(Pre/Sub)scribe

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Envisioning the Future of Computing Prize
Social and Ethical Responsibilities of Computing
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(Pre/Sub)scribe

Summary

Every technological innovation, is, by and large, neutral. The morality we assign to it is not an intrinsic feature of the technology itself, rather, its moral categorisation is dictated by the intent of its invention and its downstream applications. This perspective is neither novel nor radical. Nevertheless, American society continues to entrust profit-driven actors with unfettered control over new technologies, even those most central to healthy, functioning communities.

(Pre/Sub)scribe is a piece of speculative fiction that explores the development of 'B-Bots': synthetic bacterial mimics that can modulate the gut microbiome, permitting sustainable treatment for the many conditions—irritable bowel syndrome, type 2 diabetes, some cancers, and depression, to name few—that are linked to dysbiosis in the gastrointestinal tract.[1] The concept of 'B-Bots' emerged from recent discoveries that have begun to elucidate the mechanisms by which the microbiome can define our health; the activity of the microbes inside us affects everything from our ability to use vitamins to the rate of neuronal degradation.[2] *(Pre/Sub)scribe* showcases how this plausible technology could harness these mechanisms to more deliberately interact with our 39 trillion bacterial roommates, quickly correcting any dissonance in the ecosystem. A treatment like 'B-Bots' would revolutionise how we approach innumerable medical issues.

However, this work of fiction exists in the all-too-real context of the American profit-driven healthcare system: the trajectory of 'B-Bots' from conception to subscription-based, corporatised product is similar to those of many modern technological advances, and the experiences depicted herein are inspired by real events.[3] From the author's perspective as a non-American raised with universal healthcare, it seems disingenuous to pretend that the benefits of any medical advance would not be corrupted by the reality of healthcare in the United States today.

To borrow phrasing from one of the characters, "I still think that B-Bots can and will do a lot of good". That 'good' requires that access to technology, medical and otherwise, must be free, just and equitable—that will only be possible as we strive toward a free, just and equitable society.

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[1] de Vos, A., Tilg, H., Hul, M. V., & Cani, P. D. (2022). Gut microbiome and health: Mechanistic insights. *Gut*, *71*, 1020–1032. https://doi.org/10.1136/gutjnl-2021-326789

[2] Correia, A. S., Cardoso, A., & Vale, N. (2023). Oxidative stress in depression: the link with the stress response, neuroinflammation, serotonin, neurogenesis and synaptic plasticity. *Antioxidants*, *12*(2), 470. https://doi.org/10.3390/antiox12020470

[3] For example:
A.B.C News. *Wisconsin man dies after inhaler cost jumps $500, according to family's lawsuit*. ABC News. Retrieved 6 February 2025, from https://abcnews.go.com/US/wisconsin-man-dies-after-inhaler-cost-jumps-500/story?id=118422131

2032, Palo Alto, CA

Her coffee cup was bright orange, glittery, and patterned with cats. Insofar as a mug can be loud, this one bordered on screaming. This was on purpose. Several drops of hot coffee escaped over the rim as she placed it on the boardroom table with shaky hands. This, too, was on purpose. Men, especially the sort of men who decide to become venture capitalists in Silicon Valley, tended to respond best when she appeared just a little nervous. Bashful, with a hint of quirkiness. It was a fine line; pushing it too far meant no investors and a high likelihood of someone following her to the parking lot to ask for her number.

Once satisfied that all seven in attendance had been suitably primed by her performance, Katie began.

"Two months ago, I had my first cup of coffee in almost a decade." She punctuated the sentence with a hefty sip from the colourful mug."During my first couple years of grad school, I worked until two most nights. I'd slam two or three cups of coffee with breakfast and would be on my third RedBull by the time it got dark. A midnight stop at the falafel place counted as dinner." Fishing around in her pocket, she withdrew a package of foam earplugs. She tossed them towards the skittish-looking man to her right. "If you're squeamish, grab a pair of these for this next part." It was an obvious gimmick, but the boys at Google ate it up last week, so she'd decided to stick with it.

