UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

IN RE: Acetaminophen – ASD-ADHD Products Liability Litigation **This Document Related To: All Cases**	**22md3043 (DLC)**

MEMORANDUM OF LAW IN SUPPORT OF PLAINTIFFS' RULE 702 MOTION TO EXCLUDE DEFENDANTS' EXPERT DR. WENDY CHUNG

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INTRODUCTION

Much like the classic Dickens novel, this motion is a tale of two Wendy Chungs. The first one is a brilliant geneticist who, in her daily job, studies and speaks about the causes of autism spectrum disorder ("ASD") and attention-deficit/hyperactivity disorder ("ADHD"). The second one is the defense expert seeking to testify in this case. The Dr. Chung who gives TED talks and authors scientific articles acknowledges that ASD and ADHD result from an interaction between an offspring's genes and environmental exposures, including drugs taken by mothers during pregnancy. The defense expert witness here opines that, in almost all cases, ASD and ADHD are caused by genes alone. Outside of litigation, Dr. Chung conducts important research and, in keeping with sound scientific practice across all scientific disciplines, transparently explains the methods she uses to reach her conclusions. In this litigation, Dr. Chung somehow cannot identify her methods but claims they are obvious. As a distinguished researcher, Dr. Chung co-authored an important scientific study with one of Plaintiffs' experts, Dr. Brandon Pearson, showing a gene-environment contribution to neurodevelopmental disorders. Dr. Chung's doppelganger in this litigation claims she barely knows who Dr. Pearson is.

Under the liberal Federal Rules of Evidence, the first Dr. Chung—eminently qualified, rigorous, and transparent in her work—might have offered admissible expert testimony to assist the trier of fact. That would be so *even if* she proffered an opinion at odds with Plaintiffs' overwhelmingly grounded conviction that prenatal use of acetaminophen can cause neurodevelopmental disorders in offspring. But the Dr. Chung whom Defendants have designated here has little in common with that distinguished scientist. The Court should exclude her testimony and expert report for three fundamental reasons.

First, Dr. Chung cannot and does not identify the methodology she employed to reach her conclusions. That fatal defect makes it impossible for Plaintiffs and the Court to test the reliability

of her opinions. When asked point-blank "what methods" she used, Dr. Chung simply adverted to her experience: "Being able to assess genetic contributions to conditions, being able to understand the relative weight of the contributions and how to design studies to assess genetic contributions to conditions." *See* Ex. 2, Chung Dep. Tr. at 57:7–12. But "trust me, I understand this," is not a method. It is the sheerest *ipse dixit* and inadmissible under Rule 702. *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 597 (1993); *see also Gen. Elec. Co. v. Joiner*, 522 U.S. 136, 146 (1997); *Nachimovsky v. Nike, Inc.*, No. 22-866, 2023 WL 4504461, at *2 (2d Cir. July 13, 2023).

Second, Dr. Chung's conclusions are premised on a basic scientific error. Her opinion that ASD and ADHD are predominantly *inherited*, that is, genetic, stems from statistics showing that ASD and ADHD are highly *heritable*. Heritability, however, measures the source of a trait's variance in a population, not the *cause* of its development in an individual. Height is roughly as heritable as Dr. Chung contends ASD and ADHD are (80–90%). But no informed scientist would therefore conclude that all 6-foot-tall people in a population owe approximately 58 to 64 of their vertical inches to genes. Other causal factors, namely environmental exposures, are at play. Dr. Chung freely admits as much when it comes to ASD—just not in her report for this case.

That heritability is not a measure of causation is not even a controversial point of debate in the scientific community. It is a bedrock fact that is universally accepted. *See, e.g.*, David S. Moore & David Shenk, *The Heritability Fallacy*, WIREs Cognitive Sci., Jan. 2017, at at 1 (hereinafter "Moore & Shenk"). An opinion premised on defying scientific truths is not merely "shaky," it is "junk science" that federal courts are obliged to exclude. *See In re Ephedra Prods. Liab. Litig.*, No. 04 MD 1598 (JSR), 2005 WL 8178810, at *6 (S.D.N.Y. Sept. 20, 2005); *Nat'l*

Envelope Corp. v. Am. Pad & Paper Co. of Del., No. 06 Civ. 12988(SHS)(RLE), 2009 WL 5173920, at *5 (S.D.N.Y. Dec. 30, 2009).

Third, Dr. Chung's approach to the crucial public health question posed by this litigation deviates sharply from the way she approaches scientific questions in her daily professional role as a preeminent academic and researcher. Dr. Chung's *own* recent study with Dr. Pearson supports the causal role of gene–environment interactions in ASD and ADHD. On top of that, Dr. Chung has repeatedly pointed to several well-recognized environmental contributors to these disorders, including one, valproic acid, that is already sold with an express ASD/ADHD warning. In this litigation, however, Dr. Chung does not even acknowledge this evidence. She *disregards* evidence inconvenient to Defendants' case, cherry-picking only the sources that purportedly generate the conclusions that Defendants prefer.

That sort of testimony does not present a good-faith disagreement between earnest scientists that Rule 702 leaves to juries. *See Kumho Tire Co. v. Carmichael*, 526 U.S. 137, 152 (1999) (an expert must "employ[] in the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field"); *In re Rezulin Prods. Liab. Litig.*, 309 F. Supp. 2d 531, 563 (S.D.N.Y. 2004) ("[A]n expert may not 'pick and chose' from the scientific landscape and present the Court with what he believes the final picture looks like." (quotation marks omitted)). Instead, Dr. Chung's testimony necessitates that this Court, in its role as gatekeeper, keep her preordained conclusions from reaching the trier of fact.

LEGAL STANDARD

"Rule 702 embodies a liberal standard of admissibility for expert opinions," *Nimely v. City of New York*, 414 F.3d 381, 395 (2d Cir. 2005), but "the proponent of expert testimony has the burden of establishing by a preponderance of the evidence that the admissibility requirements of Rule 702 are satisfied," *United States v. Williams*, 506 F.3d 151, 160 (2d Cir. 2007).

Admissible expert testimony must be reliable and relevant. *See Daubert*, 509 U.S. at 597. The Court must therefore ask three questions: is the expert qualified to offer the testimony; is the testimony "ground[ed] in the methods and procedures of science," *i.e.*, is it reliable; and will the testimony "assist the trier of fact to understand the evidence or to determine a fact in issue," *i.e.*, is it relevant? *Id.* at 590–91 (quotation marks omitted); Fed. R. Evid. 702.

For purposes of this Motion, Plaintiffs do not dispute that Dr. Chung is generally qualified to discuss potential genetic contributions to neurodevelopmental disorders like ASD and ADHD. "Even when an expert is qualified," however, "it is the role of a district court to perform a 'gatekeeping function' by ensuring that 'an expert's testimony both rests on a reliable foundation and is relevant to the task at hand.'" *Fed. Trade Comm'n v. Vyera Pharms., LLC*, No. 20CV00706 (DLC), 2021 WL 5336949, at *3 (S.D.N.Y. Nov. 16, 2021) (Cote, J.) (quoting *In re Mirena IUS Levonorgestrel-Related Prods. Liab. Litig. (No. II)*, 982 F.3d 113, 122–23 (2d Cir. 2020) (hereinafter *Mirena II*)).

