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A taxonomy of reasoning flaws in the anti-vaccine movement

Robert M. Jacobson [a,b,*], Paul V. Targonski [a,c], Gregory A. Poland [a,c]

[a] *Vaccine Research Group, Mayo Clinic, 200 First Street Southwest, Rochester, MN 55905-0001, United States*
[b] *Department of Pediatric and Adolescent Medicine, Mayo Clinic, 200 First Street Southwest, Rochester, MN 55905-0001, United States*
[c] *Department of Internal Medicine, Mayo Clinic, 200 First Street Southwest, Rochester, MN 55905-0001, United States*

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Abstract

In a scholarly analysis of widely held misconceptions, Gilovich provides a classification scheme of common flaws in reasoning seen in contemporary society. He broadly categorizes these flaws as having cognitive determinants or in having motivational and social determinants. In this survey, the authors examine the various claims against routine childhood and adult vaccines as made by the more public and more organized entities of the anti-vaccine movement as well as those made apparent by surveys of parents and other groups of individuals. The claims illustrate the breadth of reasoning flaws while providing a basis for anticipating and correcting them.

Keywords: Logic; Decision making; Vaccines

The anti-vaccine movement represents an ongoing, broad, and diverse set of groups and individuals who often share concerns based on a variety of shared misconceptions [1–3]. Unfortunately, parents who seek to delay or avoid routine vaccinations for their children do indeed put their own children at higher risk for disease [4–6], and their actions contribute to the failure of communities to achieve protective vaccination rates [4,7]. Experience has shown their decisions contribute to herd immunity failure even among highly vaccinated populations [8,9]. Finally, the more organized groups opposing vaccination stall or hinder public health initiatives to introduce or strengthen vaccine programs [2,7,10].

In a scholarly analysis of widely held misconceptions, Thomas D. Gilovich, Chair and Professor of Psychology at Cornell University, laid out a taxonomy or classification scheme of common flaws in reasoning seen in contemporary society [11]. The taxonomy was based on observation and was not meant to be all-inclusive. It involved two broad categories of determinants of questionable beliefs: cognitive and motivational/social.

The cognitive flaws result from a natural desire to find order and predictability in random data, a difficulty in detecting and correcting biases in incomplete and unrepresentative data, and an eagerness to interpret ambiguous and inconsistent data to fit our theories and expectations. The motivational/social flaws result from wishful thinking and self-serving distortions of reality, pitfalls of second-hand information and miscommunication, including mass media sources, and exaggerated impressions of social support. This taxonomy is outlined in Table 1.

In this survey, the authors identify the most common of the various claims against routine childhood and adult vaccine as made by the more public and more organized entities of the anti-vaccine movement as well as those made apparent by surveys of parents and other groups of individuals. These findings illustrate Gilovich's taxonomy by classifying anti-vaccine claims. Understanding such reasoning flaws may assist in addressing concerns that parents and others may have.

1. Methods

We surveyed the literature through Medline and EMBASE for surveys in the English language identifying the more

* Corresponding author at: Department of Pediatric and Adolescent Medicine, Mayo Clinic, 200 First Street Southwest, Rochester, MN 55905-0001, United States. Tel.: +1 507 266 4598; fax: +1 507 266 5201.
E-mail address: jacobson.robert@mayo.edu (R.M. Jacobson).

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Table 1
Gilovich's taxonomy of common flaws in reasoning

Cognitive determinants
Desire to find order and predictability in random data
Difficulty in detecting and correcting biases in incomplete and unrepresentative data
Eagerness to interpret ambiguous and inconsistent data to fit theories and expectations
Motivational/social determinants
Wishful thinking and self-serving distortions of reality
Pitfalls of second-hand information and miscommunication including mass communication
Exaggerated impressions of social support

common parental and public misconceptions regarding routine vaccination. Using Medline 1966 to October Week 2, 2006, with an intersection of citations found for the keywords of "Parents" and "Vaccination" and the union of the set of citations from keywords "Risk Assessment" or "Perception" or "Culture" or "Attitude to Health," we found 32 original investigations that identified parental beliefs regarding vaccination and one systematic review [12].

Using EMBASE, 1988–2006 Week 42, with an intersection of citations found for the keywords "Parent" and "Vaccination" with the union of the set of citations from keywords "Risk Assessment" or "Perception" or "Health Belief" or "Attitude", we found 22 articles. These included nine original surveys and interviews of parents for their beliefs about the risks and benefits of vaccination (vaccines directed toward the prevention of infectious diseases and their complications and specifically excluding allergy vaccinations). It also included the one systematic review previously cited [12].

