Leaded Gasoline

POISON EVERYWHERE

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This story highlights four tactics of science misinformation and disinformation efforts: neglect of refuting information, deviant criteria of assent, conspiracy theories, and attacks on legitimate scientists. See our website article Characteristics of Science Misinformation/ Disinformation Efforts for more information regarding these tactics.

> [Danita] was described as singing nursery rhymes, dancing, being a very bright kid. She became ill and was taken to Rainbow Children's Hospital with a fever and sore throat. She was stuporous. A neurosurgeon looked at her and thought she had a brain tumor because she had signs of increased intracranial pressure. They took her to the OR as an emergency. On the way up, they drew her blood for lead. … After recovery [from brain surgery], she had hyperactivity, attention deficit disorder, and a low IQ. Her blood lead [measurements] returned while she was in the OR and was as high as they could measure. It was over 100. That was the ceiling of their measurement. So here was a case of a kid with an extraordinarily high blood lead and evidence of dead brain tissue. (Herbert Needleman, as cited in Rosner & Markowitz, 2005, p.334)

Tragic, acute instances of lead poisoning such as Danita's were at one time often caused by ingestion of lead paint. Prior to its ban in 1978, lead was added to paint to reduce its drying time and increase its durability. Leaded paint also tastes sweet, and teething children chewing on windowsills and other lead paint surfaces (even children's toys sometimes contained lead paint) naturally liked the taste. The harm from acute lead poisoning is readily identifiable, and this brought attention to the existence of serious dangers facing children. Unfortunately, leaded gasoline presented a more pervasive and insidious form of lead poisoning that would spread over the course of five decades during the mid-20th century. Why did the scientific community take so long to agree upon the existence of such a serious threat to public health? Why didn't the government intervene earlier or the public recognize the hazards that they were facing?

Silencing the Knock

The advent of mass-produced automobiles in the early years of the 20th century transformed society and resulted in incredible demand for vehicles. However, those early automobiles also suffered from numerous issues which initially threatened their utility. One problem that automobile manufacturers struggled with was how to maintain consistent combustion of fuel in the vehicles. Internal combustion engines that run on gasoline spray a mixture of air and fuel into a combustion chamber that is then ignited by a spark from a spark plug (Figure 1). The resultant expansion of gas from the rapid burning forces the piston down, and that force is

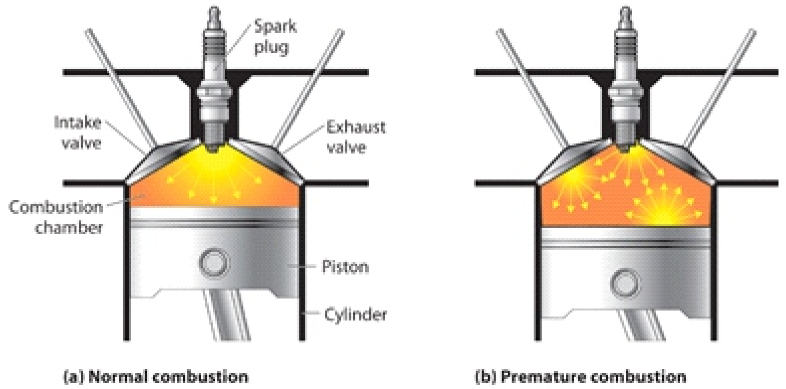


Figure 1. Normal engine combustion and combustion with “knock” (LibreTexts, 2019).

converted into rotational movement that is used to make the car wheels turn (link to animation to assist with understanding). The piston then moves back up the cylinder, and the process repeats thousands of times every minute as a car is driven. However, the compression of the fuel-air mixture as the piston moves back up the cylinder can cause premature combustion, resulting in multiple explosions versus one purposeful source of ignition at the spark plug. That uncontrolled ignition throws off the precision timing of the engine, and a characteristic "knock" is produced that over time can seriously harm an engine.