To be reliable, "[a]n expert opinion requires some explanation as to how the expert came to his [or her] conclusion and what methodologies or evidence substantiate that conclusion." *Riegel v. Medtronic, Inc.*, 451 F.3d 104, 127 (2d Cir. 2006). The expert's views need not be established to the point of "scientific certainty"—experts "may express professional opinions that fall short of definitive proof" provided that their methods for reaching those opinions are reliable. *Restivo v. Hessemann*, 846 F.3d 547, 576 (2d Cir. 2017). After all, "*Daubert* was designed to exclude 'junk science.' It was never intended to keep from the jury the kind of evidence scientists regularly rely on in forming opinions of causality simply because such evidence is not definitive." *In re Ephedra Prods. Liab. Litig.*, 393 F. Supp. 2d 181, 190 (S.D.N.Y. 2005). Yet "nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence

that is connected to existing data only by the *ipse dixit* of the expert." *Kumho Tire Co.*, 526 U.S. at 157 (quoting *Joiner*, 522 U.S. at 146). In its gatekeeping function, therefore, the Court "must focus on the principles and methodology employed by the expert.". *Amorgianos v. Nat'l R.R. Passenger Corp.*, 303 F.3d 256, 266 (2d Cir. 2002). Expert testimony "based on data, a methodology, or studies that are simply inadequate to support the conclusions reached" should be excluded. *Id.* And "it is critical that an expert's analysis be reliable at every step." *Id.* at 267. An expert "may not 'pick and chose' from the scientific landscape and present the Court with what he believes the final picture looks like." *In re Rezulin*, 309 F. Supp. 2d at 563 (quotation marks omitted); *see also Daniels-Feasel v. Forest Pharms., Inc.*, No. 17CV4188, 2021 WL 4037820, at *5 (S.D.N.Y. Sept. 3, 2021) (experts "must not cherry-pick"), *aff'd*, No. 22-146, 2023 WL 4837521 (2d Cir. July 28, 2023). An expert must bring to the courtroom "the same level of intellectual rigor that characterizes the practice of an expert in the relevant field" and that the expert would bring to his or her day job. *Restivo*, 846 F.3d at 577 (quoting *Kumho Tire Co.*, 526 U.S. at 152); *see also In re Fosamax Prods. Liab. Litig.*, 645 F. Supp. 2d 164, 187 (S.D.N.Y. 2009).

ARGUMENT

I. Dr. Chung's Report Has No Objective Methodology.

An expert report must offer more than conclusions. To show that a conclusion is reliable, the report must provide "some explanation as to how the expert came to" that conclusion, including "what methodologies or evidence substantiate that conclusion." *Riegel*, 451 F.3d at 127. Dr. Chung's report fails this basic requirement.

Dr. Chung's report purports to identify "the known genetic etiologies of ASD and ADHD," to address "the published epidemiological studies" showing an association between prenatal APAP exposure and those conditions, and "to assess whether these studies have properly accounted for genetic confounders." Ex. 1, Chung Report ¶ 2. Nowhere does Dr. Chung identify what question

this review is ultimately supposed to answer, how she identified the studies she reviewed, or how she weighed the studies to reach her conclusions. There is no section titled "Methodology" in her report. In fact, Dr. Chung *disavows* relying on any specific method to support her conclusions: "[T]he field of genetics and genomics in particular is extremely complex and rapidly evolving. I would argue one of the most rapidly evolving in all of science. Because of that, we tend not to have rigid sort of rule books in terms of how this is done, so as we do this, I can only point to I use state of the art methods that a geneticist or genomist would use in my field." Ex. 2, Chung Dep. Tr. at 69:15–70:1. But Rule 702 does not permit an expert witness to baldly assert that a field is complicated, promise that she has deployed "state of the art methods," and expect the Court to let a jury take her word for it. As the Rule now makes plain, the party that offers expert testimony has the burden of proving it is admissible by a preponderance of the evidence. *See* Fed. R. Evid. 702 (as amended Apr. 24, 2023). Naked assurances of various methods—state of the art or otherwise—does not come close to meeting Defendants' burden.

Of course, if Dr. Chung *actually had* a reliable method but simply could not name it, that would be passing odd, but might still suffice. Dr. Chung's testimony confirms, however, what is intuitive: she could not name her method (or methods) because *she did not use one* recognized by scientists. For example, standard practice in published studies is for the authors to specify the question under review and the search terms they used to identify the relevant body of literature they are analyzing or relying upon. Dr. Chung did not apply this transparent approach in her report. She claimed that explaining these steps—as is common in published studies, including ones Dr. Chung authors—was unnecessary, because those terms would have been "intuitive" and "obvious" to her "colleagues" in the scientific community.[1] Even if that were true, the *Daubert* standard does

[1] *See* Ex. 2, Chung Dep. Tr. at 62:12–16 ("I did not specifically list search terms, in large

not envision a jury composed of PhDs. *See United States v. Mejia*, 545 F.3d 179, 194 (2d Cir. 2008); *DiBella v. Hopkins*, 403 F.3d 102, 121 (2d Cir. 2005) ("Expert testimony must be helpful to the jury in comprehending and deciding issues beyond the understanding of a layperson."). And these steps were, apparently, not wholly intuitive even to Dr. Chung, whose report fails to discuss—among significant other evidence of environmental contributions to ASD and ADHD—a review article on environmental exposures and ASD (by Pugsley et al.) that is cited multiple times in the recent study that *she herself* co-authored with Plaintiffs' expert Dr. Pearson. *See* Ex. 2, Chung Dep. Tr. at 227:4–21, 233:3–235:3; Ex. 3, Pugsley et al. (2021); Ex. 4, Baker et al. (2023).

However Dr. Chung came up with the body of literature she reviewed, she also provided no explanation for which studies she credited and which she discounted. By her own admission, "I have not employed a weighting factor," Ex. 2, Chung Dep. Tr. at 73:9–10, "I did not use . . . a methodology of weighting, per se," *id*. at 78:21–22. When she was asked why she could not tell Plaintiffs "what your methodologies are in your report" for weighting the evidence, *id*. at 80:11–12, Dr. Chung conceded "I don't think that's a doable thing to do because of our field," *id*. at 80:16–18, essentially contending that there is something special about the field of genetics that immunizes it from the strictures of Rule 702.

Dr. Chung's report, bereft of a methodology, thus boils down to a naked conclusion: the causes of ASD and ADHD are predominantly genetic, environmental contributions play a tiny role, and we can be sure the environmental factor of acetaminophen exposure plays no role. *See* Ex. 1, Chung Report ¶ 3.ii. Dr. Chung is entitled to this opinion. Despite prior inconsistent

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part, because many of my colleagues—this would have been intuitive."); *id*. at 63:18–22 ("I simply thought it was obvious in terms of the question, that that's how I would search, and that's how, even beyond another scientist intuitively, one would have searched on those terms.").

statements outside of this litigation, she may even sincerely believe it now. And it is entirely possible that she could have explained how she arrived at that conclusion by deploying reliable scientific methods that the Court and Plaintiffs could assess. Armed with *that* report, Dr. Chung could be permitted to testify, and Plaintiffs could challenge her opinion at trial, leaving it for the factfinder to decide who is right. But Dr. Chung has ensured that her opinion is untestable. She rejects all the epidemiological evidence she found (based on whatever search terms she did or did not use) that shows APAP's contribution to ASD and ADHD because, without a weighting or a grading, she thinks the evidence is unpersuasive. Any challenge to that opinion must fail, in Dr. Chung's view, because she assures us that she used "state of the art methods"—whatever they are—and her "field" is so complicated that it is not possible to explain her approach any further than that. Ex. 2, Chung Dep. Tr. at 69:15–70:1, 80:16–18.

