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Omission Bias in Vaccination Decision: Where's the "Omission"? Where's the "Bias"?

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Abstract

Several studies have reported that parents are often reluctant to vaccinate their own or other people's children, even when the balance of health risks and benefits clearly favors vaccination. This reluctance has been interpreted as a manifestation of "omission bias", a general tendency to prefer inactive to active options even when inaction leads to worse outcomes or greater risks. The research raises significant public health concerns as well as worries about human decision biases in general. In this paper we argue that existing research on vaccination decisions has not convincingly demonstrated any general reluctance to vaccinate nor has it made the case that such a tendency, if found, would constitute a bias. We identify several conceptual and methodological issues that, we argue, cloud interpretation of earlier studies. In a new questionnaire-based study we examined the vaccination decisions of undergraduate students (N=103) and non-student adults (N=192). In both groups a clear majority chose to vaccinate when disease and vaccination risks were balanced. Vaccination intentions appear to be less a function of generalized preferences for action or inaction than they are of the regret respondents expect to feel if vaccination or non-vaccination were to lead to a poor outcome. Regret-avoiding choices led some respondents to favor vaccination, others to oppose it. In two follow-up studies, few respondents mentioned action or inaction per se in explaining their choices. Finally a series of methodological studies suggests the likely sources of misleading results in earlier studies.

Key words: Vaccination, regret, omission bias, action, justification.

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A number of studies have reported an "omission bias" in decision making, a tendency towards "… the choice of a potentially harmful omission over a potentially less harmful act" (Asch et al. 1994: 118), or "… to favor omissions (such as letting someone die) over otherwise equivalent commissions (such as killing someone actively)" (Ritov & Baron, 1990: 263). Ritov and Baron (1990), for example, offered students a (hypothetical) choice between exposing a child to a disease with some risk of death and giving a protective vaccine with some risk of lethal side-effects. Most subjects demanded that the vaccine risk be significantly smaller than the disease risk before they would vaccinate (i.e. take action). Spranca, Minsk and Baron (1991: Experiment 4) asked subjects to judge a physician's (hypothetical) decision on whether or not to recommend a risky brain surgery that would cure a disease that threatened permanent brain injury. In some cases the surgery was described as higher in risk, in others the disease itself was riskier. The subjects, unsurprisingly, preferred the less risky option in each case, but generally rated the inactive option as better, or as less bad, than the corresponding active option. Spranca et al. (1991) found that subjects judged the active theft of $100 to be morally worse than merely failing to point out a store's $100 error in one's favor (Experiment 5). Their subjects also judged the active poisoning of a tennis opponent to be more immoral than simply failing to warn him of a suspect dish (Experiment 1). Baron (1992: Experiment 1) found large majorities of subjects reluctant to commit a single murder even if it would lead to saving the lives of two other individuals. The effect known as omission bias thus touches on important issues of medical, ethical and mundane decision making.

As many of these authors note, a plausible psychological mechanism underlying the effect relies on an association between active choice and increased regret. The classic demonstration of this effect is that of Kahneman and Tversky (1982) in their example of two investors who lose the same moderate amount of money, one by changing his portfolio, the other by failing to change it. By a huge majority, subjects judged that the investor who actively changed would feel more regret over his loss than would the investor who sat still. There is now a considerable literature on this linkage between action and regret. Kahneman and Miller (1986) propose that, in many contexts, taking action is more "abnormal" than inaction, and this abnormality amplifies emotions (such as regret) associated with a bad outcome. Gilovich & Medvec (1995) report evidence of a reversal of the linkage over time, with inaction more strongly associated with regret in the longer term. Landman (1987) examined the converse linkage of positive outcomes and such emotions as rejoicing. Other authors have examined its connection to decision responsibility (Connolly, Ordóñez & Coughlan, 1997; Zeelenberg, van Dijk & Manstead, 1998); and the relationship between real and imagined regrets (Feldman, Miyamoto & Loftus, 1999; Crawford, McConnell, Lewis & Sherman, 2002).

There thus appear to be two converging bodies of evidence pointing to an important decisional bias. First, there are numerous studies (Baron, in personal correspondence, claims some 30 experiments by himself and others) that have reported omission bias in a variety of contexts. Second, there is a plausible mechanism, the action-regret linkage, by which to account for a generalized reluctance to take action when consequences of action and inaction are roughly balanced. This convergence has led a number of authors (e.g. Asch et al., 1993; Meszaros et al., 1996) to voice concern that important medical benefits such as childhood vaccinations are being significantly underused. The broader issue of a possible widespread reluctance to vaccinate is of obvious current concern in light of terrorist bioweapons threats.

A close examination of the evidence, however, raises questions about both omission bias and its supposed link to anticipated regret. In the next section of the paper we review a number of findings that suggest that action is not invariably associated with increased regret. In the following section we examine the omission bias literature itself, particularly focusing on vaccination decisions. We find a number of conceptual and methodological concerns that raise questions both about the prevalence of omission (non-vaccination) and about the claim that it reflects a bias. We then report a scenario-based study of vaccination decisions, examining participants' preferences for vaccination and non-vaccination, and the role of anticipated regret in these preferences. The concluding section of the paper discusses both theoretical and practical implications of these results. An appendix develops a formal model of risk-balancing in decisions like vaccination and derives some unintuitive implications. A second appendix reports several methodological studies that point to plausible sources of earlier misleading results.

The linkage between action and regret

As noted above a number of earlier studies found evidence that poor decision outcomes are more regretted when they are the result of action than of inaction. Several recent studies have raised questions about the invariance of this relationship. First, both in our own work (Connolly et al., 1997; Ordóñez & Connolly, 2000) and in studies by Zeelenberg et al. (1998), subjects anticipated significant levels of regret over poor outcomes for which they had no decision responsibility. Further, between-subject studies (N'gbala & Branscombe, 1997; Connolly & Reb, 2001) do not replicate the within-subject results of Kahneman & Tversky (1992) in the two-investors problem. (See also Sevdalis & Harvey, 2001). Second, in Connolly and Reb (2001) and in Zeelenberg, van den Bos, van Dijk and Pieters (2001), the key issue seems to be less whether or not the agent took action, but whether or not this (in)action was justified (see Connolly and Zeelenberg, 2002). In Zeelenberg et al (2001), for example, a soccer coach who changes his team and then loses was seen as feeling regret over this action only if the team's previous record did not justify the change. If the team had been doing poorly, the change was seen as appropriate, and the subsequent loss attracted little regret. Similarly Seta, McElroy and Seta (2001) found that regret was associated with action only when the (in)action taken was inconsistent with the agent's personality or prior record. Kahneman and Miller (1986) propose that perceived normalcy is a common justificatory rationale, and that inaction is, in many – but not necessarily all – contexts, the normal (and thus more readily justified) choice.

Since justifiability is likely to be context-dependent, and to vary across individuals, these demonstrations weaken the assumed robustness of the action-regret linkage. For some people and settings, action may be seen as less justified, and thus more regrettable, than inaction but it seems clear that the reverse may also be true for other people and other settings. There are, of course, other mechanisms that might shape a tendency to prefer inaction. Baron and Ritov (1994), for example, suggest both an "inaction heuristic", a generalized rule of avoiding direct harm, and an alternative account based on loss aversion. Before pressing further with rival explanations, however, we should examine the robustness of the phenomenon itself. How strong is the evidence for a generalized tendency to prefer inaction in realistic choice contexts?

Studies of moral intuitions.

Two lines of evidence are commonly cited in support of the idea that humans predominantly prefer inactions (omissions) to actions. One line of work concerns our moral intuitions on matters such as killing someone rather than allowing someone to die, stealing money versus not correcting an equivalent error in one's favor or, more generally, actively causing a bad event to happen rather than passively allowing it to happen. Many of the demonstrations are, by design, quite far from the everyday experience of the subjects: an opportunity to win a tennis game by poisoning an internationally famous tennis star (Spranca et al., 1991), to save lives by deflecting the path of a run-away railroad car (Petrinovitch & O'Neill, 1996) or to protect another person by intercepting a bullet in a shopping-mall shoot-out (Royzman & Baron, 1999). These ingeniously contrived scenarios are more in the spirit of illustrations from introductory ethics textbooks than samples of the real lives of real people. They gain their exemplary power precisely because they assume away such realistic details as how the respondent is to know that the gunman has only a single bullet and unerring aim, and will kill, with certainty, exactly one person; or how the tennis player is to know that his opponent will be sickened but not killed by the tainted salad dressing, or that his own pleasure in winning will be undiminished by his dinner-time trickery. As Petrinovich and O'Neill (1996) note in a review of such studies, "Philosophers often create *fantasy* moral dilemmas to investigate the nature of moral beliefs and intuitions" (p.146; emphasis added); and Baron (1992:322) notes of a hostage murder scenario, "… I assumed that the case was not realistic". These stories are contrived to probe a moral intuition, not to model a realistic choice. Thus, Petrinovitch and O'Neill (1996: 149) instruct their subjects: "Accept only the information given and try not to introduce additional assumptions that go beyond the problem as stated. Although some of the questions might appear artificial…".