"Next thing I knew, I was vomiting acid whenever I ate anything besides oatmeal. I always had ulcers on the inside of my mouth, and let me tell you, throwing up when you also have open sores in your mouth is distinctly unenjoyable. I was constantly exhausted, bloated and cramping. My skin was pale and clammy. Over six months I lost over twenty pounds." She paused for another sip. "But I was a grad student, fight? I didn't have time to go to the doctor, and my health insurance sucked enough that I probably couldn't afford to fix anything anyway."

No one had taken her up on the offer of earplugs—no one ever did, that wasn't the point—but there was a definite tinge of green amongst the rapt faces.

"I was lucky that other people were in the lab when I fainted. The bottle of acid I'd been holding spilled and soaked through my lab coat, but my lab-mates reacted quickly enough to keep the damage to a minimum." Katie pulled up her sleeve to reveal the mottled scar that blanketed most of her forearm.

The man at her right swore, then half-heartedly attempted to disguise it with a cough. "Brutal, right? I'd just gotten a new tattoo there too." Her flippancy was rewarded with a light ripple of laughter.

"The ER doctors dealt with the burn pretty quickly, but I was in such rough shape that they admitted me. Over the ten days I was there, the doctors determined I'd developed a severe vitamin B12 deficiency, irritable bowel syndrome and chronic acid reflux to such a degree that I was in danger of needing surgery to reinforce my esophageal sphincter."

Katie smiled. "Okay, tough part's over." She took another sip of coffee; several of the prospective investors followed suit. "Over the next year, I did everything right. Changed my diet, went to bed early… it all helped a bit, but if I got at all stressed, or slipped up and had a single sip of seltzer water, all my symptoms came back with a vengeance.

"Another grad student, Sucharita, was studying the human gut microbiome. Chatting with her made me wonder if what I was experiencing was due to a residual change in the microbiome of my GI tract—perhaps the flora now in residence were more prone to exacerbating inflammation and pH shifts. I was working in a metaproteomics lab at the time, and convinced my advisor to let me spin up an experiment and run samples on our mass spectrometer after hours.

"In brief, we took a look at my microbiome, hers, and those of a couple other friends. Using metaproteomics meant that we could not only determine the community composition of each of our personal microbiomes, we could also map out which bugs were doing what. We saw what each type of microbe was eating, what they excreted, and even got hints of how they competed with other microbes.

"My body hosted a completely different microbial network than the others. This wasn't surprising; we know that gut dysbiosis can result from or contribute to everything from depression to kidney disease.[4] Traditional methods, such as the faecal transplants, can help, but often can't outcompete a dysbiotic system that's stabilised in the gut. Nor can they address underlying conditions, such as, in my case, a previously undiagnosed autoimmune disease that weakens my ability to take up B12."

When it was off, the screen inset in the darkened glass wall behind her was all but invisible. Now it lit up to display a sleek title slide.

B-Bots: Real-time Responsive Therapeutics

With the investors' attention shifted to the screen, Katie allowed herself a brief sigh. *God, I hate monologuing,* she thought. Sucharita hated it more, though, which is why Katie always got stuck leading the investor meetings while Suchi got to sit on a remote feed and direct the slideshow from the comfort of her office.

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[4] Correia, A. S., Cardoso, A., & Vale, N. (2023). Oxidative stress in depression: the link with the stress response, neuroinflammation, serotonin, neurogenesis and synaptic plasticity. *Antioxidants*, *12*(2), 470. https://doi.org/10.3390/antiox12020470
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Rothschild, D., Weissbrod, O., Barkan, E., Kurilshikov, A., Korem, T., Zeevi, D., Costea, P. I., Godneva, A., Kalka, I. N., Bar, N., Shilo, S., Lador, D., Vila, A. V., Zmora, N., Pevsner-Fischer, M., Israeli, D., Kosower, N., Malka, G., Wolf, B. C., … Segal, E. (2018). Environment dominates over host genetics in shaping human gut microbiota. *Nature*, *555*(7695), 210–215. https://doi.org/10.1038/nature25973