As but one concrete example, she waves away all epidemiological studies that contradict her conclusion by asserting that they do "not adequately control for genetic/familial confounding," Ex. 1, Chung Report ¶ 3.ix, meaning that they fail to entirely eliminate the possibility that a gene is what causes both some pregnant mothers to take acetaminophen and their offspring to develop ASD or ADHD, suggesting that the gene is the *real* cause of the condition. Yet she does not explain how much of a discount should apply to such a study or how to design a better one. And she lists several reasons why genetics *cannot* be adequately controlled for. *See id*. ¶¶ 3.vii, 82. Meanwhile, she fails to note that the Gustavson study, which she describes as "the only study that evaluated whether maternal acetaminophen use was associated with ADHD clinical diagnoses in children using a sibling-controlled design," *id*. ¶ 103, was, as explained by Plaintiffs' expert Dr. Andrea Baccarelli, "hugely underpowered" and thus incapable of providing reliable evidence of genetic confounding. Ex. 5, Rebuttal Report of Andrea Baccarelli (hereinafter Baccarelli Rebuttal

Report) at 6. Perhaps she thought this flaw in the study merited *some* weight, *no* weight, or *great* weight while still being insufficient to change her mind. The Court will never know. That inability to test Dr. Chung's approach is precisely the sort of deep-seated methodological flaw that requires that the expert's opinion be excluded. *See, e.g.*, *United States v. Gissantaner*, 990 F.3d 457, 463–64 (6th Cir. 2021) ("An untestable scientific theory is all theory and no science. In the absence of proof that a technology can be tested, there is no way to show whether it works (its 'refutability' or 'falsifiability,' a scientist would say) and no way to give it 'scientific status.'" (cleaned up)).

To be clear, Plaintiffs are not suggesting that geneticists can never offer expert opinions. Dr. Chung's own work outside this case shows that there is an accepted methodology she could have applied here. In a 2019 meta-analysis published in *Genetics in Medicine*, Dr. Chung and her co-authors offer readers a section explaining their "Materials and Methods" before turning to the results. Ex. 6, Srivastava et al. (2019) at 2414–15. Like Dr. Chung's report, this meta-analysis essentially offered the conclusions of the authors after a review of existing data. But *unlike* Dr. Chung's report, in their meta-analysis Dr. Chung and her co-authors were transparent about the specific question under review, their search parameters, and how they screened the studies they collected, even going so far as to include a flowchart of the collection and screening process. *See id*. at 2416 fig.1. Dr. Chung and her fellow authors also took care to describe the methodology used to assign weight to the 30 articles included in the meta-analysis, as well as how these articles influenced their final conclusions. *See id.* at 2416–17.

Expert witnesses must bring to "the courtroom the same level of intellectual rigor that characterizes the practice of an expert in the relevant field." *Kumho Tire Co.*, 526 U.S. at 152. Plaintiffs' experts detail their methods for selecting and assessing relevant evidence. Dr. Chung does not. That sort of outcome driven approach does not yield admissible expert testimony. *See*

Faulkner v. Arista Records LLC, 46 F. Supp. 3d 365, 381 (S.D.N.Y. 2014) ("[M]ethodology . . . aimed at achieving one result . . . is unreliable, and . . . must be excluded.").

II. Dr. Chung's Report Is Premised on a Basic Scientific Error.

The crux of Dr. Chung's report is the assertion that "[g]enetic variants account for most known causes of ASD and ADHD." Ex. 1, Chung Report, ¶ 3.ii. This assertion drives her conclusion that "[t]he epidemiological studies that are posited to show an association between prenatal acetaminophen exposure and the development of ASD or ADHD do not establish that acetaminophen, as opposed to background genetic and/or familial factors, was responsible for the observed associations." *Id.* ¶ 3.ix.

This key assertion is in turn premised on Dr. Chung's claim of ASD and ADHD's heritability. Dr. Chung says that the "[g]enetic mutations and genetic variants that cause ASD and ADHD are highly heritable, with heritability estimates for both conditions being on average 80-90%." *Id.* ¶ 3.iii. As she correctly notes, "[h]eritability is the fraction of the variability of the phenotype," in this case ASD and ADHD, "that is due to inherited genetic factors." *Id.* ¶ 44. Put more plainly, genetic differences are 80–90% of the reason why some people in a population develop ASD or ADHD and others do not.

Dr. Chung's error lies in conflating this statistic, even assuming its accuracy, with causation. It is this statistic that leads her to conclude that inherited genes are the predominant cause of ASD and ADHD. *See id.* ¶ 55 ("Studies have established that genetic factors are the predominant cause of ASD. Twin studies have reported a heritability range of, on average, 80-90% for ASD."); *id.* ¶ 72 ("Research has established that genetics are the predominant cause of ADHD. The heritability of ADHD is estimated to be an average range of 80-90%." (citation omitted)). And if that opinion were not clear enough in her report, she reiterated it throughout her

deposition.[2] In her view, then, genes cause ASD and ADHD to the virtual *exclusion* of environmental exposures, such as drugs taken during pregnancy. Environmental exposures are thus relegated to, at most, a potential causal role in only "individual rare cases." Ex. 2, Chung Dep. Tr. at 343:14–24.[3]

This understanding of heritability, and thus the entire premise of Dr. Chung's report, is fundamentally flawed. As Dr. Baccarelli explains, heritability "does not mean *in*heritability." Ex. 5, Baccarelli Rebuttal Report at 9 (emphasis added). "Heritability is a statistical term often misinterpreted," as it is in Dr. Chung's report, "to mean that a significant percentage of a trait or disorder is directly and exclusively inherited through genes." *Id.* at 8. But "the amount of variation

[2] *See, e.g.*, Ex. 2, Chung Dep. Tr. at 58:17–59:2 ("So for both of those conditions, autism and ADHD, being 80 to 90 percent of the variants attributable to genetic factors, that is the overwhelming contributor to those conditions."); *id.* at 83:12–19 ("So that when—tries to understand causation or contributors to both of those phenotypes that the overwhelming, underlying contributors are genetics. And as we estimate that, using estimates of heritability, those numbers are extremely high; 80 to 90 percent for both of those conditions."); *id.* at 84:21–85:8 ("It is just what I said; that heritability is inherited genetic factors. I will also state that there are other genetic factors that are not inherited, but this is putting a point that the overwhelming majority of the probability of an individual having autism or ADHD, 80 to 90 percent of that is due to heritable or inherited genetic factors, in addition to which there are de novo genetic factors, which means that all told, genetics is the overwhelming predominance in terms of contributors."); *id.* at 337:7–14 ("The questions are, I believe, in the heritability estimates of 80 to 90 percent that have been calculated for autism, as well as for ADHD, and those estimates show that the overwhelming contribution is genetic for both of those conditions.").

