A Statistical Literacy Debate

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The following pages show arguments in a debate about whether vaccinations should be compulsory. I have two purposes in mind: (1) to further refine the definition of "statistical literacy" by proposing that a statistically literate person is one who possesses tools and skills for participating in evidence-based debates, and (2) to use this and other scripted debates for student instruction and assessment.

Because statistical conclusions are uncertain, heavily dependent on the form of data collection, and in many other ways prone to misinterpretation, their presence in a debate—in which one side attempts to tear down the other's arguments—provides an ideal platform for learning and sharpening the skills for critical evaluation of statistical arguments.

Resolved: That Vaccination Should be Compulsory

ARGUMENTS IN FAVOR
INTRODUCTION

For the benefit of individuals and society, vaccination against specific diseases should be mandatory except for people deemed likely to experience severe side effects. Vaccinations have been shown to eliminate or significantly curtail smallpox, polio, bacterial meningitis, diphtheria, measles, mumps, pertussis, rubella, hepatitis B and chicken pox. These are diseases that can cause tremendous suffering and death, as well as an economic burden to society through the cost of health care and the disruption to normal commerce. Vaccinations are not 100% effective in preventing disease and they can produce side effects, but the benefits to individuals and society far outweigh the risks. According to the U.S. Centers for Disease Control, vaccinating all U.S. children born in a given year from birth to adolescence would prevent about 14 million cases of disease and save an estimated 33,000 lives (Park, 2008). In order to achieve the individual and societal benefits of total eradication of a disease, the vaccinations must be used by all eligible people, not just some. For this reason, vaccination should be compulsory.

In our argument, we will provide convincing evidence that vaccination reduces the risk of disease, that the risks and costs of side effects are small compared to the risks and costs of the epidemics that would result in the absence of vaccination, that decliners cause injury not only to themselves but also others, and that it is therefore unethical *not* to make vaccination compulsory.

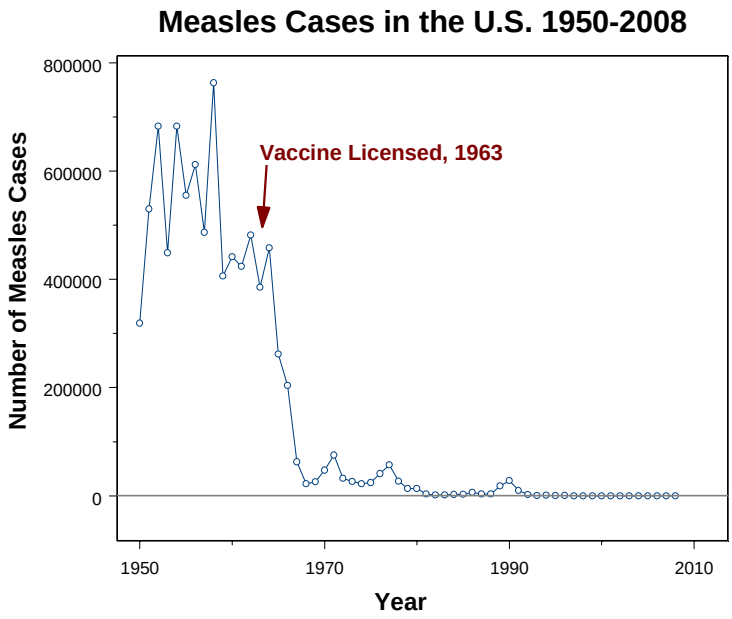
We start with small pox, a terrible infectious disease that causes death in 80% of children affected (Riedel, 2005) and blindness in 65% to 85% of the survivors (Jezek, 1981). At one point in history, one in seven children in Europe died from small pox (Fenner, et al, 1988). In the 19th century, an estimated 300 to 500 million people died from the disease (Koplow, 2003). In 1967, 2 million died from it. After a global vaccination program in the following decade, small pox was eradicated (World Health Organization, 1979).

Another example is measles. In 1958 there were 763,094 cases (Orenstein, et al, 2004) and 552 deaths in the United States (Centers for Disease Control and Prevention, 2008). With the help of new vaccines, the number of cases dropped to fewer than 150 per year (Centers for Disease Control and Prevention, 2008). As evident in Display 1, there is convincing evidence of a decline in the distribution of yearly measles cases in the U.S. since the introduction of the vaccine (p-value < 0.0001; data from Centers for Disease Control and Prevention, 2009). This is one of many examples. Display 2, for another, shows convincing evidence of a decline in Rubella cases since the commencement of vaccination (p-value < 0.0001).

Comment [ds1]: Here's a statistical conclusion. Notice that the author uses the subjective term "convincing evidence" to communicate the results associated with the very small p-value.

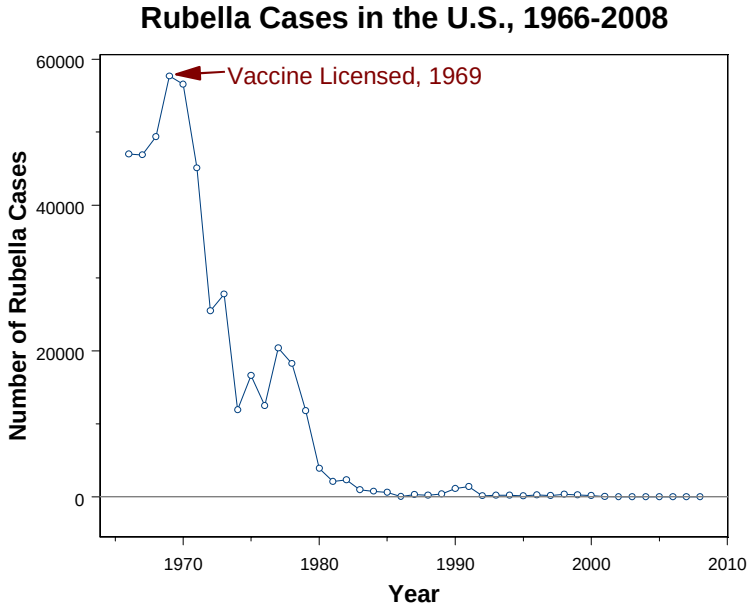
Comment [ds2]: And another.

