

Nicotine Supplementation and Thesis Writing

1 The Problem

The biggest hurdle in writing my PhD thesis was motivation. I had ideas. I had results. I had a structure in mind. But I just couldn't bring myself to write it down.

Part of the problem was simple and generic. As my advisor says, writing a dissertation is *labor*. His intended connotations are not of onerous work like ditch-digging, but of childbirth. To take ideas in one's head and get them onto the page (with a properly formatted bibliography) is labor. The carefully crafted anatomy of the ideas, while perfect inside the mind, suddenly becomes an obstruction to passage onto the page. And like a dutiful obstetrician, my advisor could give me all manner of encouragement and support, but I was the one who ultimately had to push.

Part of the problem boiled down to my preferences. I love writing, but I hate *formal writing*. Thesis writing is largely devoid of self-expression and humor; the individuality in a PhD thesis lives in the content—not in the presentation. I was the only one who could have written my dissertation because I developed the ideas, but anyone with access to the same mathematics in my head could have written more-or-less the same thesis. I imagine that many graduate students share these feelings. I am also a procrastinator. Specifically, I am a so-called *productive procrastinator*; I will chronically avoid working on the most important thing by working on the second most important thing. Indeed, while I am writing this very sentence I ought to be applying for jobs. Between teaching, a book deal, and other mathematical papers, I had ample distractions from my thesis work.

Finally, part of the problem was emotionally complex and highly specific to my graduate school experience. I essentially had to restart my PhD four years in. My first research project in the field of homotopy type theory (HoTT) was an abject failure. I completely fell out of love with the subject after years of work, turning each day spent on HoTT research into a marshmallow test; could I delay gratification another day to get the marshmallow of a doctorate degree down the line? On too many days, the answer was “no.” Research progress was slow and painful. Moreover, in an unexpected development, a top figure in HoTT published a paper to which my work was a highly-specific special case. I'd say that I got scooped, but his work was so much better than mine that it would be an insult. In any event, I had to change my research direction after four years of work. My PhD thesis is therefore the product of about 16 months of research in a totally different field of mathematics. While I am proud of the ideas and results, I was saddled with thoughts of how much better my thesis could have—no, should have—been. There are theorems to be strengthened, applications to be developed, and connections to be explored. While some of these avenues will be explored by others, I had a deep-seated feeling that *it should have been me*. Consequently, the thesis itself came to represent a ≈ 200 page report on my failure as a graduate student. Combine these feelings with my propensity for productive procrastination and distaste for formal writing, and the outcome is obvious.

The motivational problem I was facing can be restated in terms of reward signals. Progress on my most important project—my dissertation—had an abnormally low reward signal. With each completed page, the joy of progress was diminished by a coupled sadness about another 500 words that should have been better. My other research projects, weight-lifting, teaching, and my book all had much higher reward signal per unit of effort. Progress would never be made without a change to this dynamic.

2 The Solution

I should have seen a therapist. Surely my feeling of failure as a graduate student is not isolated to my thesis, but is a larger problem that ought to be solved internally. But I had a deadline; I had to finish this summer. While a sixth year as a math graduate student is frustrating, it isn't

uncommon. Of the eleven people in my PhD cohort, three students took a sixth year to finish (and one dropped out, which in my book counts as needing extra time and having the foresight to not take it. I envy you, Ming). A seventh year, on the other hand, is humiliating. If you need a seventh year, you need a really good excuse, and probably should have dropped out. There was simply no time to build rapport with a therapist and incorporate his insights into my daily life and self-conception.

A chemical solution would be much more efficient, but I didn't think a reputable psychiatrist would be likely to prescribe me an amphetamine on the requisite timeline. I'm too principled to go to a pill mill, and my psychiatrist father is too principled to become a pill mill for family members. It was time to get creative.