[3] *See also* Ex. 2, Chung Dep. Tr. at 96:14–97:7 ("At this point in terms of understanding, quote/unquote, the environment—or I will take that liberally to say nongenetic environment, we do believe that there is a small contribution of those nongenetic factors because that heritability is not one. It is not 100 percent. But on the other hand, being that it is 80 to 90 percent, that means that the overwhelming contribution is genetic, and that to be able to implicate something that is environmental must contribute—must consider those genetic confounds potentially in terms of understanding a nongenetic or environmental contributor."); *id.* at 296:1–10 ("Well, I think we can go back to data that we've talked about before with the heritability of 80 to 90 percent, the overwhelming majority of the probability is associated with genetics. That number is not 100 percent, so there clearly is something nongenetic, but the overwhelming preponderance of risk and the risk that we have strong data to support with replication are genetic factors.").

in a trait in a population that can be ascribed to genetic differences," which is what heritability measures, "does *not* mean that the trait is directly inherited through genes. Therefore, a high heritability index does not imply that environmental factors cannot play a role in the emergence of a trait or disease." *Id.* at 9. Put differently, that genes might account for 80–90% of the variation in a population for a given trait does *not* mean that genes alone cause 80–90% of the development of that trait in a given case.

Plaintiffs agree that genes play an important role in the development of ASD and ADHD. In many if not all cases, however, genes cause ASD or ADHD by *interacting* with environmental exposures. Genes are the trigger that an environmental exposure, such as a drug taken during pregnancy, can pull. This concept is familiar in the law. Every 1L learns in torts class that the "defendant takes the victim as found," including a plaintiff with an eggshell skull. Restatement (Third) of Torts § 31 cmt. a (2010). When a tortious act combines with weak bones to cause greater-than-normal harm, the defendant must pay for that harm even though someone with stronger bones would have been less injured. Similarly, someone without genes linked to ASD or ADHD might never develop either condition no matter the environmental exposures. But even people *with* those genes often do not develop either condition. Numerous genetic variants associated with ASD/ADHD are prevalent and generally harmless, unless triggered by an environmental factor like APAP. Environment thus plays a substantial role. And when an environmental exposure, such as a drug taken during pregnancy, results in a genetic interaction that leads to a condition like ASD or ADHD, the law uses a word for that interaction: causation. The causal contribution of the environmental exposure does not vanish simply because someone's susceptibility to developing ASD or ADHD might be 80%, 90%, or even 100% due to genes passed down from his or her parents. As 1Ls also learn in torts class, injuries can and often do have

multiple causes, but "[t]he existence of other causes of the harm does not affect whether specified tortious conduct was a necessary condition for the harm to occur." *Id.* § 26 cmt. c. Genes may well be a but-for cause. But prenatal acetaminophen exposure is the proximate cause.

The fundamental error Dr. Chung hopes the jury will make is a common one for laypeople. So much so that leading geneticists, the National Institutes of Health ("NIH"), and (outside of this litigation) Dr. Chung herself are quick to dispel it. For instance, in *The Heritability Fallacy*, geneticists David Moore and David Shenk observe that the "term 'heritability,' as it is used today in human behavioral genetics, is one of the most misleading in the history of science." Ex. 7, Moore & Shenk at 1. The "measurable heritability of a trait *does not* tell us how 'genetically inheritable' that trait is," nor does it "inform us about what causes a trait, the relative influences of genes in the development of a trait, or the relative influence of the environment in the development of a trait." *Id.* Think of height, "which has a heritability that has oftentimes been measured at close to 90% in each of numerous different populations." *Id.* at 5. That does not mean that 90% of a given person's height comes from genes. Indeed, average heights can vary drastically within similar genetic populations. For example, "South Koreans are, on average, nearly five inches taller than North Koreans." *Id.* That is not due to genetics; "their gene pools do not substantially differ." *Id.* The difference stems from an environmental fact, namely, that "food is not equally plentiful in North and South Korea." *Id.* This example reveals what the heritability statistic obscures: inherited genes are not the exclusive cause of the trait. Rather, genes and the environment *interact* to cause the trait.

These interactions—often referred to as "gene–environment interactions" or "GxE"—are well-recognized, including in the cases of ASD and ADHD. One of the institutes within NIH, the National Institute of Environmental Health Sciences ("NIEHS"), devotes a section of its online

"Health & Education" resource to "Gene and Environment Interaction." Ex. 8, NIEHS, *Gene and Environment Interaction*. As the Institute explains:

> Few diseases result from a change in a single gene or even multiple genes. Instead, most diseases are complex and stem from an interaction between your genes and your environment. . . . Subtle differences in one person's genes can cause them to respond differently to the same environmental exposure as another person. As a result, some people may develop a disease after being exposed to something in the environment while others may not.

Id. at 1. The Institute goes on to explain that it is studying "a wide range of diseases and disorders with genetic and environmental components." *Id.* It then lists several examples of such disorders. "Autism" is the first entry, where the NIEHS cites a study finding that "[h]igh levels of air pollution increase the risk for autism in children with a genetic variant called MET, which is involved in brain development." *Id*. That variant "did not increase the risk for the 75% of the population exposed to lower levels of air pollution, suggesting that autism may be caused by an interaction of genetic and environmental factors." *Id*.

When asked at deposition for a source supporting the contrary view espoused in her report, Dr. Chung pointed to "standard genetic textbooks," specifically "Emery and Rimoin." Chung, Tr. at 297:16–298:20. Yet this textbook agrees with Dr. Baccarelli, Moore and Shenk, and the NIEHS, not with Dr. Chung's report. According to the latest edition, "focusing on the heritability loses a lot of information and is not recommended." Ex. 9, *Emery and Rimoin Emery & Rimoin* (7th ed., 2018) at 401. This lost information includes environmental exposures. The book has a whole section on "Environmental Influences on the Epigenome," where it notes the likelihood that, "in the case of phenotypically heterogenous diseases such as schizophrenia *and autism spectrum disorder (ASD)*, . . . there are multifactorial etiologic factors to consider. These encompass genetics and environment (often referred to as 'G x E' effects)." *Id*. at 101 (emphasis added). Nor is this textbook new to this view. According to the prior edition, "heritability estimates cannot

take into account relatively invariant or pervasive environmental factors, which may be acting in concert with genetic factors." Ex. 10, Chapter 110, *Emery & Rimoin* (2013) at 3. Indeed, "[g]iven the clear evidence for both genetic and environmental factors in ASD etiology[,] it is not really that productive to argue which is more important. Common conditions are caused by a combination of genes and the environment, *not one or the other*." *Id*. (emphasis added); *accord* Ex. 11, Chapter 109, *Emery & Rimoin* (2013), at 2 (noting the high heritability of ADHD but also the "nongenetic influences that have shown repeated association with ADHD").

What does Dr. Chung say to all this? It depends on which Dr. Chung is speaking. In this litigation, she disagrees that ASD and ADHD may generally result from gene-environment interactions, returning repeatedly to the conclusion—based on the heritability statistic—that the cause is solely genetic in the overwhelming number of cases. *See supra* nn.3–4. Outside this litigation, however, Dr. Chung has repeatedly and even recently acknowledged these gene-environment interactions.