Display 1



Display 2

Comment [ds3]: Graphs have both axes labeled and are self-explanatory. Good.



In addition, there is substantial evidence that disease cases have increased in areas where vaccination has been discontinued or reduced. The Wikipedia article on "vaccination controversy" documents seven countries in which disease has increased after a reduction in vaccination rates, implying convincing evidence that there is more chance of an increase than a decrease in disease rate after a drop in vaccination rate (p-value = 0.008).

Comment [ds4]: This statistical argument quantifies this evidence: that 7 out of 7 countries that reduced vaccination rates had increases in disease. Note that the probability of 7 heads in 7 tosses of a coin is 0.008.

One U.S. study found that non-vaccinated children were 22 times more likely to acquire measles than vaccinated children (95% confidence interval: 16 times to 31 times more likely; Feiken, et al, 2000). A similar study of 15,351 children in Guinea-Bissau, West Africa showed that the morality rate among those vaccinated was estimated to be 74% of the mortality rate among those who weren't (95% confidence interval 53% to 103%; Kristensen, et al., 2000).

Comment [ds5]: Notice the confidence intervals to express uncertainty in estimated population parameters. These happen to be based on advanced statistical techniques, but we can still understand the conclusions.

An interesting feature of the graphs in Displays 1 and 2 is the spike around 1989, which corresponds to a time when more parents were declining to get their children vaccinated. In the case of measles, the incidence increased by 423% over the previous year. Of the 7,149 measles cases in the reporting period, about 60% were in people who were not vaccinated (MWWR, 6/1/1990). Some of these cases were children whose parents declined vaccination but some were children who were too young to be vaccinated or who could not be vaccinated due to medical conditions. This highlights a very important point: The choice by parents to decline vaccination for their children affects not just their children but also others who are too young or otherwise deemed medically unsuitable for vaccination. Because of a critical mass of disease incidence among the decliners, it also causes disease in some who are vaccinated (because the vaccination is not 100% successful) who would not otherwise have been exposed to the disease.

The costs of not vaccinating are enormous compared to the costs of treating the illnesses they prevent. In 2001, routine childhood immunizations against seven diseases were estimated to save over $40 billion per birth-year cohort in the U.S. (Zhou, et al., 2005).

With these arguments, we have shown that vaccination is effective in preventing disease, that decliners can cause adverse effects—in terms of health and economics—not just upon themselves but upon others and, for these reasons, it is morally imperative that vaccination be compulsory.

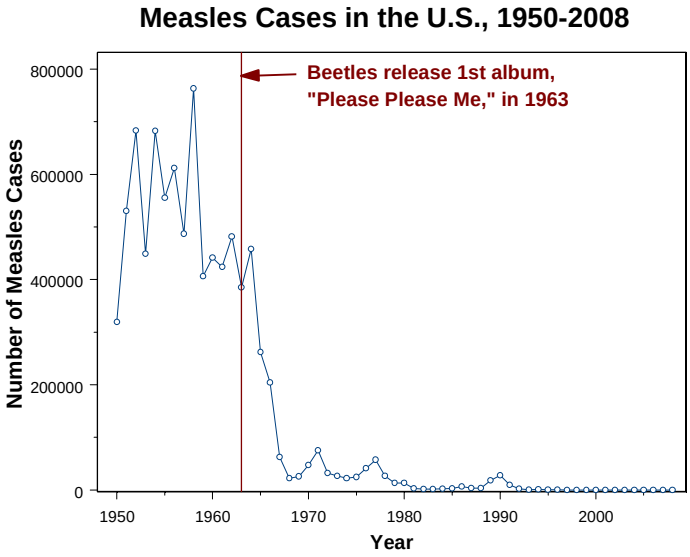
ARGUMENTS AGAINST
INTRODUCTION

The evidence that vaccines are effective is flawed and exaggerated. There is, however, strong evidence of serious side effects, sometimes with higher probability and with more serious health consequences than the disease itself. Compulsory vaccination produces great profits for pharmaceutical companies, who consequently have great incentive to overstate the benefits of compulsory vaccination and understate the risks. Making vaccines compulsory violates freedoms that we hold dear. Since we know there is a chance that vaccination can cause death or permanent disability, it is unethical to force it upon people.

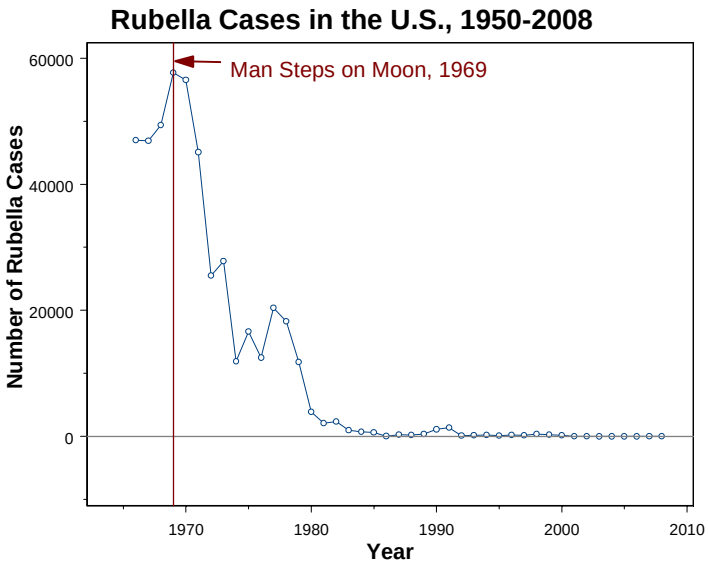
The evidence from observational studies in Displays 1 and 2 is unpersuasive because the effect of the initiation of vaccination is confounded with everything else that changed at the same time. To demonstrate this, we have made minor changes to the graphs—in Displays 3 and 4—to show some other possible "causes" of the decline. Note, for example, that there is convincing statistical evidence that the median number of measles cases per year decreased after the Beetles released their first album "Please Please Me" in 1963 (p-value < 0.0001). Does that mean that the album *caused* a decrease in measles cases? No, of course not; we would see similar conclusive evidence of a decrease after *any* event that occurred in 1963. This demonstrates that the "convincing" evidence from Displays 1 and 2 does not provide any proof whatsoever that the vaccination is responsible for the decline in disease rates.

