 ± 0.011	0.0	-	-
0	2	6	1441.84	16.16	6.651480	17.130072	24.393 ± 0.045	2 6.099 ± 0.062	25.119 ± 0.049	0.0	-	-
0	2	7	205.43	3.96	6.655520	17.146742	24.424 ± 0.032	2 5.028 ± 0.025	24.597 ± 0.027	0.0	-	-
0	2	8	1321.63	9.76	6.651950	17.131672	22.189 ± 0.011	2 4.743 ± 0.021	23.298 ± 0.011	0.0	4	edge

Table 2 is published in its entirety in the electronic edition of the *Astrophysical Journal*.

<sup>a</sup> Sample footnote for table 2.

<sup>b</sup> Another sample footnote for table 2.



Example of table continuing over pages:

Table 4: ApJ costs from 1991 to 2013

<b>Year</b>	<b>Subscription cost (\$)</b>	<b>Publication charges (\$/page)</b>
1991	600	100
1992	650	105
1993	550	103
1994	450	110
1995	410	112
1996	400	114
1997	525	115
1998	590	116
1999	575	115
2000	450	103
2001	490	90
2002	500	88
2003	450	90
2004	460	88
2005	440	79
2006	350	77
2007	325	70
2008	320	65
2009	190	68

*Table continued on next page*

Table 4, continued from previous page.

ApJ costs from 1991 to 2013		
Year	Subscription cost (\$)	Publication charges (\$/page)
2010	280	70
2011	275	68
2012	150	56
2013	140	55

SUPPORTIVE INFORMATION

Here you enter further sources of information, if desired.

ACKNOWLEDGMENTS

Enter your acknowledgments here.

AUTHOR CONTRIBUTIONS

Who helped formulate the project, who supplied data, analyses and experiments, etc.

REFERENCES

Anderson, J. R. (1983). *The architecture of cognition*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Baggio, G., Stenning, K., & van Lambalgen, M. (in press). The Cognitive Interface. In M. Aloni & P. Dekker (Eds.), *Cambridge Handbook of Formal Semantics*. Cambridge: Cambridge University Press.

Baggio, R., van Lambalgen, M., & Hagoort, P. (2008). Computing and recomputing discourse models: An ERP study. *Journal of Memory and Language*, 59, 36–53.

Baker, C. L., Tenenbaum, J., & Saxe, R. (2006). Bayesian models of human action understanding. In *Advances in neural information processing systems* (Vol. 18). MIT Press.

Baker, C. L., Tenenbaum, J., & Saxe, R. (2009). Action understanding as inverse planning. *Cognition*, 113(3), 329–349.

Beller, S. (2008). Deontic norms, deontic reasoning, and deontic conditionals. *Thinking & Reasoning*, 14(4), 305–341.

Brass, M., Schmitt, R., Spengler, S., & Gergely, G. (2007). Investigating action understanding: Inferential processes versus action simulation. *Current Biology*, 17(24), 2117–2121.

Chater, N., & Vitanyi, P. (2003). Simplicity: a unifying principle in cognitive science? *Trends in Cognitive Sciences*, 7(1), 19–22.

Csibra, G., & Gergely, G. (2007). ‘Obsessed with goals’: Functions and mechanisms of teleological interpretation of actions in humans. *Acta Psychologica*, 124(1), 60–78.

Etzioni, O., Golden, K., & Weld, D. (1997). Sound and efficient closed-world reasoning for planning. *Artificial Intelligence*, 89(1–2), 113–148.

Gallese, V., & Goldman, A. (1998). Mirror neurons and the simulation theory of mind-reading. *Trends in Cognitive Sciences*, 2(12), 493–501.

Gazzo-Castañeda, E. L., & Knauff, M. (n.d.). Defeasibility and the role of counterexamples in reasoning with legal conditionals. *Submitted for publication*.

Gergely, G., Bekkering, H., & Király, I. (2002). Rational imitation in preverbal infants. *Nature*, 415, 755.

Godfrey, P., Grant, J., Gryz, J., & Minker, J. (1998). Integrity constraints: Semantics and applications. In J. Chomicki & G. Saake (Eds.), *Logics for Databases and Information Systems* (Vol. 436, pp. 265–306). Springer US.

Hickok, G. (2009). Eight problems for the mirror neuron theory of action understanding in monkeys and humans. *Journal of Cognitive Neuroscience*, 21(7), 1229–1243.

Király, I., Csibra, G., & Gergely, G. (2013). Beyond rational imitation: Learning arbitrary means actions from communicative demonstrations. *Journal of Experimental Child Psychology*, 116(2), 471–486.

Kowalski, R. (2011). *Computational logic and human thinking: How to be artificially intelligent*. New York: Cambridge University Press.

Kowalski, R., & Sadri, F. (2009). Integrating logic programming and production systems in abductive logic programming agents. In A. Polleres & T. Swift (Eds.), *Web reasoning and rule systems* (Vol. 5837, pp. 1–23). Springer Berlin Heidelberg.

Lifschitz, V. (2002). Answer set programming and plan generation. *Artificial Intelligence*, 138(1–2), 39–54.

