

Viewpoint

Nutrition, Behavior, and the Criminal Justice System: What Took so Long? An Interview with Dr. Stephen J. Schoenthaler

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Abstract: In the ongoing series of interviews, *Challenges* Advisory Board member and Nova Institute for Health Fellow Alan C. Logan meets with thought leaders, scientists, scholars, healthcare professionals, artisans, and visionaries concerned about health at the scales of persons, places, and the planet. Here, Dr Stephen J. Schoenthaler of California State University, Stanislaus, responds to a set of questions posed by *Challenges*. For over forty years, Dr. Schoenthaler has been at the forefront of the research connecting nutrition to behavior and mental health. In particular, Dr. Schoenthaler's work has examined relationships between dietary patterns, nutritional support, and behaviors that might otherwise be associated with criminality and aggression. Although the idea that nutrition is a factor in juvenile delinquency was popularized in the 1950s, the area received little scientific attention. In the 1970s, the idea that nutrition could influence behavior gained national attention in the US but was largely dismissed as "fringe", especially by those connected to the ultra-processed food industries. Today, relationships between diet and behavior are part of the robust field called "nutritional psychiatry"; emerging studies demonstrate clear societal implications, including those within the criminal justice system. Here, Dr. Schoenthaler discusses how we got here and updates *Challenges* on where the field has moved, with an eye toward future possibilities. Dr. Schoenthaler reflects on the early influences that shaped his interest in the field and discusses the ways in which this research, especially in the context of criminal justice, is related to the many interconnected challenges of our time.

Keywords: microbiome; stress physiology; public health; personalized medicine; community health; planetary health; health inequities; non-communicable diseases; social determinants of health; serotonin



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1. Introduction

Challenges is a unique interdisciplinary journal dedicated to integrating diverse scholarly discourse related to the Grand Challenges currently facing our societies and the planet at-large. To that end, the journal is continuing its series of spotlight interviews that cut across disciplines, professions, and perspectives. In collaboration with the Nova Institute for Health, the spotlight interviews seek out individuals with remarkable experience and wisdom; they are queried on their work, experiences, and ideas, and in particular, how those ideas cut across disciplines in the promotion of health and flourishing at scales of persons, places, and the planet.

In recent years, the far-reaching consequences of a global food supply dominated by ultra-processed foods have entered mainstream scientific discourse. These foods are generally recognized as those that are dense in calories, low in nutrients, low in fiber, high in sugar and/or fat and/or sodium, and inclusive of various emulsifiers, flavor enhancers, and other synthetic additives. The development of the NOVA food classification system has allowed researchers to more readily identify foods that meet specific ultra-processed

food criteria; there is significant overlap between those foods and what was often referred to, historically, as “junk food”, “highly-processed food”, and “convenience food” [1]. Research has shown that ultra-processed food consumption is associated with multiple diseases, disorders, and a higher risk of mortality [2–7]. There is compelling evidence that ultra-processed foods have addictive properties [8,9]. Included in this conversation is the idea that calorie-dense but nutrient-poor ultra-processed foods are contributing to the risk of mental disorders (most notably depression and anxiety [10–15]) and antisocial behavior [16]. Indeed, there has been growing acceptance that nutrition should be a significant consideration in the field of psychiatry [17].

Of course, the idea that food influences the mind is as old as recorded history. In 1899, an article in the *Journal of the American Medical Association* claimed that a “proper diet is our most powerful agent” in the treatment of melancholia [18]. In 1954, Dr. George Watson and colleague Andrew L. Comrey conducted a small controlled study published in the *Journal of Psychology*. The pair reported that a vitamin–mineral cocktail could improve symptoms in persons with various mental disorders [19]. The paper received very little scientific interest (it has only been cited 17 times on Google Scholar to date, of which 6 are by Watson!), but it was picked up by a Los Angeles news wire service, and a synopsis appeared in several newspapers [20]. One reader who became a passionate advocate for nutritional interventions as a preventative measure against juvenile delinquency was actress and fashion designer Gloria Swanson. In public addresses, Swanson quoted from the Watson and Comrey paper [21] and stated, “I can’t believe juvenile delinquency doesn’t come from the lack of proper nutrition. If the body can become sick from this, then why not the mind?” [22]. The newspapers stated that Swanson’s “war is with processed foods” [22]. So influential was Swanson that in 1958, the journal *Modern Nutrition* devoted several pages to her campaign to use nutrition as a preventive measure against juvenile delinquency [23]. In 1972, Watson published his book “*Nutrition and Your Mind*” [24], which received considerable media attention, including cover headlines in *Cosmopolitan* magazine (“Can diet banish depression and cure emotional ills? It already has!” [25]) and *McCall’s* magazine (“A startling new theory: Diet—not psychiatry—can cure mental illness”) [26]. The problem with Watson’s book and Swanson’s campaign as an “influencer” was that they were heavy on conjecture and light on science, and both relied mostly on Watson’s small-scale published work from the 1950s [19,27,28]. The lack of solid evidence was made clear in 1977 when the United States Senate examined the potential consequences of unhealthy diets and inadequate nutrients on mental illness and juvenile delinquency. Senator George McGovern concluded that “this whole area [nutrition and behavior] that we are talking about here today is probably the most poorly funded of any of the others of mental illness. This is really the purpose of this hearing, to generate some understanding of the need for more research in this area” [29]. The Senate hearings generated national media attention, with headlines such as “Junk Food: What’s it doing to your mind?” [30]. The short answer to such headline queries was simple—in 1977, scientists did not know much at all.

Although it might appear that the contemporary acceptance that nutrition is an important variable in behavior is a recent by-product of the increased scientific scrutiny of ultra-processed foods, such is not the case. The late 1970s and early 1980s represent the historical nucleus of the *scientific* study of nutrition and mental health, and in particular, how the topic intersects with the criminal justice system. One researcher who was working on the convergence of ideas during this era is Dr. Stephen J. Schoenthaler, now a professor in the College of the Arts, Humanities and Social Sciences at Stanislaus University in California. Dr. Schoenthaler is uniquely positioned to discuss the history of this work—he has a wealth of publications in the field, including many that have generated media headlines. *Challenges* was honored that Dr. Schoenthaler agreed to be the subject of the journal’s ongoing Nova Spotlight interviews.

Dr. Schoenthaler earned his master’s degree at Syracuse University and his PhD in sociology and criminology at the State University of New York (Buffalo) in 1978. After several years at Virginia Wesleyan University and the University of Southern Mississippi,

he took up a post at California State University, Stanislaus. His work over the last forty years has placed him at the forefront of nutrition and behavior, particularly as it intersects with juvenile delinquency, correctional treatment, and the criminal justice system at large.

2. The Nova Interview

Nova: Can you tell us a little bit about your early academic pathway? Looking back, can you see how your road from bachelor's degree to PhD shaped your current interests?

