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Cognitive Processes and the Decisions of Some Parents to Forego Pertussis Vaccination for Their Children

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ABSTRACT. **Public health analyses suggest that, in spite of the possibility that pertussis vaccine may cause rare cases of neurological injury, catastrophic risks to individual children are lower if they are vaccinated. A number of parents, however, choose not to vaccinate their children. The purpose of this study was to investigate the decision processes of some parents who choose to vaccinate and some parents who choose not to do so.**

Surveys were mailed to 500 randomly selected subscribers of *Mothering* magazine. Two hundred and ninety-four completed questionnaires were returned (59%). In addition to well-recognized factors in vaccination decisions, perceived dangers of the vaccine, and of the disease and susceptibility to the disease, several cognitive processes not previously considered in vaccination decision studies were found to be important predictors in this population of parents: perceived ability to control children's susceptibility to the disease and the outcome of the disease; ambiguity or doubts about the reliability of vaccine information; a preference for errors of omission over errors of commission; and recognition that if many other children are vaccinated, the risk to unvaccinated children may be lowered.

Although perhaps most cases of undervaccination for pertussis reflect more general problems of health care access, some parents choose to forego vaccination for their children for other reasons. Traditional risk–benefit arguments alone will be unlikely to persuade these parents to reassess their decisions. Efforts to increase childhood vaccination must incorporate an understanding of the cognitive processes that help drive these decisions. J CLIN EPIDEMIOL 49;6:697–703, 1996.

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Pertussis vaccine has been a focus of controversy and public policy debate in the United States and abroad. In Japan and England, vaccination rates dropped following publicity about rare but serious neurological injury temporally related to pertussis vaccination. Regional whooping cough epidemics, including many deaths, followed these declines in vaccination [1,2]. In the United States, where the pertussis vaccine is usually delivered as one component of a diphtheria–pertussis–tetanus (or DPT) five-dose series, declining DPT immunization rates and increasing incidences of whooping cough also have been observed [3,4]. The number of cases of whooping cough reported in 1993 was the highest since 1976, and represents a doubling of reported cases over 1992 [5]. Public health authorities have expressed concern that "widespread discussion of the risks of the current pertussis program may be eroding confidence in childhood immunization programs in general" [6].

There is disagreement in the medical community about whether the vaccine can cause neurological injury. Efforts to resolve the controversy by reassessing scientific data have led to different conclusions. A committee of the Child Neurology Society concluded that the vaccine does not cause neurologic injury [7]. An Institute of Medicine committee concluded that the evidence supporting a causal link was weak but possible [8]. A large U.S. study concludes that there is no increased risk of neurological illness after DPT [9].

Health policy analyses have consistently concluded that, even if the vaccine does cause rare cases of brain damage, the benefits of the pertussis vaccine outweigh its risks both for individual children and for society as a whole [10–12]. Nonetheless, some parents and physicians, disturbed by the controversy surrounding the vaccine, fear that the probabilities of injury may actually be much higher than policy studies presume [13]. The debate over this vaccine suggests that different decision makers may process information about vaccines differently. As the United States attempts to reduce the financial barriers to childhood immunizations in general, a variety of nonfinancial barriers such as errors in judgment and decision making may continue to limit progress. We conducted a study to explore how the decision processes of parents might lead them to forego pertussis vaccination for their children.

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We explored several different hypotheses. First, past studies and models of childhood vaccination decisions suggest that parental concern about vaccine safety is the best predictor of nonvaccination [14]. The Health Belief Model, for example, treats vaccination decisions as a function of perceived susceptibility to and severity of disease as well as concern about vaccine benefits and risks [15,16]. According to risk–benefit models like these, parents who choose not to vaccinate their children may perceive that, on balance, vaccination is more dangerous than nonvaccination. Decisions based on the balance of risks and benefits might be sensitive to changes in the side-effect profile of the vaccine such as those that may characterize a new acellular pertussis vaccine with fewer minor side effects [2,17].

Second, parents may believe, correctly or not, that statistical analyses of pertussis and vaccine risks do not apply to their children. They may believe, for example, that public health statistics reflect an average population that has little to do with their children. They may also believe that they control whether their child gets the disease or how it progresses. Studies indicate people sometimes believe they can affect the outcome of even purely random events [19].

