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An Ethics of Expertise Based on Informed Consent

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ABSTRACT: *Ethicists widely accept the notion that scientists have moral responsibilities to benefit society at large. The dissemination of scientific information to the public and its political representatives is central to many of the ways in which scientists serve society. Unfortunately, the task of providing information can often give rise to moral quandaries when scientific experts participate in politically charged debates over issues that are fraught with uncertainty. This paper develops a theoretical framework for an "ethics of expertise" (EOE) based on the notion that scientists have responsibilities to provide information in a way that promotes autonomous decision-making on the part of the public and its representatives. Moreover, insofar as the principle of informed consent has developed in biomedical ethics as a way for physicians to promote autonomous decision-making on the part of their patients, this paper suggests that the informed-consent concept may suggest a set of criteria and guidelines that can help scientists to fulfill their similar ethical responsibilities to the public. In order to illustrate how the resulting EOE could provide practical guidance for scientific experts, the paper examines a case study involving the dissemination of information about the low-dose biological effects of toxic chemicals and carcinogens.*

An Ethics of Expertise Based on Informed Consent

I. Introduction

Ethicists widely accept the notion that scientists have moral responsibilities to benefit society at large.[1-4] These responsibilities can be justified based on at least five considerations.[4] First, scientific researchers often pursue their work with public funds that are intended to benefit the public. Second, most researchers benefit throughout their careers from public education, grants, and state-sponsored benefits, so they have a

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responsibility to give back to their community. Third, scientists are accorded specialized authority and respect by society, so it seems reasonable to think that they have reciprocal responsibilities to society. Fourth, the scientific community plausibly has an implicit contract with society to supply relatively unbiased, objective information that can promote the public good. Fifth, scientific researchers, like all moral agents, have a responsibility to take reasonable steps to protect others from potential harms. Some of the specific ways in which scientists can discharge these responsibilities to serve society include: educating the public about science, increasing public interest in science, warning the public about public-health and environmental concerns, promoting responsible science and technology policy, debunking junk science, and informing the public about important consequences of scientific research.[3(pp.147-148)]

The dissemination of scientific information to the public and its political representatives is central to many of the ways in which scientists serve society. Unfortunately, this task of disseminating information can often give rise to moral quandaries when scientists participate in politically charged debates over issues like global warming, the teaching of creationism in public schools, the environmental and health effects of pollution, or the causes of and solutions to rapidly rising obesity rates. For example, scientists have to address the following questions:

- how to characterize and frame the current state of scientific information on debated issues;
- how (and to what extent) to express the full range of opinions held by different members of the scientific community concerning debated issues;
- how to present the various sorts of uncertainty associated with scientific information;
- whether or not to advocate specific policy responses to debated issues;
- whether to allow social or ethical values (e.g., the desire to protect vulnerable human or environmental communities) to influence the presentation of scientific information;
- how to prevent public misinterpretation of scientists' views; and
- how the answers to each of the preceding questions should vary in the different contexts in which scientists provide information (e.g., courtroom testimony, newspaper articles, Congressional hearings, citizen gatherings, and journal articles).

Given the complexity involved in providing scientific information to the public, it is unfortunate that relatively few thinkers have devoted attention to developing an "ethics of expertise" (EOE) for scientists.[3-7] For example, Kenneth Pimple suggests that scientists' social responsibilities in general (let alone their specific responsibilities for disseminating information) have received less analysis than ethical issues "internal" to scientific practice (e.g., management of data, relationships among researchers, or treatment of human and animal research subjects).[2] Moreover, the few previous efforts at developing an EOE do not appear to be entirely satisfactory as they currently stand. For example, based on the need for *trust* between experts and laypersons, John

Hardwig has proposed a promising EOE that includes 21 ethical maxims.[5(p.92ff)] Nevertheless, he does not show in any detail whether the concept of trust is rich enough to provide a basis for adjudicating conflicts among the maxims or to specify how the maxims should be applied in particular cases. Another problem is that some of those who have begun to develop an ethics of expertise have come to conflicting conclusions. For example, Kristin Shrader-Frechette argues that, in some situations, it may be appropriate for researchers to develop deliberate interpretations of their findings rather than trying to provide as little interpretation as possible.[4] In the context of debates over ecological research on deforestation, she claims that "… in situations of uncertainty researchers probably ought to interpret findings more in the way required to serve preservation rather than development".[4(p.94)] David Resnik has responded to Shrader-Frechette by suggesting that her proposed interpretations would damage scientific objectivity, and he argues that scientific objectivity is so crucial to society that it is doubtful whether it is ever morally justifiable to sacrifice it for the sake of advancing other social goods.[3,6]

In an effort to alleviate some of the weaknesses in previous research concerning the ethics of expertise, this essay suggests a new theoretical framework for exploring these questions.[a] In particular, it suggests that one might build a promising EOE for scientific experts based on the notion that the scientific community should promote the ability of those who use scientific information to make autonomous decisions that accord with their own beliefs and values. Moreover, the paper argues that the previous analyses of informed consent provided by biomedical ethicists may provide a set of criteria and guidelines that can help scientists to fulfill these ethical responsibilities. In other words, the scientific community's responsibilities to promote autonomous decision-making can be conceptualized as responsibilities to enable members of the public (and their political representatives) to provide informed consent to personal and political decisions that affect their well-being. Others have previously suggested that the ethical requirement to obtain consent from the public to decisions about science policy should influence the manner in which these decisions are made.[8-11] Nevertheless, these previous studies have focused primarily on evaluating whether particular decision-making procedures enable the *public* to provide consent rather than on systematically elucidating the responsibilities of the scientific *experts* who provide the information that facilitates public consent. In an effort to remedy this deficiency, the present paper examines how the responsibility to promote the public's consent to social and personal decisions could yield ethical guidance for scientific experts.

a. Although the theoretical framework proposed in this paper is new, it may be compatible with much of the previous work written on the ethics of expertise. For example, it is plausible that one of the best ways for experts to maintain the trust of decision makers who depend on them for information is to promote the ability of those decision makers to provide informed consent to the decisions that they make. Thus, one could potentially regard an EOE based on informed consent as a way of fleshing out and specifying Hardwig's EOE based on trust. At the very least, the EOE proposed in this paper would presumably support most of the maxims that Hardwig proposed in his earlier work.