By 1916, automobile industry researchers and inventors, such as General Motors' Charles Kettering were investigating gasoline additives to increase the ability of the fuel to be compressed without igniting prematurely—a property that would come to be known as "octane rating." In December 1921, one of Kettering's assistants, Thomas Midgley (see: [insert Ozone story title] for Midgley's role in the development of CFCs), reported that the octane rating of gasoline could be significantly increased if tetraethyl lead (TEL) (Figure 2) was added to it, thereby minimizing knocking (Graebner, 1986; Kovarik, 2005). Within a year, an agreement was signed between the DuPont corporation and General Motors—both run by the du Pont family at the time— for DuPont to produce TEL (Kitman, 2000). By 1923, the first leaded gasoline was being produced in Dayton, Ohio, and stations were selling leaded fuel to the public by February of that year (Graebner, 1986; Rosner & Markowitz, 1985; Walsh, 2007).

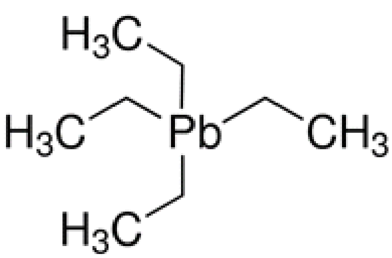


Figure 2. The structural formula of tetraethyl lead (MilliporeSigma, 2022)

Concern about TEL was quickly expressed by numerous people, including William Mansfield Clark, Professor of Chemistry at Johns Hopkins University, who wrote that TEL was, "a serious menace to the public" (Rosner & Markowitz, 1985). Such alarm should not have been surprising - the effects of lead poisoning have been recognized since antiquity, when Romans tragically used lead acetate to sweeten wine (Kovarik, 2005). Prominent figures such as Benjamin Franklin and Charles Dickens had written about lead poisoning (Kovarik). In 1839, a paper examining over 1,200 cases of lead poisoning was published (Aho, 2020). By 1857—four years before the American Civil War—an article in *Scientific American* stated that, "all combinations of lead are decidedly poisonous" (Kovarik, 2005). Kettering was undoubtedly aware of those facts when he insisted on referring to TEL as "ethyl"—a name which conveniently dropped any mention of lead (Figure 3).

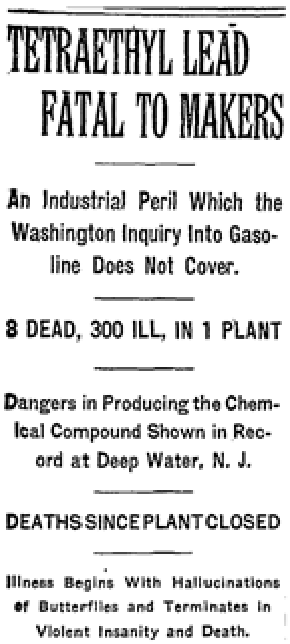
Despite the concerns expressed by some scientists, production of TEL moved forward at DuPont's large facility in Deepwater, New Jersey. By August 1924, Standard Oil of New Jersey (now Exxon) also began production of TEL at its Bayway refinery in Elizabeth, New Jersey (Kitman, 2000). That same month, General Motors and Standard Oil of New Jersey created the Ethyl Gasoline Corporation, with Charles Kettering and Thomas Midgely appointed as president and vice president, respectively (Adler, 2006).

Figure 3. "Ethyl" branding of TEL (Helmenstine, 2018)

The House of Butterflies

Less than two months after production of TEL began at Bayway, terrifying reports began to emerge from the plant. Workers there were reportedly exhibiting the telltale sign of lead poisoning, such as blue lines on their gums. But their other symptoms were far more concerning and included hallucinations, paranoia, uncontrollable muscle spasms, and even sudden bouts of violent or suicidal behavior (Kovarik, 2005). Five Bayway workers died horrific deaths due to the poisoning, and 35 others fell ill, meaning that an astonishing 82% of employees at the facility had been poisoned by TEL (Rosner & Markowitz, 1985). A number of the afflicted workers had to be forcibly taken away in straitjackets, as they writhed and screamed about the hallucinations that they were experiencing (Graebner, 1986; Kovarik, 2005). A supervisor at the building told a newspaper reporter that, "these men probably went insane because they worked too hard" (Rosner & Markowitz, 1985). Despite attempts by Standard Oil to blame the supposedly careless workers, fear among the general public spread about TEL as newspapers described the chemical as "loony gas" (Kovarik, 2005).