She assembled her features into a conspiratorial expression as their gaze returned to her. “That’s where B-Bots come in. B-Bots are ingestible, persistent therapeutic agents with the potential to revolutionise healthcare—and they’re the reason I can stand here today with this delightful cup of coffee. These tiny machines each perform up to ten distinct chemical reactions. We currently have over two hundred reactions on offer, each mediated by synthetic proteinaceous catalysts. Depending on user needs, B-Bots can integrate into their existing microbiome to enhance or add functionalities, or disrupt a harmful microbial community and help a healthier one establish.”

Behind her, a scanning electron microscope image showed a collection of short rods, each one embossed with a honeycomb pattern. Black arrows highlighted tiny hairs bristling at their ends. “These particular B-Bots will take up residence in the stomach. The polar fimbriae are specific to the surface mucosal cells, allowing the B-Bots to securely attach themselves. This texture”—she waved vaguely at the image—“is engineered to prevent biofilm formation.[5] B-Bots should last at least six years after placement; even early prototypes have been going strong for four. ”

“Once secured, they get to work. I’ll give you some examples of my own B-Bots: some scavenge various compounds from food and microbial excreta, then perform reactions needed to enhance B12 production and compensate for my substandard uptake. Others help regulate my stomach’s acidity through pH-responsive synthesis of a famotidine analog—those are the ones doing the heavy lifting on the coffee.”

A bald man with a generous moustache raised his hand. “How do you charge ‘em?” he asked. A Canadian accent coloured his mellifluous baritone.

Katie acknowledged the question with a nod. “Oh, just plug the charging cable into your belly button,” she said breezily. His moustache wiggled as he chuckled. “Actually, that was a major challenge. Using chemical energy, like bacteria do, requires too much metabolic flexibility. We ended up iterating on existing nanoscale vibrational energy-harvesters, using broad-bandwidth designs and 3D-printed crystalline piezoelectric films.[6] Basically, B-Bots generate their own energy as your movement agitates them inside you.”

He scribbled something in the notebook in front of him. “Can you deactivate them, or remove them somehow?”

“Of course. Initial models had a chemical deactivation switch, whereby users ingest capsules containing a proprietary peptide mix. Those peptides then bind surface receptors on

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[5] Schwibbert, K., Richter, A. M., Krüger, J., & Bronze, J. (2023). Laser-textured surfaces: a way to control biofilm formation? *Laser & Photonics Reviews, 18*(1), 2300753. https://doi.org/10.1002/lpor.202300753

[6] Debnath, B., & Kumar, R. (2022). A comparative simulation study of the different variations of PZT piezoelectric material by using a MEMS vibration energy harvester. *IEEE Transactions on Industry Applications, 58*(3), 3901–3908. IEEE Transactions on Industry Applications. https://doi.org/10.1109/TIA.2022.3160144
Kim, S.-G., Priya, S., & Kanno, I. (2012). Piezoelectric MEMS for energy harvesting. *Kim*. https://dspace.mit.edu/handle/1721.1/75255

the B-Bots, triggering them to dissolve their attachment fimbriae. They're then flushed from the body. However, we've begun experimenting with Bluetooth integration for better user control. New models will carry an internal reservoir of signal peptides, housed in a vesicle built of hardy ether-linked phospholipids. A simple Bluetooth receiver tethers each vesicle to the energy-harvester chip. If any B-Bots are no longer desired by a user, they can select them for deactivation in the B-Bot management app. Selected B-Bots then direct an electric pulse to their vesicle, weakening the membrane integrity sufficiently for the peptides to escape and incite fimbria dissolution." On the screen, polished diagrams illustrated the process.

More scribbling, now accompanied by feverish typing from others at the table. A few surreptitious whispers added to the chorus.

Katie continued blithely, detailing results from animal models and clinical trials. By the meeting's end, five of the seven had offered handshake commitments; another emailed her that evening to sign on.