We combined the 2 literature review sets, discarding 2 duplicates, for a total of 40 original studies and 1 systematic review (Table 2). We read these and then classified the most common reasoning errors by the taxonomy that Gilovich created and illustrate that taxonomy.

2. Results

The first of the cognitive flaws (Table 1) is one's natural desire to find order and predictability in random data. For example, one observes an apparent change in an occurrence rate of an important event. While the apparent change may be only the result of a random fluctuation or cluster, the observer seeks to impose an order and looks for an explanation.

In the field of vaccines, this flaw is evident in the common misconception that results with the occasional occurrence of sudden infant death syndrome (SIDS) in the days following the administration of the diphtheria, tetanus, and pertussis (DTP) vaccine. This belief persists despite multiple studies that demonstrated the lack of an association between sudden infant death syndrome and DTP vaccination [13–15].

But, with millions upon millions of doses given each year to infants in the first 6 months of life across industrialized countries and with sudden infant death syndrome being the most common cause of infant death among infants 1 month or older, the coincidence of SIDS following DTP vaccination just by chance will be relatively frequent. When the two events occur, with SIDS following vaccination, well-meaning and intelligent people will blame the vaccine. They seek order out of randomly occurring events.

The second of the cognitive flaws (Table 1) relates to one's difficulty in detecting and correcting biases in incomplete and unrepresentative data. Gilovich describes this as a common cause of people's mistaken beliefs. One can readily point to two of the most common misconceptions regarding vaccination used by the anti-vaccine movement in its literature [16]. The first is that the diseases against which we vaccinate had already begun to disappear before vaccination and were going to disappear anyway regardless of the adoption of routine vaccination. The second is that vaccine-preventable diseases are no longer threats from which one must protect oneself.

These twin misconceptions are commonly said to be the product of vaccination's own success. By reducing the risk of the disease, the occurrence rates of that disease drop dramatically. As a result, over time, new generations of parents are vaccinating their children against diseases for which the parents lack direct experience or even awareness. For example, it has been generations since the vast majority of parents in highly developed countries have experienced a case of diphtheria, infantile pertussis, or tetanus.

Contemporary parents may incorrectly presume from the absence or reduced occurrence of disease that the disease is no longer circulating and hence is no longer a threat. In a survey of 391 parents claiming exemption from vaccines required for school attendance, 37.2% indicated that their children were not at risk for the disease [17]. Similarly, 20.9% indicated that the disease was not dangerous.

These beliefs represent cognitive flaws arising from the difficulty in detecting and correcting biases in incomplete and unrepresentative data. The absence of disease does not mean the virus or bacteria is eradicated or that the disease is not a threat. The control of a disease has instead resulted in dramatic reductions in circulation. Measles, polio, and mumps epidemics have occurred recently even among highly vaccinated populations as a result of immigrating persons carrying or infected with these viruses [18–21]. Since no vaccine protects 100% of the time and since persons may choose not to receive the vaccine or vaccinate their children, enough unprotected individuals may be exposed to sustain an epidemic. Furthermore, those who choose to remain unvaccinated do indeed have a higher risk of vaccine-preventable disease [5].

The third of the cognitive flaws (Table 1) relates to one's eagerness to interpret ambiguous and inconsistent data to fit theories and expectations. The Centers for Disease Control and Prevention describe the belief that "the majority of people who get disease have been vaccinated" as a common misconception regarding vaccination [16]. Actually, this perception

Table 2
Published surveys on parental beliefs regarding vaccinations

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may be quite accurate in certain outbreaks. In highly vaccinated populations, given an inherent failure rate for any vaccine and given travel and migration of persons from under-vaccinated and nonvaccinating regions of the world, in some epidemics, the majority of people who do get the disease will have been vaccinated [8]. The mistaken belief is not so much the perception, but the interpretation that such data support the idea that the vaccines do not work. It is a mathematical phenomenon that cannot be easily explained or eliminated. Consider a college campus of 18–22-year-old students well vaccinated against mumps with one to two doses. Let us go so far as saying among these 4000 students that 95% have been vaccinated. Of those 3800 vaccinated, half of them, 1900, have received only one dose and the other half, the other 1900, have received both doses. We can presume a failure rate of 10% among those who received one dose, resulting in 190 susceptible students. A failure rate of only 5% among those who received two doses results in another 85 susceptible students. Thus, on campus, we have 275 susceptible vaccinated students in the same, small geographic area. Recall that we also had 200 students who never got a dose of vaccine at all and thus all 200 can be presumed to be susceptible. That means the majority of the susceptible students, 275/475 or 57.9% were vaccinated. If an exposure from an infected campus visitor results in an outbreak, and exposures occur randomly among the vaccinated and the unvaccinated, then those susceptible students are the ones who will develop the disease. No matter what proportion is exposed and contracts the disease, assuming equal likelihood of exposure, chances are the majority of those affected will have been vaccinated.