In response to Standard Oil's crisis at Bayway, DuPont attempted to maintain tight control over information regarding the health of its workers at its Deepwater TEL plant (Rosner & Markowitz, 1985). However, investigations by journalists began to paint a disturbing image of the facility: During the two years that the plant had been operating, over 300 workers had suffered from lead poisoning, and 10 had died (Kovarik, 2005; Rosner & Markowitz, 1985). Hazardous exposure to TEL was so rampant that employees were known to stop talking mid-sentence to grab at non-existent flying insects, leading to workers to refer to the plant as "The House of Butterflies" (Kovarik, 2005; Rosner & Markowitz, 1985).


TETRAETHYL LEAD FATAL TO MAKERS

An Industrial Peril Which the Washington Inquiry Into Gasoline Does Not Cover.

8 DEAD, 300 ILL, IN 1 PLANT

Dangers in Producing the Chemical Compound Shown in Record at Deep Water, N. J.

DEATHS SINCE PLANT CLOSED

Illness Begins With Hallucinations of Butterflies and Terminates in Violent Insanity and Death.

Figure 4. New York Times article (Bent, 1925).

In the aftermath of these disastrous revelations, TEL proponents attempted to defend leaded gasoline through the use of a newly published report from the United States Bureau of Mines supporting the argument that leaded gasoline exhaust fumes would not cause lead poisoning (Rosner & Markowitz, 1985). Critics were quick to point out that not only had General Motors funded the government research, but that the Ethyl Corporation had been given unprecedented veto control over the conclusions of the study, and the methodology was also suspect (Kovarik, 2005; Rosner & Markowitz, 1985).

NATURE OF SCIENCE CONNECTIONS

Industry has a long history of funding scientific research, with many significant advances owed to these relationships. However, such funding can lead to ethical questions in certain circumstances. Numerous studies of the effects of industry funding on research integrity (e.g., Tereskerz, et al., 2009) have reported that instances of undue influence on all aspects of studies have resulted. However, safeguards in science do exist. For instance, scientists are required to disclose all potential conflicts of interest related to their research. The global scientific community also helps to mitigate any inappropriate influence that may occur with individual scientists.

With the conclusions of the study disputed, the United States Surgeon General temporarily halted sales of leaded gasoline in 1925, and held a conference about the safety of the product in May of that year (Hamilton, 1972; Kitman, 2000; Rosner & Markowitz, 1985). The conference brought together the major industry supporters of TEL along with prominent critics of leaded gasoline. During the event, industry representatives blamed workers for safety failures and portrayed TEL as vital to conserving fuel and to the overall progress of the United States (Rosner & Markowitz, 1985). At the core of industry's argument was the notion that TEL was the only adequate anti-knock gasoline additive that was available (Kovarik, 2005). However, well-known alternatives did exist. For example, ethanol was a clean, safe, effective, anti-knock chemical that was commonly used in many countries (Kitman, 2000; Kovarik, 1993; Kovarik, 2005). Both Kettering and Midgley knew this, and Midgley even wrote that ethanol was "of course the fuel of the future" (Kovarik, 2005). Ethanol was ignored because it couldn't be patented, it was already being widely produced by individuals with stills, and it would take up 10-20% of every gallon of fuel sold—an unappealing prospect for petroleum producers (Kitman, 2000). In other words, ethanol was ignored because, unlike TEL, it wasn't financially lucrative.