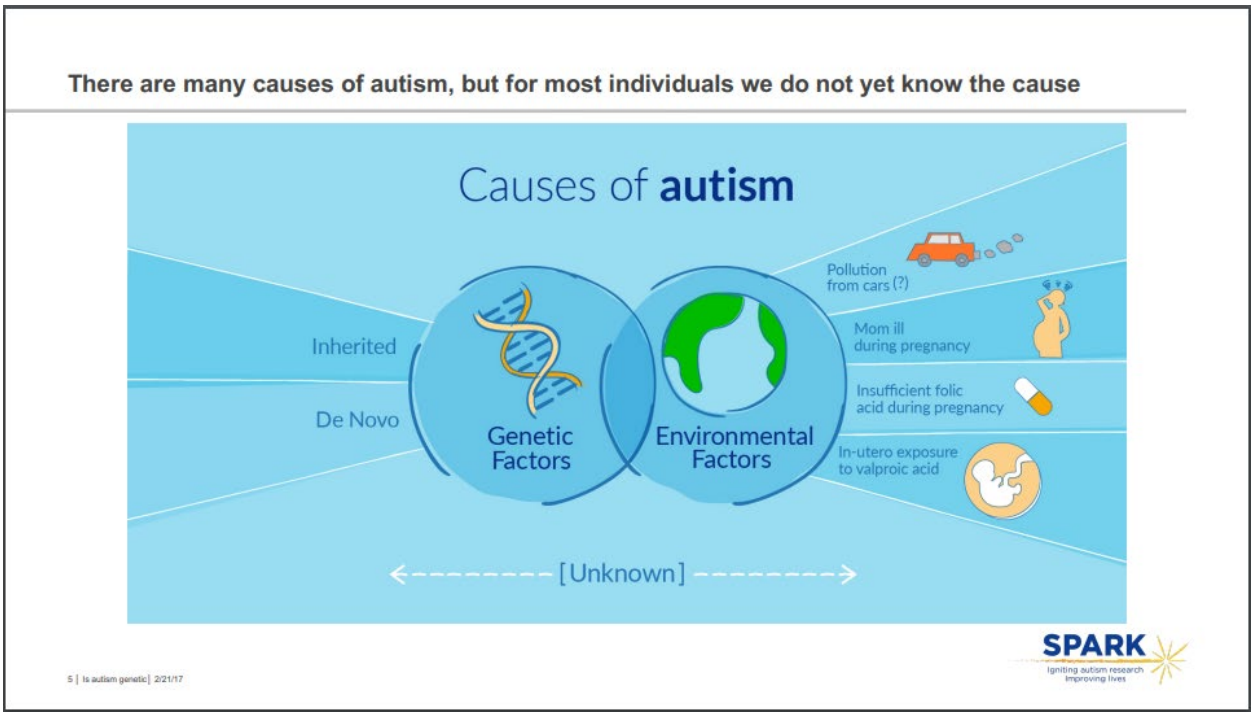
Rewind the clock a decade. In her 2014 TED talk on "Autism—what we know (and what we don't know yet)," Dr. Chung posed the question "what does cause autism?" Ex. 12, Chung TED Talk. Her answer:

> In fact, there's probably not one single answer. Just as autism is a spectrum, there's a spectrum of etiologies, a spectrum of causes. Based on epidemiological data, we know that one of the causes, or one of the associations . . . is advanced paternal age, that is, increasing age of the father at the time of conception. In addition, another vulnerable and critical period in terms of development is when the mother is pregnant. During that period, while the fetal brain is developing, we know that exposure to certain agents can actually increase the risk of autism. In particular, there's a medication, valproic acid, which mothers with epilepsy sometimes take, we know can increase that risk of autism.

Id.. Although Dr. Chung did not use the word "environment," she was acknowledging environmental contributors to ASD, "[i]n particular . . . a medication, valproic acid," taken by

some mothers "while the fetal brain is developing." *Id.* At no point did she tell the TED audience that environmental exposures contribute to ASD in only "individual rare cases." Ex. 2, Chung Dep. Tr. at 343:18. To the contrary, she told them that her talk would focus on genes "*not because* genes are the only cause of autism, but it's *a cause* of autism that we can readily define and be able to better understand the biology and understand better how the brain works so that we can come up with strategies to be able to intervene." Ex. 12, Chung TED Talk (emphases added); *see also* Ex. 13, Rebuttal Report of Robert M. Cabrera (hereinafter Cabrera Rebuttal Report) at 3.

Her views were the same in 2017, when she gave a presentation titled "Is Autism Genetic?" for the Simons Foundation Powering Autism Research for Knowledge (SPARK), an ASD-research initiative in which Dr. Chung is the principal investigator. *See* Ex. 2, Chung Dep. Tr. at 273:21–274:1. That presentation included the following slide on the causes of ASD:



Ex. 14, SPARK Presentation Slides (Feb. 21, 2017), at 5.

In this depiction, "Genetic Factors" and "Environmental Factors" are shown as equal-sized and overlapping circles, clearly suggesting that genes and environment interact to cause ASD and are equally important in that interaction. Shown among the environmental factors are air pollution, which the NIEHS highlighted, and in-utero exposure to valproic acid, which Dr. Chung herself highlighted in her TED talk. No slide in the deck says that genes are the near-exclusive cause of ASD. Rather, as the title of this slide notes, "[t]here are many causes of autism." Dr. Chung said the same in her verbal remarks:[4]

> These genetic factors in some individuals can be an important cause of autism but it's certainly not the only cause that we see of autism. There are certainly other I'm just going to call them environmental factors . . . that are not encoded in the genes that are exposures that we have over our lifetime. These exposures as we were talking about can happen even before birth . . . exposures that the mother may have in terms of either infections . . . [or] medications that the mother may be exposed to . . . . All of these factors can be important in terms of the developing brain before the baby's even born . . . . And in fact there's probably a complex interplay between both the genes as well as these exposures.

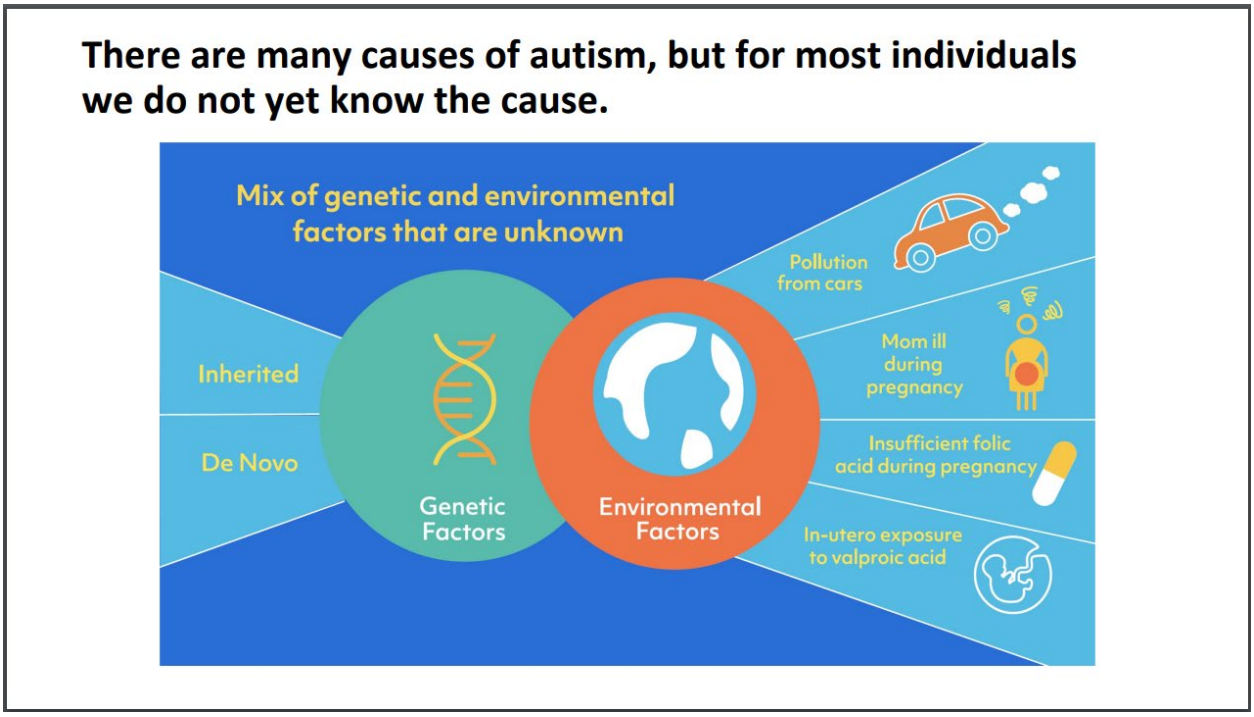
Ex. 15, Audio Excerpt of 2017 SPARK Presentation. This all aligns with the gene-environment interactions described above. Dr. Chung goes on to acknowledge, at least for "certain individuals," that ASD may result from "a combination of a genetic predisposition with just the right exposure" while stating that the difficulty lies in "discern[ing] for any one individual with autism" whether the cause was genetic, environmental, or both. *Id*. "And to be honest," she said, "before we start doing some other investigations we oftentimes don't know for any one individual what that answer is." *Id*. Yet her report for this case proposes an *a priori* answer foreclosing any need to investigate environmental contributions in most cases: based merely on population-wide heritability statistics,