The next section of the paper begins by arguing that scientists have responsibilities to promote autonomous decision-making by members of the public. It then analyzes the informed-consent concept (drawing on previous studies from the biomedical-ethics literature) in order to suggest a series of ethical guidelines for scientific experts who wish to promote the autonomy of decision-makers. The third section of the paper adopts a case-study approach in order to illustrate the promise of the EOE suggested in this paper. It argues that an EOE based on informed consent can provide practical guidance concerning the responsibilities of researchers who are disseminating debated information concerning the low-dose biological effects of toxins and carcinogens. Thus, the paper both sketches a theoretical framework for an EOE based on informed consent and shows how it can provide practical ethical advice to working scientists. The paper does not claim that this EOE provides an *exhaustive* account of the social responsibilities associated with the dissemination of scientific information. Moreover, experts have other social responsibilities (e.g., choosing appropriate research projects, maintaining fidelity to employers, and whistleblowing under some circumstances) besides those associated with disseminating information. The following two sections do illustrate, however, that this EOE appears to provide a justifiable and coherent framework for highlighting and organizing a number of ethical considerations associated with disseminating expert knowledge.

II. An Ethics of Expertise Based on Informed Consent

The Plausibility of Informed Consent as a Theoretical Framework

The principle of informed consent has become a central feature of biomedical ethics during the course of the twentieth century. In the context of the professional-patient relationship, obtaining informed consent provides a way of ensuring that patients receive adequate information about the range of treatment options available and the risks and benefits associated with them. In the context of medical research, obtaining informed consent promotes the ability of people to make a thoughtful decision about whether to participate in potentially risky studies. In both contexts, ethicists such as Tom Beauchamp and James Childress argue that the requirement to obtain informed consent plays a crucial role in meeting the ethical principles of *beneficence* and, especially, *respect for autonomy*.[12] They note that, although the precise nature of autonomy is heavily debated in moral philosophy, "Virtually all theories of autonomy agree that two conditions are essential for autonomy: (1) *liberty* (independence from controlling influences) and (2) *agency* (capacity for intentional action)."[12 (p.58, italics in original)] The requirement that physicians and biomedical researchers obtain informed consent from patients and research participants is designed to ensure that both of these conditions for autonomy are met.[b]

b. There is, admittedly, a good deal of philosophical debate about the nature of autonomy, its ethical importance, and its relation to informed consent.[12] For example, James Stacey Taylor has recently argued that the concept of respecting patient autonomy is too limited to provide an

Insofar as the principle of informed consent has been designed to promote autonomous decision-making, it seems to provide a promising theoretical basis for developing an EOE. One of the main justifications for an EOE is to prevent experts from taking undue license in the way they provide information to members of the public. Specifically, to the extent that experts seek to serve society as a whole, they cannot disseminate information in a manner that serves only the beliefs and values of individual clients. Rather, they must aspire to provide information in such a way that members of society with diverse beliefs and values can all use the experts' information to make and support decisions that accord with their own perspectives. This goal of respecting the multiplicity of values present in society has recently become the subject of increased attention, because numerous authors have worried that scientific experts may (consciously or unconsciously) smuggle value judgments into supposedly "value-free" analyses. This leads to a covert weakening of democratic participation in policy-making, because the values of scientific experts surreptitiously replace the values of citizens.[9,14,15] Therefore, the goals of obtaining informed consent in biomedical ethics appear to overlap with the goals of formulating an EOE for scientific researchers; both processes are designed to help the recipients of information make autonomous decisions (i.e., to engage in intentional actions that accord with their own values).[c]

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adequate justification for requiring informed consent; rather, the ethical importance of obtaining informed consent should actually be grounded primarily on concern for the well-being of patients.[13] It is worth noting, therefore, that this paper's major ethical suggestions can be justified without appealing to respect for autonomy. The paper presupposes only that (1) scientists have responsibilities to promote the ability of members of the public to make and support personal and social decisions in accordance with their own beliefs and values, and (2) promoting informed consent to these decisions is a good way for scientists to meet those responsibilities. Thus, an ethicist like Taylor could still accept both presuppositions of this paper; he would just provide a different justification (other than respect for autonomy) for thinking that scientists should promote the ability of people to make decisions in accordance with their own beliefs and values.

c. Two caveats should be noted regarding the idea that the goals of obtaining informed consent in biomedical ethics overlap with the goals of formulating an EOE for scientific researchers. First, it is noteworthy that Hardwig[5 (p.91)] appears to agree with this paper's contention that scientists should provide information to members of the public in a manner that preserves their autonomy, but he denies that the physician-patient relationship in biomedical ethics provides a good model for formulating an EOE. This apparent contrast with the position of the present paper occurs because Hardwig thinks of the physician-patient relationship as governed by the physician's responsibility to serve an individual patient's *best interests*. Thus, he thinks that scientists cannot emulate the role of a physician, because they have to respect the disparate interests of different members of society. This paper focuses instead on the physician's responsibility to *respect the autonomy* of patients, which is a responsibility that can be applied to a scientist's relationship with society at large. A second caveat is that, if one took the view that scientists could legitimately decide what is in the best interests of society as a whole (independently of the beliefs and values of society's individual members), one could argue that they should disseminate information in a manner that directly promotes those societal interests. This paper presumes that, in general, the best way for scientists to serve society is to promote the autonomy of individuals. This does not preclude, however, the occurrence of some cases (such as in public-health contexts) in which scientists have additional ethical responsibilities based on fiduciary responsibilities to society as a whole.

Therefore, this paper suggests that an EOE for scientists might be based on the notion that the scientific community has responsibilities to disseminate information in a manner that promotes the ability of the public to provide informed consent to decisions that draw on that scientific information. Because the concept of informed consent has already been analyzed in extensive detail by biomedical ethicists,[12,16-19] it provides a ready-made theoretical framework for guiding scientific experts who disseminate information to the public.