Third, parents may forego pertussis vaccination because of a cognitive phenomenon known as *ambiguity aversion*. While uncertainty exists when one is not sure whether an outcome will occur, that is, when its probability is neither zero nor one, ambiguity exists when the probability itself is not known for sure; for example, when experts disagree about the likelihood of an event. In a variety of different contexts, subjects are averse to options with ambiguous outcomes [19,20]. Parents who choose not to vaccinate their children with DPT may be interpreting the disagreement about the risks of the vaccine as an indication that the vaccine is riskier than mean estimates. In addition, the skepticism of some parents about scientific or medical information may increase their sensitivity to ambiguity compared to other parents.

Fourth, parents who decide not to vaccinate their children against pertussis may be exhibiting omission bias. When making vaccination decisions, some individuals prefer acts of omission over acts of commission, even if the expected outcome of omission is worse; for example, they feel more responsible for an adverse outcome caused by their decision to vaccinate than for the same outcome caused by their decision to withhold vaccination [21]. One study has linked omission bias with decisions to forego pertussis vaccination [22]. It is argued that omission bias is an error in decision making, for it fails to produce the best possible consequences [21].

Fifth, nonvaccinators may rely on the herd immunity provided by the vaccinations of others. Nonvaccinators might recognize that, if enough other children are vaccinated, the risk to their own children will be lower if they are not vaccinated than if they are vaccinated. A study of students attending a university health clinic found that this "free riding" logic explained the hypothetical vaccination choices of some students [23].

To examine the decision processes that lead some parents to forego vaccination, we compared a selected group of parents who choose to vaccinate their children with parents who choose not to do so. DPT vaccination rates vary widely among communities, but they are poor in almost all parts of the United States. Only about half of U.S. children in urban or rural settings are up to date by their second birthday [24,25]. However, parents who are nonvaccinators by choice represent only a small portion of the population of nonvaccinators [26,27]. To understand the decisions made by these parents, we surveyed a population that included a disproportionate number of parents who were nonvaccinators by choice.

METHODS

Subjects

Questionnaires were mailed to 500 subscribers to *Mothering* magazine who were chosen by a random selection process from an alphabetical list of their total subscribership in five states. Randomization of the subscription list was achieved by generating a list of the appropriate number of random integers (125 each for New Jersey and California; 84 each for Pennsylvania, Oregon, and Washington) within the appropriate range for each state (i.e., between 1 and the total readership for that state), then selecting those subscribers whose position in the alphabetized state subscription list corresponded to those numbers. There were over 5000 total subscribers in the 5 states sampled, and we sampled approximately 10%.

The pretesting that led us to suspect that the readership of *Mothering* magazine included a large number of nonvaccinators consisted of interviews and early drafts of surveys distributed to nonvaccinators we had located in the Philadelphia area. A set of approximately 20 preliminary surveys and follow-up interviews of parents opposed to DPT vaccination had suggested that the readership of this magazine included a large proportion of people with children at about the age of vaccination and a relatively large number of DPT nonvaccinators. At the time of the survey, *Mothering* had printed several articles on childhood vaccination, including DPT vaccination, some in favor of pertussis vaccination and some opposed [28]. Half the questionnaires were sent to states that require pertussis vaccination (California and New Jersey), and half to states that do not (Oregon, Pennsylvania, and Washington) [29].

Instrument

In most questions, subjects were asked to give yes or no answers, choose from among options, or give subjective estimates on a 1–9 scale. Exceptions are noted below.

Respondents were classified as vaccinators or nonvaccinators based on their answer to the question: "Would you have a normally healthy baby of yours vaccinated against whooping cough even if there were no law requiring it?" The decision factors described above (i.e., perceived risks of the disease and vaccine in general; perceived risks of disease and vaccine to children of the respondent; perceived ability to influence susceptibility to and severity of the disease and vaccine side effects; ambiguity effects; skepticism about medical information; omission effects; and free riding) were assessed by examining differences in survey responses between vaccinators and nonvaccinators.

Subjects were also presented with information about the actual risks and probabilities of the disease and of the vaccine. This listing, reproduced here as Table 1, was constructed from the medical literature and reviewed for accuracy by the Centers for Disease Control (Atlanta, GA). Changes in assessments after viewing Table 1 were measured.

Ambiguity effects were measured by describing two different hypothetical scenarios. In both cases the mean risks and benefits of the vaccine were described identically. However, in one case subjects were told that there was disagreement in the scientific community about the risks and side effects, while in the other case they were told that there was scientific consensus. The likelihoods of using each vaccine were compared for vaccinators and nonvaccinators.