These fantasy moral dilemma studies commonly find a preference for inaction: active or direct evil-doing is often judged more reprehensible that indirect or passive tolerance of evil. (Spranca et al., 1991; Haidt & Baron, 1996; Royzman & Baron, 1999; Petrinovitch & O'Neill, 1996). The pattern is not invariable, however. Recent work by Tanner and Medin (2002), for example, identifies a number of issues in which common moral intuitions appear to call for action, and inaction is seen as morally deplorable. Where the earlier studies appear to have identified a range of moral issues in which the dominant rule is "Thou shalt not", the more recent work identifies other issues in which the preferred rule is "Thou shalt". It is, anyway, unlikely that such moral intuitions are the predominant drivers of real, mundane decisions such as flu vaccination.

Studies of realistic decisions

Although much of the literature on "omission bias" in mundane decisions seems to postulate a rather broad and general tendency towards inaction, it is quite possible that the same individuals may display such a tendency in one class of decisions but not another. Doctors, for example, have been found to be reluctant to take action in some contexts where action might be justified (Cohen and Pauker, 1994), while appearing over-eager to take action in others where such action is harder to support (Ayanian and Berwick, 1991). We will therefore focus here specifically on one important class of decisions, those involving vaccination, leaving for later study the question of whether or not our findings generalize to other settings in which omission bias has been claimed.

Major studies of vaccination decisions include Asch et al (1994); Baron (1992, Experiments 1 and 2); Baron and Ritov, (1994, Experiment 4); Meszaros et al, (1996); Ritov and Baron (1990, 1998, Experiment 4) -- a total of 10 studies involving some 900 participants. All have reported data suggesting that a substantial number, often a majority, of participants are reluctant to vaccinate when vaccination and disease risks appear comparable or favor vaccination. All have interpreted this reluctance as evidence of "omission bias". The central thrust of this paper is to challenge both of these claims, on several grounds.

The first worry concerns measurement methods. In laboratory studies of real-world vaccination decisions, the most commonly used measures of omission tendency ask the respondent to balance risks between two options. For example in Asch et al (1994), the respondent was told that her child is exposed to a specified risk of contracting a flu, and that an effective but potentially risky vaccine is available. How safe must the vaccine be before the respondent would vaccinate her child? In the Asch et al study, respondents demanded a sizable risk premium (vaccine risk less than 40% of flu risk) before they would vaccinate, a result the authors interpreted as indicating a strong preference for inaction (not vaccinating) over action (vaccinating). The logic of this measure is developed in more detail in Appendix 1.

There are a number of problems in this risk-balancing approach. First, of course, it supposes that the subject can approximate the complex balance of utilities and probabilities represented in Equation 1. This is not a trivial task. (See Connolly, 1985, for a discussion of the unintuitive results of such utility/probability balancing in another context of binary choice under risk, the juror's assessment of "reasonable doubt"). Second, the logic of the measure is compelling only if one assumes that the respondent considers the facts provided by the experimenter as appropriate for her decision – for example, that the population flu risk given is appropriate for her child, and that the vaccine risk is honestly presented by the manufacturer. If Asch et al's respondents assumed that the vaccine manufacturer was understating the real risk, or that their children were healthier or better-protected than the average child, then their demand for a risk premium could have been simply a way of equating real risk between the two options.

Second, interpreting the risk premium as a measure of preference for inaction requires one to make the strong assumption that the subject considers only the outcome elements specified in the scenario by the experimenter (the state of the child's health and one's horror at directly causing harm). This assumption may be defensible in a deliberately artificial scenario aimed at isolating a moral intuition (see Petrinovitch and

O'Neill's instructions to their subjects, quoted above). However, in studies of realistic decisions such as vaccination, it seems undesirable (and, perhaps, impossible) to exclude factors that parents would, in fact, consider in making their decisions. Our interest is not what they might do in an artificial world but what they would do in the real world. In the context of a real vaccination decision a parent's choice might be shaped by innumerable other factors other than those specified in the researcher's scenario: a horror of needle-pricks, the cost of, distance to and inconvenience of vaccination clinics, the ability vaccination allows to control the timing of the child's possible sickness, the relevance and trustworthiness of the probabilities offered (Meszaros et al., 1996), the support or disapproval of her friends, altruistic, free-riding, and herd immunity considerations (Hershey, Asch, Thumasathit, Meszaros & Waters, 1994), exposure to nagging by medical personnel or to sick children in a clinic waiting-room, reluctance to engage in complex risk/benefit assessments and any number of other factors. At best, the risk-balancing measure reflects the aggregate influence of multiple factors such as these -- a list that may or may not include action or inaction per se. An individual who is disinclined to vaccinate, or who demands a risk premium to do so, might be revealing a preference for inaction per se, but might just as plausibly be revealing any of a dozen other preferences. Reluctance to vaccinate, in short, is only the most tenuous evidence for a general reluctance to act.

A third concern with the risk premium evidence is that there may have been inadvertent bias in the response scales used. In Asch et al.'s study, the only responses allowed were those indicating a risk premium favoring the vaccine. Respondents who indicated a preference for vaccination even if it were riskier than the flu were simply excluded, as “suggesting they had misunderstood the question” (p.121). In Ritov and Baron (1990: Experiments 1 and 2), similarly, only responses indicating vaccine risk less than flu risk were allowed. In their Experiment 4, vaccine risk was specified and respondents indicated the lowest flu risk at which they would vaccinate. The responses were thus bounded below at zero, but unbounded above, so that the means would have been inflated by any large-number responses participants used to register reluctance to vaccinate under any circumstances. (We present evidence in Appendix 2 that the measurement procedures used in these earlier studies do indeed produce distortions of exactly these sorts.)

The final, and perhaps most telling, concern with the risk balancing approach is simply that it produces extraordinary numbers. As noted above the subjects in Asch et al. (1994) demanded risk premiums implying that they typically felt that a child’s death from vaccine was about 2.5 times as bad as is death from flu, and a similar result is implied in Meszaros et al. (1996). We find this ratio surprising, but not entirely unbelievable. However, equivalent questions in Ritov and Baron (1990, Experiment 4: 274) imply ratios ranging from 10:1 (Case 3) to 258:1 (Case 1). The authors interpret these results as indicating an “immense omission bias” (p.274) on the part of their subjects, though without explaining why this bias should vary to such an extraordinary degree from study to study. We develop an alternative interpretation, based on measurement bias, later in the paper. Whatever the interpretation, one must surely treat with suspicion a procedure that produces utility estimates that vary across studies by a factor of more than 100, and where the highest estimate indicates that one’s grief at the death of a child is less than 1%

due to the death per se, more than 99% to one's agency in bringing it about. (Appendix 1: Example 2).

In summary, we see the risk balancing procedure as having several weaknesses. It requires the subject to make complex tradeoffs of utility and probability; it requires the experimenter to make strong assumptions about what elements are included in the subject's model and how these elements are valued; its implementations to date appear to have inadvertently incorporated measurement bias; and it yields implausible and widely varying numerical estimates of the outcome utilities. The methodological experiments reported in Appendix 2 strongly suggest (a) that the procedure is flawed, and (b) that the flaws would lead directly to a mistaken inference that most respondents are vaccination averse (though, as we have argued above, this is still a long way from demonstrating omission bias).