It is important to note, of course, that the EOE developed in this paper does not incorporate all the actual details of the consent process that plays a role in biomedical contexts. For example, I am obviously not proposing that scientists should ask those who receive information from them to read and sign a consent form. This paper does not treat "informed consent" as an event or as a signature but rather as an *autonomous authorization* of personal or social decisions.[12] Thus, to say that the scientific community has a responsibility to promote the informed consent of decision makers is merely to say that scientists should provide information in a way that enables people to make autonomous decisions. This paper contends that, because biomedical ethicists have suggested guidelines and criteria that are likely to promote autonomous decision-making (i.e., informed consent) in a medical context, those guidelines and criteria seem like promising candidates for promoting autonomous decision-making in other contexts that draw on scientific information. At the very least, examining the guidelines and criteria used to promote informed consent in biomedical situations may spur further reflection about how the situations in which other scientific experts disseminate information resemble or differ from the medical context.

The Details of an EOE Based on Informed Consent

The basic principle of an EOE based on informed consent might run something like the following:

> (EOE-IC) (a) The scientific community has *prima facie* duties, in contexts in which scientific information is likely to be used for particular individual or group decisions, to disseminate that information in a manner that promotes the ability of those affected by the decisions to provide some form of informed consent to them. (b) Individual scientists have *prima facie* duties not to hinder (and in some cases to facilitate) the ability of the scientific community to fulfill its duties.

The EOE-IC principle is divided into parts (a) and (b) in order to emphasize that the responsibilities of the scientific community and the responsibilities of individual scientists should probably be distinguished. As Resnik points out, it may not be appropriate to expect every scientist to play an equal role in fulfilling the responsibilities of the scientific community.[3] Some scientists might be more comfortable than others in engaging with the media to provide information to the public, for example. Moreover, philosophers like Helen Longino[20,21] and Miriam Solomon[22] have suggested that the scientific community as a whole may be able to

provide objective perspectives in a manner that one should not expect from individual scientists. The EOE-IC principle includes part (b), however, because it seems reasonable to expect all scientists at least to avoid *hindering* the ability of the scientific community to promote the public's informed consent to science-based decisions. It is also important to note that the EOE-IC principle requires only that the scientific community promote *some form* of informed consent. In principle, individuals affected by a public policy decision might provide their consent via a number of more or less direct ways, including voting in a referendum, electing representatives to make the decision, or participating in a consensus council or citizen advisory committee.[8,14,23] The important point for the purposes of this paper is that, no matter how the public provides consent to personal or social decisions, consent cannot be obtained unless the decision-makers have adequate scientific information on which to base their decision.

Most biomedical ethicists suggest that the concept of informed consent can be broken down into several "components" that serve as necessary conditions for it to promote autonomous decision-making. Thus, one can identify scientists' responsibilities in specific cases under the EOE-IC principle by considering what scientists would need to accomplish in order to meet these components of informed consent. In this paper, the analysis of five components (disclosure, understanding, voluntariness, competence, and actual authorization or consent) in Beauchamp and Childress's fifth edition of their *Principles of Biomedical Ethics*[12] will be employed. Their work is a good reference, both because they base their analysis on the particularly extensive earlier study of informed consent by Faden and Beauchamp[16] and because their book is one of the most widely respected biomedical ethics texts. The rest of this section examines how the first three components (disclosure, understanding, and voluntariness) could yield a list of ethical considerations for scientists who disseminate information to policymakers or to the public at large. (A list of these guidelines is summarized in Figure 1.)

Figure 1: A list of ethical considerations for disseminating information (assuming that one can at least roughly identify potential decisions that might be affected by the information) based on the EOE-IC principle suggested in section II.

Considerations based on disclosure:

- The dissemination of information should arguably meet the *reasonable person standard* of disclosure, which should be augmented by the *subjective standard* when groups of users with particular informational needs can be identified

- Disclosed information should generally include particular *categories* of information that can be justified based on the reasonable person standard of disclosure, perhaps including:
    - major *uncertainties* in current scientific information
    - major *disagreements* within the scientific community
    - major *conflicts of interest* that might influence the judgment of experts
    - the *benefits* of proposed actions (when particular actions are under consideration)
    - the *risks* of proposed actions (when particular actions are under consideration)
    - major *alternatives* to proposed actions (when particular actions are under consideration)

- Using an analogy to the therapeutic privilege, experts who deal with information that could significantly diminish the autonomy of particular individuals or groups (especially those that are already disadvantaged) should explore one or more of the following options, depending on the details of the situation:
    - disclosing the information in a manner that will cause the least damage to the autonomy of those who are at risk
    - contributing to societal initiatives that would diminish the harmful impact of the disclosed information
    - refraining from disclosing the information
    - avoiding obtaining the information

Considerations based on understanding:

- Information should be presented in such a way as to promote the substantial understanding of decision-makers, where substantial understanding involves having justified, relevant beliefs about all the information that is *material* or *important* to assessing the nature and consequences of one's actions

- Information should be presented in such a way as to avoid common sources of *mis*understanding:
    - information overload
    - misleading framing of information
    - false beliefs that result in unjustified inferences

Considerations based on voluntariness:

- When providing information that may influence people's decisions, experts should arguably engage in *persuasion* rather than *coercion* or informational *manipulation* (at least when the manipulation is sufficiently serious to be incompatible with substantial understanding), with these terms having the following meanings:[12 (94-95)]
    - coercion involves the intentional use of credible and severe threats of harm
    - persuasion involves convincing others through the use of reasons
    - manipulation involves influencing others by means other than coercion or persuasion

- Interpretations of research results should promote the substantial understanding of those receiving the information, and interpretations should definitely not involve informational manipulation that prevents substantial understanding

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The first component identified by Beauchamp and Childress is *disclosure*.[12] In biomedical contexts, this component reflects the fact that physicians or researchers need to disclose particular sorts of information about proposed clinical procedures or research projects in order for patients or research subjects to provide informed consent to them. In the context of a general EOE for scientists, this component reflects the notion that those who make decisions based on scientific information cannot provide adequate informed consent to those decisions unless they receive the right sorts of information. As Beauchamp and Childress[12] explain, ethicists and legal scholars have typically worked with three potential standards of disclosure: professional practice, subjective, and reasonable person standards. Let us consider each of these standards in turn.