RED FLAG

Neglect of refuting information

The lead industry's public insistence that TEL was the only viable anti-knock compound—despite significant scientific information to the contrary—is a common warning sign of pseudoscience.

QUESTION 1

Undue bias (e.g., inappropriate interpretation of data due to a conflict of interest) is a potential threat to good science. How does a diverse global scientific community assist in mitigating this issue and assist the public and policy-makers in detecting misinformation/disinformation?

Some experts at the conference strongly pushed back against industry's arguments, urging a more cautious approach of first determining the safety of TEL instead of moving forward with production until dangers were identified (Hamilton, 1972; Rosner & Markowitz, 1985). The dean of the Harvard medical school, David L. Edsall, presciently noted:

> …manufacture of tetra-ethyl lead could be made safe, as the manufacture of many very poisonous substances has been made safe, but that the problem of its use was much greater. Here it will be necessary to protect the public against slow, cumulative lead poisoning. The fact that no such cases are being reported at present is no proof of the lack of danger. Early cases of chronic lead poisoning are seldom diagnosed correctly unless the man is engaged in a well-known lead industry. (Hamilton, 1972, p.99)

At the close of the conference, many remained uncertain about TEL and little progress had been made. The Ethyl Corporation did agree to suspend TEL production until further research had been conducted, and the Surgeon General announced that a group of experts would be assembled to investigate the health effects of leaded gasoline. The committee's ensuing empirical study was completed within the year and concluded that insufficient evidence existed to ban TEL in gasoline (Rosner & Markowitz). However, the experts emphasized the need for adequate regulations and further study (Rosner & Markowitz, 1985).

NATURE OF SCIENCE CONNECTIONS

Knowledge in science takes time to become well-established. Confidence grows when findings from many studies, vetted by the proper experts, converge in a coherent manner. Until scientific knowledge becomes well-established, decisions must be made acknowledging uncertainty. To act or not to act are both decisions with consequences.

QUESTION 2
How may purveyors of misinformation/ disinformation take advantage of the time that is often required for scientific information to become well-established?

A Pervasive Poison

The Surgeon General's committee recommendations went unheeded by the government, leaving industry with the opportunity to fill the regulatory and research void itself. Over the next four decades, industry policed itself with *voluntary* regulations regarding TEL production and use (Graebner, 1986).

At the same time, corporations and industry-funded researchers dominated the study of leaded gasoline. One particularly prominent voice regarding the effects of leaded gasoline was Robert Kehoe (Rosner & Markowitz, 2007). Kehoe was the head of the Kettering Labs at the University of Cincinnati, and he played a significant role in influencing lead research for several decades during the middle of the 20th century. Kehoe also received considerable funding from corporations with a vested interest in leaded gasoline, and was even the medical director at the Ethyl Corporation (Rosner & Markowitz, 2007; Warren, 2005). At the core of Kehoe's views on lead was the argument that it is naturally found in our environment—a conclusion that stemmed from his study of remote Mexican villagers who exhibited elevated blood lead levels (Needleman, 2000). Kehoe therefore thought that certain levels of the element should be expected in our bodies and not considered harmful unless a certain threshold is exceeded (Warren, 2000). Utilizing research methodology that would unlikely be permitted today, Kehoe had participants eat or breathe varying amounts of lead over extended periods of time to determine the safe threshold of lead in the blood—an amount he concluded was 80 µg/dL. “Kehoe and the Kettering laboratory were able to translate industry's needs into the language of science through the creation, funding, and control over publication of lead related research.” (Kovarik, 2005, p.391).

NATURE OF SCIENCE CONNECTIONS

How was a single man able to influence lead research so significantly for decades? Even while Kehoe was actively conducting research, a Public Health Service official commented that the domination of the field by one small group was unusual (Kovarik, 2005). Kehoe benefitted from ample industry funding and a relatively homogenous group of researchers both geopolitically and demographically. A major safeguard of science therefore is a diverse, global scientific community that is less likely to bend to inappropriate outside influences.