The problem of requiring a respondent to make numerical estimates of acceptable risk can be avoided if he or she is simply given a choice between two options, as in Baron (1992: Experiment 1) where subjects were asked whether they "should", and whether they "would", vaccinate their own child against a flu with a 10 in 10,000 mortality rate if the vaccine had a 5 in 10,000 mortality rate. On balance we prefer this choice procedure to the numerical risk estimating procedure (though see Appendix 2, Experiment M 2, for evidence that it may still retain measurement error problems). However, even if the procedure is interpreted as capturing the respondent's real preference, it does not establish that the preference is biased in the sense of showing a departure from a generally agreed-upon normative standard. To establish bias, one must further assume (a) that the only outcomes that *should* be considered are those shown in Equation 1, and

(b) that the respondent *should* value both good outcomes equally, and both bad outcomes equally. Neither normative claim seems self-evidently true. Why should a parent not consider other factors, such as those sketched earlier? And why should no allowance be made, for example, for an element of parental rejoicing when a prudent choice rather than simple luck heads off a child's illness? Both normative assertions are required before a preference for inaction compels a verdict of error. Whether the evidence suggests a predominant tendency towards or against vaccination, there seems to be no clear basis to claim that such a tendency would be a bias.

Prior questionnaire studies of vaccination preference

In light of the methodological concerns discussed above, and the widely varying results reported in the studies, it is difficult to assess from existing studies the distribution of vaccination preferences in the general public. Asch et al. (1994) intentionally selected a sample of adults markedly more hostile to vaccination than the general public: the subscribers to Mothering magazine, a journal somewhat opposed to conventional medicine, and in which several articles opposing diptheria-pertussis-tetanus (DPT) vaccine had recently appeared. They found a mean anti-vaccine risk premium of approximately 2.5:1 (after eliminating two respondents who indicated a pro-vaccine risk premium). Using a similar sample, Meszaros et al. (1996) found almost no risk premium for self-reported vaccinators, and about 2.2 for self-reported non-vaccinators. Using student subjects, Ritov and Baron (1990), found a tendency to anti-vaccination risk premiums in their Experiments 1 and 2 , with wide variation depending on whether the same or different children were affected by flu and vaccine. Their Experiment 4 yielded the extraordinarily large anti-vaccine risk premiums discussed earlier (ranging up to

256:1). Baron (1992, Experiment 1), in a scenario offering a pro-vaccine risk premium of 2:1, found more than 80% of subjects thought they should, and 70% that they would, vaccinate, and both percentages rose to above 90% after a brief persuasive message. Baron and Ritov (1994, Experiment 4) found 19% of subjects leaning against vaccination even with a vaccine risk premium of 10:1, and about 50% doing so when risks were roughly equal, though 12% were pro-vaccine even when vaccine risks were 1.3 times flu risks. Ritov and Baron (1995, Experiment 4) found a small majority (57%) willing to vaccinate when vaccine and flu risks were approximately equal, and only 4% unwilling to take any vaccine risk. Ritov and Baron (1999) similarly report that a minority of their sample held avoidance of risky vaccination as a "protected value" for which they were not prepared to make any tradeoffs. We are hesitant to attempt a summary of these widely varying responses, other than to note that (a) most of the data suggest that at least some respondents are reluctant to vaccinate when significant risk is involved in doing so; (b) all the studies reviewed involve one or more of the measurement problems discussed in Appendix 2.

The present study

The study reported here had two purposes. First, given the practical public health issues involved, we wished to assess preferences for a hypothetical flu vaccination in two populations, students and non-student adults. Second, we wished to examine the possibility that regret avoidance might offer a more compelling account of vaccination preferences than does a hypothetical general aversion to taking action (i.e. "omission bias"). In addition to simply measuring vaccination preferences, the study examines the extent to which respondents expect to feel regret if they were to experience a bad outcome from either vaccination or non-vaccination. It also examines the relationship between these anticipated regrets and the respondents' readiness to choose vaccination for their children.

We used a scenario in which the negative outcomes of vaccination and non-vaccination were described as equally likely, and as very similar in content, so that no complex balancing of probabilities and utilities was required of the participants. The logic of the simple risk-balancing model would predict indifference between vaccination and non-vaccination for this case. Any general tendency toward omission (inaction) should thus shift the predominant choice sharply in the direction of non-vaccination. We also included measures of regret and several other negative emotions that the respondents might associate with the two bad outcomes, to allow us to test the hypothesis that respondent choices will be regret avoiding. Method and results are described in the following sections.

Method

Task. Participants read a scenario in which they were asked to imagine themselves in the role of a parent having to decide whether or not to vaccinate his or her small child. The scenario, modified from one used by Asch et al. (1994) and Ritov and Baron (1990), read as follows:

> "Imagine that, in Arizona, there have been several outbreaks of a certain kind of flu, which can cause severe illness in children under three. Only a small number of children exposed actually catch this flu, but for those who do it's quite

severe. The children get very sick with high fevers, a lot of pain, and generally feel horrible for several weeks.

A vaccine for this kind of flu has been developed and tested. The vaccine eliminates any possibility of the child getting the flu. The vaccine, however, can sometimes cause side-effects that are very similar to the severe flu symptoms: high fever, pain, feeling horrible. Fortunately, these unpleasant effects are rare. In fact, the risk of a vaccinated child getting the unpleasant side-effects is about as low as the chance of a non-vaccinated child getting severe flu symptoms.

Imagine that you are married and have one child, a one-year old. You have spent a lot of time trying to decide whether or not to have the child vaccinated against this flu. After talking to several doctors, reading medical journals and consulting with friends it's now time to decide whether to have your child vaccinated or not."

Participants. The study included two different groups of participants. The first (N=192) were recruited in the jury waiting room of a large Southwestern city. Volunteers completed questionnaires while waiting to be called for jury service. The pool was predominantly (61%) women, and ranged in age from 19 to 78 with a mean of 41.8 years. 60% reported themselves currently married, 13% divorced or widowed, 26% single. Most (86%) reported that they had received at least some college education. Sixty-seven percent reported having one or more children. The second group (N=103) were business undergraduates at a large Southwestern university, participating for course credit. The sample included a majority (55%) of men, and ranged in age from 19 to 39, with a mean of 21.1 years. Only one student reported having children. The student sample is thus typical of the young and mainly childless samples used in earlier studies, while the juror sample is more closely representative of the larger adult population: older, predominantly married, and with parenting experience.

Measures.

Vaccination intention. After reading the scenario, participants were asked: “How would you decide?” They indicated their vaccination intention on a seven-point scale anchored at –3: Definitely not vaccinate; 0: Don’t know; and +3: Definitely vaccinate. They were also asked, on two similar scales, what they would decide if, instead of the equal risks stated in the scenario, the risk of a vaccinated child getting the unpleasant side-effects were (a) higher or (b) lower than the risk of an unvaccinated child getting the severe flu symptoms.

Emotion ratings. Respondents were asked to assess the extent to which they would experience each of 11 emotions if their vaccination decision were to turn out badly. On one page, the respondents were asked to imagine their feelings if their vaccinated child experienced the severe side-effects. On a second page they were asked about their feelings if their unvaccinated child experienced the severe flu symptoms. The emotions assessed were regret, self-blame, guilt, anger, shame, responsibility, dissatisfaction with self, disappointment, sadness, pain and happiness. A short header preceded both instruments:

> “Suppose you [did decide] [decided not] to vaccinate. Unfortunately, your child is one of those who has the [bad vaccine side-effects] [severe flu symptoms]: high fever, a lot of pain, and several weeks of feeling very sick.

How much do you think you would experience each of the following feelings in this situation?"

Responses were on 0 to 10 scales anchored at 0: I wouldn't experience this at all, and 10: I would experience this a lot.

Relative seriousness ratings. Participants were asked on a final page:

"From what you understand of the story, how do the severe flu symptoms and the vaccine side-effects compare in terms of overall seriousness? Would you say that (check one):

( ) The severe flu symptoms are more serious overall than the vaccine side-effects.

( ) The severe flu symptoms are less serious overall than the vaccine side-effects.

( ) The severe flu symptoms are just as serious overall as the vaccine side-effects."

A response indicating flu symptoms were perceived as less serious was coded as –1, equally serious as 0, and more serious as 1. To control for possible question-order effects, half of the questionnaires were assembled with emotion ratings preceding the vaccination intention questions. Within each, half of the emotion ratings addressed side-effects first, the other half addressed severe flu first.