According to the professional practice standard, a professional community's typical practices count as the criteria for adequate disclosure. Although this standard may be helpful in legal contexts, it is arguably too weak for developing an *ethics* of expertise, because ethics is concerned with *evaluating* professional practices rather than merely preserving them.[17(p.17ff)] The subjective standard holds that the adequacy of disclosed information should be judged based on the specific informational needs that the individual giving consent needs to know. Although this may be an excellent guide for some cases in the clinical setting,[17] it is probably impractical as a general standard for an EOE, because scientific experts generally disclose information to many people (who may have somewhat different informational needs) rather than to individuals.

According to the reasonable person standard, the criteria for adequate disclosure are based on the information that a reasonable person would want to receive when he or she is faced with a particular decision. This standard faces at least two problems of its own, but it appears likely that it can still provide valuable guidance about disclosure for the purposes of an EOE. The first problem is that the standard may not require adequate consideration of the different needs of individuals. One can respond, however, that even if one remains somewhat skeptical that *meeting* the reasonable person standard is always a sufficient condition for *achieving* adequate disclosure, one can still acknowledge that *failure* to meet the reasonable-person standard is a sufficient condition for *preventing* adequate disclosure. Thus, one can at least use the reasonable person standard to identify information that, if left undisclosed, would be ethically problematic under the EOE-IC principle. One could then supplement the reasonable person standard with the subjective standard by claiming that, when a scientific expert can identify a particular group of people who will make significant use of the information that she is providing, the expert should try to meet the special informational needs of that group.

A second problem with the reasonable person standard is that the notion of a "reasonable person" may be difficult to specify. One might respond, however, that there are likely to be many situations in which, under any justifiable definition of a "reasonable person," that person would want a particular set of information. In particular, biomedical ethicists have argued that physicians should disclose all information that is *material* to the action under consideration (both from the perspective of the professional and of the individual giving consent). Material information is defined as that which is relevant to deciding whether to take a particular action, rather than taking another action or doing nothing at all.[16(pp.302ff), 39(p.22)] In the biomedical context, this generally includes the purpose of consent, its nature and limits, the professional's recommended course of action, the risks and benefits of the proposed procedure, alternative courses of action, and perhaps the professional's conflicts of interest.[12,19,24] Although the contexts in which scientific researchers disclose information may sometimes be very different from the contexts in which clinicians or researchers obtain informed consent from patients or research subjects, it seems likely that the reasonable person standard of disclosure could be employed to develop a comparable list of material information that decision-makers would want to receive from scientific experts. For example, this information might include: major

uncertainties in current scientific information, major disagreements within the scientific community, major conflicts of interest that might influence the judgment of the experts, the benefits of proposed actions (when particular actions are under consideration), the risks of proposed actions, and the major alternatives to proposed actions (see Figure 1).

In their reflections on the component of disclosure, biomedical ethicists have also considered the conditions under which it is justifiable for professionals to withhold information intentionally from individuals who are giving consent. Beauchamp and Childress[12] list these situations under three categories: the therapeutic privilege, the therapeutic use of placebos, and the performance of research. The therapeutic privilege involves withholding information if one judges that a depressed, emotionally drained, or unstable patient would be harmed by it. The other two categories (therapeutic use of placebos and performance of research) involve withholding information from patients for the sake of producing a placebo effect or obtaining valid research data that require subjects to be unaware of the details of what is being done to them. Although not all of these categories seem applicable to the case of scientific experts, one might argue that the guidelines for allowing physicians to withhold information based on the therapeutic privilege might also be applicable to scientists who must decide whether they should withhold (or refrain from gathering) information that might be socially harmful.[1,25]

In particular, Beauchamp and Childress[12] suggest that one way to justify withholding information based on the therapeutic privilege is to show that the information would actually *hinder* a patient's autonomy rather than *promoting* it. Thus, the EOE-IC principle suggests that experts should also consider withholding (or at least being very circumspect about disseminating) information that would be likely to challenge the autonomy of particular members of society. In this respect, the EOE proposed in this article might accord well with some of Philip Kitcher's recent proposals in his book *Science, Truth, and Democracy*.[1] Kitcher argues that scientists may have a responsibility to avoid collecting particular forms of information (or at least to be very careful about disseminating that information) if it would detract from the autonomy of members of society who are already disadvantaged.[1(pp.93ff)] For example, he argues that those who study whether particular racial, ethnic, or gender groups have lower levels of intelligence than other groups have special responsibilities to be careful about how they disseminate their findings. Based on the disclosure component of informed consent (and the therapeutic privilege in particular), the EOE-IC principle would arguably support Kitcher's suggestion.

The second component of informed consent (after disclosure) is understanding. According to Beauchamp and Childress, substantial understanding requires the acquisition of pertinent information and justified, relevant beliefs about the nature and consequences of one's actions.[12] There are several aspects of this component that could yield ethical considerations for an EOE. First, Faden and Beauchamp have emphasized that those making a decision plausibly do not need *perfect* understanding of the information relevant to their decision in order to provide adequate informed consent; they merely need *substantial* understanding.[16] This point is important, because a number of philosophers and sociologists of science have worried that

incommensurability between the perspectives of experts and lay people might provide a serious impediment to democratic decision-making about scientific issues.[15] The EOE-IC principle suggests that informed consent (and thus reasonable democratic decision-making) is still possible if the lay people making a decision can develop enough justified, relevant beliefs based on their communication with scientists. For example, Faden and Beauchamp argue that substantial understanding merely requires that decision-makers understand all the information that is *material* or *important* for their decisions (although it may admittedly be somewhat difficult to determine precisely what information is material or important in any given case).[16]

A second and particularly crucial issue that biomedical ethicists have emphasized concerning the component of understanding is that there are a cluster of common ways in which disclosed information may be *mis*understood by those who receive it. These sources of misunderstanding might be particularly important to consider for scientists who disseminate information to the public. One source of misunderstanding is "information overload." Thus, it might be advisable in some contexts for scientists to withhold unimportant information, especially if it involves unfamiliar terms or is difficult to organize in a meaningful fashion.[12(p.90)] Another very important source of misunderstanding is the *framing* of disclosed information. Beauchamp and Childress emphasize in the biomedical context, for example, that "choices between risky alternatives can be heavily influenced by whether the same risk information is presented as providing a gain or an opportunity for a patient, or as constituting a loss or a reduction of opportunity."[12(p.90)] Framing is likely to be an important issue for scientific experts to consider under the EOE-IC principle as well, because philosophers and sociologists of science have argued that framing can play an important role in disputes that draw on scientific information.[26,27]