Comment [ds6]: Important rebuttal: we cannot draw causal conclusions from observational studies.

Display 3

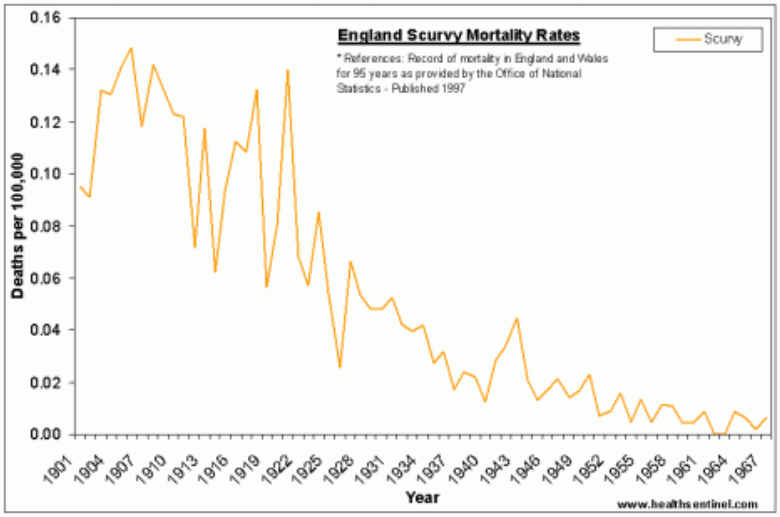


Display 4



In fact, disease rates were already decreasing before the vaccinations were introduced, due to better hygiene and health conditions. Display 5 shows the number of deaths due to scurvy in England between 1901 and 1967 (Armstrong et al., 1999). Although there is no vaccine for it, the incidence of scurvy has decreased just as dramatically as for measles and rubella.

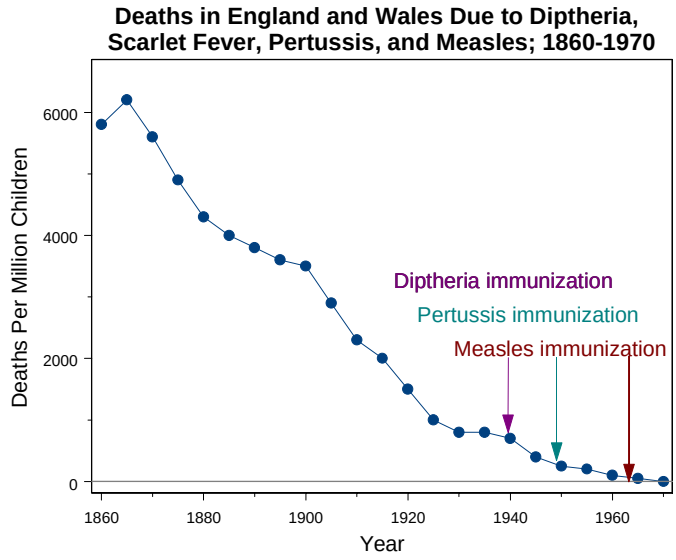
Display 5



Furthermore, the introductions of the vaccines had no effect on the *rate of decline* of disease. Display 6, for example, shows the death rates from four diseases for children in England and Wales between 1860 and 1970. As apparent in the graph, there is no effect of the introduction of the vaccines on the rate of decrease of the death rate (p-value = 0.08 for change after the Diptheria vaccination was introduced, for example).

Comment [ds7]: Here's a statistical conclusion from a p-value in the 0.05 to 0.10 range. The other side should contest this wording. Instead of "there is no effect," it should say "there is no evidence of an effect" or "there is only suggestive evidence of an effect."

Display 6



The proponents of vaccination point to observational studies such as the one in West Africa showing that the mortality rate is lower among those who got vaccinated than among those who didn't. First of all, the evidence of a difference between the two groups in that study is very tenuous, since the 95% confidence interval for the ratio of mortality rates includes 1. Second, to the extent that there *is* evidence, it is most likely due to the confounding variable, wealth of the family. The families that were wealthy were more likely to get their children vaccinated and were also more likely to live in better conditions and with better health care. It is probable that these better health conditions were responsible for the difference in mortality rates, and not the vaccination.

Comment [ds8]: The Con side is correctly questioning the Pro side's conclusion from the West Africa study. Although the estimated mortality rate was lower for the group that was vaccinated, the data are also consistent with a population mortality rate that is higher. The study was not powerful enough to resolve this any further.

Comment [ds9]: Here, again, is a rebuttal of a conclusion from an observational study. Causal conclusions cannot be drawn from the observational study because there may be confounding variables, which are correlated with both the decision to get vaccinated and with the probability of getting the disease. The Con side makes this rebuttal stronger by proposing a plausible confounding variable.