I recall reading a study some time ago about nicotine supplementation for the purpose of habit formation. I say "I recall reading" because I have subsequently tried and failed ¹ to find the study. It may have been an essay, or a dream, or worse—a Twitter thread. Here are the details of the study, as I recall (or perhaps invented) them.

- A collection of new runners who did not use nicotine products were divided into an active group and a control group.
- All participants were given a workout plan with scheduled runs spanning a few months.
- Runners in the active group were given nicotine patches to wear during their workouts. Importantly, the nicotine patches were to be worn by the active group *only* during the workouts, but at no other time. The control group was not given nicotine.
- A significantly greater portion of the active group finished the workout plan than the control group. Moreover, among the runners in both groups *who did complete the workouts*, a greater portion of those in the active group continued to run afterward by their own volition.

The interpretation of this study is obvious. The process of starting a running program (or any workout program for that matter) is difficult. While it's good for you and can become extremely enjoyable in the long term, habituating the body to regular exercise is a painful process—often more painful than fun. Nicotine supplementation is an effective tool for tweaking reward signals during this critical time so as to improve the likelihood of following through on a workout plan. Moreover, nicotine supplementation is conducive to habit formation, even after the supplementation ceases. One may analogize this procedure to operant conditioning. Each workout presents a binary choice: either go on that run, or don't. The choice to run is reinforced with a nicotine reward. In seeking out that reward (and perhaps a touch of chemical addiction), behavior is driven toward exercise.

My thesis situation mapped almost perfectly onto the new runners. Like the runners, I had a difficult task I wanted to start doing consistently. Or, more accurately, a difficult task that I *wanted* to want to start doing. In a sense, the runners and I had difficulties that fit in to the more general problem schema of the non-idempotence of desire ². The new runner doesn't want to run; it hurts and it makes her feel weak and out of shape. But she *wants* to want to run. If she sticks with running for long enough, the desire to desire may eventually become simply desire. Similarly, I didn't want to work on my thesis; it made me feel like a failure. But I *wanted* to want to work on my thesis. In both situations, the only way out is through. If the motivational dynamics were similar ³, why shouldn't the psychopharmacodynamics of nicotine supplementation be similar as well?

2.1 The procedure

My procedure itself was extremely simple.

¹If you know the study/paper/Twitter thread I am referring to, please let me know. I would love to see how my procedure compared to theirs.

²I am firmly of the belief that many statements of the form "I want to do X, but ..." should instead be read as "I want to want to do X, but I don't want to do X." The conflation of "want" and "want to want" is perhaps the most common lie we tell ourselves and others.

³While I was primarily focused on motivation and habit formation, there is another similarity; nicotine likely has some positive effects for both physical and cognitive performance. This should be unsurprising, as nicotine is a simulant. For a (somewhat critical) analysis of the impact of nicotine on physical performance, see [this paper in Sports Medicine](#). For a (largely positive) collection of resources on the impact of nicotine on cognitive performance, see [this piece by Gwern](#).

1. I purchased 2mg nicotine lozenges from a CVS pharmacy. Like all nicotine products in the United States, these lozenges are pricey, but not prohibitively so. Initially, I was using [large lozenges](#), which could be easily broken in half.
2. I would only start working on my thesis when I knew I would be able to do so for at least 45 minutes, uninterrupted. This was a precautionary measure to ensure that my work sessions would be long enough for blood nicotine concentration to peak, and that I would be able to associate the nicotine with the thesis work.
3. When I would start working on my thesis, I would place 1/2 of a of a lozenge in my upper lip. When I wasn't consciously moving the lozenge around in my mouth to facilitate dissolving, a large lozenge would last approximately 4 hours.
4. Whenever I would stop working (or start working on something other than my thesis), I would remove the lozenge from my mouth, and save the rest for my next work session.
5. After approximately two months, I switched to [smaller 2mg nicotine lozenges](#) because they were the only ones available at the pharmacy. Each of these lozenges lasted approximately 3 hours.
6. In total, the nicotine supplementation lasted for ≈ 4.5 months. I worked on my thesis for probably 9 hours per day on average, for a standard three nicotine lozenges per day after switching to the smaller lozenges.