A third source of misunderstanding is that those receiving information may have false beliefs that invalidate decisions made on the basis of technically correct disclosed information. For example, let us say that scientific experts were to disclose that environmental factors are more important than genetic factors with regard to their causal role in the current worldwide increases in obesity rates. Decision-makers might still not be able to provide adequate informed consent to policy decisions if they had false beliefs about the most appropriate ways to address those environmental factors. Thus, the EOE-IC principle would encourage scientists to anticipate and counteract false beliefs, misleading framing, and other forms of misunderstanding that might prevent members of the public from making autonomous decisions in response to scientific information.

A third component of informed consent, voluntariness, also may yield guidelines for scientists who disseminate information. In order to analyze this component, Beauchamp and Childress[12] describe three ways in which people can be influenced when making decisions: (1) coercion (deliberate and successful influence by a credible threat of harm that the influenced person cannot resist), (2) persuasion (deliberate and successful influence by appeals to reason), and (3) manipulation (any deliberate and successful influence that is neither coercive nor persuasive).[28,29] They claim that consent is not voluntary if it is the result of coercion or of informational manipulation

that prevents substantial understanding of a decision situation. In other words, voluntary consent must involve only persuasion or informational manipulation that is sufficiently minor to be compatible with substantial understanding. In the medical context, physicians have responsibilities under this component to minimize informational manipulation that could be produced by selective presentation of information, tone of voice, and framing.[12(p.95)]

Scientific experts arguably have similar responsibilities under the EOE-IC principle suggested in this paper. For example, a growing number of empirical studies indicate that comparative pharmaceutical studies that are sponsored by corporations with financial interests in the results of the study tend to be biased in favor of the interested corporations.[30,31] To the extent that experts deliberately and effectively manipulate information in order to obtain those misleading results, their behavior would be ethically problematic under the voluntariness component (and, presumably, the understanding component) of informed consent. The voluntariness and understanding components might also provide guidance for addressing the dispute mentioned in the introduction of this paper (regarding the extent to which experts should interpret disseminated results) between Shrader-Frechette and Resnik.[4,6] One would arguably need to consider in particular cases whether the interpretation of information qualifies as a manipulation that prevents substantial understanding of the decision situation or whether the interpretation actually promotes the understanding of those making the decision.

Objections and Clarifications

Despite the potential guidance provided by the theoretical framework suggested in this section, one might raise several different objections to it. First, one might worry that the EOE-IC principle is too demanding. For example, it might seem unrealistic to expect scientists (who are busy trying to do research) to spend time worrying about how the public might be likely to misunderstand the information that they disclose. In response, however, one might argue that the scientific community, as part of a profession that receives extensive taxpayer funding and public respect, arguably has at least some responsibilities to provide usable information to the public and its policy-making representatives. In addition, it is important to note that the EOE-IC principle states only that the scientific community has *prima facie* responsibilities to promote informed consent. Thus, other responsibilities (e.g., gaining new information, meeting the needs of one's employer, or satisfying other ethical duties) could sometimes take priority over the responsibilities stated in the EOE-IC principle. Finally, part (b) of the EOE-IC principle acknowledges that some scientists may have more responsibility to serve the public's interests than others; part (b) merely requires that all scientists avoid *hindering* the ability of the scientific community to fulfill its social responsibilities.

A second objection to an EOE based on informed consent is that there are significant *differences* between the contexts in which clinicians obtain informed consent from patients and the situations in which the EOE-IC principle would apply. Thus, one might question the attempt in this paper to glean insights from the

biomedical literature on informed consent and to use them to guide scientific experts who disseminate information to the public or to policy makers. For example, one important difference between these two contexts is that, whereas clinicians address their disclosures to particular patients, it may be somewhat unclear to whom scientific experts should be directing their disclosures of information. The information provided by scientific experts may be relevant to a variety of different decisions, and it is often not merely one person (or even one group) providing informed consent to each decision. Another difference is that scientists are generally not involved in the entire informed consent process to the extent that physicians in clinical settings are; the responsibilities of scientists arise primarily from the components of informed consent associated with *providing information*. A third difference is that, whereas a single physician might be the primary source of information for the informed consent of his or her patients, social decisions are generally based on information disseminated by many different scientists. Thus, the responsibilities of individual scientists might be somewhat different than the responsibilities of individual clinicians. A fourth difference is that, whereas physicians provide information to their patients via a fairly standardized process (e.g., discussing a consent form with a patient), scientists disseminate information to the public in a very wide variety of situations. These contexts might include public testimony before government policy makers, legal testimony in court cases, original journal articles, commentaries, review articles, taped interviews for television news, interviews for newspaper articles, and presentations for citizen gatherings.

In response to all these differences, however, one might argue that they do not provide any direct reason to deny that scientific experts have a responsibility to promote the informed consent of decision-makers who draw on scientific information. Rather, the differences suggest that one must apply the EOE-IC principle in a manner that is sensitive to the particular situations in which scientists find themselves, which may be significantly different in some cases from the situations of medical researchers or clinicians. For example, one of the most important differences between the situations of clinicians versus those of other scientific experts is that it is arguably much easier to identify the specific decisions that are being considered and the particular individuals who are giving their consent in a clinical setting. This does not appear to be an insuperable problem for the EOE-IC principle, however, as long as one applies it with sensitivity to particular situations. In many cases, it may be fairly obvious to scientific experts that their disseminated information is likely to be used for particular decisions. For example, section III of this paper analyzes a case in which experts know that their work will be highly relevant to government regulators who set exposure guidelines for toxic chemicals and carcinogens.