The exaggerated effectiveness of vaccinations would not be so critical if vaccinations were safe, but they have been linked to autism, diabetes, and brain damage. In 2008, the U.S. government acknowledged that vaccination of a Georgia girl as an infant caused brain disorder with autism-like symptoms (Park, 2008). Evan DeLeo, son of a New York science teacher, was developing normally until he was a year old. The day the boy received his fourth dose of Hib vaccine, he was rushed to the hospital with tremors and a 104 deg F fever, which later led to seizures. He recovered, but several months later he received the first of two measles, mumps, and rubella (MMR) vaccination shots. Within months, he stopped talking was diagnosed with autism (Park, 2008). This is not an

Comment [ds10]: Classic use of "anecdotal evidence." The pro-side should point out the weakness of this argument.

isolated event. In a 1998 Lancet article, a British gastroenterologist reported on a dozen similar young patients who were suffering from autism-like developmental disorders. Eight of the children began exhibiting signs of autism days after receiving the MMR vaccine" (Wakefield, 1998).

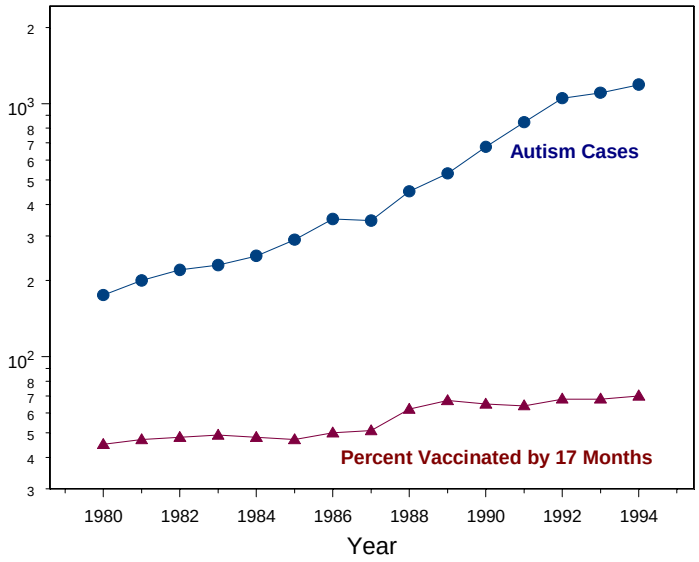
Since the 1980s, the number of vaccinations U.S. children receive has doubled, and in that same time, autism diagnoses have soared threefold. Displays 6 and 7 show the autism prevalence and vaccination rate in California between 1980 and 1994 (Dales, et al., 2001). These data provide convincing evidence of a link between MMR vaccination and autism (p-value = 0.000002). Associated with each 1 percentage point increase in the MMR rate was an estimated 6.7% increase in the median annual number of autism cases in California (95% confidence interval 5.4% to 8.2% increase). The MMR vaccination percentages explain 90% of the variation in annual autism count variability!

Comment [ds11]: Here's a statistical conclusion with confidence interval.

Comment [ds12]: This part of the conclusion is based on an "R-squared" statistic. In part, this is an attempt to diminish the strength of the pro-side's sure-to-come rebuttal that these data are from an observational study.

Display 6

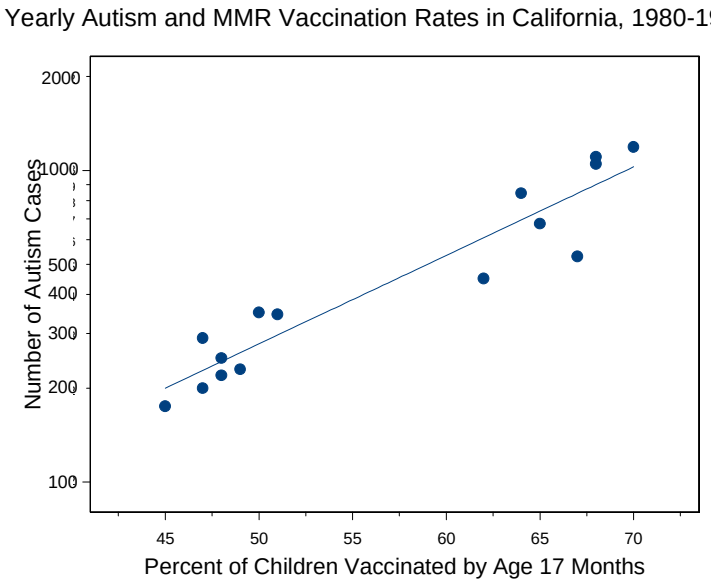
Autism and Vaccination Rates, California, 1980-1994



The vaccination for diphtheria, pertussis, and tetanus (DPT) is also dangerous. The part of the DPT vaccine that carries the greatest side effects is the pertussis (whooping cough) part. From a large case-control study of British children, it was estimated that the odds of death or physiological, behavioral, neurological or physical dysfunction was 5.5 times greater in children who had the diphtheria, tetanus, and pertussis (DPT) vaccination than for those who didn't (95% confidence interval: 1.6 times to 23.7 times greater; Miller et al., 1993). The incidence rate of pertussis in the U.S. is about 5 cases per 100,000 people and the mortality rate among those who get it is 1 in 500, which implies that the probability of dying from pertussis in the U.S. is 1 in ten million. The probability of a

serious adverse reaction to the vaccination is 1 in 140,000.

Display 7



These arguments have shown that the tradeoff between the risks of disease and the risks of serious adverse effects of vaccination is not as obviously one-sided as the pharmaceutical industry wants us to believe. The government should not force individuals to take the government's gamble. Each individual should have the freedom to choose what to put in their and their children's bodies. As with what we eat and drink, we should be given autonomy over our own bodies.