Dr. Schoenthaler: Sure. My father and grandfather were both nutritionally-oriented physicians, so I was originally going to pursue a career in clinical medicine. However, early on at the State University of New York, Geneseo, I switched from pre-med to sociology. After obtaining the bachelor's degree I knew I wanted to be an educator, so I entered Syracuse University's graduate sociology program. After I graduated in 1975, I taught sociology in two community colleges in upstate New York. More important, though, to how my career would unfold, was a teaching post in New York's maximum-security prison, Attica. Many people are familiar with Attica because of the 1971 riot that remains the deadliest in US prison history. In the aftermath, as part of reform measures, the state legislature offered an associate's degree program to inmates. I was invited to teach sociology, starting with 25 inmates who were doing 25 to life. . . with the possibility of parole if they did well. I can say with confidence that the inmates were the best students I have ever taught. After a year there I enrolled in a PhD program at the State University of New York, Buffalo, with the experience at Attica driving my focus on criminology. Looking back, I can clearly see those years helping to shape my current interests.

Nova: Early in your career you worked at Virginia Wesleyan University and then at the University of Southern Mississippi. What did your early career in sociology look like? Why were you motivated to study the relationship between nutrition and behavior?

Dr. Schoenthaler: Even though I was brought up, through my father and grandfather, appreciating the role of nutrition in clinical and public health, it wasn't really on my radar in terms of criminology, or human behavior. I was interested in the work of the sociologist-criminologist Edwin Hardin Sutherland and others who examined conflict, social disorganization, and the ways in which the risk of criminal behavior relates to personal associates or social relationships. The switch occurred after reading about probation officer Barbara Reed's testimony to the US Senate Select Committee on Nutrition and Human Needs. This was in 1977. Reed reported that her efforts to reduce sugar and remove highly-processed items from the typical diet reduced recidivism. I was intrigued, but definitely entered this line of inquiry with skepticism.

Nova: Your work in this area began in earnest in 1980. Can you summarize what you found in your first investigation of diet and behavior in a juvenile facility operated by the Virginia Department of Corrections?

Dr. Schoenthaler: After obtaining permission from the state's nutritionist, the chef introduced food preparation changes that were primarily aimed at lowering added sugars. I examined documented incidents of antisocial behavior among juvenile subjects who had experienced the modified diet for three months, and compared them to those who had entered the facility prior to the dietary transition. Those on the modified low-sugar diet had a 45% lower incidence of documented disciplinary actions [31]. Importantly, this diet was introduced in a covert way, wherein the rank-and-file personnel did not know that the head of food preparation had made the changes. This was a small study, there were 58 juveniles in total, 24 of which had experienced the dietary transition. You could refer to it as a pilot study, but the results were encouraging. These initial results led to follow-up studies at the Tidewater detention facility, and others in Los Angeles County, California, and Coosa Valley, Alabama.

Nova: Were these follow-up studies also attempts to lower dietary sugar?

Dr. Schoenthaler: Yes, they all used the generalized approach to swap out foods with high amounts of added sugar and fat. For example, we traded high-sugar breakfast

cereals with those that were not presweetened, canned fruits with dense added sugars were either drained and rinsed, or we used whole fruits. Sugar-sweetened beverages, soft drinks and powdered instant drink mixes, you know, the type of mixes that imitate actual juice, were swapped with 100% juice derived from citrus and other fruit. We traded high-sugar and high-fat snacks—cookies and potato chips, for example, with fresh fruit, vegetables, cheeses, and whole-grain products. We also used whole grain bread and brown rice.

Nova: Can you summarize what you found?

Dr. Schoenthaler: In the twelve correctional institutions that we studied, through 1985, we found that there was a 47% reduction in documented offenses, infractions, and other indicators of antisocial behavior. These included reductions in overt violence, acts of theft, verbal aggression, and insubordination to corrections personnel. Collectively, these studies involved over 8000 juveniles [32,33]. In the social science research tradition, these would be referred to as quasi-experimental studies. It is understood that quasi-experimental designs are never considered definitive because there can be many limitations. For example, if intervention A is consistently followed by result B, that might suggest possible causation, but often not since it remains possible that something else changed at or near the same time. Still, quasi-experimental projects provide tremendous value in the considerations of possible effect-size, sample-size, and duration, for subsequent high-quality randomized clinical trial that follow CONSORT statement guidelines.

Nova: So, we are talking about a whole-of-diet approach in that early work. At the time, there was a major emphasis on dietary sugar as a direct culprit in aggression and violent behavior. There was some evidence indicating that dietary sugar-induced hypoglycemia might produce aggression [34], and that criminal offenders, especially individuals with antisocial tendencies, have differing responses to glucose tolerance tests [35]. However, do you think that the high sugar intake that you observed among offenders was also surrogate marker of a diet with nutritional deficits and the presence of foods that were, at that time, and are perhaps even more so today, ultra-processed?

Dr. Schoenthaler: Yes, I noted at the time that these were dietary modifications that were simply intended to lower the consumption of foods that were otherwise dense in calories, but low in nutrients and fiber. We were eliminating exactly the types of foods and beverages that are ultra-processed according to the now widely accepted NOVA food classification system [6]. I also noted at the time that the clear behavioral improvements we were witnessing may, or may not have been, a product of added dietary sugars, per se.

Nova: Given the very high levels of ultra-processed foods in the western industrialized nations—between 50–60% on the average, and in some cases, individuals are steadily consuming a diet of 80% ultra-processed foods—researchers are examining the ways in which these foods influence human physiology, metabolism, and craving. In his new book *Ultra-Processed People*, physician-scientist Dr. Chris van Tulleken describes the effects of placing himself on an 80% ultra-processed food diet for a month. Also, under the supervision of King's College London's Dr. Tim Spector, participants in the Twins UK study have been placed on an ultra-processed foods diet for two weeks. What is clear from van Tulleken and participants in the twin study is that there are cognitive consequences to regularly consuming these foods [36,37]. Knowing what we know now about the potential harms, the ethics of placing people on ultra-processed foods as an intervention is debatable. Looking back, though, in one of your studies the correctional facility opted to revert back to their standard fare, which was presumably a typical ultra-processed dietary pattern. What happened there?

Dr. Schoenthaler: You are talking about the regional detention center in Coosa Valley, Alabama. The administration there was interested in a design that would query whether or not a reversion to the original baseline diet—and yes, you can safely characterize that baseline diet as a high ultra-processed foods diet—would make a difference. In total it was a 22-month study, of which the last six months was a reversion back to the original diet. Among the 104 juveniles involved, we observed a 54% increase in antisocial behavior during that “intervention” period. Today, it would certainly be difficult to justify an ultra-

processed foods intervention in a group with so many vulnerabilities. At the time, and sadly to a degree today, dietary business-as-usual in these institutions was based on the slogan that all foods are part of a balanced diet [38].

Nova: Yes, Colombia University's famed professor of nutrition, Joan Dye Gussow, was highly critical of the "it's all part of a balanced diet" narrative peddled by the American Dietetic Association (ADA) and their corporate partners [39]. It wasn't that long ago that the ADA was publishing "nutrition fact sheets", paid for by soft drink manufacturers no less, claiming that soft drinks are all part of the balanced diet. In turn, those "fact sheets" were used by soft drink manufacturers to try and stop soft drink vending machines from being removed from schools [40]. Let's talk more about the ADA, now called the Academy of Nutrition and Dietetics. In 2001, scientist Michael F. Jacobson, a vigorous critic of the ultra-processed food industry, referred to the ADA as an arm of industry [41]. Why do you think they were motivated to issue a position statement, in 1985, after your research was gaining national attention, that basically concluded that in regard to nutrition and criminal behavior, 'there is nothing to see here' [42]?