Admittedly, one might still worry that there are likely to be other cases (perhaps involving highly theoretical or esoteric science) in which disseminated information does not have obvious implications for individual or societal decisions. One potential response to this worry is that the situations in which a theoretically sophisticated ethics of expertise is really needed are the situations in which scientific information is likely to be used for particular social or personal decision-making, and those situations are

covered by the EOE-IC principle. A second response is that, because even theoretical or esoteric science might eventually become relevant to practical decision-making in the future, the EOE-IC principle would arguably encourage researchers who disseminate such information to meet basic scientific responsibilities (e.g., making claims that are as objective and reliable as possible). That way, future users of the information could at least be assured that the scientists making the claims were following the basic norms of the scientific community.

A final objection to the arguments in this section might be that its discussion of the EOE-IC principle has been overly general. The paper has not explored how the specific maxims proposed by Hardwig might be supported or questioned based on the concept of informed consent. Furthermore, although it suggested that the understanding and voluntariness components might provide guidance for resolving the disagreement between Resnik[3,6] and Shrader-Frechette,[4] this section has not decisively argued for one side or the other in their dispute. Finally, although the paper has acknowledged that scientists might have differing responsibilities depending on the contexts in which they provide information, it has not provided a systematic list of the variables that scientists might need to consider when crafting their dissemination of information. (These variables might include the gender, age, and experience level of the scientist; the prestige of the scientist and his or her institution; the dissemination activities of other members of the scientific community; the degree of uncertainty or disagreement in the scientific community; and the potential impacts of the decisions that need to be made.) Although a thorough examination of all these issues is beyond the scope of this paper, perhaps the best way to begin responding to this objection is to turn to section III, which illustrates how the EOE-IC principle can provide practical guidance in a particular case study.

III. Hormesis: A Case Study from Contemporary Toxicology

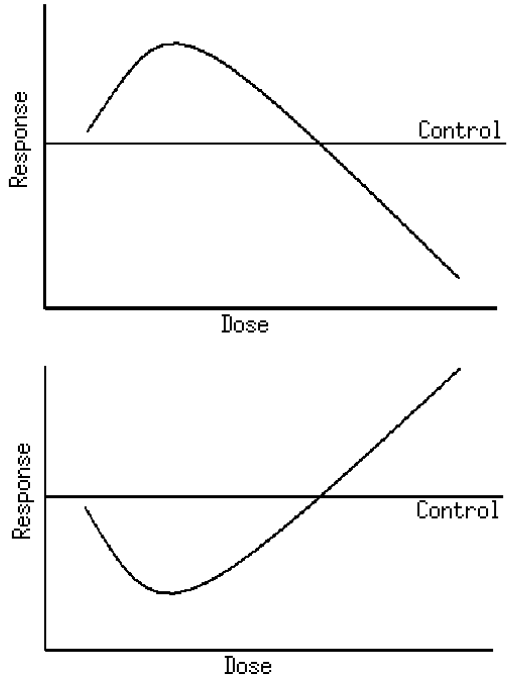
Background

The low-dose effects of toxic and carcinogenic chemicals are currently a hot topic of discussion in environmental research and public policy. Because the costs for cleaning up and regulating toxic chemicals increase dramatically as their concentrations decrease, significant amounts of money are at stake in scientific and policy debates about these effects. It is difficult to get statistically significant data to settle these disputes, however, because it would require studies with enormous numbers of experimental animals. The result is an ongoing conflict between representatives from the medical, environmental, industrial, and military communities concerning the most appropriate models to use for extrapolating data on the high-dose effects of toxins down to lower dose levels. On the one hand, some research indicates that a number of chemicals may "mimic" hormones such as estrogen or otherwise interfere with the endocrine system and therefore produce surprisingly harmful effects on humans and wildlife at very low doses.[32,33] On the other hand, some scientific researchers and industry groups are appealing to an alleged biological phenomenon called hormesis to

support the notion that current governmental regulatory standards overestimate the harm caused by low-dose exposure to toxins.[34]

The phenomenon of hormesis involves beneficial or stimulatory effects caused by very low doses of toxic chemicals that are harmful or inhibitory at higher doses (see Figure 2). A familiar example of this sort of dose-response curve is that of alcohol. *Low* levels of alcohol *decrease* human mortality rates below control levels. Nevertheless, *high* levels of alcohol consumption *increase* human mortality rates above control levels. Other alleged examples of hormesis are more counter-intuitive than that of alcohol (and some researchers would argue that alcohol does not provide a genuine example of hormesis). For example, some evidence seems to indicate that, at particularly low dose levels, some plant growth inhibitors may actually increase plant growth and some carcinogens may decrease tumor development.[35]

Figure 2. Examples of the general form of hormetic dose-response relationships. The bottom curve could represent the hormetic effects of a carcinogen on the incidence of tumors, whereas the top curve could represent the hormetic effects of growth inhibitors on plant growth.



In recent years, the prominent toxicologist Edward Calabrese has performed at least three extensive literature searches designed to uncover evidence for hormesis in previous toxicology studies.[36-38] Although these literature searches may have methodological weaknesses,[39-43] Calabrese and Baldwin claim that they have enough

evidence to suggest that hormetic effects are widely generalizable across different species, biological endpoints, and toxins.[34,35] Other researchers have agreed that "[t]here can be no doubt about the reality of hormesis."[44(p.278)] Calabrese and Baldwin's recent discussion of the hormesis hypothesis in the journal *Nature*[34] and a review of their work in *Science*[45] appear likely to promote and legitimize even more discussion of the phenomenon in the future.

The hormesis case (as well as other scientific debates about the low-dose effects of toxic chemicals) illustrates the importance of having an EOE, because the researchers investigating hormesis need to consider a number of issues. These include: how confidently to present their results; how (and whether) to present the views of scientists who disagree with them; how to characterize uncertainties associated with their work; and whether to incorporate societal values (e.g., concern about potential biological harms caused by chemicals and potential economic harms caused by stringent chemical regulations) in the interpretation of their results. For the sake of simplicity, this section focuses on one particular dissemination situation related to hormesis research, namely, Calabrese and Baldwin's recent paper in *Nature*. This case study illustrates how the EOE-IC sketched in section II can clarify moral issues that would otherwise be ambiguous. The *Nature* paper is arguably a good case for analysis, because: (1) it has been one of the most high-profile means by which information about hormesis has been disseminated to policymakers and the public; (2) Calabrese (a co-author of the paper) is one of the most important researchers who has investigated the hormesis phenomenon; and (3) some elements of the paper are sufficiently ethically questionable that it provides an opportunity to illustrate how the EOE-IC from section II can provide helpful moral guidance.