2034, Ellensburg, WA

"I swear, they're a game-changer," the girl in the video said, earnestness plastered across her face. "When B-Bots introduced their *Balance* mental health mix, I finally caved and started the free trial. I'm not a scientist, so don't quote me, but apparently there are a bunch of neurons in your gut that get all inflamed when your microbiome is off, which messes with your brain.[7] It's linked to loads of problems—depression, anxiety, maybe even Parkinson's. *Balance* B-Bots calm that inflammation and do a ton of other stuff—they're like super-powered probiotics."

A chipper pop song played as she showcased the glossy box her B-Bots had shipped in. "I've taken SSRIs and supplements forever, but adding B-Bots made an *insane* difference." She leaned towards the camera. "If you've followed me a while, you know I never do promos… but I just couldn't gatekeep this. My baseline mood's higher than ever and my anxiety is non-existent. Definitely check them out, the link's in my bio! Use code 'SHAYLA2-VIDSTR' for 20% off your first two months."

The video paused with a tap of Briar's finger. Against the background of the coiffed video creator, his hands were stunningly ragged: cuticles picked raw, nails nervously nibbled to stubs. Red half-moons marked his palms, remnants of how his fingernails had dug in as he'd clenched his fists during a recent panic attack. Briar had ignored most of the hype around B-Bots; insurance seldom covered them, and besides, none of the conditions B-Bots purported to treat were things that Briar struggled with enough to be worth the cost (though the lactase B-Bot enticed him: ice cream was a potent motivator).[8] *Balance*, though—"Stupid name," he muttered—sounded promising; especially with the sting of the $70 co-pay for anti-anxiety medication still fresh from his morning pharmacy trip. Promising enough to click on a link, at least.

BALANCE™, the product page read, *is an innovative B-Bot mix designed to alleviate depression, anxiety and other mood disorders.*[9] *Reports of ameliorated mental health upon long-term use*

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[7] Correia, A. S., Cardoso, A., & Vale, N. (2023). Oxidative stress in depression: the link with the stress response, neuroinflammation, serotonin, neurogenesis and synaptic plasticity. *Antioxidants*, *12*(2), 470. https://doi.org/10.3390/antiox12020470
de Vos, A., Tilg, H., Hul, M. V., & Cani, P. D. (2022). Gut microbiome and health: Mechanistic insights. *Gut*, *71*, 1020–1032. https://doi.org/10.1136/gutjnl-2021-326789
Han, Y., Wang, B., Gao, H., He, C., Hua, R., Liang, C., Zhang, S., Wang, Y., Xin, S., & Xu, J. (2022). Vagus nerve and underlying impact on the gut microbiota-brain axis in behavior and neurodegenerative diseases. *Journal of Inflammation Research*, *15*, 6213–6230. https://doi.org/10.2147/JIR.S384949
Rothschild, D., Weissbrod, O., Barkan, E., Kurilshikov, A., Korem, T., Zeevi, D., Costea, P. I., Godneva, A., Kalka, I. N., Bar, N., Shilo, S., Lador, D., Vila, A. V., Zmora, N., Pevsner-Fischer, M., Israeli, D., Kosower, N., Malka, G., Wolf, B. C., … Segal, E. (2018). Environment dominates over host genetics in shaping human gut microbiota. *Nature*, *555*(7695), 210–215. https://doi.org/10.1038/nature25973

[8] Gingold-Belfer, R., Levy, S., Layfer, O., Pakanaev, L., Niv, Y., Dickman, R., & Perets, T. T. (2020). Use of a novel probiotic formulation to alleviate lactose intolerance symptoms—a pilot study. *Probiotics and Antimicrobial Proteins*, *12*(1), 112–118. https://doi.org/10.1007/s12602-018-9507-7