[4] The following is a transcription with punctuation added. Dr. Chung's full presentation is available at SPARK, *Is Autism Genetic?* (Mar. 2017), https://sparkforautism.org/discover_article/is-autism-genetic/.

which had been measured when Dr. Chung gave this presentation, *see* Ex. 1, Chung Report, ¶¶ 55, 72, she now concludes that genes by themselves are the sole cause in almost all cases.

After watching this portion of her presentation, Dr. Chung asserted at her deposition that "what I was trying to say within this video, aimed at a lay audience to be able to make things simple, is that it's complicated." Ex. 2, Chung Dep. Tr. at 301:23–302:1; *see also id*. at 309:1–5 (asserting that she was, "again, for a lay audience, trying to make this relatively simple"); *id*. at 330:20–21 ("For ease of reading this slide, we have these two circles of equal size"). To put that in *Daubert* terms, when Dr. Chung elsewhere tried to do exactly what an expert witness is required to do—provide knowledge that would assist "the untrained layman," *Mejia*, 545 F.3d at 194 (quotation marks omitted)—she depicted the complicated causes of ASD with two equal-sized, overlapping circles, one for "Genetic Factors" and one for "Environmental Factors," explaining that "there's probably a complex interplay between both the genes as well as these exposures." Which is the opposite of what she says here.

Fast forward to the present day. In a SPARK presentation *from April of this year*, Dr. Chung used substantively the same slide from her earlier presentation, with the same equal-sized, overlapping circles; the same recognized environmental contributors to ASD (*e.g.*, in-utero exposure to valproic acid); and the same title noting that "[t]here are many causes of autism."



Ex. 16, SPARK Presentation Slides (Apr. 25, 2023), at 5. "It'll sound sacrilegious," she said, "but even though I'm a geneticist it's not all about the genes in one person and across communities."[5] And when it comes to real-world cases, Dr. Chung has nowhere near the certainty in genes that is expressed in her report, stating at deposition that, "for any one person" so far observed by SPARK, "the totality of their contributors to their autism"—even their genetic contributors—"is not yet fully understood" in a full 90% of cases. Ex. 2, Chung Dep. Tr. at 332:2–333:8.

Dr. Chung has recognized the role of environmental exposures in causing neurodevelopmental disorders when speaking to scientific audiences, too. *See* Ex. 17, Myers et al. (2020) at 591 (article co-authored by Dr. Chung observing that "[t]he neurodevelopmental phenotype, whether pathological or not, depends on the profile of quantitative deleterious effects

[5] The full presentation is available at SPARK, *SPARK and the Future of Autism Research* (Apr. 26, 2023), https://sparkforautism.org/discover_article/webinar-spark-autism-research-2/. The portion of the presentation in which Dr. Chung uses the slide above is timestamped 4:41 to 7:37.

associated with the rare variant, other sources of genetic variation such as polygenic and oligogenic background risk, *and environmental* and stochastic variation." (emphasis added)); Ex. 18, Schaaf et al. (2020) at 7 (article co-authored by Dr. Chung noting, "The incomplete penetrance and variable expressivity of ASD in the presence of a high-impact genetic variant may be under the influence of additional genetic variation, including common genetic variation or epigenetic factors and possibly *environmental contributions*" (emphasis added)).

In sum, Plaintiffs' experts, the NIEHS, genetics texts, and Dr. Chung (when speaking outside this litigation) all agree: neurodevelopmental disorders such as ASD and ADHD can result from an interaction between genes and environmental factors. It is a fallacy to conclude, based on a population-wide *heritability* measurement, that these disorders are entirely *inherited*, and therefore genetic, in most cases or any case. Dr. Chung's proffered testimony taking the opposite tack is not only self-contradictory, but inherently flawed. Either way, her testimony cannot get past the *Daubert* gate. *See Gopalratnam v. Hewlett-Packard Co.*, 877 F.3d 771, 784 (7th Cir. 2017) (affirming exclusion of testimony by expert whose "central underlying premise . . . was not only unsupported, but in fact contrary to generally accepted . . . science"); *Amorgianos*, 303 F.3d at 267 ("The reliability analysis applies to all aspects of an expert's testimony: the methodology, the facts underlying the expert's opinion, the link between the facts and the conclusion, *et alia*." (quoting *Heller v. Shaw Indus., Inc.*, 167 F.3d 146, 155 (3d Cir. 1999) (cleaned up))). And "every indication is that [Dr. Chung] applies in [her] own work a more rigorous methodology before making causal determinations," thus avoiding general causal statements based on false premises, "than [she] has in this case." *In re Fosamax*, 645 F. Supp. 2d at 188.

III. Dr. Chung's Report Reaches Unreliable Conclusions.

Given its flawed premise, Dr. Chung's report would be expected to reach unfounded conclusions. It does.

Dr. Chung's rejection of environmental contributions in all but "individual rare cases," Ex. 2, Chung Dep. Tr. at 343:14–24, conflicts with generally accepted environmental contributors to neurodevelopmental disorders and other birth defects. *See* Ex. 13, Cabrera Rebuttal Report at 8 ("Dr. Chung goes so far as to defend thalidomide, misoprostol, and valproic acid. . . . [T]hese chemicals are not merely associated with ASD, these chemicals are *known* human teratogens, i.e., they have caused congenital malformations and functional deficits in humans."). These include air pollution, a contributing exposure recognized by the NIEHS and in Dr. Chung's SPARK presentations, and valproic acid, another contributing exposure recognized in Dr. Chung's SPARK presentations.

Valproic acid offers a vivid example of Dr. Chung's flawed approach. Citing a single observational study regarding ASD and a single observational study regarding ADHD, the FDA-approved label for valproic acid (an anti-seizure medication marketed as Depakote) warns that, "[a]lthough the available studies have methodological flaws, the weight of the evidence supports a causal association between valproate exposure in utero and subsequent adverse effects on neurodevelopment, including increases in autism spectrum disorders and attention deficit/hyperactivity disorder (ADHD)." Ex. 19, Depakote ER Full Prescribing Information at 31. One would assume that an expert reviewing the (far more substantial) epidemiological data showing a causal association between APAP exposure in utero and the same neurodevelopmental disorders, as Dr. Chung purports to do, would be keenly interested in this example. Dr. Chung herself claims "a general understanding," Ex. 2, Chung Dep. Tr. at 177:7–9, of what "analogy" means in the Bradford Hill context—namely, that "[s]ubstantiation of relationships similar to the putative causal relationship increases the likelihood of causation." *Mirena II*, 341 F. Supp. 3d at 243.