Dr. Schoenthaler: I'm not sure why the ADA was motivated to produce a formal position statement. I do recall that my colleague, sociology professor Dr. Walter Doraz, was really upset with the definitive language used by the ADA. The ADA had concluded that a causal link between diet and crime had not been demonstrated, which was fair enough. However, they also claimed, definitively, that diet was not an important factor in violent behavior. That's the part that upset Dr. Doraz. His complaints on the matter were published as a letter to the editor of *Nutrition Today* [7]. Dr. Doraz discussed his ongoing communications with the ADA, and he concluded, based on those discussions, that the organization was unaware of the full scope of the research on diet and behavior. They also appeared unaware of how the available research was relevant to antisocial behavior. Furthermore, he examined the body of evidence upon which the ADA made its conclusions, and it turned out to be a collection of opinions collated by a group of California skeptics. As he wrote in *Nutrition Today*, the king has no clothes! As to the motivations of the ADA, and whether or not their rush to produce a position statement was related to their well-known ties to the sugar, soft drink, and processed food industries, I will leave that for others to ponder. As trusted nutritionist Dr. Marion Nestle has long-since pointed out, the ADA, now simply known as the Academy, has worrisome relationships with the unhealthy foods industry [8].

Nova: Let's return to sugar. It is commonly stated in media that the relationship between dietary sugar and changes to behavior is a "myth" that has been debunked. Mostly, this is based on the 1995 meta-analysis by Dr. Mark Wolraich which concluded that sugar "does not affect the behavior or cognitive performance of children" [43]. Included in that meta-analysis are studies that Wolraich and colleague Richard Milich conducted with funding from the sugar industry—"Sugar Associates Inc" and "The Sugar Association" [44]. In fact, research shows that the relationship between acute and chronic sugar consumption on cognition, attention-deficit hyperactivity disorder, and externalizing behavior, remains an open question [45–48]. Moreover, recent human research has shown that the acute administration of glucose can curb the aggression that otherwise accompanies social rejection [49]. This would suggest that when glucose levels drop rapidly, as they might do in subclinical hypoglycemia [50], there could be a higher risk of aggression. Do you think we've seen the last word on dietary sugar and behavior?

Dr. Schoenthaler: We have definitely not seen the last of the sugar and behavior debate. I never thought sugar was the only story, or even the primary feature of the diet and crime discourse. Still, it is really important to point out that no real conclusions can be drawn from the highly-referenced Wolraich meta-analysis. Why? Because almost all of the studies on sugar and childhood behavior in that meta-analysis used aspartame as a placebo! A few used saccharin. Think about that. You enter a study with the hypothesis, based on the observations of untold numbers of mothers, that sugar can cause behavioral

disturbances. And you choose as the placebo a chemical agent, now definitively proven, to cause short- and long-term changes to the brain and behavior [9–12,51–53]? Please! The idea that aspartame does not influence childhood behavior is based on a 1994 study involving 15 children [54]. And yet, that meta-analysis is trotted out routinely in media, books, and uncritical academic articles, to say it is a myth that sugar causes childhood behavioral changes. Knowing what we now know about aspartame and saccharin, the actual myth is that sugar and childhood behavioral disturbances are a myth. At the risk of turning this into an Abbott and Costello routine, it is better to say that the actual bunk is the notion that childhood sugar-related behavioral changes have been debunked! In the meantime, there have been growing epidemiological links between sugar consumption, aggression, and criminality [55,56]. The recent study you mentioned, on acute glucose consumption protecting against aggression, is interesting. Again, the problem is that the placebo was a can of 7-UP Light, which means we cannot say whether glucose was protecting against aggression or the aspartame in the so-called placebo, and the associated unfulfilled expectancy of sugar, was provoking aggression. The authors of the study do not make mention of that possibility. They also didn't specify what artificial sweetener was in the 7-UP Light placebo, but in Germany at the time when the study was conducted, 7-UP Light contained significant amounts of aspartame. Still, the inclusion of a social stressor in the study is exactly what has been missing from the historical studies on glucose tolerance tests, hypoglycemia, and mood—the studies have generally relied upon self-reported mood in the hours following the test, whereas they have not subjected participants to social rejection or other laboratory-induced social stressors as blood glucose drops. There are many ways to test this. The simulation tests of road rage and aggressive driving is an example that would be worthy of study under conditions of reactive hypoglycemia [57]. There is likely to be a subset of the population wherein the slang term 'hangry', combining the words hunger and angry, is a real phenomenon in the hours following consumption of a large bolus of sugar.

Nova: Some of your critics argued that trading out soda and other sugar-sweetened beverages and replacing them with juices, even if 100% juice, may have made little difference to total dietary sugar intake. However, we now know that citrus and other juices carry polyphenols and other phytochemicals that appear to influence human cognition, mood, and various biological markers [58–60]. In fact, one recent study showed that actual 100% orange juice improved mood in young adults compared to an orange "fruit drink" (with similar glucose/fructose content). The difference was in the flavonoid content, which was very low in the orange "fruit drink" (28 mg per 100 g) and high in the 100% orange juice (158 mg per 100 g) [61]. In 1982 the Florida Department of Citrus noticed that you had swapped out unhealthy snacks and sugar-sweetened beverages and replaced them with whole fruits and juices instead [62]. Can you tell us about your citrus juice study?

Dr. Schoenthaler: We identified a secure juvenile detention facility that had already made efforts to provide a low-sugar diet to the youths within the facility. The baseline situation was one where the juveniles sat at tables designed for eight people. On each table, there were two pitchers; one contained water and the other contained milk. Our approach was simple—we had a third pitcher with 100% orange juice added to each table. The design allowed each juvenile to regulate his/her intake of orange juice, milk, water, and the other foods as well. No attempt was made to monitor how much orange juice each individual juvenile consumed because that would have almost certainly compromised the blinding. However, we knew that the overall milk consumption didn't waver, so the subjects were apparently swapping water for orange juice. The disciplinary records of the six-month period predating the orange juice exposure—involving 239 juveniles—were compared to the records during which the exposure took place. That latter time frame involved 242 juveniles. The results showed a 47% reduction in antisocial behavior per-juvenile per-day among the 242 juveniles on the high-orange juice diet [63].

Nova: Knowing what we know now, isn't it safe to say that your dietary intervention was carrying more polyphenols and other dietary antioxidants? Much of the research in the field of nutritional psychiatry, including the recent orange juice and depression study, is now correlating the polyphenol and nutrient intake with microbiome markers. Some scholars have argued that the positive results you found may actually be mediated by the microbiome [64]. This isn't a new idea, of course. In his 1972 book, *Nutrition and Your Mind*, Watson argued that administering "healthy" bacteria, in the form of yogurt and *Lactobacillus acidophilus* supplements, along with nutrient-dense, fiber-rich foods, could "restore" the intestinal microflora, which he believed was a factor in abnormal behavior [24]. What are your thoughts?