2.2 How much nicotine is this, really?

This is a subtle question. It would be easy to say that an average cigarette contains 10mg of nicotine, so each lozenge contains 1/5 the nicotine of a cigarette. It would also be inaccurate. Here are a few considerations.

- There are several different ways to measure the amount of nicotine consumed. Should we measure by total quantity consumed? Peak blood nicotine concentration? Area-under-the-curve of blood nicotine concentration? These different measures likely have different influences on both efficacy and addiction risk, in ways that I do not understand at this time.
- Different methods of administration result in radically different blood concentration curves. For example, smoking a cigarette in a series of distinct puffs creates a series of many discrete spikes of blood nicotine concentration. A lozenge, on the other hand, slowly raises blood nicotine concentration to an equilibrium level, and keeps it there so long as a lozenge is in the mouth. Some data on these blood concentration curves can be found in [this paper](#).
- Different methods of administration have different bio-availabilities, making comparison difficult. In the process of smoking a cigarette, much of the nicotine is lost to the flame and does not reach the brain. It has proven difficult to find data on the bio-availability of nicotine across different methods of administration. The only estimates I was able to find with a cursory Google/LLM search were largely-unsourced estimates on [promotional materials](#) for various tobacco and nicotine products, which I am not particularly inclined to trust.
- The way one uses a nicotine lozenge itself impacts the absorption rate. Holding a lozenge under the tongue instead of tucked in a lip [increases the absorption rate](#). Moreover, the absorption rate is increased by sucking the lozenge and moving it around in the mouth.

In short, I do not have a clear sense of how much nicotine this really is. In an absolute sense, it's not that much. 2mg nicotine lozenges are recommended to medium-use smokers to curb cravings while quitting cigarettes, in comparison to the 4mg lozenges recommended to heavy smokers. Zyn pouches come in 3mg and 6mg sizes, and Zyn users often use far more than 2–4 pouches per day. What was unusual about my usage (and much heavier than someone who smokes cigarettes or uses nicotine lozenges to curb cravings) is that I was likely keeping my blood nicotine concentration at-or-near its max for 6–12 hours per day, every day.

2.3 How did it feel?

The impact of the nicotine lozenges on my workflow was immediate. I am a night owl by nature, and tend to have a productivity spike after 5:00 PM. For the first few nights I supplemented nicotine, I felt focused and was able to work far later than usual, without noticing the passage of time. I was keeping my productivity often until 3:00–4:00 AM. I felt as though I could work indefinitely, and only went to bed when I chose to.

As my body acclimated to the nicotine, I no longer felt a “rush” that kept me up through the wee-hours of the night. My usual bed time became a comfortable 2:15 AM, at which point I felt tired. Even though the rush had ceased, I still felt an increased motivation to work, including during “normal” working hours—something I had become unaccustomed to in graduate school. Even as my late night work hours diminished, my total daily work hours climbed steadily.

While my feelings of failure and disappointment about my thesis did not halt completely, they did meaningfully diminish through the process. As my thesis came together (and I had more ideas to add to my thesis that I have deemed valuable), I began to feel more proud of my work than I ever had before. After two months of nicotine supplementation, I would say that each hour spent on thesis writing felt $\approx 20\%$ as bad as it did before supplementation.

I did, at times, find it difficult to strictly adhere to the nicotine supplementation program as written. It was more difficult than expected to commit to an hour or more of uninterrupted work at any given time. Maybe 30 minutes into a session I would get a call from my girlfriend, or perhaps I would get hungry and need to break for lunch. More troubling, I regularly found myself with nicotine in my mouth while I wasn’t working, not so much by intention, but by apathy. I would never put a lozenge under my lip other than at the start of a work session, but I became quite lazy about removing the lozenge when the session ended. Sometimes I would forget about the lozenge all-together. Other times, I would justify keeping the lozenge in my mouth on the grounds that I would start working again soon. I also became less careful about not taking micro-breaks to check the news, do a crossword puzzle, or check in on another work project while a Lozenge was in my mouth. In total, I would estimate that 75–85% of the time I spent with nicotine in my mouth was actually spent on thesis work.