But valproic acid receives just a passing mention in Dr. Chung's report. *See* Ex. 1, Chung Report ¶ 68. Her reasons for disregarding this conspicuous analogy are twofold. First, she has not "comprehensively reviewed the valproic acid data and relationships to autism or ADHD" for purposes of this case. Ex. 2, Chung Dep. Tr. at 202:24–203:2; *see also id*. at 206:8–11, 206:18–21. Second, though she was confident enough in the studies showing valproic acid's association with ASD to single out valproic acid in her 2017 SPARK presentation, she now asserts that "those were the best studies at the time," and, "[s]ince then, there have been improvements in terms of some of the epidemiological studies that have been done to do—to go back and readdress the same questions, oftentimes adding complexity to the studies." *Id*. at 310:24–311:6. Yet Dr. Chung does not identify any new evidence that in-utero exposure to valproic acid does *not* increase the risk of ASD or ADHD, again because she did not review valproic-acid evidence for this case. *See id*. at 311:13–16. Nor can her apparent skepticism of this evidence explain why she again singled out in-utero exposure to valproic acid in her SPARK presentation in *April of this year*. Indeed, in Dr. Chung's recently published study with Dr. Pearson, which she fails to mention here, she cites a 2022 article that reiterates the continued recognition of in utero exposure to valproic acid as a contributor to ASD and ADHD. *See* Ex. 3, Pugsley et al. (2022) at 717 tbl.2.

At deposition, Dr. Chung pointed to the caveat on the same slide that the "mix of genetic and environmental factors are unknown." Ex. 2, Chung Dep. Tr. at 331:5–6; *see* Ex. 16, SPARK Presentation Slides (2023), at 5.[6] That is not an explanation, but a concession that her views outside this litigation are inconsistent with her view in this litigation that ASD and ADHD are almost entirely genetic phenomena.

[6] Dr. Chung suggested that this caveat was "added" to the 2023 presentation. Ex. 2, Chung Dep. Tr. at 331:5. A similar caveat is at the bottom of the analogous slide in her 2017 presentation. *See* Ex. 14, SPARK Presentation Slides (2017) at 5.

Dr. Chung had the same responses when asked about other toxicants known to contribute to ASD and ADHD in offspring. Thalidomide, mercury—she had not studied them. *See* Chung, Tr. at 133:22–134:6, 258:18–23.[7] For the same reason, she would not even say whether pregnant women should smoke marijuana. *Id*. at 186:10–15. Needless to say, an expert cannot support an opinion, *e.g.*, that genes are the near-exclusive cause of ASD and ADHD, by not reviewing evidence to the contrary, *e.g.*, of environmental exposures. *See In re Rezulin*, 309 F. Supp. 2d at 563 ("[A]n expert may not 'pick and chose' from the scientific landscape and present the Court with what he believes the final picture looks like." (quotation marks omitted)).

As for exposures like air pollution and chlorpyrifos (a pesticide), Dr. Chung focused on "the timestamp in terms of when these studies were done." Ex. 2, Chung Dep. Tr. at 180:6–11; *see* Ex. 8, NIEHS, *Gene and Environment Interaction* at 3 n.1 (citing 2014 air-pollution study); Ex. 20, Carter & Blizard (2016) at 3 (citing human and animal chlorpyrifos studies from 2014, 2015, and 2016). For Dr. Chung, the year 2014 is ancient history. The "modern era" began "[w]ithin the last five years." Ex. 2, Chung Dep. Tr. at 203:6–9; *id*. at 104:19–22 ("I'll timestamp when this particular paper was published, which was in 2014, which is already almost a decade ago, which in terms of genetic history is ancient."). Yet Dr. Chung does not say what happened in 2018 or after to usher in this modern era. Sibling-controlled studies, the tool that Dr. Chung primarily emphasizes "for controlling genetic/familial confounding in observational epidemiological studies," have existed since before then; Dr. Chung's own report relies on such studies from "ancient" times. Ex. 1, Chung Report ¶ 77; *see id*. ¶ 72 (citing 2008 sibling study);

[7] *See* Ex. 20, Carter & Blizard (2016) at 89 tbl.1 (listing, in a table of compounds that have been implicated in autism, certain drugs used in pregnancy, including thalidomide, valproate, and acetaminophen); Ex. 3, Pugsley et al. (2021) at 714–15 tbl.2 (listing, among other environmental exposures associated with elevated ASD risk, mercury and cannabis).

id. ¶ 78 (citing 2015 sibling study). So have "polygenic risk scores," another tool on which she relies. *See* ¶ 46 (noting that the tool has "emerged in the last 15 years"); *see also* Ex. 21, Herzig et al. (2022) at 3 ("PRSs were introduced into human genetics by Wray et al. 2007."). And again, Dr. Chung cites no later evidence using these tools (which have their own issues, *see infra*) to disprove that either air pollution or chlorpyrifos is associated with the development of ASD or ADHD. Hence the reference to the air-pollution association still appears on the NIEH's "Gene and Environment Interaction" page to this day.

Dr. Chung herself has contributed "modern era" evidence of the role of gene-environment interactions in causing neurodevelopmental disorders such as ASD and ADHD. In a study titled *Environmental Carcinogens Disproportionately Mutate Genes Implicated in Neurodevelopmental Disorders*—which Dr. Chung co-authored with Dr. Pearson, and which was published on August 3, 2023 (thirteen days after she signed her expert report in this case), Dr. Chung explored the "vulnerability of disease-associated gene sets" to "environmental mutation." Ex. 4, Baker et al. (2023) at 1. This study demonstrates that several environmental mutagens "disproportionately mutate genes related to neurodevelopmental disorders including autism spectrum disorders . . . and attention deficit hyperactivity disorder," supporting "the possibility that neurodevelopmental disorder genetic etiology is partially driven by a contribution of *environment-induced* germ line and somatic mutations." *Id*. (emphasis added).

Despite working with Dr. Pearson on this study for "[a]pproximately two years," Ex. 2, Chung Dep. Tr. at 214:4, Dr. Chung refused to testify to his scientific integrity. *See id*. at 213:25–214:1 ("I wouldn't say that I know one way or the other in terms of integrity."). Indeed, despite serving on the Columbia faculty with Dr. Pearson for several years, Dr. Chung acts as if she barely even knows him. *See id*. at 214:23–215:2 ("Q. Can you comment about him at all in any respect,

or is he a stranger to you? A. I've met with Dr. Pearson, to my knowledge, on two occasions."). Their email exchanges tell a different story, with Dr. Chung supporting Dr. Pearson when a journal declined to accept their study for publication: "Don't give up. New ideas are harder to change minds but long term are of high impact." Ex. 22, Emails 6/9/22–10/26/22; *see also* Ex. 23, Emails 3/14/22–3/24/22 ("I personally remain quite interested in your research and as I've said before would be willing to add components to SPARK to support this line of research if there are things you think would be helpful."); Ex. 24, Emails 1/6/22. In any event, Dr. Chung confirmed that "I stand behind the conclusions of this manuscript." Ex. 2, Chung Dep. Tr. at 221:11–25. Those conclusions directly conflict with her causal opinions here.