Results

Overall a clear majority of respondents favored vaccination in the base-line scenario we presented, (equally low risks of severe side-effects and of severe flu). Of 293 respondents, 192 (65.3%) favored vaccination versus 73 (24.8%) who opposed it ($\chi^2(1)$ =

53.44, $p < .001$). This tendency was still stronger when respondents considered the hypothetical case in which the vaccine risk was lower than the flu risk, 71.7% versus 22.5%, but it reversed when the opposite balance of risks was suggested, 39.9% versus 52.6% (Table 1). A 3(Risk: vaccine risk lower vs. equal risk vs. vaccine risk higher; within-subject) x 2(Sample: general population vs. students; between-subjects) repeated measures ANOVA of vaccination intention showed a significant main effect for Risk, ($F(2, 582) = 57.05$, $p < .001$), but no significant main effect for Sample, ($F(1, 291) = 1.85$, ns) and no significant Risk x Sample interaction ($F(2, 582) = 2.22$, ns). Both pairwise differences were significant. Vaccination intention was higher when vaccine risk was lower than baseline (M =1.15, 0.84; $t(292) = 2.62$, $p<.01$), and lower when vaccine risk was higher than baseline (M = -0.34, 0.84; $t(292) = 9.28$, $p<.001$). Vaccination intention was reliably greater than zero for both baseline ($t(293) = 7.34$, $p<.001$) and low vaccine risk ($t(292) = 9.79$, $p<.001$) conditions, and reliably negative ($t(292) = 2.63$, $p<.01$) for the high vaccine risk condition. The pattern of results thus suggests an appropriate sensitivity to relative risks, with a majority in favor of vaccination when the risks are equal. Given the substantial similarity in vaccination intentions for the two subject pools, subsequent findings will be reported only for the pooled samples unless significant differences were found in the analysis.

[Table 1 about here]

The size of the pro-vaccination majority is moderated by the perceived relative seriousness of the flu symptoms and the vaccine side-effects. The scenario described the two bad outcomes as equally serious. Both involved “high fevers, a lot of pain, and generally feeling horrible”, and were described as “very similar”. (Since our interest is in realistic vaccination decisions, no effort was made to equate or eliminate other aspects of these outcomes the respondents may have thought relevant). Of a pooled total of 290 respondents, a majority ($\underline{n}$=175 or 60.3%) rated the flu and the vaccine side-effects equally serious. Among these a majority favored vaccination (53.7% vs. 34.9% opposed, $\chi^2 = 7.03$, $\underline{p}<.01$), and mean vaccination intention was significantly positive ($\underline{M} = .33$, $\underline{t}(174) = 2.16$, $\underline{p} < .05$). A substantial minority of respondents ($\underline{n} = 92$, 31.2%) rated the flu as more serious than the vaccine side-effects, presumably considering other factors as well as those specified in the scenario. These respondents were overwhelmingly in favor of vaccination (90.2% in favor, 3.3% opposed, $\chi^2(1) = 78.4$, $\underline{p} < .001$). Even among those few who saw the side-effects as more serious than the flu symptoms ($\underline{n} = 23$, 7.8%) there was a slight tendency to favor vaccination (56.5% in favor, 39.1% opposed), but this difference was not statistically significant ($\chi^2(1) = .73$, ns). This pattern of results (Table 2) suggests that perceptions of the relative seriousness of flu and side effects are systematically related to vaccination intentions. In fact, the two measures are significantly correlated, $\underline{r} = .31$, $\underline{p} < .001$. The more serious the flu is perceived to be in comparison to the vaccine side-effects, the stronger the intention to vaccinate.

There is thus evidence of at least some degree of thoughtful risk-balancing in the overall pattern of responses, with enthusiasm for vaccination appropriately related both to relative probabilities and to perceived relative seriousness of the possible bad outcomes. The overall tendency is to prefer vaccination: When vaccination and non-vaccination present equally serious risks at equal probabilities, vaccination is preferred in both pools of respondents by a substantial majority.

[Table 2 about here]

Are these vaccination intentions consistent with the respondents' expectations of the feelings of regret they would experience over poor outcomes from either vaccinating or not vaccinating? To assess this we used the single-item measures of regret in the questionnaire. (We have also replicated the following analyses with a five-item regret index developed by Connolly & Reb (2001), which includes measures of shame, dissatisfaction with self, guilt and self-blame as well as the regret measure. The results using these index measures were at least as strong as the single-item results reported here, and will be omitted for brevity). Mean scores on (1) regret associated with a poor vaccination outcome, and (2) regret associated with a poor non-vaccination outcome are shown in Figure 1 plotted against respondents' vaccination intentions.

[Figure 1 about here]

As Figure 1 suggests, those strongly favoring vaccination tend to see vaccination side-effects as much less regrettable than they see the flu itself. Those strongly opposed to vaccination see the reverse balance. A simple linear regression model including the two regret ratings as well as the seriousness ratings as independent variables and vaccination intention as dependent variable showed all three regression coefficients significantly different from zero, with an overall adjusted $\underline{R}^2$ of .24 (Table 3). This suggests that subjects distinguish between the relative seriousness of the possible outcomes and their relative regrettability, and use both assessments in arriving at their decisions on whether or not to vaccinate.

[Table 3 about here]

Figure 1 also clarifies a potentially misleading result in between-subject studies of the relationship between action and regret. For our sample as a whole, non-vaccination (inaction) regret is higher than vaccination (action) regret (M = 6.74, 6.08; t(290) = 2.98, $p < .01$), an apparent reversal of several earlier findings. As Figure 1 shows, however, this overall difference is simply the result of the pro-vaccination majority among our respondents, combined with the regret differences shown. There are simply more pro-vaccination respondents (who see the flu as more regrettable) than there are anti-vaccination respondents (who see vaccine side-effects as more regrettable).

Since half of the respondents stated their vaccination intentions after, the other half before, rating their anticipated emotions, we were able to check for the possibility of priming effects by building separate regression models of vaccination intent for those respondents who assessed emotions first and those who assessed emotions last. The regression coefficients for both regret measures were larger when emotions were assessed before vaccination intentions than when they were assessed after: For regret associated with vaccine side-effects, Beta = -24, -.09 ($z = 2.17$, $p<.05$, one-tailed); for regret associated with flu, Beta = .31, .19 ($z = 1.68$, $p<.05$, one-tailed). The emotions-first model, similarly, predicted more of the variance in vaccination intent than did the emotions-after model (a marginally significant result: adjusted $R^2 = .31, .18$; $z = 1.42$, $p<.1$, one-tailed). This suggests a possible priming effect: Vaccination intentions may have been more strongly influenced by regret anticipations for respondents who considered their emotions before they made their vaccination decisions.

Discussion

A number of earlier studies have been interpreted as demonstrating “omission bias”, a broad tendency to prefer inactive to active decision options, even when the latter offer lower risks or better payoffs. If such a tendency were widely shared, it would raise the worrying possibility that important decisions, including such medical decisions as whether or not to vaccinate a child, might be biased towards inaction rather than action when risks and consequences are comparable. Since much of the concern on this issue was initially raised by scenario-based studies of vaccination decisions, our first purpose in this study was simply to reassess the prevalence pro- and anti-vaccination views in two populations: students and the general adult population. A second purpose was to explore the possibility that regret avoidance might offer a more compelling account of vaccination preferences than does a hypothetical general aversion to taking action (i.e. “omission bias”).

We suspected (and methodological studies reported in Appendix 2 confirm) that the risk balancing measures used in earlier studies might have produced misleading results. We wanted to avoid asking the subjects to make complex tradeoffs among probabilities and utilities of good and bad outcomes. We therefore used a simplified scenario in which a vaccine offered a child complete protection from a disease, but at risk of side-effects similar to the symptoms of the disease, and where the risks of disease and side-effects were equal. A respondent attempting to minimize risk to the child, and considering only the outcomes and probabilities specified, should be indifferent between accepting or declining vaccination in this scenario. Even a modest tendency towards inaction (an “omission bias”) would then be reflected in a predominance of anti-vaccination choices.

Our findings, however, showed a clear pro-vaccination majority, in both respondent pools, for respondents who rated disease and vaccine side-effects equally.

Respondents who rated the disease effects as more serious were pro-vaccination by a huge majority. Even those who rated the vaccine side-effects as more serious were still somewhat in favor of vaccination. Overall enthusiasm for vaccination responded in the appropriate direction to modified scenarios in which relative probabilities of the poor outcomes were increased or decreased. In aggregate, therefore, participants responded in the appropriate direction to differences in relative seriousness and relative risk of poor outcomes, but with a marked overall tendency to favor vaccination rather than oppose it, towards commission rather than omission.