[9] Kumar, A., Pramanik, J., Goyal, N., Chauhan, D., Sivamaruthi, B. S., Prajapati, B. G., & Chaiyasut, C. (2023). Gut microbiota in anxiety and depression: unveiling the relationships and management options. *Pharmaceuticals*, *16*(4), 565. https://doi.org/10.3390/ph16040565
Schneider, K. M., Blank, N., Alvarez, Y., Thum, K., Lundgren, P., Litichevskiy, L., Sleeman, M., Bahnsen, K., Kim, J., Kardo, S., Patel, S., Dohnalová, L., Uhr, G. T., Descamps, H. C., Kircher, S., McSween, A. M., Ardabili, A. R., Nemec, K. M., Jimenez, M. T., … Thaiss, C. A. (2023). The enteric nervous system relays psychological stress to intestinal inflammation. *Cell*, *186*(13), 2823-2838.e20. https://doi.org/10.1016/j.cell.2023.05.001
Kumar, A., Pramanik, J., Goyal, N., Chauhan, D., Sivamaruthi, B. S., Prajapati, B. G., & Chaiyasut, C. (2023). Gut microbiota in anxiety and depression: unveiling the relationships and management options. *Pharmaceuticals*, *16*(4), 565. https://doi.org/10.3390/ph16040565
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of other B-Bot products inspired this targeted treatment. BALANCE™ harnesses our most potent reactions to establish a mindful microbiome, and integrates new B-Bot functionalities to simultaneously provide rapid symptom relief: 88% of users saw their symptoms improve after just two weeks.

BALANCE™ is clinically proven to suppress pro-inflammatory cytokines, decrease blood-brain barrier permeability,[10] *and accelerate gastrointestinal colonisation of desirable* Lactobacillus *and* Bifidobacterium *strains. When used with a normal diet*, BALANCE™ B-Bot capabilities include complete synthesis of:*[11]

- *short-chain fatty acids*[12] *(acetate, butyrate, propionate)*
- *Siallyllactose*
- *Fructo-oligosaccharides*
- *GABA*
- *Vitamins B1, B2, B3, B6, B9, B12*
- *Indole-3-propionic acid*

**See FAQs for dietary guidelines.*

Briar did some quick mental math. After the week-long free trial, it was $65 per month; with @Shayla2's discount, it dropped to $52. There'd been a big uproar when B-Bots adopted their subscription model, but even at the time Briar had thought people were overreacting. *Definitely working out for me now*, he mused. It seemed like a good deal; better to try them for a couple months than have to shell out $400 or more on something that might not work for him.

The site made him create an account before requesting the trial—*another damn account, Jesus*. Briar selected one of his usual three passwords (W1ndyC1ty!), linked his credit card and address, then navigated back to the trial request form. He skimmed the terms of service: the standard 'don't sue us', 'consult a doctor if you're dying', 'terms subject to change' et cetera. "Okay, whatever," he grumbled, tapping 'Accept'.

B-Bots Inc. is pleased to offer free, expedited shipping, a pop-up announced. *Confirm your shipping address to continue*.

Despite his efforts to maintain low expectations, a little hope flickered to life, pixel by pixel, as the confirmation screen appeared.

Correia, A. S., Cardoso, A., & Vale, N. (2023). Oxidative stress in depression: the link with the stress response, neuroinflammation, serotonin, neurogenesis and synaptic plasticity. *Antioxidants*, *12*(2), 470. https://doi.org/10.3390/antiox12020470

[10] Kumar, A., Pramanik, J., Goyal, N., Chauhan, D., Sivamaruthi, B. S., Prajapati, B. G., & Chaiyasut, C. (2023). Gut microbiota in anxiety and depression: unveiling the relationships and management options. *Pharmaceuticals*, *16*(4), 565. https://doi.org/10.3390/ph16040565

[11] Kumar, A., Pramanik, J., Goyal, N., Chauhan, D., Sivamaruthi, B. S., Prajapati, B. G., & Chaiyasut, C. (2023). Gut microbiota in anxiety and depression: unveiling the relationships and management options. *Pharmaceuticals*, *16*(4), 565. https://doi.org/10.3390/ph16040565