Dr. Schoenthaler: Animal and human studies certainly support the idea that the gut microbiome plays an influential role in mental health, behavior, and even aspects of personality [65]. Currently, the evidence indicates that this relationship is bi-directional [66]. In our context of aggression, there are quite a few animal studies showing that the microbiome is a factor [67]. We have lot's more to learn, but it is becoming quite obvious that dietary patterns and specific nutrients, including polyphenols that are considered "non-essential", shape the gut microbiome and its diversity. In turn, this might explain some aspects of mental health and behavior [68]. This includes aggressive behavior [69]. So, there is good reason to suspect that the dietary changes in our studies were providing nutritional support for a healthy microbiome. Based on the mounting evidence showing that probiotic supplements can provide benefit in depression and anxiety [70], Watson may well have been over the target in his proposals. There is some preliminary human research indicating that oral probiotics can lower aggressive thoughts [71] and ongoing studies are looking at whether or not probiotics can decrease impulsive and compulsive behaviors [72]. I'd be interested in seeing research on the gut microbiome in juveniles and adults in correctional facilities, and to learn whether or not probiotics or other microbiome-targeting interventions influence aggression in larger studies.

Nova: Can we talk a little bit more about mechanisms? Critics complained that your early research did not prove causation, and that possible mechanisms were ill-defined. With volumes of since-published bench investigations and clinical trials, a more sophisticated understanding of mechanistic pathways is now in place. Of course, we still have miles to travel before these links are fully understood. How would you summarize the leading mechanistic pathways?

Dr. Schoenthaler: Most of the mechanisms have been widely discussed in the fields of nutritional neuroscience and nutritional psychiatry [73,74]. At this point we know that there are dietary factors that work for optimal brain health, and those that work against it. Some nutrients and dietary constituents work directly to support neuronal structure and function, especially by providing support in the manufacture of neurotransmitters and the integrity of neuronal membranes. These factors range from vitamins, minerals, amino acids, and essential fatty acids. These nutrients often interact with each other through enzymatic reactions. For example, the essential fatty acids docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) are important to neuronal structure and function, but an adequate intake of B vitamins, particularly folate, is necessary for the transport of these fatty acids [75]. So, when you pull on one nutritional thread, you find it is connected to many others. We could pick out magnesium, and find that low concentrations are linked to callous behavior in children [76]. However, magnesium's role in the body intersects with many other nutrients. Beyond the more direct influences of nutrients on neuronal structure and function, we also know that a high-quality nutrient-rich diet can curb the inflammatory immune chemicals, cytokines, for example, that are otherwise implicated in anxiety, depression, and even more serious forms of mental illness. Dietary factors, including essential fatty acids and the natural chemicals that give fruits and vegetables their colors, tastes, and textures—polyphenols and other phytochemicals—can also influence the production of chemicals such as brain-derived neurotrophic factor, which plays an important role in brain plasticity over the course of a lifetime [77]. Nutrition can also work at the epigenetic level

to influence brain and behavior, and one of the more exciting areas of research is the ways in which high-quality nutrition can support mitochondrial function, providing the energy behind rational decision-making and prosocial behavior [78]. Then there is the microbiome and the gut-brain-axis which appears to be highly influenced by dietary factors. On the other hand, ultra-processed foods can contribute to low-grade inflammation and oxidative stress that, in turn, can disturb mood and contribute to aggression and antisocial behavior. Fried foods, as just one example, appear to contribute to neuroinflammation via a number of pathways, including alterations to the blood-brain barrier [79]. How this manifests, behaviorally, might depend on the intersectionality of food on genetics, personality, lived experiences, the immune system, and stress reactivity, to name a few factors [80,81].

Nova: It is important to capture the cultural petri dish in which you were first conducting this research. This was a time when the purveyors of ultra-processed foods were encountering strong criticism from high-profile nutritionists such as Joan Dye Gussow and scientist-advocate Michael F. Jacobson [82,83]. They argued that much of the food in industrialized nations isn't food at all, but merely 'food-like products'. Of course, such industry critics were labeled as 'food faddists', per the classic propaganda technique of name-calling. In 1983, when your work was gaining traction, you told journalists that "*when I looked at some of the criticism of this field [nutrition and behavior], I found it came from industries and professionals that had a self-interest in saying it doesn't work*" [84]. Can you talk a little bit more about that?

Dr. Schoenthaler: This is an extension of our ADA discussion. I really didn't give it too much thought. I mean, I knew that the sugar and highly-processed foods industry wouldn't be fond of what I was finding in my research, but I didn't realize there was such entrenchment of the industry within university-based academic nutrition. There was an article by Michael Jacobson and others that did showcase some of the deep ties in the 1970s and 1980s, but it wasn't until recently that public health researchers have really pulled back the curtain on the systemic nature of the problem. I entered the arena from the social sciences and soon learned that institutional nutrition was nearly as rigid as the correctional systems I had been studying. My colleague Dr. Doraz articulated that in his aforementioned letter to the editor in Nutrition Today. As much as some members of the institutional nutritional community criticized us for not being PhD-holding nutritionists, we also found that there was a lack of understanding, especially among skeptics, of the basics of social science research methodology and what it is like to work in correctional facilities. As Dr. Doraz pointed out, almost none of the critics had training in the criminal justice field [85]. On our end, we did have qualified nutritionists overseeing the research implementation.

Nova: Indeed, thanks to the work of Dr. Cristin Kearns and others we now know the extent to which Harvard's chair of nutrition, Dr. Fredrick Stare (1910–2002), was supported by the sugar industry [86,87]. Stare was a sugar industry front man who claimed in his syndicated column that critics of sugar are "*pseudoscientists, a few scientists, food faddists, and a variety of consumers*" [88]. Stare urged a doubling of dietary sugar intake, testified to Congress that high-sugar cereals were "good food" and subsequently received US \$200,000 (≈\$1 million today, inflation-adjusted) in funding from cereal and snack manufacturers [89]. Stare is just one example. Examination of the tactics of the ultra-processed food industry has flipped the question of who, precisely, were and still are, the food cultists and pseudoscientists [90–95]. This has been an issue for public health for many years. Yet, here you were in correctional facilities, already well-known to be rigid and inflexible to change, trying to develop and study nutritional interventions that were being labeled "pseudoscience". Aside from industry-associated critics, can you describe the ways in which certain correctional facilities were open to your line of inquiry, or what type of resistance you encountered?

Dr. Schoenthaler: You know, I really didn't encounter much in the way of resistance in the facilities. On the contrary, I found that the leadership within the facilities was open-minded to something that was relatively inexpensive to implement with significant potential for the wellbeing of both inmates and personnel. Now, my own approach was

not overly complex, it wasn't a restrictive diet, it was mostly a matter of food swaps for items that still had broad appeal. I think there were cases of well-meaning citizen groups that got involved with various youth correctional facilities and were going down more of a health-food store route, with tofu and all manner of alternative foods that were intended to address allergies. Here, the word allergy was being used in the very broadest sense of the term, as a catch-all, and not in the way a conventional allergist would see it. That's not something with which I became involved. The problem, though, was that this well-intended approach ended up diluting, I think, the credibility of what my own group was doing. Since the focus on allergies was leading to potentially restrictive diets, running the risk of nutritional inadequacies, it was a problem. At one point I think the American Civil Liberties Union threatened to sue any correctional institution that got involved in mandating restrictive diets. Again, that's not what we were doing in our studies. Ours involved a fully nutritionally adequate diet, and based on what we now know, far and away more nutritious and health-promoting than the standard fare. The detractors conflated the allergy theories with our work, and used it in intellectually dishonest ways to try and discredit our work.