While scientists such as Kehoe dominated the field of lead research, studies that did not support the safety of leaded gasoline were occasionally published in the decades following the Surgeon General's 1925 conference. One of the first threats to the broader lead industry involved another major consumer product of the early 20th century: leaded paint. By the

1930s, that children were particularly at risk due to lead exposure was becoming evident (Rosner & Markowitz, 2007), and the number of children being diagnosed with lead poisoning was dramatically increasing (Warren, 2005). In 1943, Byers and Lord (1943) published an influential study that identified effects of chronic lead exposure on neurological development and behavioral outcomes—an important shift from the focus on short-term, acute poisoning that paralleled other notable issues of the era (e.g., see DDT: The Rise and Fall of a "Miracle" Chemical). The lead industry responded by threatening Byers with a million-dollar lawsuit if he continued his research, and thereby successfully halted the scientist's work related to lead (McGarity, 2004). The lead paint industry also suggested that the victims were "sub-normal" before poisoning, or that the children had incompetent parents who raised them in slums (Warren, 2005; White et al., 2009). However, even Kehoe acknowledged the dangers of interior lead paint to children (Rosner & Markowitz, 2007). By the mid-1950s, industry agreed to voluntarily reduce the lead content of interior paint to <1% (Warren, 2005). Federal regulations on lead paint did not go into effect until over two decades later, in 1978 (Adler, 2006). As lead paint declined, leaded gasoline continued its ascent, driven onwards by soaring motor vehicle sales (Figure 5.). Advances

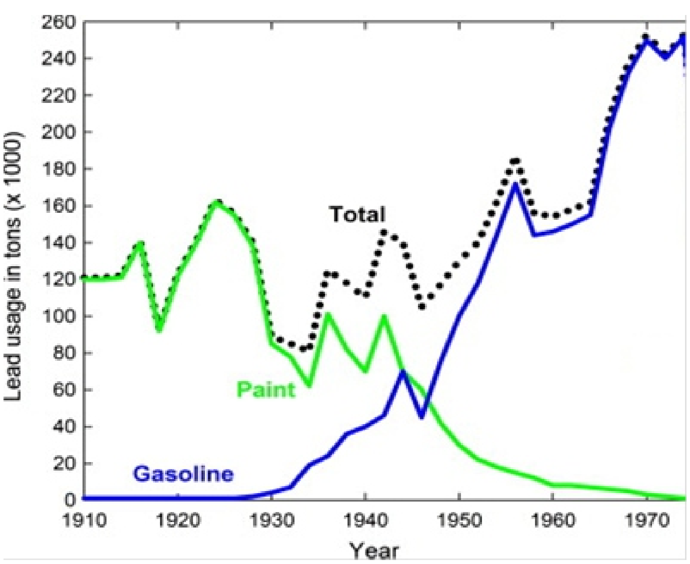


Figure 5. *Lead use (adapted from Laidlaw & Filippeli (2008).*

in technology also resulted in more powerful engines with higher compression, and therefore required higher octane fuel (Graebner, 1986). The need for higher octane ratings in turn led to calls for increases in TEL in leaded gasoline.

RED FLAG

Attacks on legitimate scientists

Note the attacks on legitimate scientists who conducted research that was potentially damaging to the lead industry. Byers was threatened with legal action, which effectively silenced him. Patterson was personally insulted, his funding was cut, and pressure was applied to fire him. Regardless of the form that these attacks on legitimate scientists take, they are a classic warning sign that the perpetrators may be involved with pseudoscience.