2.4 The aftermath

At the time of writing, I am approximately two weeks nicotine free. My last 2mg nicotine lozenge was nestled behind my upper lip on the left side approximately fifteen minutes before my thesis defense, and swallowed shortly after for a fully-gummed smile in a celebratory photograph with my committee. I can honestly report that quitting nicotine was extremely easy (and I intend on using this fact to frustrate smokers and vape users for the rest of my life). I did not experience meaningful withdrawal symptoms. For approximately two days after I stopped using nicotine, I experienced a bit of head fog. In magnitude, the fog was less than what I feel after ≈ 24 hours without coffee. I am not sure to what extent this head fog was due to nicotine withdrawal; celebrating my thesis defense was my first time having a non-trivial quantity of alcohol in approximately a year. Some portion of my foggy head was probably just a very mild hangover from a celebration dinner.

Since I stopped taking nicotine, I have not had anything which I would call a “craving.” Since I have never experienced a craving for nicotine or any other substance, it’s hard to know what a craving feels like. If I’m honest, I do find myself lightly missing the lozenges though. They tasted nice, and I miss the sensation of a small pressure on my upper gums. For the first few days after my defense, I would find myself subconsciously placing my tongue behind my upper lip. Currently, I have a nasty upper respiratory infection, and I find my cough drops migrating to the exact spot I would put the lozenges, seemingly by their own volition. However, I do not feel a desire for nicotine *per se*. I would estimate the probability that I use any nicotine product in the next three months at somewhere between 1% and 5% ⁴. I’d bet ⁵ a significant portion of my net worth against it, but not my life.

⁴The primary risk factor here is not a relapse into regular use, but soft plans to visit some Italian friends.

⁵If you are interested in being a counter party to such a bet (with odds), let me know. A little extra financial motivation to stay nicotine-free couldn’t hurt.

3 Commentary

My self-experiment with nicotine supplementation for motivation and productivity was, by my standards, an enormous success. I firmly believe that if I had not began nicotine supplementation, I would have failed to complete my thesis defense this summer. I have taken the last two weeks pretty easy, first to entertain my family who came to celebrate the successful defense, then as a well-deserved break, and finally due to being bedridden with a fever for a few days. I look forward to finding out if, like the active group runners, my productive gains persist beyond the end of the nicotine supplementation.

All that said, there are a few reasons you shouldn't believe me.

1. This is an anecdote based on a half remembered study/Twitter thread, with an adhoc supplementation procedure which was changed part-way through and only partially adhered to.
2. I did not record enough data to provide any quantitative data about my experience.
3. Just like how pharmaceuticals often feel more effective because interventions are sought at-or-near the worst point in an illness, my decision to begin nicotine supplementation may have coincided with the moment I knew "I have to get serious right now or this isn't going to happen at all." That is, my decision to begin a weird self-experiment to complete my thesis may itself be an indicator that I was ready to put my feeling aside and start working.
4. My motivations are not completely pure. I *wanted* nicotine supplementation to work. I distinctly remember having the thought "if this nicotine supplementation works, that would make for a really interesting essay." Indeed, I even have a series of voice notes in my phone describing my thoughts and feelings through the first few days of use. The fact that I wanted nicotine supplementation to work (beyond my desire for *anything at all* to help me write my thesis) should reduce your confidence in my claims.

Even with these considerations in mind, I still believe that nicotine supplementation was critical for me. The stimulant effects of nicotine gave me the kick-in-the-ass I needed to power through the first few days of thesis work. As the euphoria of a new stimulant diminished, the conditioning effects carried me through. I would have three fewer letters on my future business cards if I had not used nicotine products.