For reasons discussed earlier we see no reason to conclude that these preferences reflect "bias", whether of omission or commission. It seems likely that many, perhaps most, of the respondents brought to the problem considerations additional to those specified in the scenario. A substantial minority judged the flu more serious than the vaccine side-effects, suggesting the influence of outside, non-scenario considerations such as those discussed earlier. We simply do not know what non-scenario factors (possibly including generalized preferences for action or inaction) influenced individual decisions and by how much, so we can form no assessment of whether or not their inclusion constituted an error or bias. The evidence shows only that there were such influences and that, in aggregate, they led a majority of our respondents to prefer vaccination to non-vaccination.

Our data do provide a partial picture of our respondents' decision processes. We found that intention to vaccinate or not was predicted by three measures: the respondent's assessment of the relative seriousness of the disease and the vaccine side-effects; her assessment of the regret she would feel if vaccination turned out badly; and her assessment of the regret she would feel if non-vaccination turned out badly. Overall respondents tended to view the disease as more serious than the side-effects of the vaccine, and to judge a bad non-vaccination outcome as more regrettable than a bad vaccination outcome. The majority were thus, on balance, inclined towards vaccination. As Figure 1 shows, both vaccinators and non-vaccinators chose the option they saw as less regrettable.

We further probed the robustness of these findings with two smaller studies, using student samples. In the first ($N = 69$) we modified the scenario to eliminate the issue of decision agency on behalf of the child. The participants were asked about the vaccination choices they would make for themselves, if the vaccine were free and easily available. In the base-line scenario the choices were balanced (31 in favor of vaccination, 31 opposed). They were strongly pro-vaccination if side-effect risks were to drop: 53 (76.8%) in favor, 13 (18.8%) opposed ($\chi^2(1) = 24.24$, $p < .001$), and strongly opposed if side-effect risks were to rise: 60 (87.0%) opposed, 6 (8.7%) in favor ($\chi^2(1) = 44.18$, $p < .001$). As in the main study, we found that both expected regret over a bad vaccination outcome ($\beta = -.21$, $p < .09$) and over a bad non-vaccination outcome ($\beta = .39$, $p < .01$) were significant predictors of vaccination intention.

We also asked these respondents to explain, in open-ended form, how they had arrived at their vaccination decisions. The responses were independently coded by two coders, using the categories shown in Table 4. The coders agreed on 87% of their initial codings; remaining differences were resolved by discussion. As Table 4 shows, the commonest explanations involved general statements of trying to balance the risks and benefits of the two options (associated with both pro- and anti-vaccination choices); fear or dislike of shots or drugs in general, or the inconvenience or cost of getting them (strongly associated with anti-vaccination choices); and specific advantages of vaccination such as control of timing or freedom from worry about flu exposures (associated with pro-vaccination choices). Strikingly, only two of the 69 respondents made any mention of issues related to action or inaction per se. One anti-vaccination respondent said: “I am a firm believer in leaving things to fate and not messing with fate”. One pro-vaccination respondent said: “If you vaccinate, whether or not you got any symptoms, you were still trying to help yourself. If you didn’t vaccinate and you got sick then I would definitely be upset with myself because I didn’t get a vaccination”. None of the other 67 respondents mentioned action/inaction issues at all.

[Table 4 about here]

In the second follow-up study ($N = 66$) we modified the scenario so that the bad outcomes of both disease and side effects were the child dying, rather than becoming sick, to replicate more closely the scenarios used by Asch et al. (1994), Meszaros et al (1996), and Ritov and Baron (1992). As in the main study, only a minority (24 or 36.4%) opposed vaccination in this version, while 29 respondents (45.3%) favored it ($\chi^2(1) = .5$, ns). A hypothetical reduction of the side-effects risk raised the pro-vaccination majority to 56 (84.8%) versus 8 (12.1%) opposed ($\chi^2(1) = 36.00$, $p < .001$). A hypothetical increase in the risk of side-effects generated a large anti-vaccination majority: 59 (89.4%) opposed, 3 (4.5%) in favor ($\chi^2(1) = 50.60$, $p < .001$). In short, these subjects again showed an appropriate sensitivity to relative risk of flu and side-effects, with a modest overall tendency in favor of vaccination. In addition, both regret after vaccinating (β = -

.24, $p < .06$) and after not vaccinating ($\beta = .25$, $p < .05$) were again significant predictors of vaccination intention.

Coding of the open-ended explanations using a slightly more elaborate scheme (Table 5) showed acceptable inter-coder reliability (initial agreement 83%), with disagreements resolved by discussion. As before the predominant explanation mentioned some form of risk and benefit balancing. Five pro-vaccinators (8% of respondents) expressed general pro-vaccine beliefs; four non-vaccinators (6%) argued that their child's risks were or could be made lower than the population risk; and four undecided respondents, perhaps budding academics, suggested that more research was needed. As before, few respondents (5 of 66, 8%) mentioned action/inaction per se. One, a non-vaccinator, said "I'd feel horrible if I did something (made a choice) that caused death. Even worse than if it naturally happened". Three pro-vaccinators mentioned action/inaction issues. One said: "I would want to feel like I did my best to prevent harm to my child. I would rather vaccinate if it would reduce the risk of getting the flu". A second said: "Because if you vaccinate you are taking an active step and not being passive". A third said: "I feel that precautions are necessary in this case, and that trying to protect the well-being of someone else is more worthwhile than chancing exposure". Finally, one respondent, who was undecided on whether or not to vaccinate, said: "If my child died from the flu it would be a natural cause. If my child died from the vaccine, it would be because of my choice – not nature doing its own stuff". None of the remaining 61 respondents mentioned action/inaction per se as an element in his or her vaccination decision. As before, it appears that action/inaction was a salient issue for very few of our respondents. For those who did mention the issue, it was at least as likely to point towards vaccination as towards non-vaccination.

[Table 5 about here]

We are, for obvious reasons, hesitant to extrapolate the results of this study to actual vaccination decisions. It does not appear that student samples are much different from the general public in responses to vaccination-related scenarios. It is, however, unclear what relationship exists between the hypothetical decisions reported in scenario studies and the actual decisions adults make for their own real children, or for themselves. There is some modest evidence showing the two are related. Both Asch et al. (1994) and Meszaros et al. (1996) found a significant relationship between self-reported use of DPT vaccine and the risk-balancing measure of reluctance to vaccinate discussed earlier. If that measure is accepted at face value, these data show that subscribers to Mothering magazine are at least modestly consistent in their self-reports of their behavior in the real world of DPT vaccine and in the hypothetical world of the vaccination scenario. We have no evidence on the validity of these self-reports.

One of the concerns that motivated this study was the suggestion that an “omission bias” was deflecting parents from seeking advantageous vaccinations for their children. We are somewhat reassured on this score. Given a scenario in which flu and vaccine risks were balanced, most respondents, students and adults alike, chose to vaccinate (i.e. take action), suggesting that, whatever general tendency towards inaction or omission there may be, it is not sufficiently strong to overwhelm pro-vaccination factors for most people. The respondents showed reasonable sensitivity to relative seriousness and relative risk of the disease and the vaccine side-effects. They also showed some sensitivity to the regret they expected to feel if these bad outcomes were to eventuate, and made predominantly regret-averse choices – which, in this case, led a majority to pro-vaccination decisions, though a substantial minority were opposed. Two follow-up studies in which respondents chose on their own behalf, or for a child where the risks were fatal, showed similarly little evidence of any general tendency toward inaction, and very few respondents mentioned such factors in explaining their decisions. Those who did were at least as likely to favor vaccination as to oppose it. Again, respondents in these follow-up studies showed regret aversion, regardless of their choices.

Since our findings contrast sharply with the earlier findings of omission bias in vaccination decisions, we conducted several methodological studies of the measures used (Appendix 2). These studies show that two features of the earlier measures – the truncation of probability response scales, and the asymmetry of open-response matching scales – could well have produced inadvertent bias in the earlier studies. More broadly, they suggest that complex risk-balancing of the kind called for in both matching and choice measures may be simply too complex for many respondents. Measures that in one form show substantial vaccine aversion show exactly the reverse after apparently harmless modification, and intendedly convergent measures of the same construct fail even rudimentary tests of consistency. In short, while respondents do generally respond in appropriate directions to increased risk or seriousness of one or other of the outcomes of the vaccination decision, their numerical estimates of the risk balancing involved should be treated with considerable caution.