However, in the mid-1960s, a challenge arose to Kehoe's dominant views about acceptable, natural levels of lead in the human body. Claire Patterson, a geophysicist at CalTech, inadvertently strayed into the debate over lead while researching the age of the earth (Kovarik, 2005). Patterson's plan was to utilize uranium-lead radiometric dating to determine the age of his samples, which requires precise knowledge of the ratio of uranium to lead. However, to the dismay of the geophysicist, he found that lead was contaminating nearly everything in his laboratory. Through the use of extraordinary measures such as working within an ultraclean chamber with purified reagents (Needleman, 2000), Patterson was able to conclude that atmospheric lead levels were 1,000 times higher than they had been prior to industrialization (Kovarik, 2005). Where Kehoe had interpreted the relatively high baseline levels of lead throughout members of the public as an indicator of natural levels present in the human body, Patterson convincingly argued that those results instead reflected the nearly inescapable poisoning of humanity through water, air, soil, and other means following the Industrial Revolution (Warren, 2000). Kehoe, who peer-reviewed Patterson's paper, stated that the geophysicist was "woefully ignorant," "naïve," and that his paper should only be published so that it could be "faced and demolished" (Kovarik, 2005; Needleman, 2000). Others attempted to disparage the geophysicist by portraying him as a radical activist:

> Rather than address scientific concerns relating to Patterson's studies, the lead industry attacked Patterson personally and sought to tie him to political activists of the environmental movement. (Adler, 2006, p. 76)

According to Patterson, the Ethyl Corporation offered him research funding to produce work that would be more favorable to them (Needleman, 2000). During high-profile Congressional hearings in 1966, Patterson and Kehoe faced off again, representing opposing views about the dangers of lead. However, following Patterson's appearance in D.C., his research funding was cut, and pressure was placed on his dean to fire him (Kovarik, 2005). The geophysicist's work was sound though, and he not only retained his position, but he also managed to expand his work on historical lead levels. By studying lead in ice packs, ocean sediment, deep sea tuna, and even mummies, Patterson produced further data that corresponded with the atmospheric increases that he had previously documented (Kovarik, 2005; Needleman, 2000). An eventual review of Kehoe's study of Mexican villagers—research which had been central to his position—revealed that the isolated people had elevated lead levels because of the high amounts of the metal in their clay dishes (Needleman, 2000). As Patterson had argued, high levels of blood lead were not inherent to humans, but rather reflected the ubiquitous nature of the poisoning that modern society had wrought upon itself.

A Phaseout…For Some

As the modern environmental movement gained momentum throughout the 1960s, increasing scrutiny was placed on air quality and the deleterious effects of pollution on humans—particularly in cities plagued by smog, such as Los Angeles. That attention, combined with passage of the Clean Air Act of 1963, the creation of strong federal regulatory agencies (e.g., the Environmental Protection Agency in 1970), and shifting scientific consensus on the dangers of lead, posed a considerable threat to leaded gasoline. That fact was not lost on General Motors, who divested themselves of the Ethyl Corporation in 1962, as they quietly began working on a means of removing pollutants from car exhaust (Kovarik, 2005). When the Clean Air Act was amended in 1970 to require a significant reduction in those exhaust pollutants, General Motors announced that new vehicles would be equipped with catalytic converters to do so (Kovarik, 2005). The catalytic converters would be rendered ineffective by leaded gasoline though, requiring the fuel to be phased out (Wilson & Horrocks, 2008).

However, just because General Motors had decided to move on from leaded gasoline did not mean that the Ethyl Corporation was ready to give up without a fight. When the EPA passed regulations requiring a phased drawdown of the lead content in gasoline by over 77% from 1973-1979, the company sued the government, and won (Kovarik, 2005). As a result, the scheduled lead reductions were delayed until the government managed to win a subsequent case against Ethyl several years later (Kovarik, 2005).