The apparent devaluation of vaccination looks worse if the vaccination rate on campus was 99%. If all 99% vaccinated got two doses, 238 students are susceptible, and all but 40 were vaccinated. It is not that the vaccine is unacceptably flawed. In fact, a 95% efficacy rate is quite good. It is simply the paradox of vaccine failure in highly vaccinated populations. The mistaken belief is a result of inappropriately interpreting observations of vaccine-failures.

Mistaken beliefs arise not just from cognitive flaws in reasoning, but also from motivational and social determinants of questionable belief. There are three major forms of this identified by Gilovich (Table 2), and the first of which is wishful thinking and self-serving distortions of reality. One of the misconceptions regarding vaccination identified by the Centers of Disease Control and Prevention is that regarding "hot lots." A television show reported that certain lots of vaccines were more likely to be associated with adverse events than others [16]. This report based its conclusions upon an erroneous misinterpretation of the Vaccine Adverse Events Reporting System (VAERS) reports. Regardless, those in the anti-vaccine movement are not swayed by the CDC's arguments to correct the misinterpretation because of the anti-vaccine movement's belief in a vast conspiracy of physicians, public health officials, and the pharmaceutical industry [22–25]. The argument goes that this triad will of course suppress information regarding hot lots and adverse events in general. When a public health official or a physician or an industry representative defends vaccines, the believer in this conspiracy senses a cover-up.

The claims regarding autism and the measles vaccine also illustrate this flaw in reasoning [26]. One might very well ask, why the public was so receptive to the claim that measles-containing vaccines cause autism. Humans naturally wish to find causes for bad outcomes, and ecologic studies that indicate apparent parallels to trends conjure up etiologic considerations. That autism seems to be epidemic, increasing in frequency and notoriety each year, and seemingly so just as governments and health officials have stepped up measles vaccination, supported in the public's mind the sense that Wakefield et al. might have uncovered the truth and that measles vaccine may cause autism [27]. In fact, despite repeated epidemiologic studies to the contrary, measles vaccination rates fell as did measles–mumps–rubella vaccination rates, epidemics ensued, and children suffered the very real effects of under-vaccination [28,29]. To date, despite the overwhelming evidence against Wakefield's conjectures, the revelations of his ulterior motives, and the retractions of his co-authors, parental confidence in routine vaccination remains shaken [30]. A Swedish study in 2005 reveals that parents choosing not to vaccinate against measles do so predominantly out of a fear of side effects from the vaccine [31]. Despite the evidence, many parents are reluctant to abandon their wishful thinking and self-serving distortions of reality.

One might go further and explore the self-serving distortions that the anti-vaccine movement feeds with the autism debacle as an example. They include the desire for causation to a frightening phenomenon, the desire to link an act of commission rather than omission or chance to a bad outcome, and the desire to identify a blameworthy cause outside one's realm of control. The first two feed the litigious appetites existing in the U.S. and spreading to other industrialized countries. The third feeds a conspiracy-hungry public suspicious of some massive collusion between big medicine, big industry, and big government. A 2005 survey of U.S. parents claiming nonmedical exemptions indicates that a major reason for their decisions was their distrust of the government [17]. Similar studies report similar findings from around the world [32].

Other common themes of the anti-vaccine movement readily play to this motivational determinant. A Dutch survey published this year described a pair of prevalent negative beliefs among parents regarding vaccines that influences their decisions to allow vaccination of their children [33]. Parents in this survey commonly held the belief that children receive too many vaccines at once and that the vaccinations interfere with natural development.

The belief that children receive too many vaccines at once resonates with a parent's natural desires to minimize painful and harmful interventions and their expressed concerns that vaccines are both. A meta-analysis of qualitative studies of

parents regarding barriers to vaccination indicated the twin themes of vaccines as painful and harmful appeared in more than half of the studies as prevalent and important barriers [12].

The belief that vaccines interfere with natural development appeals to an attractive logic that medical interventions in general, and vaccinations in particular, are *artificial* and therefore *unnatural*, *unwelcome*, and *unnecessary*. Thus, that a medical intervention and especially a combination of medical interventions might overwhelm one's system is that much more unnatural, unwelcome, and unnecessary.

