Intermediate Stable States in Substance Use

Can allowing use prevent abuse?
Dynamics of Substance use

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0158323
### Table 3. Estimated Cumulative Incidence of Drug Use by Age 15 and 21 y among 22–29 y Olds

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Unweighted n</th>
<th>Alcohol</th>
<th></th>
<th></th>
<th>Tobacco</th>
<th></th>
<th></th>
<th>Cannabis</th>
<th></th>
<th>Cocaine</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>By 15 y</td>
<td>By 21 y</td>
<td></td>
<td>By 15 y</td>
<td>By 21 y</td>
<td></td>
<td>By 15 y</td>
<td>By 21 y</td>
<td>By 15 y</td>
<td>By 21 y</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Percent</td>
<td>Percent</td>
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<td>Percent</td>
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<td>Percent</td>
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<td>1.6</td>
<td>2.2</td>
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<td>New Zealand</td>
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<td>74.1</td>
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<td>94.1</td>
<td>0.9</td>
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<td>—</td>
<td>26.8</td>
<td>1.4</td>
<td>61.8</td>
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</tbody>
</table>

Data from the World Mental Health Surveys. Weighted data, Taylor series linearisation for variance estimation.

*Not asked in this country.

*Fewer than 30 persons in the entire sample of this country used this drug, so estimates have not been produced.

SE, standard error.
doi:10.1371/journal.pmed.0050141.t003


**Figure 1.** The frequency of any use of caffeine, alcohol, nicotine, and cannabis by year from ages 9 to 41 years.
Fig. 1. Cumulative probability of transitioning to dependence on nicotine, alcohol, cannabis and cocaine among users of these substances.
Stable Intermediate states in substance use

• Previous modeling and empirical work on substance from a nonlinear dynamical system perspective models two alternative stable states: zero-use and abuse

• Many intervention and prevention strategies aim at the no use state
  • For many youth these strategies fail

• In this project, we look at possible intermediate stable states of recreational use

Work with Han van der Maas, Roseann Peterson, Hanna van Loo, Steven Aggen, Kenneth Kendler, Egbert van Nes & Marten Scheffer
Drugs as instruments: A new framework for non-addictive psychoactive drug use

Christian P. Müller (a1) (a2) and Gunter Schumann (a1) 
https://doi.org/10.1017/S0140525X11000057 Published online: 10 November 2011
In response to: Drug instrumentalization and evolution: Going even further
Related commentaries (1)

Tobacco “chippers” – individual differences in tobacco dependence

Saul Shiffman
Clinical Psychology, 706 OEH, University of Pittsburgh, Pittsburgh, PA 15260, USA

Original Article

Careers with Heroin

Gail A. Crawford, Melvin C. Washington & Edward C. Senay
Pages 701-715 | Published online: 03 Jul 2009
Download citation https://doi.org/10.3109/10826088309027364

Prospective Analysis of Behavioral Economic Predictors of Stable Moderation Drinking Among Problem Drinkers Attempting Natural Recovery

Empirical exploration

- Empirical sample of 1796 men
- Reports on lifetime use per year on alcohol, cannabis and nicotine use
- Use classified as (1) zero-use, (2) recreational use and (3) abuse, based on literature and expert opinion
  - Alcohol abuse: > 60 drinks per month
  - Nicotine abuse: > 5 cigarettes per day
  - Cannabis abuse: > 6 times used per month
- Descriptive investigation of transition probabilities between years, and number of people who reported such transitions

Shiny app

https://sachaepskamp.shinyapps.io/intermediate_stable_states/
Proportion of subjects reporting at least one transition

(a) Alcohol use

(b) Tobacco use

(c) Cannabis use
(a) Alcohol use
(b) Tobacco use
(c) Cannabis use

Raw number of transitions
Theoretical model 1: descriptive

\[
\frac{\partial \theta}{\partial t} = I - 10 \times \theta + A \times \theta^3 - \theta^5
\]

\[
U = \frac{e^\theta}{1 + e^\theta}
\]
Theoretical model 2: conceptual

- Positive consequences
- Negative consequences
- Negative lower bound
- Usage
- Self-control

Arrows indicate positive (+) and negative (-) relationships.
Theoretical model 2: conceptual
Theoretical model 2: conceptual

Usage

Positive consequences

Self-control

Negative lower bound
Theoretical model 2: conceptual

Positive consequences

Negative consequences

Negative lower bound

Usage

Self-control
Equilibrium equations:

\[ N_{\text{eq}} = N_{\text{lower}} + (1 - N_{\text{lower}}) \times U^{p_n} \]
\[ S_{\text{eq}} = \frac{H^{p_s}}{H^{p_s} + U^{p_s}} \]

Dynamical equations:

\[ \frac{\partial U}{\partial t} = r_u \times U \times (1 - U) \times (P - S \times N + A \times U) \]
\[ \frac{\partial S}{\partial t} = r_s \times S \times (1 - S) \times \left(1 - \frac{S}{S_{\text{eq}}}\right) \]
\[ \frac{\partial N}{\partial t} = r_n \times (1 - N) \times \left(1 - \frac{N}{N_{\text{eq}}}\right) \]
After age 16: small usage shock every 4 months.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Explanation</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U$</td>
<td>Usage</td>
<td>Starts at 0</td>
</tr>
<tr>
<td>$S$</td>
<td>Self-control</td>
<td>Start at 1</td>
</tr>
<tr>
<td>$N$</td>
<td>Negative consequences</td>
<td>Start at $N_{\text{lower}}$</td>
</tr>
<tr>
<td>$P$</td>
<td>Positive consequences</td>
<td>See below</td>
</tr>
<tr>
<td>$r_u$</td>
<td>Rate of $U$ dynamics</td>
<td>0.25</td>
</tr>
<tr>
<td>$r_s$</td>
<td>Rate of $S$ dynamics</td>
<td>0.1</td>
</tr>
<tr>
<td>$r_n$</td>
<td>Rate of $N$ dynamics</td>
<td>0.1</td>
</tr>
<tr>
<td>$A$</td>
<td>Addictiveness or Proneness</td>
<td>Drawn from $U(0.2,0.4)$</td>
</tr>
<tr>
<td>$N_{\text{lower}}$</td>
<td>$N$ lower bound</td>
<td>Drawn from $U(0.1,0.3)$</td>
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<tr>
<td>$p_n$</td>
<td>Exponent</td>
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<tr>
<td>$H$</td>
<td>Point at which Self-control is 0.5</td>
<td>Drawn from $U(0.5,0.9)$</td>
</tr>
<tr>
<td>$p_s$</td>
<td>Exponent</td>
<td>7</td>
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</tbody>
</table>
Call for Speakers!

Conference on Complex Systems 2019
Nanyang Technological University
30 September - 4 October 2019

Satellite session on complexities of adverse behavior
Acknowledgements

Workshop Dynamical systems, networks, and psychopathology: Marieke Wichers, Jessica Hartmann, Laura Bringmann, Angélique Cramer, Claudia van Borkulo, Kenneth Kendler, Roseann Peterson, Hanna van Loo, Han van der Maas, IJolanda Kossakowski, Lourens Waldorp, Denny Borsboom, Sacha Epskamp, Eiko Fried, Marten Scheffer, Egbert van Nes, Sanne Gijzel, Don Robinaugh, and Gaby Lunansky.

Thank you for your attention!

The University of Amsterdam
Institute for Advanced Study

The Psych Systems Project