Overall we find no evidence for either "omission" or for "bias" as shaping vaccination decisions. The data suggest, instead, that both pro- and anti-vaccination decisions are shaped, in part, by regret avoidance. There is, of course, debate as to whether regret-avoidance of this sort is normatively proper (for example Bittner, 1992) but there seems little question that it does influence real choices (e.g. Zeelenberg, 1999). There is also evidence that regret expectations can be shaped by considerations of what is normal (Zeelenberg et al., 2001; Kahneman & Miller, 1986); by the justifying rationales the decision maker has available (Connolly & Reb, 2001; Connolly & Zeelenberg, 2002); and even by direct persuasion (Baron, 1992). This suggests that efforts to influence vaccination decisions might be usefully targeted at regret expectations, and the justifications for action and inaction on which they depend. Issues of action and inaction per se do not seem to have a very substantial role in vaccination decisions, at least to the extent that these decisions are well represented by simplified scenario-based studies of the sort reported here. Within the obvious limitations of such studies, the answers to both the questions in our title seem to be negative: it is difficult to make a convincing case that either "omission" or "bias" has been demonstrated in the vaccination setting.

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Table 1

Numbers of Respondents Indicating Pro- & Anti-Vaccination Intentions versus Relative Risk of Vaccine Side-Effects and Flu

Vaccination Intention	Relative Risk of Vaccine Side-Effects and Flu: If Vaccine Risk Higher		Base-Line Scenario		If Vaccine Risk Lower	
	n	Percent	n	Percent	n	Percent
Negative*	154	52.6%	73	24.8%	66	22.5%
Don't know	22	7.5%	29	9.9%	17	5.8%
Positive	117	39.9%	192	65.3%	210	71.7%
Total	293	100%	294	100%	293	100%

* "Negative" includes all responses from –1 to –3 (i.e. anti-vaccination); "Positive" includes all responses from +1 to +3 (i.e. pro-vaccination).

Table 2

Numbers of Respondents Indicating Pro- & Anti-Vaccination Intentions versus Perceived Relative Seriousness of Side-Effects and Flu

	Perceived Relative Seriousness of Side-Effects and Flu					
Vaccination	Flu Less Serious		Equally Serious		Flu More Serious	
Intention	n	Percent	n	Percent	n	Percent
Negative*	9	39.1%	61	34.9%	3	3.3%
Don't know	1	4.3%	20	11.4%	6	6.5%
Positive	13	56.5%	94	53.7%	83	90.2%
Total	23	100%	175	100%	92	100%

* "Negative" includes all responses from –1 to –3 (i.e. anti-vaccination); "Positive" includes all responses from +1 to +3 (i.e. pro-vaccination).

Table 3

Summary of Regression Model Predicting Intention to Vaccinate from Regret Scores and Rated Relative Seriousness of Side-Effects and Flu

Variable	B	SE B	β
Rated Relative Seriousness of Side-Effects and Flu**	.81	.18	.24*
Vaccination Regret	-.15	.03	-.25*
Non-Vaccination Regret	.24	.04	.38*

Note. Adjusted $R^2 = .24$ ($N = 287$, $p < .001$).

* $p < .001$.

** A rating of flu symptoms as less serious than the side-effects was coded as -1, equally serious as 0, and more serious as 1.

Table 4

Coding of open-ended explanations given for vaccination decisions in first follow-up study (vaccination for oneself)

	Decision		
	Don't Vaccinate	Don't Know	Vaccinate
	(N = 31)	(N = 7)	(N = 31)
1. Fear, dislike, distrust, cost or trouble of shots or drugs	10	0	1
2. Balance of risks and/or benefits	12	2	14
3. Control of timing or certainty of outcomes, reduce worry	0	0	4
4. Risks of flu, side-effects or both are low.	3	0	3
5. My chances are generally better/worse than those in scenario	5	0	1
6. One should not be passive	0	0	1
7. One should not mess with fate	1	0	0
8. Other, and uncodable	6	4	5
9. No explanation given	1	1	3

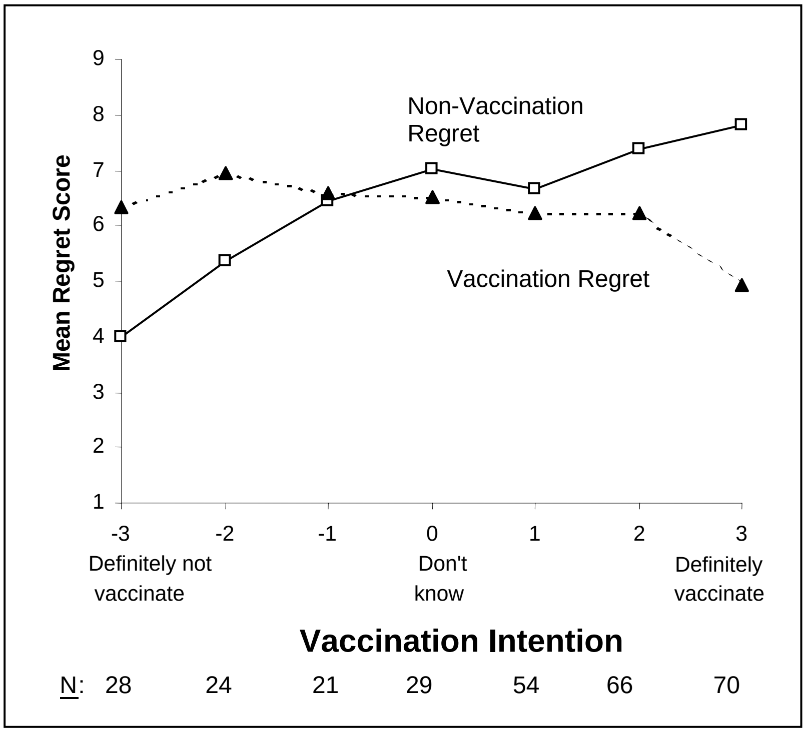
Table 5

<u>Coding of open-ended explanations given for vaccination decisions in second follow-up study (worst outcome is child's death)</u>

	Decision		
	Don't Vaccinate	Don't Know	Vaccinate
	(N = 24)	(N = 13)	(N = 29)
1. Fear, dislike, distrust, cost or trouble of shots or drugs	1	0	0
2. Balance of risks and/or benefits	14	2	15
3. Control of timing or certainty of outcomes, reduce worry	0	0	1
4. Risks of flu, side-effects or both are low.	1	0	0
5. My child's chances are generally better/worse than those in scenario	0	0	0
6. One should not be passive	0	0	3
7. One should not mess with fate	1	1	0
8. Other vaccine drawbacks (e.g. new & untested, possible long-term risks)	2	0	0
9. I could control risks (move, give special care, child may not be exposed)	4	0	0
10.More research is needed	0	4	0
11. Generalized belief in vaccine benefits	0	0	5
12. Other and uncodable	2	6	6
13. No explanation given	0	0	0

Figure 1

Mean Regret Scores versus Intention to Vaccinate



Appendix 1

The vaccination decision may be modeled as a binary choice under risk, of the following form. A decision is to be made between two alternatives A1(Vaccinate) and A2 (Do not vaccinate). A1 leads with probability P1 to a "good" outcome G1 (Child healthy) and with probability (1-P1) to a "bad" outcome B1 (Child sick). Alternative A2, similarly, offers {G2, P2; B2, (1-P2)}. Assuming a decision maker with utilities U(.) for these outcomes, he or she will be indifferent between A1 and A2 iff

$$P1*U(G1) + (1-P1)*U(B1) = P2*U(G2) + (1-P2)*U(B2) \qquad (1)$$

The numerical values of P1 and P2 at which a subject feels indifferent between A1 and A2 thus cast some light on his or her utilities for the four outcomes. If one is prepared to make the further assumption that U(G1) = U(G2), (that is, one is equally pleased with the child's health, whether it resulted from good luck or from benefits of the vaccination) then the indifference ratio of P1 to P2 can be used as a coarse measure of the relative size of U(B1) and U(B2), (the utilities associated with a child sick or dead from the vaccine and the child sick or dead from the flu). Our interpretation of the "omission bias" literature is that it concerns the relative size of these two utilities.