ARGUMENTS IN FAVOR
REBUTTAL

The Volvo Fallacy, also known as the Fallacy of Misleading Vividness, is committed when an individual bases a decision on a rare but vivid anecdote despite statistical evidence that the decision is unwise—such as a man deciding for safety reasons not to buy a Volvo, despite it's positive record of safety, because he heard about a Volvo whose wheel fell off on a highway, leading to a fiery and fatal crash. The human mind tends to place undue weight on the vivid image at the expense of rational evaluation of statistics. The anti-vaccination movement is driven by the Volvo Fallacy in this way: Since disease rates are now low, people don't tend to have relatives or neighbors with horrible diseases like polio, and we don't hear news reports about children suffering or dying from pertussis. We do, however, hear anecdotes about children who get autism after receiving vaccinations. The terrifying image of the possibility of a vaccination-autism links causes some parents to misjudge the overwhelming statistical evidence that the consequences of non-vaccination (and the epidemics that would result) are much worse than the consequences of vaccination.

Comment [ds13]: The Volvo Fallacy. There are reasons why people should not rely entirely on statistical evidence in making decisions, but a vivid image is probably not a good one.

In this rebuttal, we will counter the opposing side's claim that the evidence of effectiveness of vaccines is flawed. We will also show that the evidence for side effects is misleading, that the comparison of probabilities of disease and side effects is deceptive, and the actual tradeoffs between vaccination and non-vaccination make it clear that the anti-vaccination proponents are misreading the statistical evidence.

The anti-vaccination side states that the evidence for the effectiveness of vaccines is from observational studies and therefore not proof that the vaccine causes the reduction in mortality rate. The observational evidence is, however, very clearly consistent with the proposition that the vaccine works. Further, unlike the release of the first Beetles album, there is a scientific theory by which the vaccine is expected to work and there is also evidence of a "dose-response" effect—that greater vaccination rates lead to greater reductions in disease rates. There is, therefore, a preponderance of observational evidence that is consistent with the hypothesis that vaccinations are effective. In addition—and very importantly—there are also *randomized experiments* which provide convincing evidence that vaccines *caused* a reduction in disease rates.

Comment [ds14]: The Pro side is saying here that even though statistical conclusions of causation cannot be drawn from observational studies, that doesn't mean that observational studies are worthless, and here's why.

In the Salk polio vaccine trials of 1954, for example, researchers randomly assigned children to receive a polio vaccine or placebo. Of the 200,745 vaccinated children, 82 got polio. Of the 201,229 placebo-treated children, 162 got polio. The statistical analysis of these data indicates overwhelming evidence that the vaccine *caused* a reduction in polio probability (1-sided p-value = 0.0000001). In other words, there were only two possible explanations for the reduced polio rate in the vaccinated children: either (1) the vaccination caused a reduction in the probability of the disease or else (2) the children who were bound to get the disease anyway were disproportionately allocated to the placebo group. The p-value—one in ten million—describes the probability that a disparity as large as the one observed could be due entirely to explanation 2. Thus explanation 2 is not realistic, leaving convincing evidence for the causal explanation. The

Comment [ds15]: Ah ha—a randomized experiment and a statistical conclusion of causation!

odds of getting polio, incidentally, were estimated to be 97% greater for those who receive placebo than for those who receive the vaccine (95% confidence interval: 51% to 157% greater).

A meta analysis of randomized experiments on the pertussis vaccine carried out between the 1930s and 1950s, as another example, showed that the odds of pertussis for placebo users were estimated to be 4.5 times as great as for those who received the vaccine (95% confidence interval: 3.8 times to 5.6 times greater; Jefferson, 2006).

Regarding the link between the MMR vaccine and autism, Wakefield, the lead author of the study was later accused of improper scientific conduct and falsifying the data. Ten of the thirteen authors of the original paper wrote a retraction of the conclusion that there was evidence of a causal link between the vaccine and MMR. Because the Wakefield study caused such a great public health concern (it lead to the reduction in vaccination rates which lead to increase in diseases, as evident from the spikes around 1990 on Displays 1 and 2), many other studies considered the possible link between MMR and autism. Importantly, the collection of 12 families with children who developed autism was not a random sample of such families. It was people who suspected an MMR-autism link who were self selected to go to Wakefield's clinic. For this reason, the evidence is entirely anecdotal representing an extreme case of biased sampling; there are no valid statistical conclusions to be drawn about any larger population of families.

As a result of the controversy started by Wakefield, many studies investigated the MMR-autism link. A Danish study of 537,000 children estimated the probability of autism in vaccinated children to be only 92% as large as the probability of autism in unvaccinated children (95 percent confidence interval: 68% to 124% as large). The authors concluded that this was strong evidence against the hypothesis that MMR causes autism (Madsen et al, 2002).

In claiming a connection between MMR vaccination and Autism with Displays 6 and 7, the anti-vaccination side is committing the Fallacy of Over-Interpreting Spurious Correlation. They claim that the high correlation of MMR and autism in California implies a causal link. But the spurious correlation of variables that change over time is a more likely explanation. If there is one variable that increases by about 5% per year and another than also increases by about 5% per year, then they will be very highly correlated, even if there is absolutely no causal relationship. In Display 8, below, for example, we show the same California annual autism counts along with the U.S. consumer price index at the beginning of the year. Although a causal link between these two variables is preposterous, the consumer price index can explain 89% of the variation in autism incidence—essentially identical in its explanatory power to MMR vaccination rates, thus illustrating the weakness of the correlation argument to establish a link between MMR and autism.

About the DPT and brain damage link, we have several comments. First, even though there may be a statistically significant association from the British between death or physiological, behavioral, neurological or physical dysfunction and the DPT vaccine, the

Comment [ds16]: It's good that the Pro side followed up the p-value statement (about "statistical significance") with an estimate and confidence interval (to clarify "practical significance").

Comment [ds17]: A "meta analysis" is a statistical analysis of results of published articles. This naturally arises in many debates as a way of summarizing many studies.

Comment [ds18]: The Con side should object to the wording of this conclusion. A lack of evidence that MMR causes autism—which is the proper conclusion here—is not the same as evidence that MMR doesn't cause autism. (The authors are committing the Fallacy of Accepting the Null.)