Nova: Yes, what you are referring to was a 1970s and 1980s movement called **clinical ecology**, which basically had people checking under the bedcovers for all signs of allergy. Every health ailment and social ill imaginable was being labeled allergy. It's too bad, because there was some legitimacy to the basics of healing with ecology in mind [96]. On that note, do you think that the sensationalized criminal defense approaches in the 1980s—that is, those claiming a perpetrator committed homicide due to sugar or monosodium glutamate-containing foods, the so-called “Twinkie Defense”—set the field back?

Dr. Schoenthaler: Ah, the Twinkie Defense. Here we have another myth that something is only a myth! It is often claimed that the origins of the Twinkie Defense, as it pertains to securing a lesser sentence in the famous Harvey Milk case, is essentially a myth, and that the defense team barely mentioned junk food as part of the defense strategy. That's not what the trial transcripts show. This is worth dissecting for a moment, if for no other reason than for the sake of corrective history. Initially, defense psychiatrist Dr. Martin Blinder sets the stage that consumption of junk foods was a form of self-medication related to the depression of the defendant, Dan White: *“whenever he felt things were not going right, he would abandon his usual program of exercise and good nutrition and start gorging himself on junk foods: Twinkies, Coca Cola”*, said Dr. Blinder. However, the defense attorney Douglas R. Schmidt drills down, asking Dr. Blinder the following: *“Doctor, you have mentioned this ingestion of sugar and sweets and that sort of thing. . . does that have any significance, or could it possibly have any significance?”* Dr. Blinder responds: *“Well, I think, Mr. Schmidt, there are probably three factors that are significant. First, there is a substantial body of evidence that in susceptible individuals large quantities of what we call junk food, high sugar content food with lots of preservatives, can precipitate anti-social and even violent behavior. There have been some studies, for example, where they have taken so-called career criminals and taken them off all their junk food and put them on milk and meat and potatoes, and their criminal records immediately evaporate. There have been a lot of studies in which individuals who are susceptible to these noxious stimuli, when given these noxious stimuli will undergo complete change and engage in behavior which they normally would not. That's number one.”* Dr. Blinder goes on to describe factors 2 and 3 as being pressures associated with White's physical and emotional exhaustion and his employment relationship with the city officials; he then draws them together as such: *“If it were not for all the tremendous pressures on him the weeks prior to the shooting, and perhaps if it were not for the ingestion of this aggravating factor, this junk food, with all three factors, did not impinge upon him at the same time, I would suspect that these homicides would not have taken place.”*, said Dr. Blinder [97].

Dr. Blinder didn't coin the term “Twinkie Defense”, but he is explicitly stating in the transcript that junk food is a noxious factor, he refers to “lots” of studies demonstrating associated behavioral changes, acting in ways and doing things that are out of the ordinary,

and that such behavior can be remediated by a return to what a reasonable person would assume to be a minimally-processed simple diet. He combines the ideas of scientific research, with junk food as a noxious aggravating factor, and he does so after a lead by the defense. That's hardly a "throwaway remark" about junk food, as seems to be presented in modern, revisionist versions [98]. I'm not sure that pundits who claim the Twinkie Defense is a myth have actually read the transcripts. If they did read them, they would know that the prosecution's own witness, psychiatrist Dr. Roland Levy, was led into questioning to refute the diet-crime connections: "*Doctor Levy, are you familiar with any studies and any prevailing scientific bodies of thought relating to the ingestion of sugar, foods with preservatives such as what's commonly known as junk foods and including, for example, chocolate cupcakes of Twinkie variety, Coca-Cola, candy bars and potato chips, for example, as those relate to being causative factors in influencing anti-social or sociopathic behavior?*", asked prosecutor Tomas Norman. Dr Levy responded, "*I am unaware of any prevailing psychiatric opinion that such factors are significant in relationship to any type of mental illness. And I am unaware of any publications in major journals which state that*" [97]. These exchanges clearly demonstrate that the prosecution was well aware of the defense tactics.

Now, if Dr. Blinder had merely left it at 'Twinkies and Coke' as a form of self-medication for White's depression, well then, yes, it would be a myth. However, based on Dr. Blinder's full testimony and defense attorney Schmidt's lead-in, it is completely understandable that the term Twinkie Defense would emerge in the media just days after the trial. Junk food was clearly part of the 3 central and interwoven factors presented for jury consideration of diminished capacity. White was presented as a vulnerable person caught up in a cycle of stressed-induced junk food consumption, the behavioral consequences of that consumption, based on science, based on sugar and preservatives, brought him closer to a criminally-impulsive threshold. The 12 jurors never emerged to make a statement on the extent to which this cycle of junk-food-related vulnerability influenced their decision to agree with the defense that White had diminished capacity. However, at least one juror remarked after the trial that "it sounded like Dan White had hypoglycemia", a concept that the defense had introduced [99]. So, the idea that the Twinkie Defense is a myth, meaning that the defense never used junk food as a central strategy, and that it had zero bearing on the outcome, emerges as the actual myth. Now, to the question of setting back the topic of nutritional criminology. Yes, I do think, at first blush, it is reasonable to conclude that it set the field back. The perception was that the jury let the perpetrator, White, off with a light sentence because at least part of his diminished capacity was related to the noxious stimuli of junk foods. Within months, legislatures were taking steps to clamp down on diminished capacity defenses, let alone food-related diminished capacity. So, perception became reality. It also became a joke, an absurd translation that somehow a healthy rational person would eat a cupcake and engage in criminality. That's not what this field was about. That said, I think it brought the topic into the national conversation and allowed for discussions that needed to be had. The idea that distressed persons turn to unhealthy foods, so-called comfort foods, as a form of self-medication, is an important area of emerging research [100]. So, there is this bi-directionality between ultra-processed foods, mood, and behavior [101].

Nova: You are right, even before jury deliberations started, in a nationally-syndicated article, the *Chicago Tribune* reported that the defense "has been so short on explanations that it seems to have chosen, as one possible rationale, White's junk food diet", and that the defense psychiatrist was convinced that White's "deep depressions were escalated by the sugar-heavy diet" [102]. Clearly there was real-time reporting that junk food was presented as a central factor. One thing is for sure, the corporate conglomerate that owned Twinkies, the International Telephone and Telegraph Corporation (ITT) [103], didn't see any slump in sales. So said their vice president for public affairs, Robert Keane, who added that he couldn't "believe a rational jury paid serious attention to that [diet and crime] issue" [99]. In the year after the White case, ITT and its marketing machine transported 1 billion Twinkies into the esophagi of Americans [104]. Moving past the mythology of the case to the reactionary attempts to eliminate diminished capacity as a defense, is it also

possible that this area of research presents society with uncomfortable truths concerning biology and criminal culpability?