- Lombrozo, T., & Carey, S. (2006). Functional explanation and the function of explanation. *Cognition*, 99(2), 167–204.
- Luo, Y., & Baillargeon, R. (2005). Can a self-propelled box have a goal?: Psychological reasoning in 5-month-old infants. *Psychological Science*, 16(8), 601–608.
- McCarthy, J., & Hayes, P. (1969). Some philosophical problems from the standpoint of artificial intelligence. In B. Meltzer & D. Michie (Eds.), *Machine Intelligence* (Vol. 4, pp. 463–502). Edinburgh University Press.
- Mueller, E. (2006). *Commonsense Reasoning*. San Francisco, CA: Morgan Kaufmann Publishers.
- Paulus, M., & Király, I. (2013). Early rationality in action perception and production? a theoretical exposition. *Journal of Experimental Child Psychology*, 116(2), 407–414.
- Pijnacker, J., Geurts, B., van Lambalgen, M., Buitelaar, J., & Hagoort, P. (2010). Reasoning with exceptions: An event-related brain potentials study. *Journal of Cognitive Neuroscience*, 23(2), 471–480.
- Pijnacker, J., Geurts, B., van Lambalgen, M., Kan, C., Buitelaar, J., & Hagoort, P. (2009). Defeasible reasoning in high-functioning adults with autism: Evidence for impaired exception handling. *Neuropsychologia*, 47(644–651).
- Pollock, J. (1995). *Cognitive Carpentry: A Blueprint for How to Build a Person*. MA, USA: MIT Press Cambridge.
- Pollock, J. (1997). Reasoning about change and persistence: A solution to the frame problem. *Nous*, 31(2), 143–169.
- Reiter, R. (1988). On integrity constraints. In *Proceedings of the 2nd conference on Theoretical Aspects of Reasoning about Knowledge, TARK'88* (pp. 97–111). San Francisco, CA, USA: Morgan Kaufmann Publishers.
- Saxe, R., & Carey, S. (2006). The perception of causality in infancy. *Acta Psychologica*, 123(1-2), 144–165.
- Schueler, G. (2003). *Reasons and purposes: Human rationality and the teleological explanation of action*. New York, NY: Oxford University Press Inc.
- Stenning, K., & van Lambalgen, M. (2008). *Human Reasoning and Cognitive Science*. Bradford Book, The MIT Press, Cambridge, Massachussets.
- van Lambalgen, M., & Hamm, F. (2005). *The Proper Treatment of Events*. Malden: Blackwell Publishing.
- Varga, A. (2013a). *A formal model of infants' acquisition of practical knowledge from observation* (Doctoral dissertation). Department of Philosophy, Central European University, Budapest.
- Varga, A. (2013b). *A formal model of infants' acquisition of practical knowledge from observation* (Doctoral dissertation). Department of Philosophy, Central European University, Budapest.
- Williams, B. (1981). Internal and External Reasons. In B. Williams (Ed.), *Moral Luck* (pp. 101–113). Cambridge: Cambridge University Press.
- Zentgraf, K., Munzert, J., Bischoff, M., & Newman-Norlund, R. (2011). Simulation during observation of human actions – theories, empirical studies, applications. *Vision Research*, 51, 827–835.

## A: SAMPLE APPENDIX SECTION

We derive the result in Eq. (2). We consider a linear  $C_L(\tau_L + \tau_{Pav}) = K_L(\tau_L + \tau_{Pav})$ , and make two further simplifications: (i) the subject does not engage in leisure in the pre-reward state (and so works for the whole price when it works); and (ii) *a priori*, arbitrarily long leisure durations are possible ( $\lambda = 0$ ). Then the reward rate in Eq. (1) becomes

$$\rho^\pi = \frac{RI + K_L\{\mathbb{E}[\tau_L|\text{post}] + \tau_{Pav}\}}{P + \mathbb{E}[\tau_L|\text{post}] + \tau_{Pav}} \quad (\text{A.1})$$

As discussed in the *Results* section, the probability of engaging in instrumental leisure in the post-reward state is  $\pi([L, \tau_L] | \text{post}) = \exp[-\{\beta(\rho^\pi - K_L)\}\tau_L]$ , which is an exponential distribution with mean

$$\mathbb{E}[\tau_L|\text{post}] = \frac{1}{\beta(\rho^\pi - K_L)} \quad (\text{A.2})$$