Overview of the Nature *Paper*

Current uncertainties about how best to evaluate the evidence for hormesis and to describe the hormesis phenomenon are at the root of the ethical questions associated with the *Nature* paper. One problem, as this author (Elliott) points out, is that researchers do not currently agree on one particular concept for describing it.[46] For example, some researchers define hormesis "operationally," as any case in which a toxin produces opposite biological effects at low versus at high doses. Other researchers define it "mechanistically," as a phenomenon that involves overcompensation processes or other particular causal mechanisms. Still other researchers appear to define it somewhat "normatively," such that hormesis involves *beneficial* effects produced by low doses of chemicals that produce *harmful* effects at higher doses. An even more basic difficulty is that the current evidence for hormesis is compatible with at least three different "characterizations" of the frequency with which it occurs:

(1) "Occasional" (O) characterization: Hormetic dose-response curves occur occasionally as one of many different dose-response curves that toxins display, but they do not predominate over these other curves.

(2) "Partial Predominance" (PP) characterization: Hormetic dose-response curves predominate over other curves for non-carcinogenic toxins, but they do not predominate over other curves for carcinogenic toxins.

(3) "Total Predominance" (TP) characterization: Hormetic dose-response curves predominate over other curves for both non-carcinogenic and carcinogenic toxins.

The variables that affect the occurrence of hormetic dose-response curves are still a matter of investigation. For example, Vichi and Tritton provided evidence that hormetic effects might be particularly likely to occur in systems that are already stressed as the result of exposure to sub-optimal conditions.[47] Because of current uncertainty about the nature of the hormesis phenomenon, toxicological experts have to make difficult decisions about which characterizations of hormesis to emphasize when giving information to the public and to policymakers.

The most obviously questionable aspect of the *Nature* paper is that it presents the "Total Predominance" (TP) characterization of the frequency of hormesis as if it were the only characterization supported by current evidence. Moreover, the paper fails to acknowledge that many (perhaps most) toxicologists would be unconvinced that current evidence decisively favors the TP characterization. To illustrate this point, consider the following four quotations from Calabrese and Baldwin's article:

(CB1) "The hormetic model is not an exception to the rule – it is the rule."[34(p.691)]

(CB2) "Now, we not only know that it [i.e., hormesis] exists but accept its dominance over other models."[34(p.692)]

(CB3) "Most notably it [i.e., hormesis] challenges the belief and use of low-dose linearity in estimating cancer risks, and emphasizes that there are thresholds for carcinogens."[34(p.692)]

(CB4) "As both types of biological response [i.e., the biological responses to non-carcinogens and carcinogens] follow the hormetic paradigm and display similar quantitative features of the dose response, the EPA could use the hormetic model as default to assess risk in both non-carcinogens and carcinogens."[34(p.692)]

These four quotations clearly suggest that the TP characterization is the one supported by current evidence, and Calabrese and Baldwin do not indicate in their paper that other toxicologists might think differently.

Despite Calabrese and Baldwin's apparent confidence in their preferred characterization of the frequency of hormesis, however, other opinions appear to be reasonable. For example, Wayne Jonas argues that it is still plausible, given current evidence, to characterize the frequency of hormesis as only *occasional*:

> Less than 1% of over 20,000 studies reviewed [by Calabrese and Baldwin] came close to true hypothesis testing of hormesis in experimental settings…. The criteria for rigorous 'proof' of hormesis will be different than those the authors [i.e., Calabrese and Baldwin] have used simply to 'identify' [that] hormesis may exist. In the former [i.e., rigorous proof of hormesis] one would want to assure proper dose verification, randomization of samples,

> blinding of outcome measures, proper statistical analysis, and full reporting of all data."[41(pp.626-627); see also 43, 48,49]

Moreover, in her recent news article on hormesis in *Science*, Jocelyn Kaiser quotes William Farland (risk assessment chief at the U.S. EPA) as saying that it is not yet clear that the benefits of low-dose chemicals outweigh their risks. Farland also allegedly claimed that the concept of hormesis "has been taken over by rhetoric."[45(p.376)] Kaiser also quotes Frederick vom Saal, a University of Missouri-Columbia biologist who is well known for his studies of endocrine disrupting chemicals, as saying that Calabrese's notion that low-dose effects are often healthy "is where Ed [Calabrese] falls off the edge of the earth."[45(p.376)]

Finally, even if one were to conclude with Calabrese and Baldwin that there is sufficient evidence to think that hormetic dose-response curves predominate over other dose-response curves for *non-carcinogenic* toxins, there are at least two additional reasons to question whether hormetic dose-response curves also predominate for *carcinogens*.[40] First, Calabrese and Baldwin's evidence for hormesis comes primarily from literature studies of previous research, but those previous investigations examined relatively few carcinogenic substances. Second, many of the carcinogenic endpoints for which U-shaped dose-response curves were identified in the literature studies were endpoints *related* to carcinogenesis (e.g., cell division or DNA-repair enzyme activity) that do not provide completely convincing evidence for the occurrence of hormesis on endpoints that reflect the *entire process* of carcinogenesis (e.g., cancer-related illness or mortality).

Given that Calabrese and Baldwin failed to acknowledge alternative characterizations of the frequency of hormesis in their *Nature* paper, their publication appears to be ethically questionable according to the maxims of Hardwig's EOE. For example, his first maxim for experts begins, "Admit when you don't know, when you're guessing, and when your opinion is only a reasonable estimate. *Don't overestimate the scope or certainty of your knowledge*…".[5(p.92)] italics added). Moreover, his second maxim states:

> Tell the truth as you see it in your professional judgment, but don't give the impression that you speak for the community of experts when you do not. When the community of expert opinion is divided, there is an obligation to say that it is. When your opinion is a minority view within the community of experts, you should make that clear.[5 (p.92)]

Based on these maxims, one might conclude that Calabrese and Baldwin's dissemination of information in the *Nature* paper is obviously unethical.