In 1974, a team of researchers led by the psychiatrist Herbert Needleman investigated the lead content in 2,500 elementary children's teeth, and concluded that exposure to the toxic metal was even more widespread than previously thought, and that both lead paint and leaded gasoline were to blame. In a subsequent study Needleman et al. (1979) considered 40 possible variables on students' achievement, and concluded that only lead exposure could explain the differences:

> Children with high lead levels scored significantly less well on the Wechsler Intelligence Scale for Children (Revised) than those with low lead levels. This difference was also apparent on verbal subtests, on three other measures of auditory or speech processing and on a measure of attention. … The frequency of non-adaptive classroom behavior increased in a dose-related fashion to dentine lead level. Lead exposure, at doses below those producing symptoms severe enough to be diagnosed clinically, appears to be associated with neuropsychologic deficits that may interfere with classroom performance. (p.689)

As Needleman's work on lead accumulated, he became a target of unfounded accusations of scientific misconduct—first by a scientist working with the lead industry in 1982 and then again by an attorney from a law firm associated with the Ethyl Corporation in 1991 (Kovarik, 2005; Rosner & Markowitz, 2005). Needleman was subjected to extensive investigations, and his data were even physically locked in file cabinets so that he could not access them without supervision (Rosner & Markowitz, 2005). Ultimately, Needleman was cleared of any wrongdoing in both cases though. The psychiatrist later stated:

> It's very clear to me that in 1990 there were now 30 papers from around the world all saying the same thing— except for Claire Ernhart. The [lead industry] couldn't contest that, so what were they going to do? If they could discredit my work, the whole thing would collapse or be fundamentally revised. (Rosner & Markowitz, 2005, p.337)

RED FLAG

Attacks on legitimate scientists

The attacks on Needleman focused on harassment via unfounded accusations of scientific misconduct. This is yet another method used to attack scientists when their research is sound and therefore unable to be fruitfully challenged via standard scientific ways (e.g., journal publications).

In addition to accusations of misconduct, another common technique that the lead industry utilized to undermine threatening studies had long been employed by Kehoe. That included "…attack, question all research as ultimately imperfect, and maintain all the while that the burden of proof must fall on public health advocates and not on industry" (Kovarik, 2005, p. 393). In practice, one way that this was utilized was to try to undercut lead studies involving humans, because all possible variables could not be controlled for (Kovarik, 2005). Of course, controlling for all possible variables is an impossible feat in any study, and any researcher who would make such demands would be inadvertently disqualifying their own body of work as well.

RED FLAG

Deviant criteria of assent

Kehoe's strategy to selectively dismiss research on the grounds that it was imperfect, while failing to hold his own studies to such impossible standards is a classic example of the pseudoscience strategy of "deviant criteria of assent."

As a diverse range of studies converged on the dangers of leaded gasoline, the lead industry eventually even attempted to characterize the damaging research as part of a conspiracy theory aimed at them, as demonstrated by the Ethyl Corporation's Donald Lyman, who told the New York Times in 1984:

> Five or six scientists, together with the rabid environmentalists, have used the media very skillfully putting over their views, but there's a lot of responsible opinion that doesn't support that. … Unfortunately, the atmosphere we're now in prohibits objective scientists from coming forward. And why should they, when they would be crucified by the press, the EPA and the environmentalists. (as cited in Needleman, 2000, p.34)

RED FLAG

Conspiracy Theories

Resorting to conspiracy theories to explain why scientists do not support a particular stance on an issue is a warning sign of pseudoscience.

QUESTION 3

Why are policymakers and the public susceptible to the misinformation/disinformation tactic of "…attack, question all research as ultimately imperfect, and maintain all the while that the burden of proof must fall on public health advocates and not on industry"?

Despite the efforts of the lead industry, consensus among scientists regarding the dangers of leaded gasoline was eventually reached. By 1985, the EPA recognized "overwhelming evidence" of the dangers of leaded gasoline, and decided to cut TEL from 1.1 g/gal to 0.1 g/gal in January of the following year (Kovarik, 2005; Needleman, 2000). A meta-analysis in 1990 provided further evidence that the scholarly literature to that point broadly supported the notion that even low levels of lead exposure led to lower IQ in children (Wilson & Horrocks, 2008). Universal screening of children for lead exposure became a major initiative in the United States as the scope and severity of lead contamination finally gained widespread recognition.