We tested for the presence of omission bias by asking, for a hypothetical disease, how many deaths from a protective, but sometimes fatal, vaccine respondents would accept in order to avoid deaths from the disease [21]. The question was designed so that subjects who con-

TABLE 1. Risk table from questionnaire[a]

Complications	Per 1 million unvaccinated children	Per 1 million vaccinated children
Cases of whooping cough	101,900	9,700
High-pitched unusual crying	—	4,900
Temporary hospitalization with whooping cough	11,100	1,100
Temporary unconsciousness or confusion		
From whooping cough	25	2
From vaccine	—	40
Convulsions	—	2,600
Long-term brain damage		
From whooping cough	8	1
From vaccine	—	15
Death		
From whooping cough	130	13
From vaccine	—	5

[a]Source: Hinman AR and Koplan JP. Pertussis and pertussis vaccine: Reanalysis of benefits, risks and costs. JAMA 1984; 251: 3109–3113.

sidered it equally bad to die from the disease and from the vaccine (i.e., no omission bias) would choose a vaccine death rate of 4.

Tendency to free ride was measured by asking how behavior would be influenced by the vaccination decisions of others. In one question most other children the child contacts were assumed to be vaccinated, whereas in a second question all other children were assumed to be vaccinated.

Acellular pertussis vaccines have been developed that have lower rates of mild side effects. However, large-sample studies examining the rate of occurrence of serious side effects for the new vaccines have not yet been conducted. We tested whether such a vaccine would be attractive to nonvaccinating parents in spite of the ambiguity about serious side effects. A hypothetical new pertussis vaccine was described as having fewer mild side effects than the old vaccine but the same low rate of serious side effects (e.g., brain damage and death) when tested on 2 year olds. Subjects were told that the new vaccine has not yet been tested on large samples of younger babies, so the side effect rates among infants might be either higher or lower than with the 2 year olds. The appeal of this hypothetical vaccine to vaccinators and nonvaccinators was compared.

Analysis

Chi-square tests were used to compare proportions and t tests were used to compare means. The degree to which the demographic profiles of parents and each of the decision factors listed above predict the probability that a given parent does or does not vaccinate against pertussis was assessed with a probabilistic regression analysis. The model was achieved by first constructing a model that included all the experimental factors discussed so far and then eliminating nonsignificant factors in a backward, stepwise procedure. Analyses were performed using SAS (v. 6.07) on a VAX 6400 computer.

RESULTS

Demographics

Two hundred and ninety-four completed questionnaires were received (59%). The mean age of respondents was 35 years. The mean age of respondents' children was 3.75 years. Ninety-four percent of respondents were women. Seventy-eight percent had at least a college degree. Sixty-seven percent had discussed the question of DPT vaccination with their pediatrician within the last 2 years. Median household income was between $45,000 and $60,000 per year. Only 8% had no private health insurance. Ninety-eight percent of respondents were Caucasian. There were no statistically significant differences between vaccinators and nonvaccinators in any of these demographic traits.

Fifty-seven percent of respondents were classified as vaccinators; 43% were classified as nonvaccinators. The self-reported vaccination behaviors of vaccinators largely agreed with their responses to this item. Only 3% of children of vaccinators were reported to have had no DPT vaccination. The reported behavior of nonvaccinators was less consistent with their attitudes. Forty-seven percent of children of nonvaccinators were reported to have received at least one dose of DPT. The youngest children of vaccinators were more likely to have received a full DPT series than were those of nonvaccinators ($p < 0.0001$).

One hundred and twenty-five (43%) respondents were from states that have no mandatory DPT vaccination law and 165 (57%) were from states where the vaccine is required to enter school. There was no significant difference in proportion of vaccinators and nonvaccinators between states that mandate DPT vaccines and those that do not. However, when asked whether DPT vaccination was mandatory in their state, a majority of respondents (61%) either said they did not know or gave the wrong answer.

Baseline Experiences and Beliefs

Table 2 reports the experiences and beliefs reported by vaccinators and nonvaccinators. Seventeen percent of all respondents combined reported they had seen people with whooping cough disease. Fifty-eight percent reported that at least one of their children had experienced some side effect from a DPT vaccine, a rate consistent with rates reported in the medical literature [30]. Vaccinators and nonvaccinators were not significantly different in terms of self-reported experience with either the disease or the side effects of the vaccine. DPT nonvaccinators tended to be opposed to childhood vaccinations in general for their children, not to the DPT vaccine alone, whereas DPT vaccinators tended to be in favor of vaccinating in general for their children ($p < 0.0001$).