Comment [ds19]: This is another way of saying that the Con side incorrectly implied a causal conclusion from an observational study.

Comment [ds20]: The Fallacy of Over-Interpreting Spurious Correlation is particularly common with variables that change over time. Any variable that changes over a time period will be correlated with every other variable that changes over the time period.

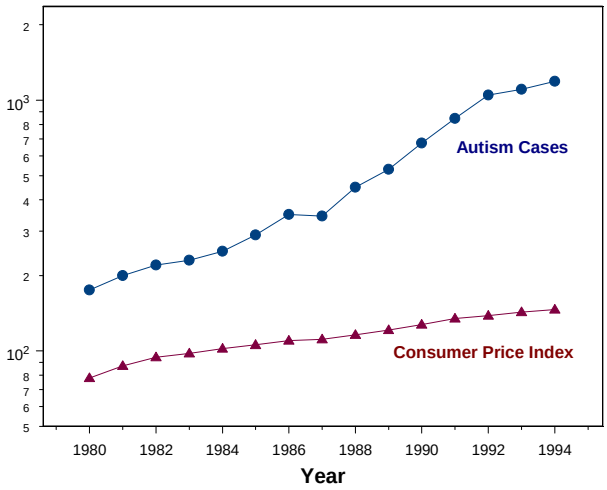
Comment [ds21]: This is a good rebuttal to the Con side's argument that MMR vaccination rate explains 90% of the variation in autism rate.

size of the effect was estimated to be very small. The incidence of these results would be extremely rare and rarer still if children with important pre-conditions are screened out. Second, the DPT vaccination is no longer in use in the U.S. The safer DaTP is used now. In general, as more is learned, the vaccines get safer and safer.

Comment [ds22]: The Pro side is noting that Statistical Significance is not the same as Practical Significance.

Display 8

U.S. Consumer Price Index and Autism in California



We, too, love freedom, but freedoms have limits in society. We are not free to endanger our neighbors by driving through red lights, driving drunk, or pouring toxic chemicals in their water supply. Because of the serious consequences of vaccination avoidance on others, declining to be vaccination is immoral and should be illegal for the same reasons.

ARGUMENTS AGAINST REBUTTAL

As evidence that disease has increased when vaccination rates have been reduced, the pro-vaccination side reported seven occurrences of country-wide disease rates increasing in response to reduced vaccination rates, as reported in the Wikipedia article on vaccination controversy (p-value = 0.0008). There is no indication, however, that these seven occurrences are a random sample of a population of changes in vaccination rates. There is every reason to believe that they were selected because they showed what the authors wanted to show. This is like claiming that cigarettes have no affect on health by finding seven smokers who lived long lives. The argument is anecdotal and the conclusion should not be taken seriously.

Comment [ds23]: This is an interesting and appropriate rebuttal to the argument that 7-out-of-7 countries that showed disease increases after vaccination rate decreases. There is no indication of how those seven events were selected. Since they weren't a random sample of such events, the Con side suggests that this evidence is no better than anecdotal.

The pro-vaccination side claims that anti-vaccination advocates are committing the Volvo Fallacy by succumbing to fears brought on by stories of serious side effects at the expense of considering statistical evidence. We reject this argument. Instead, we say we are simply interpreting the statistical evidence correctly. The disease probabilities are now small and the pharmaceutical companies are making huge profits by making people fearful of epidemics that no longer exists

The pro-vaccination side argued that there is evidence of a causal connection between vaccinations and reduction in disease rates from randomized experiments, but these are experiments that were performed 60 to 80 years ago and their use for today's populations requires unverifiable extrapolation beyond the populations on which they were based.

Comment [ds24]: It's true that randomized experiments performed on people 60 to 80 years ago may not apply to today's population, but this is a weak rebuttal. It will be difficult for the Con side to overcome the evidence from randomized experiments.

The pro-vaccination side reported the conclusion from the Danish study of 537,000 children as strong evidence against the hypothesis that MMR causes autism. With this conclusion, they committed the Fallacy of Accepting the Null Hypothesis. In fact, the Danish authors report a 95% confidence interval for relative risk of 68% to 124%. While the data are consistent with an equal risk of autism in vaccinated and un-vaccinated populations, they are also consistent with the hypothesis that the risk of autism for vaccinated children is 124% of the risk for non-vaccinated children. The pro-vaccination side consistently commits the Fallacy of Accepting the Null Hypothesis by incorrectly interpreting "no evidence of an association of MMR and autism" as "evidence of no association of MMR and autism." In fact, it is very easy to design a study showing no evidence of an association—simply make a very weak study, such as one with very few subjects.

Comment [ds25]: The Con side explains the Fallacy of Accepting the Null here.

We still maintain that despite their use of randomized experiments to argue for evidence of a causal connection, the pro-vaccination side still uses observational data to estimate the size of the benefit of the vaccination (from reductions in Displays 1 and 2, for example), so they are still producing a misleading picture of the relative risks of disease and side effects. Similarly, there's no proof that decliners cause disease rates to increase in any other subgroups. In order to convince us to give up a fundamental freedom of autonomy over our own body, we should be given much stronger evidence of the claims

made. Until then, it is simply unethical to force people to take something which could kill them are cause permanent injury.

ARGUMENTS IN FAVOR
CONCLUSION

Since 1900, the average lifespan of persons in the United States has increased by more than 30 years. On the top of the list of the 10 most important public health achievements that have lead to this improvement is vaccination. Display 9 shows that the decreases in incidence of nine deadly diseases have all been over 95% and some have been completely eradicated ("Achievements in Public Health, 1900-1999 Impact of Vaccines Universally Recommended for Children -- United States, 1990-1998").