In the risk balancing procedure, the experimenter specifies one of the two probabilities and asks the subject for a value of the other probability which would make A1 and A2 equally attractive. For example, Asch et al. (1994) specified that the risk of inaction leading to flu fatality was 10 in 10,000. Their typical subject indicated indifference between vaccination and non-vaccination if the death risk from vaccination was about 4 in 10,000. If one assumes that U(G1) = U(G2) and that P1 and P2 are both close to 1.0 (i.e. that death from either flu or vaccine is a rare event), the logic of Equation 1 implies that U(B1) is about 2.5 as large as U(B2) – that is, a vaccine-related death was judged to be about 2.5 times as bad as a flu-related death. The "risk premium" demanded for the vaccination option thus indexes the ratio of U(B1) and U(B2), as long as the logic of Equation 1 and the utility equivalence of G1 and G2 holds, as in the following example.

Example 1: Suppose that a particular individual is indifferent between vaccination, with a risk of death of 5 in 10,000 and non-vaccination, with a risk of 10 in 10,000. We may, without loss of generality, assign each outcome a utility between 0 (Worst) and 1 (Best). Assume initially that U(G1) = U(G2) = 1 (i.e. the best possible outcome is a healthy child, and the parent does not care whether this is a result of vaccination or good luck). Assume also that U(B1) = 0 (i.e. the worst outcome is the child's death resulting from vaccination). Then, substituting into Equation 1:

$$(9{,}995 \times 1.0) + (5 \times 0) = (9{,}990 \times 1.0) + (10 \times U(B2))$$

or: $$U(B2) = 0.5$$

That is, on a utility scale bounded at 0 (Worst: Vaccine-caused death) and 1 (Best: Child healthy), the flu-caused death is seen as at the mid-point. This is the basis for the comments in text that the vaccine-caused death outcome is some multiple as bad as the flu-caused death – in this case, twice as bad.

Example 2: Ritov & Baron (1990, Experiment 4) found their average subject indifferent between a vaccine risk of 10 in 100,000 and a flu risk of 2,584 in 100,000. By the same calculation as above, this corresponds to a U(B2) value of .996, indicating that the flu-caused death is virtually as desirable as the two "best" outcomes!

Example 3: Suppose we relax the assumption of equal "best" outcomes and allow instead for U(G1) to be slightly larger than U(G2) – that is, we allow a small measure of "rejoicing" (Landman, 1987; Loomes and Sugden, 1982), reflecting our extra pleasure in a good outcome that was the result of our actions. If, in Example 1, we keep U(G1) at 1.0 and put U(G2) at .99 – a very tiny amount of rejoicing – Equation 1 solves with U(B2) = 10.49, a meaningless value for a utility. Alternatively, given this same tiny amount of rejoicing, Equation 1 shows that vaccination, with its 5 in 10,000 death risk, will be preferred to non-vaccination even if there is no risk whatever of death from flu!

Comment: We find the result from Example 1 to be reasonably intuitive, but those of Examples 2 and 3 to be quite surprising. Our intuition required some education before we grasped that these utility calculations are dominated by the values of the good (non-death) outcomes, since they are so very much more likely that the bad (death) outcomes. It seems likely that actual subjects, like ourselves, tend to focus only on the undesirable branches of these options, without taking adequate account of the vastly more likely desirable branches. This ignoring of positive outcomes would constitute a much more serious decision error in such contexts than any modest distortion of the utilities of negative outcomes associated with action or inaction.

Appendix 2

We report here three methodological studies examining properties of the measures used in these and earlier studies. Experiment M1 explores scale length effects, M2 examines possible response differences due to matching versus choice formats, and M3 alternative wordings and placement of the relative seriousness question. All three use a scenario slightly altered from that used in the main study, replacing some wording that we judged to be more natural-sounding with a more exactly parallel wording to describe disease and side-effect outcomes. The new wording was:

"Imagine that in Arizona there have been several outbreaks of a certain kind of flu, which can cause severe illness in children under three. Most children get no flu symptoms at all but, in a small number of cases, the flu causes serious symptoms, the child gets quite sick and feels seriously ill for several weeks.

There is a vaccine for this type of flu. The vaccine is available at no cost and eliminates all possibility of the child getting the flu. It generally has no side-effects. However, in a small number of cases, the vaccine causes serious side-effects, the child gets quite sick and feels seriously ill for several weeks.

Imagine that you are married and have one child, a one-year old. You spent a lot of time trying to decide whether or not to have your child vaccinated against this flu. After talking to several doctors, reading medical journals and consulting with friends, it's now time to decide whether to have your child vaccinated or not".

Experiment M1: Scale length effects

After reading the above scenario, participants were told the flu risk (10 in 10,000) and asked a series of choice questions of the form "Would you vaccinate your child if the probability of getting severe vaccine side-effects were X ?" Values of X were displayed one to a line (0 in 10,000, 1 in 10,000, etc), and the respondent was asked to circle either "Yes" or "No" for each. A final page asked our standard relative seriousness question.

Two factors were varied in a full 2x2 factorial design:

a. Scale length: In the short form, respondents were asked about vaccine risks between 0 in 10,000 and 10 in 10,000. In the long form, risks ranged from 0 in 10,000 to 20 in 10,000, with a final category ">20 in 10,000".

b. Scale direction: Half the respondents saw scales that ranged upward from 0 in 10,000 to the maximum value, the others saw scales that ranged downward from their maximum to 0.

Seventy-nine student respondents completed the two-page questionnaire as part of a larger package of unrelated studies. They received course credit in return for their participation.

Results:

The primary dependent variable was the highest vaccine risk at which the respondent would choose to vaccinate. The distribution of responses for short and long forms of the scale is summarized in Table M1. As can be seen, responses on the short form of the scale suggest that almost half of our respondents demanded a risk premium for vaccination (M = 7.9, N = 40), which earlier studies would have been interpreted as evidence of "omission bias". However, responses on the long form suggest the reverse, with a majority of respondents indicating that they would accept a risk *penalty* in order to vaccinate (M = 14.8, N = 39). (Responses of ">20" were conservatively coded as 21). A Scale Length (2) x Scale Direction (2) ANOVA shows a highly significant main effect for Scale Length (F(1,75) = 34.48, p = .000), but no main effect for Direction (F<1.0) or for the interaction of Length and Direction (F<1.0).

[Table M1 about here]

As in the main study, the majority (54%) of our respondents judged flu symptoms and vaccine side-effects as equally serious overall, with a substantial minority (35%) judging flu symptoms more serious and few (10%) judging the reverse. These judgments were unrelated to scale length. 12 of 40 short-scale respondents, versus 16 of 39 long-form respondents, judged the flu symptoms more serious (chi squared = 1.05, ns). They were, however, related to vaccination intentions. Those judging the flu more serious were prepared to accept higher vaccine risks in both the short form (M = 9.67 vs. 7.14, t = 2.53, p<.02) and the long form (M = 18.56 vs. 12.17, t = 3.32, p = .000) than were those who judged the two equally serious or the vaccine side-effects more serious.

Conclusions.

We found no effect for scale direction (rising or falling risk levels), but we did find a large and important effect for scale length. Respondents restricted to vaccine risk options at or below the flu risk appeared to demand a risk premium to vaccinate. However, those not so restricted showed the opposite tendency, indicating that they would tolerate a risk penalty in order to vaccinate. Such response biases are not new, of course (see, for example, Loftus, 1975), but are of substantive importance in the present context, and could account for several earlier findings of “omission bias”. In both scale formats, respondents who judged flu symptoms as more serious than vaccine side-effects are more tolerant of vaccine risk than those who see the side effects as equally or more serious. This suggests that respondents are able to see the directional implications of the risks and payoffs they confront, but that expressing this understanding in numerical terms is strongly influenced by demand characteristics such as scale length.

Experiment M2: Matching and choice

Two alternative response formats have been used in risk-balancing measures. The choice format, such as that described in Experiment M1, presents the respondent with a series of choices of the form “The flu risk is X, the vaccine risk is Y, would you vaccinate or not?” The alternative, matching format specifies one of the two risks and asks the respondent to indicate the value of the other risk at which he or she would be indifferent between vaccinating and not vaccinating. In either format the researcher anchors on one of the two risks and asks the respondent to provide the other, either by selecting a value from those offered (in choice format) or by supplying a value for it (in matching format). In this experiment we presented respondents with both a matching and a choice task, factorially crossing which anchor appeared in which response mode. Respondents thus answered in both a matching format (anchored on a specified value of flu or side-effect risk) and in a choice format (anchored on either flu or side-effect risk). A total of 80 undergraduate student respondents completed the three-page questionnaire as part of a larger package of unrelated studies. They received course credit for their participation.