Dr. Schoenthaler: Absolutely. This is where the topic of nutrition becomes an irritant to the more broadly accepted psychosocial concepts within criminology and the criminal justice system. In fact, one of the more vocal critics of the nutrition and crime connection, California psychiatrist Dr. Gregory E. Gray, informed the *San Francisco Examiner* that the diet-behavior theories were problematic on their face because *“instead of placing responsibility for an individual’s criminal actions on himself, we’re shifting the blame to his food and providing no incentive for him to change his behavior”* [105]. Dr. Gray, who asserted that the topic was *“little more than pseudoscience”* also claimed that diet-behavior theories are appealing because they may *“relieve parents guilt about having been inadequate as parents”* [106]. So, you had all of these opinions, based on deeply-rooted emotions and personal beliefs, that somehow the reality that the human brain and subsequent behavior can be influenced by dietary factors—including substances that many researchers were considering not to be food at all—abdicated criminal responsibility. I was never suggesting that dietary factors eliminated criminal responsibility, and said so many times. I looked at nutrition in the same way that criminologists looked at alcohol. Today, the penalties for driving while intoxicated are far stiffer than they were in the 1970s and 80s, but there is much more attention to sophisticated treatment plans today, interventions that didn’t exist back then. Given the increasing research on the addictive properties of ultra-processed foods [107], and the comforting allure of hyperpalatable but unhealthy foods [108], we can imagine preventive and treatment interventions. Years ago, probation officer Barbara Reed said that trying to correct a person’s behavior in the absence of essential nutrients is like trying to ride a bicycle without filling the tires with air, it won’t work. I agree with her position. I also think that we should consider nutrition in a holistic context, because it is influenced by many psychosocial factors.

Nova: Right, in fact you addressed this in a 1986 interview with the Los Angeles Times. The journalist was querying you on your work in the context of the Twinkie Defense, and the critics who were uncomfortable with the biophysiology. You replied that “They’re afraid we’re saying that biology determines criminality. What we’re saying is that nutrition, like alcohol, influences behavior; it doesn’t determine it.” [109]. **What did you mean by using the word ‘afraid’?**

Dr. Schoenthaler: The study of, or maybe better said, enthusiasm for, the biological determinants of crime have had, shall we say, an unfortunate past. Anyone who has studied criminal justice 101 knows that Cesare Lombroso, considered by many to be a founding father of criminology, proffered that criminals could be “identified” by the likes of sloping foreheads, big ears, small eyes, facial asymmetry and what not. I mean, this stuff was taken seriously. Under the banner of phrenology, criminals were having the shape of their skull analyzed. Then we have the sorry history of eugenics. So, reentering the discussions of biology and criminal behavior would have brought out realistic concerns in the 1980s. It still does, and I get that. But we ignore genetic and epigenetic influences and the neuroanatomy and neurophysiology of aggression, antisocial behavior, and crime in general, at our peril. I think that ignoring these factors provides license for mistreatment and a vicious retaliation mindset that manifests in unacceptable conditions, abhorrent jailhouse conditions, let’s say, because the individual somehow “deserves” it. I think there is an urgent need to study the biological aspects of crime, including early-life exposures [110] and to bring the findings into policy and broader research discussions, and I am not alone in that [111,112]. At this point there is little doubt that nutrition should be part of that discussion, where genetics meets environment [113].

Nova: Can you tell us a little about the two-day summit on diet and behavior in Arlington, Virginia, in 1984? This was billed as a sort of “Woodstock” for anyone with serious interests in the field. It garnished major media coverage. Strangely, the event was co-sponsored by the American Medical Association and a conglomerate of ultra-processed food manufacturers, under the auspices of the Nutrition Foundation Inc. and

the International Life Sciences Institute (ILSI). The ILSI has since been revealed as an influence-peddling industry front group [114–117]. The *New York Times* reported that you “[Schoenthaler] had but a few minutes during a discussion period to answer the attacks of his critics” [118]. It would seem that the deck was stacked against you. Contemporary research shows just how much leverage the ultra-processed foods industry has when they sponsor academic conferences [119]. Was the *New York Times* correct? Did you feel that you were sidelined?

Dr. Schoenthaler: I remember contemplating the entire experience on the flight from DC back to California. I remember taking stock and writing out ways to make my own research better, and advance the science as a whole. I also remember not being allocated any time to articulate my experiences and positions at the conference. I think that Jane Brody captured the situation accurately. It was more than sidelining, I felt like it was a set-up, a trap, where the outcomes were predetermined. I say that because the attacks seemed so personal, like emotional reactivity to ideas that just could not compute in the minds of some. As you point out, thanks to dedicated public health researchers, we now know how the Nutrition Foundation Inc. and the ILSI operated behind the scenes to influence policy and practices. This is an ongoing problem and I’m not sure that academics and students in criminal justice are being exposed to the work of public health researchers as they unmask the tactics of the unhealthy product industries [120].

Nova: Your work has involved more than examining the role of removing ultra-processed foods in detention facilities. You have also conducted intervention trials using a basic multivitamin-mineral formula. What did you find?

Dr. Schoenthaler: My preference is to approach the topic of nutrition and criminology from the perspective of dietary patterns. We should be doing everything we can to ensure that all of society has equal access to highly nutritious foods. However, this is not the case, and it hasn’t been the case for a long time. Our most vulnerable populations in society consume high amounts of ultra-processed foods—these foods, if we can call them foods, remain an inexpensive way to obtain calories [121,122]. This isn’t exclusively an American concern. For example, research from Korea shows that juvenile delinquency is associated with greater consumption of ultra-processed foods [123]. There are nutritional realities that we have to accept. Theoretically, nutrient supplementation should help, so I think there is an obligation to study potential benefits in both prevention and treatment. Our first study was a randomized, placebo-controlled trial among 62 delinquents in a maximum-security psychiatric center in Oklahoma. The juveniles who took the vitamin-mineral supplement for three months were documented to have 28% fewer rule infractions than those randomized to placebo [124]. More recently, we studied two different multivitamin-mineral formulas—one that you might consider a basic supermarket formula, just 100% of the recommended daily allowance (RDA), and the other that might be considered high-dose. Our subjects in this randomized placebo-controlled study were housed at two separate juvenile detention facilities operated by the California Youth Authority. Interestingly, it was the group consuming the low-dose, 100% RDA, formula that witnessed significant behavioral change—39% fewer rule violations than in the placebo group. We didn’t find statistical differences with the high-dose, which suggests that minimal support, a physiologic rather than supraphysiologic dose, can make a significant difference [125].

Nova: You’ve made an important point about vulnerabilities. There is human research showing that merely provoking perceptions of poverty, powerlessness, or the perception of belonging to an under-privileged “out-group”—in a laboratory, let alone actual poverty—leads to altered dietary choices in the direction of low-nutrient, high-calorie foods [91–93]. What’s more, this lab-manipulated socioeconomic position produces taste-based perceptual shifts that increase sensitivity to the presence of energy in foods [94]. Doesn’t this suggest that there is a biopsychosocial context to the discussion?