Display 9

Disease	*Baseline 20th century annual morbidity (cases)*	*1998 annual morbidity (cases)*	*Percentage decrease in annual morbidity*
Smallpox	48,164	0	100%
Diptheria	175,885	1	100%
Pertussis	147,271	6,279	95.7%
Tetanus	1,314	34	97.4%
Poliomyelitis (paralytic)	16,316	0	100%
Measles	503,282	89	100 %
Mumps	152,209	606	99.6%
Rubella	47,745	345	99.3%
Haemophilus influenzae type b	20,000	54	99.7%

At the heart of the evidence of effectiveness of vaccines are randomized experiments. The anti-vaccination side claims that these should be discounted because they are old. The reason there aren't more modern randomized experiments is because it would be unethical to give a child a placebo when we know that a vaccination will prevent disease. Although perhaps conducted on a different population, the causal conclusions of the randomized experiments are very strong and relevant. To the extent that there is convincing evidence of a difference in disease rates in the placebo and vaccinated groups, we can be sure that it is convincing evidence of a *causal* effect of the vaccine. That the experiments were conducted in the past does not diminish the strength of the conclusion about a causal effect on humans.

Comment [ds26]: Randomized Experiments!

Fears about vaccination safety are based largely around anecdotal evidence and the Volvo Fallacy. Typically, several families realize that their children developed autism (as an example) shortly after receiving a vaccination. If a collection of 12 such families, say, unite around a common lawyer, the autism onset after vaccination appears to be more than a coincidence, but it's not because the sample is biased. If you look at enough families you are bound to find some for which a child developed autism shortly after being vaccinated, just as you are bound to find 12 smokers who live long and healthy

Comment [ds27]: Anecdotal evidence and the Volvo Fallacy.

lives. By establishing some importance to this group, the anti-vaccination side is committing the Prosecutor's Fallacy.

Comment [ds28]: The Prosecutor's Fallacy

Our side admits that there are possibilities of serious side effects, but they are very rare and getting rarer as we learn more. According to the Centers for Disease Control and Prevention ("Vaccines and Immunizations," 2009), the serious side effects rates for some of the vaccinations are currently as shown in Display 10. We include Smallpox, even though it is not a required vaccine in the U.S., to show that even one of the least safe vaccines has very little chance of serious side effect.

Display 10

Vaccination	*Serious side effect rate, per million*
DTaP	< 1
MMR	< 1
Smallpox	14-52

The chance of a serious (life threatening) side effect is very small today. Many of the statistics that the anti-vaccination side reported are based on old versions of vaccines, such as the DPT. The vaccination effort is not perfect, but it is constantly improving. Furthermore, if we can just get to the point where the diseases are eradicated—as is planned for measles by 2012 in the U.S.—there will no longer be a need for vaccination and no need for this debate. We should strive to reach that endpoint and doing so requires vaccination to be compulsory.

So many of the decisions we make in life are a gamble. Should we buy an expensive car with side airbags or a cheaper one without? How much insurance should we buy? Should we urge our close relatives to seek surgery or chemotherapy for their cancer? These kinds of decisions require us to weigh probabilities, costs and consequences. Sometimes, we make the best choice in a gamble, but still lose. Some people, in fact, will experience severe side effects due to vaccination and might not have gotten the disease at all if they were unvaccinated. But the probabilities from data indicate that the much greater risk and the much greater consequence is that associated with non-vaccination. The anti-vaccination side reports that current disease rates are low, but these aren't the ones we need to consider; it's those we would experience if a large number of people declined to be vaccinated that must be weighed against the probability of side effects, such as the 400,000 cases of measles per year in the 1960's.

Comment [ds29]: A central issue in this debate is how we manage risk. An important secondary issue is how we use existing evidence to clarify the risks.

If it were only the decliners health that was at stake, this wouldn't be such an important debate, but decliners injure the health of those who are too young or who are medically ineligible for vaccination, so their action must be considered the same way as the actions of others who risk injury to their neighbors, such as drunk drivers. Based on the evidence, it is ethically imperative to make vaccination compulsory.

ARGUMENTS AGAINST CONCLUSION

Disease rates have declined since the 1800's due to improvements in hygiene and health conditions, not vaccinations. The pro-vaccination side continues to give a misleading statement about the reduction in risk from vaccinations based on observational data.

Regarding safety, the pro-vaccination side consistently commits the Fallacy of Accepting the Null Hypothesis. In light of the confidence intervals for relative risk, it is unethical to force parents to do something to their children that may cause autism, brain damage, or death. There is a decision to be made in assessing the risks of vaccinating and not vaccinating, but that decision should reside with the parents, not the government of the pharmaceutical industry.

Comment [ds30]: The Pro side might be exasperated by this—it's like being asked to prove that UFOs don't exist. On the other hand, there does seem to be a tendency to overstate the results of non-significant side-effect studies.

Comment [ds31]: Like most important debate topics, the central issues here involve values and ethics, not statistics. It's essential, though, to resolve the existing *evidence* in order to get to the appropriate values debate.

Pharmaceutical companies have much to gain through compulsory vaccination and substantial resources to promote the public's fears about diseases and downplay the risks of side effects. Statistics on effectiveness in the pro-vaccine side's conclusions are mostly based on observational data collected over time and present a misleading picture of vaccine effectiveness because of the confounding of vaccine introduction with everything else that is changing with time. In fact, disease rates were already declining before the introduction of vaccines due to improved hygiene and health conditions, and there is no evidence that the introduction of vaccines had any effect on the rate of decline. While there may be evidence of a causal association of vaccination and disease reduction from randomized experiments, the pro-vaccination nevertheless continues to use observational data to play up the appearance of a larger effect than was shown from the experiments. In addition, diseases such as pertussis are not as serious as they once were. The requirement to take a potentially life threatening vaccination to prevent a disease that is not, itself, life threatening, is preposterous. At the very least, each individual should have the right to decide for themselves and their children whether to take the vaccination given the various risks involve. While society curbs certain freedoms—such as the freedom to drive while drunk—to prevent some people from endangering their neighbors, compulsory vaccination takes a step beyond by forcing people to put something into their body, which could kill them. Compulsory vaccination is unethical.