[12] van de Wouw, M., Boehme, M., Lyte, J. M., Wiley, N., Strain, C., O'Sullivan, O., Clarke, G., Stanton, C., Dinan, T. G., & Cryan, J. F. (2018). Short-chain fatty acids: Microbial metabolites that alleviate stress-induced brain–gut axis alterations. *The Journal of Physiology*, *596*(20), 4923–4944. https://doi.org/10.1113/JP276431

2036

B-Bot knock-offs fell into one of three categories: those that didn't do anything at all, those that did something but that something was overall undesirable, and those that actually delivered. Of the latter, most notable was the KickStarter phenomenon known as *LoveBugs*. The claim that their product could induce production of attractive pheromones through gut microbiome modifications[13] faced considerable skepticism. However, small independent trials and countless testimonials seemed to corroborate the fact that LoveBugs, whether via pheromones or otherwise, stimulated sexual attraction towards users. The furious op-eds decrying LoveBugs as 'dating cheat codes' and 'romantic brainwashing' did nothing to quell their avalanche of sales.

After the B-Bots IPO launched to great market success, no one was surprised when they immediately moved to acquire LoveBugs. Existing LoveBugs users were offered B-Bot replacements at steep discounts, which minimised public backlash. Media coverage remained largely friendly, especially as company-sponsored STEM outreach programs trickled into schools, and food-insecure households were granted subsidised subscriptions to B-Bot mixes that emphasised efficient extraction of vitamins from low-quality diets. "B-Bots changed my life", even "B-Bots *saved* my life" became common refrains everywhere from family dinners to conference presentations. Concurrently, quiet takeovers of other companies hawking B-Bot substitutes slipped through.

[13] Zhang, M., Zhang, X., Wang, X., Liu, Y., An, J., Wang, D., Cai, Z., & Hou, R. (2023). Intestinal acetic acid regulates the synthesis of sex pheromones in captive giant pandas. *Frontiers in Microbiology*, *14*, 1234676. https://doi.org/10.3389/fmicb.2023.1234676

2037, Seattle, WA

Briar had rarely opened the B-Bot app in the three years since receiving his B-Bots. Once your B-Bots were activated, there wasn't much point. The tasteful interface had only three functions: add new B-Bots, deactivate existing B-Bots, and a user inbox, which, as far as he could tell, had a sole purpose of storing the monthly subscription receipts.

The email, consequently, caught him entirely unawares.

Urgent—Update Payment Method, blared the subject line. "What the -" he mumbled. The message brightly informed him that his subscription payment had failed and his B-Bots would be terminated unless payment was received within seven days.

The credit card he'd linked to the account was the first card he'd opened. He barely used it these days—the limit was low and the rewards lousy compared to his newer cards, but it wasn't worth the credit score hit to close it. He'd set up automatic payments, so given the card's paltry $200 limit, it didn't warrant much attention.

Now, he opened the banking portal on his computer and examined his transaction history intently. Today, a B-Bots charge for $215 had failed to go through. Despite the condescending glow of the 'insufficient funds' icon, relief washed through with a sigh—clearly a system glitch.

The line below rudely soured that relief. The last charge, September 1st, sat stubbornly at $200. In August, $200 again. He read further—six months ago, $170.

The subscription charges steadily diminished back through time to eighteen months before—the last month for which the subscription rang through at the expected $65. His throat knotted in a way it hadn't for years, not since the B-Bots helped settle his anxiety into insignificance. Money had become pretty tight, but he'd known Seattle would be expensive; he'd thought he'd accounted for everything. This, though… he couldn't justify the cost. *It could still be a glitch*, an optimistic voice in his head soothed.

On the B-Bot website, a customer service chatbot thanked him for his inquiry, then suggested he check for service messages in the app and provided a link to file a formal complaint.

The B-Bot user inbox devastated any possibility of an easily resolvable mistake. Message after message announced *Subscription service update: Balance B-Bots*. The contents detailed the price increases unambiguously.