Against this evidence of gene–environment interactions, Dr. Chung cannot support the assertion that the incidence of ASD and ADHD is caused predominantly by genes and rarely by environment. And the Court cannot accept an expert report that makes such an assertion while disregarding this contrary evidence. *See In re Rezulin*, 309 F. Supp. 2d at 563. Dr. Chung certainly fails to reliably support her opinion that prenatal APAP exposure specifically cannot contribute to the development of ASD and ADHD in offspring. She refers to purportedly cutting-edge genetics tools, but neither remotely disproves environmental contributions.

Take polygenic risk scores ("PRS"), which Dr. Chung's report says "can be calculated to estimate the genetic risk or susceptibility of an individual for a disease or disorder, such as ASD and ADHD," through DNA-sequencing data. Ex. 1, Chung Report ¶ 26. Outside of this litigation, Dr. Chung has observed that this tool *cannot* reliably predict whether someone will develop ASD. In a recent article she both noted the possible "environmental contributions" to ASD and concluded that a polygenic risk score has "no clinical use as a risk prediction tool in the general population at this time." Ex. 18, Schaaf et al. (2020) at 7. She eventually admitted as much at deposition.

See Ex. 2, Chung Dep. Tr. at 351:16–18 ("And we are pointing out that this is something that cannot reliably be done based on the current information."); *id*. at 353:12–15 ("In terms of clinical application, I would not use a polygenic risk score for autism clinically at this point."). Yet Dr. Chung's report relies on this tool to bolster its key propositions, namely that ASD and ADHD are predominantly genetic conditions and that studies of environmental contributors may be wholly disregarded if they purportedly fail to adequately account for genetics. *See* Ex. 1, Chung Report ¶ 118.

Polygenic risk scores are particularly ill-suited to the role Dr. Chung uses them for in her report because it is known that they do *not* account for environmental contributions. The calculation of a polygenic risk score, as Dr. Chung explained at deposition, "is very simple. It takes genetic polymorphisms at the one end and phenotypes at the other end and does not worry about anything in between and does a calculation between the beginning and the end." Ex. 2, Chung Dep. Tr. at 357:6–11. In other words, the prediction runs from the genetic data straight to the outcome and is "agnostic" about the exposures in between. *Id*. at 357:18–19 ("We are agnostic to the middle."). In *The False Dawn of Polygenic Risk Scores for Human Disease Prediction*, which Dr. Chung had not read, *see id*. at 358:16, the authors describe this very assumption—"that each environmental factor has a small effect that is independent from the effects of the genetic factors"—as one of the "erroneous assumptions of PRS." Ex. 21, Herzig et al. (2022) at 4–5. "For most traits," they write, "this is clearly not true. The effect of the environment can be important and a given genotype can react differently across different environments." *Id*. at 5. Thus, "[t]he environment cannot be ignored and . . . [p]artitioning of the causes of variation is really illusory. The genetic variance depends on the distribution of environments and the environmental variance

depends on the distribution of genotypes." *Id*. (quotation marks and italics omitted); *see also id*. at 5–6 (noting that PRS measurements can themselves be impacted by environmental factors).

A guidance paper on the use of polygenic risk scores, titled *Addressing the Challenges of Polygenic Scores in Human Genetic Research*, further elaborates on their limitations, including the "portability problem": the fact that a score's accuracy "might be compromised when applied to a cohort that differs in key demographic characteristics from the discovery cohort(s) used to develop" the score. Ex. 25, Novembre et al. (2022) at 2096. Among the causes of this problem are "different distributions of *nongenetic* individual risk factors," such as "age, sex, diet, pollutant exposure, access to healthcare, and gut microbiome composition. In quantitative and statistical genetics, these factors are often collectively referred to as 'environment,' and they induce what are known as 'genotype-by-environment interactions' or 'context-dependent effects.'" *Id*. (emphasis added). This paper represents the guidance of the American Society of Human Genetics ("ASHG") and was approved for publication by the ASHG Board of Directors. *See id*. at 2095. Dr. Chung sits on the ASHG Board of Directors. *See* Ex. 2, Chung Dep. Tr. at 385:12–14. Yet her report once again fails to note this industry standard even while noting the use of polygenic risk scores in the two primary studies among the minimal (and exceedingly weak) evidence she offers of any genetic confounding in the observed association between prenatal APAP exposure and ASD/ADHD. *See* Ex. 1, Chung Report ¶ 84–85.

The family study, Dr. Chung's other favored analytical tool, similarly masks environmental contributions, thus reintroducing the heritability fallacy. Dr. Chung points out that "[h]eritability can be estimated using twin studies." *Id.* ¶ 44. Indeed, such studies are the basis for her heritability statistics. *See id*. ¶¶ 55, 72. But *Emery & Rimoin*—the genetics textbook Dr. Chung pointed to—advises in a chapter on "The 'Classic Twin Design'" that "focusing on the heritability loses a lot

of information and is not recommended." Ex. 9, *Emery & Rimoin* (2018) at 401. In yet another SPARK presentation, epidemiologist Craig Newschaffer elaborated that twin studies

> overestimate heritability because they assume no gene-environment interaction. And that's . . . in my view a very naïve assumption. So the estimates that we have whether you're in the 50–60% range or you're . . . holding onto a higher estimate of heritability for autism for some of the more recent family studies, you have to realize that they're likely overestimated. And the room for environmental factors to be influencing the outcome in question in this case autism is likely substantially larger than what those heritability studies put forth.

Ex. 26, Audio Excerpt of 2018 SPARK Presentation.[8] At deposition, Dr. Chung simply disagreed with this view of heritability offered through the organization for which she is the principal investigator. *See* Ex. 2, Chung Dep. Tr. at 340:20–23.

While dismissing Plaintiffs' vast epidemiological evidence for purportedly failing to adequately control for genetics, moreover, Dr. Chung also dismisses the numerous animal studies supporting a causal association between prenatal APAP exposure and ASD/ADHD. Although she is aware that "[s]everal investigators at Columbia," where she used to work, "use rodent models," *id*. at 219:6–7, she stated at deposition that "[a]nimals, in terms of their relevance, are not something that I focus on," *id*. at 77:3–5. But the witnesses whose work does focus on animal models—including Defendants' expert Dr. Craig Powell—agree that, unlike observational human studies, animal studies can be tightly controlled to remove confounding variables. Dr. Chung admittedly "did not attempt to do a comprehensive review of animal studies." *Id*. at 77:1–2. Not having done so, she cannot have a reliable opinion about what that evidence shows. And without a reliable opinion, she cannot dismiss this evidence, as she did, with the simple remark that "[a]nimals don't have autism." *Id*. at 77:3.

[8] The full presentation is available at SPARK, *Four Things to Know About Environmental Autism Risk Factors* (Mar. 2017), https://sparkforautism.org/discover_article/four-things-to-know-about-environmental-autism-risk-factors/.

Dr. Chung has thus picked and chosen "from the scientific landscape" to present the Court with a deeply skewed "final picture." *In re Rezulin*, 309 F. Supp. 2d at 563. In that picture, known environmental causes of neurodevelopmental disorders are nowhere to be found. They have been replaced with genetics, despite the facts that Dr. Chung identifies *no* evidence disproving the environmental associations and that her preferred genetic tools *cannot* provide any such evidence. This carefully arranged composition does not represent reliable science.

CONCLUSION

Dr. Chung's expert report and testimony should be excluded.

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Respectfully submitted,

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