Respondents ranked their subjective estimates of the dangers and probabilities associated with the disease and vaccine on a 1–9 scale. Compared to vaccinators, non–vaccinators believed the disease was less dangerous, the vaccine more dangerous, and the chance of contracting the disease lower ($p < 0.0001$ for all comparisons). Nonvaccinators also believed more strongly that they could prevent their children from catching whooping cough and that they could prevent a whooping cough–related complication if their child did develop the disease ($p < 0.0001$ for both comparisons). There was a trend toward vaccinators believing they could have more influence in preventing serious long-term ill effects from a whooping cough vaccine than did nonvaccinators ($p < 0.03$), although both sets of parents felt there was little they could do to prevent such effects. Overall, nonvaccinators believed that a seriously bad outcome for a baby of theirs would be more likely if they had the child vaccinated while vaccinators believed that a seriously bad outcome would be more likely if they did not have the child vaccinated ($p < 0.0001$).

Response to Standardized Information

Table 3 presents changes in subject responses after reviewing a table summarizing the risks and probabilities of the disease and of the

TABLE 2. Experiences, convictions, and initial beliefs of surveyed parents ($N = 294$)[a]

	Nonvaccinators ($N = 168$)	Vaccinators ($N = 126$)	p
Experiences			
Have you ever seen someone while he/she had the whooping cough disease? (% answering yes)	17.7%	15.8%	NS
Did any of your children have any side effects from whooping cough vaccine (% answering yes)	67.5%	53.1%	NS
Convictions			
I do not believe in having my children vaccinated . . . in general. (1 = strongly disagree; 9 = strongly agree) [mean response (SEM)]	7.1 (0.2)	2.9 (0.1)	<0.0001
Which do you think would be worse for your baby? (% choosing each option)			
Serious brain damage (requiring long-term care)	83%	73%	
Death	17%	27%	NS
Beliefs			
How dangerous do you think the whooping cough DISEASE is for babies who get it under 2 years old? (1 = not at all; 9 = extremely) [mean response (SEM)]	6.1 (0.1)	7.6 (0.1)	<0.0001
How dangerous do you think the whooping cough VACCINE is for babies who get it under 2 years old? (1 = not at all; 9 = extremely) [mean response (SEM)]	6.8 (0.1)	3.9 (0.1)	<0.0001
How likely is it that a normally healthy baby of yours would catch whooping cough? (1 = not at all; 9 = extremely) [mean response (SEM)]	2.5 (0.1)	3.8 (0.1)	<0.0001
If a normally healthy baby of yours were not vaccinated against whooping cough, how much influence do you believe you could have in preventing that child from catching whooping cough (1 = almost none; 9 = a great deal) [mean response (SEM)]	6.5 (0.2)	4.2 (0.2)	<0.0001
If a normally healthy baby of yours caught whooping cough, how much influence do you believe you, as a parent, could have in preventing any serious long-term consequences? (1 = almost none; 9 = a great deal) [mean response (SEM)]	7.2 (0.2)	5.0 (0.2)	<0.0001
If a normally healthy baby of yours were vaccinated against whooping cough, how much influence do you believe you could have in preventing that child from suffering any serious ill effects from the vaccine? (1 = almost none; 9 = a great deal) [mean response (SEM)]	2.4 (0.2)	3.0 (0.2)	<0.03
Which of the following do you think would be more likely? (% choosing each option)			
If I didn't get the baby vaccinated, he or she would get whooping cough and would get some permanent disability or would die as a result of the DISEASE	10%	93%	
If I did get the baby vaccinated, he or she would get some permanent disability or would die as a result of the VACCINE	90%	7%	<0.0001

[a]NS, not significant; standard error of the mean (SEM) is presented in parentheses for scale means.

TABLE 3. Effects of viewing information about risks of vaccine and disease

	Nonvaccinators ($N = 168$)		Vaccinators ($N = 126$)	
	Mean change in rating (SEM)	p	Mean change in rating (SEM)	p
How dangerous do you think the whooping cough VACCINE is for babies who get it under 2 years old?	−0.32 (0.137)	<0.01	−0.62 (0.139)	<0.001
How dangerous do you think the whooping cough DISEASE is for babies who get it under 2 years old?	−0.04 (0.116)	NS	0.55 (0.122)	<0.001
How strongly are you committed to your position (on DPT vaccination)? (1 = very strongly against vaccinating; 9 = very strongly in favor of vaccinating)	−0.33 (0.131)	<0.01	0.54 (0.097)	<0.001

[a]Abbreviation: NS, not significant.