Leaded gasoline was finally banned for on-road vehicle in the United States in 1996, and in the European Union in 2000 (Aho, 2020). However, despite the well-known dangers of TEL and widespread knowledge of acceptable alternatives (e.g., ethanol), leaded gasoline remained available in a number of countries well into the 21st century (Aho, 2020). The last supply of leaded gasoline for on-road use in the world was used up in Algeria in 2021 (Domonoske, 2021).

Average blood lead levels of young children (i.e., <6 years of age) in the United States peaked at an astonishing 16.5 µg/dL in 1976 (Kovarik, 2005), over three times the blood lead level identified by the World Health Organization as being associated with irreversible impairment of children's neurological and cognitive development (5 µg/dL) (WHO, 2021). However, as leaded gasoline was phased out, blood lead levels also plummeted (Figure 6). Unfortunately, leaded gasoline left a tragic legacy that long outlived its widespread use. According to McFarland et al. (2022), *>90%* of children born in the United States between 1951 and 1980 were exposed to damaging blood lead levels above 5 µg/dL. Today, no level of blood lead is considered safe for children, and adverse effects have been identified even below 5 µg/dL (Rosner & Markowitz, 2007). Generations of children have therefore undoubtedly been negatively impacted by leaded gasoline in terms of IQ, impulsivity, learning disabilities, attentional issues, hyperactivity, behavioral problems, and academic achievement. Childhood lead levels have even been demonstrated to be predictive of future arrests as an adult (Wright et al., 2021). Adults are less vulnerable to elevated lead levels than children, but exposure to the metal has been linked to an array of

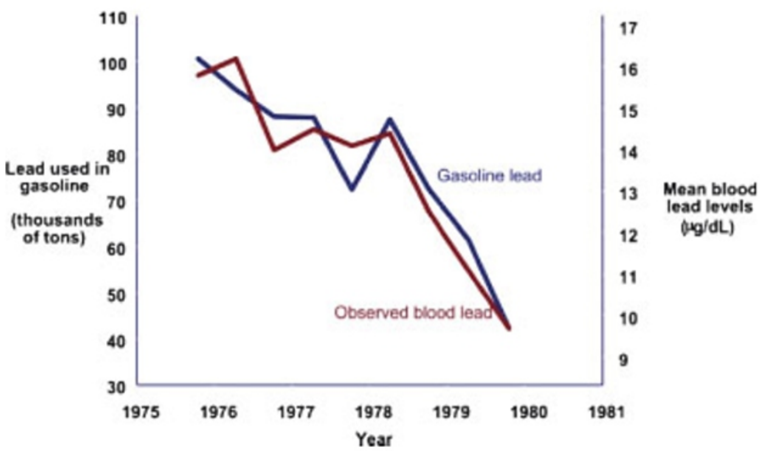


Figure 6. Lead use in gasoline compared to blood lead levels of people in the United States between the ages of 6 months and 74 years (Walsh, 2007).

cardiovascular issues and miscarriages in pregnant women (Kitman, 2000). The impact of TEL on humanity will therefore likely never be known, as we continue to deal with the mental, physical, emotional, and economic fallout from leaded gasoline well into the 21st century.

QUESTION 4
Consider the many disinformation/ misinformation tactics that exist. Why must policymakers and the public, rather than rely on their own thinking, seek the consensus view of the scientific community?

Conclusion

Lead industry efforts to obscure and confuse the toxic effects of leaded gasoline resulted in prolonged and unnecessary poisoning of millions of people during the 20th century. The unprecedented contamination of our environment was made possible in part by the lead industry's ability to dominate scientific research related to the topic, which included the use of pseudoscientific strategies such as personal attacks on scientists, holding opposing research to unrealistic standards, and ignoring refuting information. When the scientific community finally began to recognize the dangers of leaded gasoline, conspiracy theories were used to justify the shift in accepted scientific knowledge. Learning to recognize these warning signs of pseudoscience can help us to avoid such tragic efforts to distort public understanding in the future.

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