"I guess that's it, then." His empty apartment stared back, unsympathetic.

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I don't remember it being this bad. Maybe it was, and the B-Bots had pulled him out of such darkness that his mind opted to repress the memories. After deactivating his B-Bots it

took a few months for the anxiety to build, but constant, aching cramps and nausea arose within weeks. Briar wasn't alone—forums online were dotted with threads of people detailing the aggressive return of their symptoms after their B-Bots were remotely terminated for lack of payment or deliberately deactivated.

Briar was staring at the ceiling, dully wandering between social media sites, when a journalist he followed posted a pop science summary of a recent study. The article headline was in sturdy block text:

B-Bots Become Keystone Species in Gut Microbiome

"Though undoubtedly effective as an ongoing treatment, the gut microbiome can become reliant on B-Bots to fulfil critical functions and provide key metabolites. Sudden discontinuation of B-Bots can lead to ecosystem collapse, resulting in dramatic and deleterious changes in the gut's microbial community," he read aloud. A callout further down the page quoted a scientist who described the process as 'metabolic addiction'.

Briar read on. *Sucharita Bhattacharya co-founded B-Bots with Katie Banting, but severed ties with the company in 2035. In an exclusive interview with SciSpotted, Dr. Bhattacharya stated, "[we] never should've gone subscription in the first place. Hell, we should have made it open-source. Yeah, B-Bots changed people's lives, but anyone with a brain should have known it would end like this […] if we forced people into quitting cold turkey." She ended on an optimistic note. "I still think that B-Bots can and will do a lot of good—if they're put in the hands of those who aren't in it for the profit."*

There was a brief note at the end. *A B-Bots spokesperson declined to comment on the ethical responsibility of the company.*

References consulted during conceptualisation of this work

A.B.C News. *Wisconsin man dies after inhaler cost jumps $500, according to family's lawsuit*. ABC News. Retrieved 6 February 2025, from https://abcnews.go.com/US/wisconsin-man-dies-after-inhaler-cost-jumps-500/story?id=118422131

Correia, A. S., Cardoso, A., & Vale, N. (2023). Oxidative stress in depression: the link with the stress response, neuroinflammation, serotonin, neurogenesis and synaptic plasticity. *Antioxidants*, *12*(2), 470. https://doi.org/10.3390/antiox12020470

de Vos, A., Tilg, H., Hul, M. V., & Cani, P. D. (2022). Gut microbiome and health: Mechanistic insights. *Gut*, *71*, 1020–1032. https://doi.org/10.1136/gutjnl-2021-326789

Debnath, B., & Kumar, R. (2022). A comparative simulation study of the different variations of PZT piezoelectric material by using a MEMS vibration energy harvester. *IEEE Transactions on Industry Applications*, *58*(3), 3901–3908. https://doi.org/10.1109/TIA.2022.3160144

Dicks, L. M. T. (2022). Gut Bacteria and Neurotransmitters. *Microorganisms*, *10*(9), 1838. https://doi.org/10.3390/microorganisms10091838

Gingold-Belfer, R., Levy, S., Layfer, O., Pakanaev, L., Niv, Y., Dickman, R., & Perets, T. T. (2020). Use of a novel probiotic formulation to alleviate lactose intolerance symptoms—a pilot study. *Probiotics and Antimicrobial Proteins*, *12*(1), 112–118. https://doi.org/10.1007/s12602-018-9507-7

Han, Y., Wang, B., Gao, H., He, C., Hua, R., Liang, C., Zhang, S., Wang, Y., Xin, S., & Xu, J. (2022). Vagus nerve and underlying impact on the gut microbiota-brain axis in behavior and neurodegenerative diseases. *Journal of Inflammation Research*, *15*, 6213–6230. https://doi.org/10.2147/JIR.S384949

Kim, S.-G., Priya, S., & Kanno, I. (2012). Piezoelectric MEMS for energy harvesting. *Kim*. https://dspace.mit.edu/handle/1721.1/75255

