Why Do People Become Addicted: Towards a Theoretical Explanation for Eyal's Experiment-Based Hook Model

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1. Addiction: bad and not so bad

- The word "addiction" has a negative connotation.
- People get addicted to gambling, to drugs, to alcohol, to smoking.
- They try it first, and then they feel the urge to continue the corresponding habit.
- However, from the psychological viewpoint, the same habit-forming can have (and often has) positive effects as well.
- People get addicted to healthy lifestyle, like eating healthy food and exercising regularly.
- People get addicted to their creative activities ranging from art and music to scientific research.
- People fall in love with each other – which is usually a good type of addiction.

2. Addiction: bad and not so bad (cont-d)

- For bad addiction:
  - we need to understand where it comes from
  - so we can prevent it and – if it already happened – cure it.
- For good addition:
  - we also need to understand where it comes from,
  - so that we can have more people living healthy lives, we can have more people exploring their creativity, etc.
- In both cases, it is important to understand where addiction comes from, i.e., how we form the resulting habits.

3. Experiments

- Understanding can mean different things.
- We can discuss what physiological processes occur in the brain when a person becomes addicted.
- In the future, this may help us prevent the formation of bad habits and promote formation of good ones.
- However, as of now, the results of such an analysis are somewhat far away from practical applications.
- In general, we are not yet able to use this knowledge to prevent or promote habit forming.
- More practical results have reasonably recently come from a different study:
  - an analysis of which situations cause addictions and which do not,
  - without the physiological analysis of how exactly addiction is formed in the brain.

4. Experiments: Simple Lottery

- Such studies have indeed been performed.
- They are describe in Nir Eyal's book; see the last slide and references therein.
- Eyal's results can be best explained on the example of gambling addiction.
- Reason: in gambling (as opposed to other bad addictions), rewards and risks can be clearly stated in objective numerical form.
- Eyal started with a seemingly natural simple gambling model, in which a person gets:
  - a reward r with some probability p, and
  - no reward at all with the remaining probability $1 - p$.
- This can be a simplified model of playing a lottery, this can be a simplified version of playing the slot machine at a casino, etc.

5. Eyal's experiments and the resulting Hook Model

- Somewhat surprisingly, this seemingly natural arrangement did not lead to any serious habit forming.
- Participants played a little bit, but did not form a habit of playing.
- The situation changed drastically when he introduced a somewhat more realistic description of a gambling situation.
- In this description, there are two levels of rewards:
  - a very large reward R that happens with a very low probability p_ℓ, and
  - a medium-size (actually, small) reward r that happens with a medium-size probability p_m.

6. Eyal's experiments and the resulting Hook Model (cont-d)

- For example, in a lottery where a lottery ticket costs 1 dollar:
  - many people get a $5 prize and
  - very few get a very big, multi-million dollar prize.
- In simulated situations, a significant proportion of participants became addicted to playing this lottery.
- They eagerly participated in it again and again.

7. What we do in this talk

- In this talk, we provide a natural explanation for this phenomenon.
- Namely, we explain why lotteries with two levels of rewards are more addictive.

8. Human Decision Making: First Approximation

- In the first approximation, people want to maximize their expected gain.
- For a simple lottery in which we get reward r with probability p, the expected gain is $E = p \cdot r$.
- For a more realistic lottery, $E = p_\ell \cdot R + p_m \cdot r$.
- In this approximation, people play a lottery if the expected gain exceeds the price t of a lottery ticket.
- However, in this case, lottery organizers would lose money.
- So, in this approximation, people will not gamble at all.

9. Human Decision Making: A More Realistic Approximation

- A more general description of human decision making is that people maximize expected utility $\sum p_i \cdot u(r_i)$, where:
  - r_i is the i-th possible gain,
  - p_i is the probability of this gain, and
  - $u(r)$ describes the person's "utility" of gaining value r.
- The dependence $u(r)$ is not linear.
- If you have no money and you get a dollar, you are very happy.
- However, if you already have \$100 and you gain one more dollar, your increase in happiness is small.
- Empirically, $u(r) = c_u \cdot \sqrt{r}$.
- So, people would play a lottery if $\sum p_i \cdot \sqrt{r_i} > \sqrt{t}$.

10. A More Realistic Approximation (cont-d)

- People would play a lottery if $\sum p_i \cdot \sqrt{r_i} > \sqrt{t}$.
- Since the lottery organizers do not lose money, we have $\sum p_i \cdot r_i \leq t$.
- The function $\sqrt{r}$ is strictly concave, so $\sum p_i \cdot \sqrt{r_i} < \sqrt{\sum p_i \cdot r_i}$.
- Thus, $\sum p_i \cdot \sqrt{r_i} > \sqrt{t}$.
- So, in this approximation, people still will not gamble at all.

11. An Even More Realistic Approximation

- The above analysis assumed that we correctly estimate the probabilities.
- However, as the Nobelist Daniel Kahneman showed, people overestimate the values of small probabilities.
- Specifically, their subjective estimates ps_i of small probabilities p_i are proportional to square root of p_i: $ps_i = c_p \cdot \sqrt{p_i}$.
- Thus, they maximize $\sum ps_i \cdot u(r_i) = c \cdot \sum \sqrt{p_i} \cdot \sqrt{r_i} = c \cdot \sum \sqrt{p_i \cdot r_i}$.
- So, they play the lottery if $\sum \sqrt{p_i \cdot u_i} > \sqrt{t}$.
- For a simple lottery, this means that $\sqrt{p \cdot r} > \sqrt{t}$.
- Since $p \cdot r < t$, this is not possible, so a simple lottery is not addictive.

12. An Even More Realistic Approximation (cont-d)

- For a complex lottery, when $p_\ell \cdot R + p_m \cdot r \approx t$, we have

$$(\sqrt{p_\ell \cdot R} + \sqrt{p_m \cdot r})^2 = p_\ell \cdot R + p_m \cdot r + 2\sqrt{(p_\ell \cdot R) \cdot (p_m \cdot r)} > t.$$

- So, in this case, $\sqrt{p_\ell \cdot R} + \sqrt{p_m \cdot r} > \sqrt{t}$.
- This explains why more complex lotteries are addictive.

13. Bibliography

- N. Eyal and R. Hoover, *Hooked: How to Build Habit-Forming Products*, Penguin, New York, 2014.
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