Motivational and social determinants of questionable beliefs (Table 1) include, as a second determinant, problems that might be best categorized as pitfalls of second-hand information and miscommunication including mass communication. Perhaps the most serious example of this in recent time was the tragedy that resulted from the communication of the cooperative efforts of industry to remove thimerosal, a mercury-containing preservative, from vaccines. No studies linked adverse effects from the inclusion of this mercury-containing preservative in vaccines, but experts perceived a theoretical risk particularly to low-birth weight infants who potentially might accumulate amounts of mercury per body weight that would exceed one of the two U.S. government standards for exposure from the thimerosal contained in the routine vaccine series in the first 6 months of life. While no laws required the manufacturers to do so, the manufacturers worked with officials at the Food and Drug Administration to voluntarily remove the mercury from the vaccines. While this was communicated to vaccine providers in some detail, laying out that the risk was only theoretical and that no vaccines ought to be withheld during this transition period, vaccine providers across the nation in fact withheld hepatitis B vaccination of newborn infants, premature or not, in a mistaken belief that they were preventing mercury poisoning of these infants [34–38]. As one might predict, infants instead developed hepatitis B from maternal exposure and now are at risk for chronic liver disease, cirrhosis, and cancer as a result [38].

The media plays a large role in parental decisions regarding vaccination. Dannetun et al. found among parents choosing not to vaccinate against measles that the media served as their primary source of information regarding the vaccine's alleged harmfulness [31]. We can however consider this finding positively. Given that the media does appear to influence parents making decisions regarding vaccines, responsible scientists and physicians might seize on this as an opportunity to collaborate with journalists, inform them, and help them in conveying vaccine information correctly.

The third of these motivational and social determinants of questionable beliefs (Table 1) is the exaggerated impression of social support. Parents who choose not to vaccinate their children often point to the substantial percentage of other parents who fail to vaccinate their infants and toddlers on time. In fact, approximately 25% of children under two in the U.S. actually receive their vaccines on time; by 2 years of age, the average child in the U.S. has been delayed 172 days for one or more vaccines [39]. Many in the anti-vaccine movement decry day-care and school requirements for vaccines citing the substantial numbers of parents who apparently have chosen not to vaccinate. Actually, studies indicate the majority of parents whose children are not up-to-date with their vaccinations proceed with vaccination rather than choose conscientious or religious exemption in those states where such exemptions are offered. Most parents whose children are under-vaccinated cite barriers that interfered with their intentions to vaccinate and not reasons why they are refusing vaccination.

3. Discussion

These claims of the anti-vaccine movement illustrate the breadth of reasoning flaws. It is the authors' hope that the identification of these reasoning flaws might better prepare those who would promote and practice routine childhood and adult vaccination.

Gilovich has laid out a framework by which proponents of public health and routine vaccination can better understand the basis for the mistaken beliefs of parents and others who fear and oppose vaccination. By understanding the psychological flaws that result in these mistaken beliefs, proponents can take steps in their communication to address these.

As an example of how this can be effectively done, during the 2006 Iowa Mumps Epidemic, the State Epidemiologist Dr. Patricia Quinlisk and the Iowa Department of Public Health posted for the media on line a primer complete with examples to demonstrate the paradox of vaccine failures. (Iowa Department of Public Health Center for Epidemiology, "Examples Explaining Mumps Vaccine Effectiveness: Or why are so many mumps cases occurring in vaccinated people?" dated April 4, 2006, accessed November 26, 2006 at URL: http://www.idph.state.ia.us/adper/common/pdf/mumps/explaining_effectiveness.pdf) This was done in anticipation, so that the media was better equipped in dealing with the mistaken notion that arose in the Iowa epidemic that given that half those affected were vaccinated the vaccine must have been worthless or flawed. Similarly, in the introduction of new vaccines, educational materials ought to anticipate these flaws in reasoning and directly address mistaken beliefs likely to arise.

Our current system of routine vaccination has remarkably reduced the risk of once common infectious diseases. Both the further improvement as well as the continued retention of our current successes are at risk. Weakened public support and growing parental concerns have and can lead to increased rates of undervaccination and as a result outbreaks and persistence of vaccine-preventable disease. The anti-vaccine movement plays on common beliefs held by individuals, and Gilovich's classification gives us insight as

to the flaws in reasoning that lead to the acceptance of those beliefs. Our recognition and understanding of those flaws will permit us to anticipate, communicate, and educate more successfully.

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