Kumar, A., Pramanik, J., Goyal, N., Chauhan, D., Sivamaruthi, B. S., Prajapati, B. G., & Chaiyasut, C. (2023). Gut microbiota in anxiety and depression: unveiling the relationships and management options. *Pharmaceuticals*, *16*(4), 565. https://doi.org/10.3390/ph16040565

Populin, L., Stebbing, M. J., & Furness, J. B. (2021). Neuronal regulation of the gut immune system and neuromodulation for treating inflammatory bowel disease. *FASEB BioAdvances*, *3*(11), 953–966. https://doi.org/10.1096/fba.2021-00070

Rastogi, S., & Singh, A. (2022). Gut microbiome and human health: Exploring how the probiotic genus *Lactobacillus* modulate immune responses. *Frontiers in Pharmacology*, *13*, 1042189. https://doi.org/10.3389/fphar.2022.1042189

Rothschild, D., Weissbrod, O., Barkan, E., Kurilshikov, A., Korem, T., Zeevi, D., Costea, P. I., Godneva, A., Kalka, I. N., Bar, N., Shilo, S., Lador, D., Vila, A. V., Zmora, N., Pevsner-Fischer, M., Israeli, D., Kosower, N., Malka, G., Wolf, B. C., … Segal, E. (2018). Environment dominates over host genetics in shaping human gut microbiota. *Nature*, *555*(7695), 210–215. https://doi.org/10.1038/nature25973

Sadagopan, A., Mahmoud, A., Begg, M., Tarhuni, M., Fotso, M., Gonzalez, N. A., Sanivarapu, R. R., Osman, U., Latha Kumar, A., & Mohammed, L. (2023). Understanding the role of the gut microbiome in diabetes and therapeutics targeting leaky gut: a systematic review. *Cureus*, *15*(7), e41559. https://doi.org/10.7759/cureus.41559

Schneider, K. M., Blank, N., Alvarez, Y., Thum, K., Lundgren, P., Litichevskiy, L., Sleeman, M., Bahnsen, K., Kim, J., Kardo, S., Patel, S., Dohnalová, L., Uhr, G. T., Descamps, H. C., Kircher, S., McSween, A. M., Ardabili, A. R., Nemec, K. M., Jimenez, M. T., … Thaiss, C. A. (2023). The enteric nervous system relays psychological stress to intestinal inflammation. *Cell*, *186*(13), 2823-2838.e20. https://doi.org/10.1016/j.cell.2023.05.001

Schwibbert, K., Richter, A. M., Krüger, J., & Bronze, J. (2023). Laser-textured surfaces: a way to control biofilm formation? *Laser & Photonics Reviews, 18*(1), 2300753. https://doi.org/10.1002/lpor.202300753

van de Wouw, M., Boehme, M., Lyte, J. M., Wiley, N., Strain, C., O'Sullivan, O., Clarke, G., Stanton, C., Dinan, T. G., & Cryan, J. F. (2018). Short-chain fatty acids: Microbial metabolites that alleviate stress-induced brain–gut axis alterations. *The Journal of Physiology*, *596*(20), 4923–4944. https://doi.org/10.1113/JP276431

Zhang, B., Chen, T., Cao, M., Yuan, C., Reiter, R. J., Zhao, Z., Zhao, Y., Chen, L., Fan, W., Wang, X., Zhou, X., & Li, C. (2022). Gut microbiota dysbiosis induced by decreasing endogenous melatonin mediates the pathogenesis of Alzheimer's disease and obesity. *Frontiers in Immunology*, *13*, 900132. https://doi.org/10.3389/fimmu.2022.900132

Zhang, M., Zhang, X., Wang, X., Liu, Y., An, J., Wang, D., Cai, Z., & Hou, R. (2023). Intestinal acetic acid regulates the synthesis of sex pheromones in captive giant pandas. *Frontiers in Microbiology*, *14*, 1234676. https://doi.org/10.3389/fmicb.2023.1234676