3.1 Would I do this again?

Short answer: yes, absolutely. If I find myself in a similar motivational crisis in the future, I will strongly consider using nicotine supplementation. Longer answer: yes, with some modifications. There are a few aspects of my procedure that I would like to modify. Even though my nicotine supplementation was effective and I did not get addicted, I believe I could improve the risk/reward profile.

1. After an initial acclimation period, I would like to utilize an intermittent reward schedule. In other aspects of my own life, I find myself responding very strongly to intermittent reinforcement. As a silly example, I recently realized that one of the aspects I enjoy about chips with seasoning powders (Doritos, Cheeze-Its, etc.) is the rush of the sporadic chip with extra powder. If the non-uniform powder distribution across chips is a conspicuous strategy by Frito-Lay and Kellogg's to make their products addicting, it worked on me. Similarly, I think an intermittent reward schedule for nicotine supplementation could prove more effective for me with less total nicotine consumed.
2. I would like to find an approach to nicotine supplementation that would be easier to strictly adhere to. While my apathy toward lozenge removal could be overcome with effort, I don't see a clear way to stop the problem of interruptions weakening the association between nicotine reward response and the desired stimulus.
3. On a different note, I would not hide my nicotine supplementation from my loved ones⁶. Not only was it wrong of me to hide this from the people around me, they could have been useful

⁶This write-up is also an apology note to my parents, who are learning about my nicotine supplementation from this piece. Sorry Mom and Dad!

for keeping me honest about lozenge removal. After coming clean to my girlfriend mid-way through my regimen, she regularly noticed when I had a lozenge in and wasn't working. Not only does this help solve item 2 above, she could help me deal with interruptions in the future.

3.2 Should you try it?

Short answer: maybe? I'm not sure. I'm quite apprehensive to recommend nicotine supplementation, which does carry a risk of addiction, to anyone other than myself. When I was assessing the risk of nicotine supplementation, the primary downside was some probability of long term use. I came to the conclusion that long term nicotine use via lozenge (read: not smoking, vaping, or tobacco use) is slightly negative to neutral ⁷ for health. The financial impact, however, is clearly negative. A nicotine addiction, like a morning coffee addiction, is a relatively small daily expense that adds up over the year. It's basically a tax, considering the ever-increasing Pigouvian tax on nicotine products. I would feel terrible if I promised you motivation and habit formation, and instead delivered a negative perpetuity.

All that said, why did I try nicotine supplementation? Beyond my greater comfort with assuming risk myself over instructing others to take on risk, there are a few reasons I thought the likelihood of a serious nicotine addiction was low.

1. **Family history:** To the best of my knowledge, neither of my parents nor my sister have any addictions. My father smoked a tobacco pipe for some time, but quit and has been nicotine free my entire life.
2. **Personal history:** The only addiction I have ever had is caffeine. Moreover, when I have decided to cut back on caffeine use, I have been able to do so with minimal effort. I have never been a regular nicotine user before, despite sporadic social nicotine use.
3. **Consumption discipline:** I seem to have a meaningfully easier time controlling my consumption behavior than others. For example, I find modulating my weight by changing dietary habits to be quite easy. I have gone to the casino dozens of times with an amount of money I am prepared to lose, and never once spent beyond that point (even after losing my full bank roll in a historically bad zero-win-five-loss evening of blackjack). I don't think there are many ways in which I am an exceptional person, but if accounts of gambling and weight loss journeys are to be believed, I have a fundamentally different experience with controlling consumption. I earnestly think I could try heroin exactly once and be fine (and have zero interest in—or intention of—testing this hypothesis).

I sincerely believe nicotine supplementation allowed me to complete my PhD thesis. If you are suffering from motivational problems similar to my own, and have a similar self-assessed risk profile, nicotine supplementation is a tool to consider.

⁷Again, see this [this piece by Gwern](#) for a concise overview of the health-neutral argument.