Dr. Schoenthaler: It certainly does. In fact, there is intriguing research showing that taste preferences are associated with aspects of personality, including sensation seeking and antisocial traits [126,127]. However, even though there may be genetic links to food

preferences and taste, as there is with crime [128], early experiences can shape preferences in ways that determine later dietary habits [129]. We need a greater focus on the ways in which the food environment—everything from food deserts to the marketing of cheap, ultra-processed foods in marginalized communities—intersects with numerous other socioeconomic factors in areas where crime is high. When we talk about food, nutrition, and the criminal justice system, we are really talking about ingrained structures. That was one of the frustrating aspects of the criticism directed at my early studies. That is, criticism that wasn't related to ways that design could be improved—that I greatly appreciated—I mean criticism that suggested that my work was “diverting resources”, or that it was detracting from individual responsibility.

Nova: Can you expand on that?

Dr. Schoenthaler: This area of research was so new in the 1980s. Critics proposed that educating children, in schools and elsewhere, that diet might be influencing their behavior, would relieve the children of responsibility for their actions. There were also charges that this topic would somehow divert parents away from their duties as guardians, and instead write-off inappropriate child behavior as merely a product of something the child had consumed. When an area of research is emerging, especially one that conflicts with decades of institutional dogma, it is easy for critics to defend the status quo. When dogma is deeply ingrained, there is usually a power structure helping to keep it in place. At no point was I making any claims that diet absolved responsibility for criminal behavior. Poverty, lack of education, various forms of oppression, and substance misuse, are predictors of criminal behavior, and while they don't absolve perpetrators of responsibility, we should be doing everything we can to address all these factors at the structural level, and to intervene where we can. Personal responsibility is important, but it also a convenient slogan used by the ultra-processed foods industry to keep things as they are, business as usual. Exclusively focusing on an individual doesn't account for all the ways these foods are engineered and marketed to be the desired by society writ large. All the while, the criminal justice system brings more juveniles into its funnel.

Nova: The relationships between nutrition and socioeconomic factors as they intersect with the risk of juvenile delinquency—that is, before a young person enters the criminal justice system—are certainly complex. There are lots of threads you could tug on. For example, quite a few studies have shown that intelligence is a factor in criminality, yet research also shows that healthy dietary patterns in early life predict higher verbal, performance, and total intelligence quotient scores, a finding that is independent of adiposity [130]. Some of your early work examined dietary patterns and academic performance outcomes. Can you briefly describe what you found?

Dr. Schoenthaler: Sure. Under the direction of Elizabeth Cagan, the Chief Administrator of the Board of Education, New York City schools instituted sweeping changes to their food program. As Cagan testified to the US Congress in 1980, those changes included the introduction of nutritious foods, and the elimination of others. These are Cagan's actual words: “We have instituted strong restrictions on additives, preservatives, artificial colors, and flavorings. We have reduced the amount of sugar, salt, and fat, and increased the amounts of fiber by using more whole grains and fresh vegetables and fruits” [131]. Since this change was relatively abrupt, it represented an opportunity to see if there were changes in academic performance. Like most schools in the US, the New York schools were using the California Achievement Test as a standardized measurement of academic performance. We found that during this period—there was an increase in the mean national academic performance, such that the 803 New York schools in the City of New York went from 11% below the national average, to 5% above the mean [132]. That's clearly significant. Now, I can't say that the elimination of the processed foods was the causative factor, but the results certainly indicated that diet was worthy of further study. Knowing what we now know about ultra-processed foods and cognition, I'd say the arrow points strongly in the direction of causation.

Nova: In fact, doesn't some of the recent research examining the Healthy, Hunger-Free Kids Act of 2010 back up your contentions?

Dr. Schoenthaler: Yes. The Healthy, Hunger-Free Kids Act markedly improved the nutritional quality of food served in US schools. Implementation began in school year 2012–2013 and was fully implemented by 2014–2015. These changes addressed primary meals and competitive foods, such as snacks. This was a major dietary clean-up, and there is no question that it positively influenced student selection of healthy foods, and the consumption of fruits, vegetables, and whole grains, overall. The first major outcome studies are starting to roll in, showing that implementation, for example, is associated with significant decreases in body mass index [133]. The Act also allowed for a Community Eligibility Provision, whereby schools in high-poverty communities could enroll the entire student body into the free lunch and breakfast programs, regardless of individual family income. Some studies have shown that use of Provision is associated with improved academic outcomes, and even more specific to our discussion here, decreases in documented disciplinary referrals and suspension rates [134,135].

Nova: We've discussed that in some quarters your early work was dismissed as mere placebo, and some of the harshest critics referred to the notion that nutritional supplements and dietary changes could influence delinquency as "pure nonsense" and "food faddism" [106,136]. You have published multiple studies since then, including trials with tighter designs. Others have followed your research lead—most notably in the randomized-controlled studies of Bernard Gesch in the United Kingdom, Ap Zaalberg, and David Gast, separately, in the Netherlands. Gesch's study involved 231 young adult prisoners, with the outcome being disciplinary offenses before and during nutritional supplementation [137]. Zaalberg essentially replicated Gesch, and found significant reductions in reported rule-breaking incidents in the supplement group vs. placebo [138]. Gast's trials looked at nutritional supplementation and aggression in two different populations—long-stay psychiatric inpatients and people with intellectual disabilities [139]. Gesch used what was essentially a basic multivitamin-mineral with modest levels of omega-3 fatty acids and some gamma-linolenic acid, while Gast used slightly more omega-3 fatty acids along with a similar multivitamin. The point is, these trials were not using extraordinary levels of nutrients, or anything like the oft-used but poorly defined term of "megadoses". Is it satisfying to see replication of your work?

Dr. Schoenthaler: Yes, insofar as the research continues to spur on others to study the topic, then yes, it is satisfying to see this unfold. In the large field of nutritional psychiatry, there might be situations where higher levels of select vitamins or minerals might be useful in certain patients with specific needs. Yet, our approach to supplementation, and I think that of the recent international investigators you mentioned, was to stay closer to basics and try and fill in the nutrient gaps that might exist via poor nutrition. With that mindset, there is no need to study so-called mega-doses. As I see it, these successful studies aren't really an argument that all inmates in all correctional facilities should be taking dietary supplements—the findings are more of an argument that we are not doing enough to provide a nutritionally-dense diet to inmates. It also doesn't mean simply fortifying ultra-processed foods with some vitamins and a bit of essential fatty acids. Industry is very good at looking to technological fixes by fortifying junk foods, and that doesn't make them any less junky.

Nova: It is important to point out that those emerging studies on nutritional supplementation and aggression do not sit in a mental health vacuum. Intervention studies have shown that the introduction of healthy dietary patterns (at the expense of high-sugar, high-fat processed foods) can improve neuropsychiatric outcomes, including depression [140–145]. These interventions have been estimated to save millions of dollars in healthcare costs [146]. Have you and your colleagues considered the potential costs of institutions continuing to ignore the influence of dietary patterns and nutrition in the criminal justice system? Surely there is an economic factor.