TABLE 4. Self-assessment of effect of viewing table information

	Nonvaccinators, mean (SEM)	Vaccinators, mean (SEM)	p
As I viewed the table, I found that overall it made me feel (1 = less inclined to vaccinate; 5 = neutral; 9 = more inclined to vaccinate)	4.0 (0.157)	5.5 (0.148)	<0.0001

vaccine. Nonvaccinators considered the disease less dangerous after viewing the table while vaccinators considered it more dangerous after viewing the table ($p < 0.009$). Both groups considered the vaccine more dangerous after viewing the table. Yet, they drew opposite conclusions from this change. Vaccinators increased their resolve to vaccinate and nonvaccinators increased their resolve to forego vaccination ($p < 0.001$ for difference in percentage changes). As reported in Table 4, this last result was corroborated by subject self-reports of table effects ($p < 0.0001$).

Ambiguity

Vaccinator estimates of the likelihood that they would vaccinate against a hypothetical disease fell 34% when ambiguity about vaccine death-rate information was introduced. Nonvaccinator estimates fell 51% (difference significant at $p < 0.0006$). Nonvaccinators were significantly less convinced that vaccines foster immunity and were more convinced that doctors tend to overestimate the dangers of the disease and to underestimate the dangers of vaccines ($p < 0.0001$ for all comparisons).

Omission Bias

Vaccinators and nonvaccinators differed in willingness to accept deaths from a vaccine to avoid deaths from a disease. The average maximum acceptable rate for vaccinators was 3.77; for nonvaccinators it was 1.84 ($p < 0.0001$).

Free Riding

Twenty-eight percent of nonvaccinators and 18% of vaccinators indicated that they would be less likely to vaccinate if most other children their child contacts were vaccinated ($p < 0.0001$). When asked what they would do if all other children were vaccinated, 94% of nonvaccinators and 5% of vaccinators said they would not vaccinate their child ($p < 0.0001$). Free riding may not fully explain the actual nonvaccination behavior of this group, however, because nonvaccinators believed that only about 70% of the children their children contact have been vaccinated.

New Vaccine

Preferences between the current vaccine and a new vaccine with fewer mild side effects but less testing are shown in Table 5. The new vaccine appealed to 25.6% of vaccinators but only to 9% of nonvaccinators (difference significant at $p < 0.0001$).

TABLE 5. Preferences for current versus acellular vaccine[a]

Prefer	Nonvaccinators (%)	Vaccinators (%)
Old vaccine	5	56
New vaccine	9	26
Either (equally good)	1	10
Neither (equally bad)	85	9

[a] χ^2 for table, $p < 0.0001$.

Probabilistic Regression Model

Table 6 presents the results of a maximum-likelihood probit regression model designed to assess the factors that predict pertussis nonvaccination. Significant predictors (i.e., $p < 0.05$ or better) of the decision to vaccinate one's child against pertussis include, in order of statistical significance: (1) perceived dangerousness of the vaccine, (2) doubts about medical claims that vaccines are effective, (3) omission bias, and (4) belief that physicians overestimate the dangerousness of the disease, (5) perceived ability to prevent one's child from contracting the disease, and (6) perceived likelihood that one's child will contract the disease. The perceived dangerousness of the disease, the perceived ability to influence outcomes of the disease, free-riding propensity, and the introduction of ambiguity did not significantly distinguish vaccinators from nonvaccinators in the multivariate model although these were significantly different in the pairwise tests reported earlier. No significant interaction effects were found.

DISCUSSION

Most cases of undervaccination for pertussis probably reflect general problems with access to the health care system. We chose to investigate the decisions of a selected group of parents who make a more deliberate choice to forego vaccination for their children. Our results suggest that perceived dangerousness and probability of vaccine side effects are determinants of whether these parents will have their children vaccinated, and confirm similar findings stressing the importance of these factors in vaccine-related decisions [14–16]. Most strikingly, our results suggest that those who do not vaccinate have a dramatically different idea about the probability of a serious vaccine side effect than do vaccinators: 90% of nonvaccinators think it is more likely that a child of theirs would have serious long-term injury if they got vaccinated than if they developed whooping cough.

When nonvaccinators in our study were presented with the sort of risk–benefit information that leads many medical and public health experts to conclude that the risks of the disease are worse than the risks of the vaccine, they became more committed to nonvaccination, not less. Parents in each group apparently focused on that evidence in the information that would strengthen their previously held views, while discounting evidence that would not. This replicates the kind of attitude polarization described by Lord *et al.* [31].