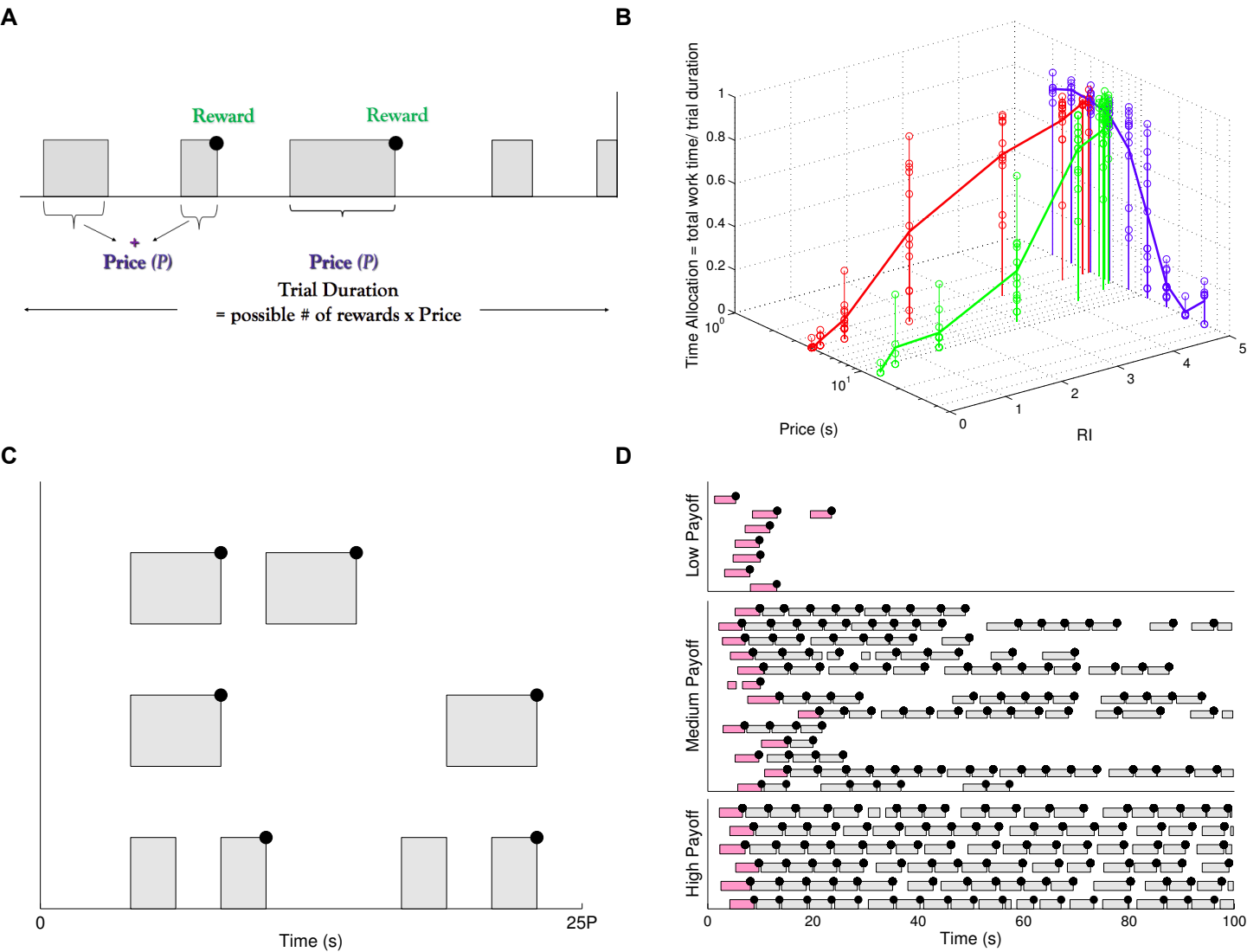
Re-arranging terms of this equation,

$$\rho^\pi = \frac{1}{\beta \mathbb{E}[\tau_L|\text{post}]} + K_L \quad (\text{A.3})$$

Equating Eqs. (A.1) and (A.3) and solving for the mean instrumental leisure duration  $\mathbb{E}[\tau_L|\text{post}]$ , we derive

$$\mathbb{E}[\tau_L|\text{post}] = \frac{P + \tau_{Pav}}{\beta(RI - K_L P) - 1} \quad (\text{A.4})$$

which is the second line of Eq.(2). This is the mean instrumental leisure duration as long as  $RI - K_L P > 1$ , and  $\mathbb{E}[\tau_L|\text{post}] \rightarrow \infty$  otherwise. When the former condition holds, we may substitute Eq. (A.4) into Eq. (A.1) and solve for  $\rho^\pi$



**Figure A.1.** Sample Appendix Caption. Here is a caption that might appear in an appendix. It is as wide as the full width of the page.

## **B: MAKING YOUR BIBLIOGRAPHY FOR AN OPEN MIND ARTICLE**

*Open Mind* uses the APA author-date bibliography style, apacite.bst. For more information on apacite, for examples in how to make your .bib file and more, see:

<http://mirror.jmu.edu/pub/CTAN/biblio/bibtex/contrib/apacite/apacite.pdf>

(In spite of the mention of apacite cite commands, please use only Natbib commands for in text citations, as shown above.)

### ***BibTeX***

You will need to use BibTeX to form your bibliography; typing in the references would be a huge and unpleasant task. Look at the openmindsample.bbl file and you'll see why typing in the bibitems would be difficult.

For a good basic introduction to using BibTeX, see <https://www.economics.utoronto.ca/osborne/latex/BIBTEX.HTM>

When you use BibTeX, the form of the bibliography will be correct. You don't need to supply a bibliography style, since that is built into the stjour.cls file.