Dr. Schoenthaler: Absolutely. If you only consider this from the very narrow perspective of institutional misconduct, the financial costs are immense. There are security and personnel costs, medical costs, property damage costs, and the costs of added incarceration time as a result of infractions. The latter costs alone are in the thousands of dollars per infraction. For example, a single preventable infraction that leads to four months of additional jail or prison time might cost US \$10,000 or more. If you look at this through the larger lens of prevention and treatment along the entire criminal justice continuum, then the financial savings would be incalculable. When I worked in Attica all those years ago, I kept thinking how much the entire enterprise was costing, and how much of it was preventable.

Nova: Another area of research that has since expanded is that of dietary additives, behavior, and mental health. For example, the well-designed double-blind placebo-controlled study in the *Lancet* showed that artificial colors and the common preservative sodium benzoate preservative increased hyperactivity in children [147]. The food color effect on behavior may not be limited to children [148]. Moreover, Dr. Kathleen Holton has shown in a series of recent studies that monosodium glutamate (MSG) and other dietary excitotoxins appear to provoke a variety of symptoms in sensitive individuals [149–152]. There are also emerging bench studies showing that dietary emulsifiers can influence gene expression within the limbic system, and heighten stress sensitivity in animals [153,154]. Of course, multiple studies have also zeroed in on the inadequate intake of single nutrients—like magnesium, for example—as playing a role in callous behavior in children [76]. Given the multifactorial nature of diet, dietary additives, and nutrient intake, is it time to return to your whole-of-diet investigations?

Dr. Schoenthaler: Yes, I think so. All of the recent and ongoing intervention studies in the area of dietary patterns and mental health should be encouraging a massive ‘Moon Shot’ like effort to bring this to a much larger scale. The recently established Advanced Research Projects Agency for Health (ARPA-H) of the federal government should be making this a top-line priority. Let’s start examining the intersection of molecular biology and nutritional epidemiology as it relates to the mental health, flourishing, and the continuum of antisocial and prosocial behavior. Let’s invest in the prevention of harm. Think of the suicide rates in the United States, increasing year over year. According to the Centers for Disease Control, the latest report showed that almost 50,000 Americans took their lives in 2022. I echo the words of Surgeon General Dr. Vivek Murthy who said *“Today’s report underscores the depths of the devastating mental health crisis in America. Mental health has become the defining public health and societal challenge of our time. Far too many people and their families are suffering and feeling alone”* [155]. Now, let’s start making serious investments in preventing that suffering.

Nova: Taken as a whole, there seems more than enough research to consider nutrition as a significant factor in the criminal justice system—from prevention through intervention. You’ve witnessed the building of more than four decades of research, a slow build, to be sure, but now it seems to be accelerating at a more rapid pace. Are you optimistic that we will see real-world changes to policy and practices within the next decade?

Dr. Schoenthaler: I’ve never really put a timeline on my own thinking and approach. Until this interview I’ve just kind of toiled at the work, but haven’t really spent much time contemplating what took so long to get here. The past decades of my academic career feel like the blink of an eye. However, based on everything we have covered here, there is every reason to think we are approaching that point of critical mass, and there are plenty of historical examples where major scientific advances can happen quickly. I mean, at this point the collateral health benefits of avoiding ultra-processed foods are already quite well established. Yes, we need to invest in large-scale research, but we also know enough already to make minimally-processed, nutrient-rich whole foods widely available and affordable. We need to make them the standard fare within institutions where civil rights still matter. If we know that ultra-processed foods are harmful, and an abundance of research shows that, then why are they still the default foods served to prisoners in the United States? We’ve

got states investing just US \$3.00 per day on inmate nutrition [156]. Three dollars? I think we will see real-world changes to policy, but not without increased awareness.

Nova: Are you working on any novel ideas at the moment?

Dr. Schoenthaler: I've been thinking a lot about the sudden drop in US crime after 1991. This wasn't an isolated drop in one city or geographic region, and it was all crimes, including homicides. We are talking about a 34% drop in violent crimes between 1991 and 2001, per the national Crime Index. No one predicted that sudden drop off. There have been various theories put forward to explain the drop, everything from the 'broken windows' theory where clamp downs on quality-of-life crime spills over to curb all crime, to computer-based models used to predict where to emphasize patrol. Various characters were lionized by the media as being responsible for the crime reductions. But a closer examination, in more recent years, has demonstrated that the 'great man' of history view, that is, that a few men were responsible for the 1990s crime-drop, is mythical take. In fact, none of the academic theories have held up under scrutiny. It is true that the crack cocaine epidemic contracted, significantly more police officers were hired, and that incarceration rates skyrocketed. University of Chicago professor Stephen J. Levitt has done an elegant job in breaking all of this this down [157]. But I suspect there is more to it. The year 1991 was the fountainhead of massive public health awareness that all women of child-bearing age should supplement with 400 mcg of folic acid to prevent neural tube defects. That campaign, and the ultimate decision to go beyond supplement advice and fortify the food supply with folic acid, in 1998, was a massive social experiment in public health. In terms of its intended target, the reduction of neural tube defects, it has certainly paid off well. Now, I understand that the campaigns to increase folic acid intake were directed at women, but there seems to be a major spill-over into the male population. Whatever the reason, we know that the red blood cell folate levels for the entire US population, both men and women, increased significantly from 1988 through 1994. By 1999, the total number of persons in the US with what is considered to be "low" red blood cell folate dropped to 2.8%, whereas in 1988 over 30% of the population had low red blood cell folate! The median red blood cell folate levels of the entire population aged 4 and older increased by over 60% during this time span [158]. Is it naïve to think that there were absolutely zero neuropsychiatric consequences to such a massive chemical change throughout the entire population, especially for vulnerable persons? Of course, I'm not saying that folic acid alone reduced homicide rates, and I'm not sure that folic acid alone is going to undo the consequences of a diet ultra-high in ultra-processed foods. However, when you look at the wealth of pre-clinical and small clinical trials on the relationship between this simple B vitamin and aggression and mood, I think there is something there, there. As mentioned earlier about other nutrients, folic acid can influence many factors, including serotonin and omega-3 levels [159–163]. Stay tuned, I'm going to be examining this in more detail.

Nova: In 1988, OMNI magazine asked well known personalities, some in science and medicine, about their own utopian thinking, or the world they would like to live in. Contemporary research on utopian thinking indicates that it can be a healthy process, increasing both personal and social hope, yielding an abstract mindset that bridges the psychological distance between the status quo ("here and now") and a better possible future [164,165]: What type of world would you like to live in?

Dr. Schoenthaler: I would like to live in a world where unnecessary violence and death through violent means are non-existent. I understand that this is a utopian exercise, but maybe we can continue to work toward that goal, and one day our descendants will look back with appreciation at our progress. They will know, as Jonas Salk said, that we were good ancestors. Kind of like how we can now look back at the awful practices that were once commonplace during the Medieval era. Humans have a tremendous capacity for empathy, love, and compassion. In my idealized future world, empathy would be prized and the prevention of avoidable harms would be prioritized.

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