A variety of other cognitive processes, not previously examined in vaccine-compliance studies, help explain the decisions of our nonvaccinators. Skepticism about medical information related to vaccines, omission bias, and perceived ability to prevent the disease were significantly higher for nonvaccinators in a multivariate analysis. Beliefs that a parent can influence the progress of the disease, recognition of free-riding potential, and ambiguity aversion were

TABLE 6. Probit regression analysis predicting nonvaccination

	Parameter estimate	Standard error	χ^2	p
Intercept	−6.75	1.13	35.86	<0.0001
Perceived danger of the vaccine	0.51	0.09	31.66	<0.0001
Doubts about claims that vaccines work	0.28	0.06	21.16	<0.0001
Omission tendency	0.24	0.06	14.95	<0.0001
Belief that doctors overestimate disease dangers	0.26	0.10	6.60	<0.01
Perceived ability to influence likelihood of catching the disease	0.16	0.07	5.71	<0.02
Perceived likelihood of catching the disease	−0.24	0.01	4.57	<0.03

also significantly higher for nonvaccinators although these did not achieve significance in the multivariate probabilistic regression model.

Some physicians and policy makers have expressed hope that a new, acellular pertussis vaccine with lower rates of minor side effects will ease parental fears, even though it will be some time before questions related to serious side effects with any new vaccine can be definitively answered. Our vaccinators found the description of an acellular vaccine, including uncertainty about its serious side effects, appealing; nonvaccinators found it less so. This result, combined with recognition that ambiguity and omission effects are important in the decisions of nonvaccinators, suggests that the new vaccine may not overcome the resistance of nonvaccinators or end the debate.

This study has several limitations. First, we surveyed a selected population of parents. We chose subscribers to *Mothering* magazine because pretesting had indicated that many of these subscribers choose not to have their children vaccinated. This population is predominantly white, well educated, and affluent, and is clearly not representative of the overall population of parents whose children are undervaccinated against pertussis, nor is it necessarily representative of well-educated, affluent, minority parents. Therefore, our results should not be generalized to these populations. Indeed, indigent or minority parents may forego vaccination at a greater rate. Second, most of our respondents were women. Vaccination decisions are likely to be shared with spouses and with pediatricians. Because we did not survey couples together or couples with their pediatricians, we are unable to assess the effects of shared decision making. Third, we cannot be sure that nonrespondents do not differ from respondents. However, any differences would have to be profound to alter our findings significantly. Finally, several of our questionnaire items involved scenarios about hypothetical diseases and vaccinations different from pertussis. We cannot be sure that our findings will generalize to actual decisions [32].

Despite these limitations, this study has several important implications for health policy. First, clinicians and policy makers may want to point out in educational materials that omission preference is a common tendency in certain populations that can reduce the health of children in these settings. In fact, Baron found that subjects who opposed vaccination could be persuaded to vaccinate by an argument emphasizing the "Golden Rule," in which subjects put themselves in the child's position and asked themselves whether they preferred a greater or lesser chance of death and whether it mattered whether these chances came about through someone's act or omission [33]. Second, clinicians could educate parents about the limits of free riding, for example by publicizing downward trends in herd immunity especially if information about subpopulations is included so that parents can judge the applicability of the trend to their children as specifically as possible. Finally, clinicians could provide nonvaccinators with suggestions to prevent the disease and control its spread.

In addition to these specific implications, this study suggests that several previously unrecognized cognitive phenomena contribute to vaccination decisions and explain why certain parents choose not to vaccinate against pertussis even though public policy analyses of risks and benefits suggest that they should. Our results have a special relevance to vaccine decisions, and we hope that the recognition of these cognitive processes will lead to better strategies by physicians and public health officials to increase the acceptance of beneficial vaccines. As efforts to reduce the financial barriers to childhood vaccination intensify, these nonfinancial barriers deserve increased attention.

To the extent that these decision processes are seen in other medical settings as well, our results may be meaningful for a host of other proxy decisions, including those made by surrogate decision makers for critically ill patients. These surrogates often face choices about withholding and withdrawing life-sustaining medical therapy, and a variety of similar cognitive processes may direct these surrogates away from the best choices.

In the most general sense, our results contribute to the growing literature that there is much more to making medical decisions than simply knowing which path is most likely to reach the best outcome. In the specific case of pertussis vaccination, certain nonvaccinating parents do not use the same decision criteria as the experts and do not weight evidence in the same ways. Clinicians and public health officials must learn to recognize and adapt to these differences in reasoning.

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