The first page in each package was a matching task. One group of participants was given the vaccine risk (10 in 10,000) and asked to fill in a number (“___ in 10,000”) for the flu risk at which they would be indifferent between vaccination and non-vaccination. The second group was given the flu risk and asked for a vaccine risk at which they would be indifferent. The second page of each package was a set of choice tasks. Half the respondents were told the side-effects risk (10 in 10,000) and given a series of yes/no choices of whether or not they would vaccinate if the flu risk were 0, 1, 2 … 20 in 10,000, with a final category of >20. The lowest flu risk at which they would vaccinate was taken as their balance point. The remaining respondents were told the flu risk (10 in 10,000) and given a series of yes/no questions for the same range of side-effect risks. The highest side-effect risk at which they would vaccinate was taken as their balance point.

Results.

Responses for the matching task are summarized in Table M2(a). As the table shows, when the question is anchored on vaccine side-effect risk, respondents tend to be predominantly opposed to vaccination (20 respondents would vaccinate only if the flu risk were higher than the vaccine risk versus 8 showing the reverse). However, when the question is anchored on flu risk, there is an opposite, pro-vaccine tendency, with 18 respondents selecting the vaccine even if it is riskier than the flu, while only 8 demand a risk premium for vaccination.

[Table M2(a) about here]

Responses for the choice task are summarized in Table M2-1(b). As before, the appearance of pro- or anti-vaccine tendency changes with question anchoring. Respondents anchored on a value of vaccine risk and choosing at various levels of flu risk show moderate vaccine-aversion: 22 demand a risk premium to vaccinate, only 11 vaccinate when the flu risks are lower that the vaccine risks. Respondents anchored on a flu risk and choosing at various levels of vaccine risk show the reverse tendency: 20 choose vaccination even when it is riskier that the flu, versus 11 choosing the reverse.

[Table M2(b) about here]

Consistency between the matching and choice responses depended on whether or not the two responses used the same anchor. Respondents anchored on the same risk (flu risk-flu risk or vaccine risk-vaccine risk) for their matching and choice tasks achieved moderate consistency. 19/40 respondents gave the same risk level at their balance or indifference points, and the two responses were highly correlated (Spearman's rho = .73, p=.000). However, when matching and choice were based on different anchors (matching anchored on flu risk, choice anchored on vaccine risk, or vice versa), consistency was much poorer. Only 11 of 40 responses matched exactly, and the two measures, which should, for consistency, have shown a negative correlation, were actually positively correlated (rho = .43, p=.006).

Conclusion.

These data suggest, as in Experiment M1, that risk-balancing responses need to be treated with considerable caution. Whether a matching format or a choice format is used, the apparent overall preference shifts depending on whether the flu risk or the vaccine risk is used as the anchor. The fill-in-the-blank format of the matching response does allow for some quite extreme responses (in our most extreme example, a readiness to use a vaccine with a 90% probability of causing harm to protect against a flu with a 0.1% probability of causing harm!). Some of these extreme responses very likely represent simple error, but it is not clear which responses indicate error, which indicate extreme but sincere views. The matching and choice responses show moderate consistency with one another when the two tasks have the same anchor (e.g. state flu risk for matching, and choose for various levels of flu risk), but are quite inconsistent when the two tasks have different anchors (e.g. match using flu risk, but choose for various levels of vaccine risk). In short, neither response format yields consistent pro- or anti-vaccine response tendencies when used alone, and the two are too mutually inconsistent to be used in combination. It has been known for some time (e.g. Slovic, 1975) that matching and choice can produce inconsistent results. As the present data show, either response mode is capable of indicating either pro- or anti-vaccination tendencies, depending on which risk is used as anchor, which as response variable. Again, response-mode effects could account for apparent omission bias in several earlier studies.

Experiment M3: Wording and placement of seriousness question

We tested two alternative wordings of the seriousness question. The first asked, as in the main study, whether the flu symptoms are more serious, just as serious, or less serious overall than the vaccine side effects. The second wording asked whether the vaccine side-effects are more serious, just as serious, or less serious overall than the flu symptoms. We also tested the effect of placing the seriousness question immediately after the scenario, before asking for decisions on vaccination preference, versus after these preference questions. These two factors were crossed factorially, for a 2x2 design with 20 participants in each cell. As in the main study, respondents were asked their vaccination intentions for the scenario as presented and for two alternative scenarios, one in which the side-effect risk was higher than the flu risk, and one in which the side-effect risk was lower. Eighty undergraduate students completed the three-page questionnaire as part of a larger package of unrelated studies. They received course credit for their participation.

Results.

There is no evidence that the wording of the seriousness question had any effect on response patterns (see Table M3). In both wordings, the majority of respondents judged the two risks to be equal (21 or 22 of 40), with a substantial minority (15 or 16 of 40) judging the flu more serious (or the vaccine side effects less). Only 3 respondents in each wording judged the flu less risky than the vaccine. Nor was there any effect of either wording or placement of the seriousness question on vaccination intentions. A two-way ANOVA showed no significant effect on vaccination intention for either Wording ($F < 1.0$), Order ($F < 1.0$) or their interaction ($F < 1.0$).

[Table M3 about here]

As in the main study, there was a clear effect on vaccination intention for both judged relative seriousness of flu and side-effects and for relative risk of the two. Those judging the flu more serious (or the vaccine less) were more likely ($M = 1.87$) to vaccinate than those who felt the risks equal ($M = 0.86$) or reversed ($M = .50$) ($F(3,74) = 3.66$, $p<.02$). For the hypothetical case in which the vaccine risk was lower than the flu risk, mean vaccination intention rose from 1.27, its baseline, to 2.29. For the hypothetical in which the vaccine risk was higher, it fell to -1.05. That is, as in the main study, vaccination intention responds in the appropriate direction to both judged relative seriousness of flu and vaccine, and to manipulations of the relative risks. There appears to be no effect for either wording or placement of the seriousness question.

Conclusion

Judgments of the relative seriousness of the flu and the vaccine side-effects do not appear to be affected by either wording or placement of the seriousness question. As in the main study, most respondents see the risks as equally serious, with a substantial minority judging flu more serious and few respondents judging the reverse. Further, neither the placement nor the wording of the seriousness question affects vaccination intentions. It seems, then, that judgments of seriousness are a relatively stable result of (a) the respondent's reading of our scenario (here carefully worded to equate the two possible bad outcomes) and (b) more general knowledge and opinions, predominantly pro-vaccine, that he or she brings to the experiment. There is no evidence that seriousness judgments reflect simple post-decision bolstering.

Table M1: Highest acceptable side-effect risk for short and long response scales

Highest Acceptable SE Risk (in 10,000)	Short Scale (0 to 10)	Long Scale (0 to >21)
0	1	2
1	1	
2	1	
3	3	1
4	1	
5	5	
6	2	
7	1	
8		1
9	4	4
10	23	9
11		1
15		1
20		6
>20		14
Total	40	39

Table M2(a): Matching responses for flu-risk vs. side-effect-risk anchors

Matching Response	Anchor: SE risk = 10 in 10,000 (i.e. enter flu risk)	Anchor: Flu risk = 10 in 10,000 (i.e. enter SE risk)
1 in 10,000	3	3
2 "	1	1
5 "	4	3
9 "		1
10 "	11	14
11 "		1
15 "	2	1
20 "		1
30 "	1	
50 "	1	3
100 "	8	6
200 "		1
500 "	4	
1,000 "	3	1
3,000 "		1
5,000 "	1	2
9,000 "		1
Total	39	40

Table M2(b): Choice responses for flu-risk and side-effect-risk anchors

Choice Balancing Risk	Anchor: SE risk =10 in 10,000 (i.e. circle flu risk)	Anchor: Flu risk = 10 in 10,000 (i.e. circle SE risk)
0 in 10,000	3	
1 "	1	1
4 "	1	1
5 "	3	4
6 "	1	
9 "	2	5
10 "	7	9
11 "	4	
14 "	1	2
15 "	4	3
19 "		2
20 "	4	4
>20 "	9	9
Total	40	40

Table M3: Ratings of flu and side-effect seriousness for alternative question wordings

	Seriousness Ratings		
Question Wording	Flu more serious (or SE less)	Both equally serious	SE more serious (or flu less)
Flu vs. SE	15	22	3
SE vs. Flu	16	21	3