REFERENCES

"Achievements in Public Health, 1900-1999 Impact of Vaccines Universally Recommended for Children -- United States, 1990-1998" MMWR, Mortality and Morbidity Weekly Report, April 02, 1999 / 48(12); 243-248. http://www.cdc.gov/mmwr/preview/mmwrhtml/00056803.htm#00003753.htm. Retrieved on 2009-07-29.

Armstrong, G. L., Conn, L. A., and Pinner, R. W., "Trends in Infectious Disease Mortality in the United States During the 20th Century ", Journal of the American Medical Association. 1999; 281:61-66.

CDC, 2009, Epidemiology and Prevention of Vaccine-Preventable Diseases, The Pink Book, Course Textbook, 11th edition; http://www.cdc.gov/vaccines/pubs/pinkbook/downloads/appendices/G/cases&deaths.PDF. Retrieved on 2009-07-23.

Dales, L. Hammer, S. J., and Smith, N. J., 2001, "Time Trends in Autism and in MMR Immunization Coverage in California," Journal of the American Medical Association, 285:1183-1185. http://jama.ama-assn.org/cgi/content/abstract/285/9/1183. Retrieved on 2009-07-27.

Feikin DR, Lezotte DC, Hamman RF, Salmon DA, Chen RT, Hoffman RE (2000). "Individual and community risks of measles and pertussis associated with personal exemptions to immunization". JAMA 284 (24): 3145–50. http://jama.ama-assn.org/cgi/content/abstract/284/24/3145. Retrieved on 2009-07-24.

Fenner F, Henderson DA, Arita I, Ježek Z, Ladnyi, ID (1988) (PDF). Smallpox and its Eradication. Geneva: World Health Organization. ISBN 92-4-156110-6. http://whqlibdoc.who.int/smallpox/9241561106.pdf. Retrieved on 2009-07-23.

Jefferson T (2006). Why the MRC randomized trials of whooping cough (pertussis) vaccines remain important 40 years after they were done. The James Lind Library (www.jameslindlibrary.org). Retrieved on 2009-07-28.

Jezek Z, Hardjotanojo W, Rangaraj AG (1981). "Facial scarring after varicella. A comparison with variola major and variola minor". Am. J. Epidemiology. 114 (6): 798–803. http://aje.oxfordjournals.org/cgi/content/abstract/114/6/798. Retrieved on 2009-07-29.

Koplow, David A. (2003). Smallpox: the fight to eradicate a global scourge. Berkeley: University of California Press.

Kristensen, I., Aaby, P. and Jensen, H., 2000, "Routine vaccinations and child survival: follow up study in Guinea-Bissau, West Africa," British Medical Journal; 321:1435. http://www.bmj.com/cgi/content/abstract/321/7274/1435. Retrieved on 2009-07-24.

Madsen, K. M., Hviid, A., Vestergaard, M., Schendel, D., Wohlfahrt, J., Thorsen, P., Olsen, J., and Melbye, M., 2002, “A Population-Bases Study of Measles, Mumps, and Rubella Vaccination and Autism,” New England Journal of Medicine, 347:1477-1482. http://content.nejm.org/cgi/content/abstract/347/19/1477. Retrieved on 2009-07-28.

Miller, D., N Madge, J Diamond, J Wadsworth, E Ross ,1993, “Pertussis immunisation and serious acute neurological illnesses in children,” British Medical Journal, 307:1171-1176 (6 November). http://www.bmj.com/cgi/content/abstract/307/6913/1171. Retrieved on 2009-07-27.

MMWR, 6/1/1990, “Current Trends Measles—United States 1989 and First 20 Weeks of 1990,” CDC, 39(21); 353-355,361-363; http://www.cdc.gov/mmwr/preview/mmwrhtml/00001632.htm. Retrieved on 2009-07-24.

Park, A., 2008, “How Safe Are Vaccines?” Time Magazine, Wednesday, May. 21, 2008; http://www.time.com/time/health/article/0,8599,1808438,00.html. Retrieved on 2009-07-23.

Riedel S (2005). "Edward Jenner and the history of smallpox and vaccination". Proc (Bayl Univ Med Cent) 18 (1): 21–5. Jezek Z, Hardjotanojo W, Rangaraj AG (1981). "Facial scarring after varicella. A comparison with variola major and variola minor". Am. J. Epidemiology. 114 (6): 798–803. Retrieved on 2009-07-23.

Vaccine Controversy, in Wikipedia, the free encyclopedia. Retrieved on 2009-07-24. http://en.wikipedia.org/wiki/Plagiarismhttp://en.wikipedia.org/wiki/Vaccine_controversy

“Vaccines and Immunizations,” 2009, Centers for Disease Control and Prevention. http://www.cdc.gov/vaccines/vac-gen/side-effects.htm. Retrieved on 2009-07-31.

Wakefield A, Murch S, Anthony A et al., 1998, "Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children". Lancet 351, 9103: 637–41. http://briandeer.com/mmr/lancet-paper.htm. Retrieved on 2009-07-27.

World Health Organization, 2007, "Smallpox". WHO Factsheet. http://www.who.int/mediacentre/factsheets/smallpox/en/ Retrieved on 2009-07-23.

Zhou F, Santoli J, Messonnier ML et al., 2005, "Economic evaluation of the 7-vaccine routine childhood immunization schedule in the United States, 2001". Arch Pediatr Adolesc Med 159 (12): 1136–44. http://archpedi.ama-assn.org/cgi/content/full/159/12/1136. Retrieved on 2009-07-24.