There are several mitigating circumstances, however, that might make Calabrese and Baldwin's actions appear to be less ethically problematic. First, the paper was published as a "Commentary" piece, and one might think that authors should be allowed to take extra liberty to express their personal views in articles of that sort. Second, one might argue that debates about the regulation of toxic chemicals provide the sort of heavily politicized scientific context in which it is to be expected that particular scientists will speak for particular interest groups. Thus, one might think that

it is unrealistic to expect individual toxicologists to provide representative information about the views of the toxicological community as a whole. Rather, one might think that one should depend on interchanges between toxicologists with opposing views in order to obtain adequate information about the current state of the science. Third, the toxicological community and the EPA have been fairly hesitant to consider changing current risk-assessment practices in response to Calabrese and Baldwin's studies of hormesis.[50] Therefore, one might suppose that there is little danger that the *Nature* paper's overly "aggressive" style will result in unjustified regulatory changes. In fact, one might argue that the public is very likely to be biased against the notion that pollution can be beneficial,[51] so proponents of hormesis need to present their views aggressively in order to gain an adequate hearing for them. A fourth reason to think that Calabrese and Baldwin may not have violated ethical standards in their *Nature* paper is that, as they emphasized in their article, there appear to be significant economic costs associated with the regulation of toxic chemicals at low doses. Thus, Calabrese and Baldwin may have been motivated to "shake up the status quo" and to interpret the data for hormesis somewhat aggressively because of the social costs of stringent chemical regulations.

The *Nature* paper thus appears to provide precisely the sort of situation in which the EOE-IC developed in section II can be helpful. Hardwig's maxims suggest that Calabrese and Baldwin's dissemination of information is questionable. Nevertheless, it is not entirely clear how to apply those maxims to this particular situation. Admittedly, it might be possible to provide adequate guidance within Hardwig's original framework merely by fleshing out his concept of trust, without turning to the notion of informed consent. The contention of this paper, however, is that the concept of informed consent has already received so much detailed analysis by biomedical ethicists that there is little to lose and much to gain by considering how the EOE-IC principle from section II might shed light on Calabrese and Baldwin's situation.

Analysis of the **Nature** *Paper Based on the EOE-IC Principle*

Following is a four-premise argument, starting with the EOE-IC principle as the first premise, that Calabrese and Baldwin should have provided some information about alternative characterizations of hormesis in their *Nature* article.

1. (a) The scientific community has *prima facie* duties, in contexts in which scientific information is likely to be used for particular individual or group decisions, to disseminate that information in a manner that promotes the ability of those affected by the decisions to provide some form of informed consent to them. (b) Individual scientists have *prima facie* duties not to hinder (and in some cases to facilitate) the ability of the scientific community to fulfill its duties.
2. The social context surrounding Calabrese and Baldwin's *Nature* paper is such that the information in it is likely to be used for decisions about the regulation of toxic chemicals.

3. In their *Nature* article, Calabrese and Baldwin did not provide representative information about the views of the scientific community concerning the O, PP, and TP characterizations of the frequency of hormesis.
4. Calabrese and Baldwin's failure to provide representative information in the *Nature* paper hinders the ability of the scientific community to meet its responsibilities stated in the EOE-IC principle.
5. Therefore, unless Calabrese and Baldwin can appeal to considerations that override their *prima facie* duties stated in premise 1, they disseminated information in an ethically questionable manner in their *Nature* article.

Consider the significance and the justification for each of the four premises of this argument. Premise (1) restates the EOE-IC principle, which was already defended in section II of this paper. Premise (2) establishes that Calabrese and Baldwin have a responsibility to meet the ethical standards in the EOE-IC principle, because they are providing information that is likely to be used for a particular societal decision. The notion that the *Nature* article is likely to influence societal decisions appears to be justifiable for at least two reasons. First, Calabrese and Baldwin explicitly suggest in the article that hormesis has significant ramifications for the regulation of toxic chemicals. Second, *Nature* is a particularly prestigious scientific journal, so the article is likely to appear significant to policymakers who are making regulatory decisions. Premise (3) merely describes the content of the *Nature* article, so it does not appear to be very controversial. Premise (4) is the crucial premise of the argument, insofar as it states that the content of the article (as described in the third premise) hinders the ability of the scientific community to meet its responsibilities under the EOE-IC principle.

In order to defend premise (4), one must argue not only that Calabrese and Baldwin *themselves* failed to promote informed consent but also that their failure hindered the scientific *community as a whole* from promoting informed consent. This is an important stipulation, because it is possible that even if individual scientists do not promote informed consent, the structure of the scientific community could be such that those individual failings do not always hinder the community as a whole from promoting informed consent. The remainder of this section argues, first, that Calabrese and Baldwin *themselves* arguably failed to promote the informed consent of decision-makers, because they failed to provide representative information about the views of the scientific community concerning the O, PP, and TP characterizations of hormesis. The section then argues that this failure also hindered the ability of the scientific community *as a whole* to promote informed consent to chemical regulations.

One way to make the argument that Calabrese and Baldwin's selective disclosure of information failed to promote informed consent is to show that the information that they withheld is *material* to those who make regulatory decisions about hormesis. The disclosure and understanding components (and perhaps also the voluntariness component) of informed consent are violated when all material information is not provided to decision-makers. According to premise (3), Calabrese and Baldwin failed to provide representative information about the views of the scientific community

concerning the O, PP, and TP characterizations of the frequency of hormesis. It does in fact appear that this information is material to decisions about the regulation of toxic chemicals, because the perspective of the scientific community concerning these characterizations seems to be extremely important for making regulatory decisions. As Calabrese and Baldwin themselves emphasize in their article,[34] the choice to emphasize one characterization rather than another could have significant ramifications for the public, both in terms of health and the economy. Therefore, insofar as all three characterizations have at least some plausibility based on current evidence (as this section has already argued), it seems important to make decision-makers aware of more than one characterization.[d] Moreover, given that toxic chemical regulation is notoriously subject to political debates and influence that could bias particular scientists,[52-55] decision-makers would arguably think that it is material to have some understanding of the views of the scientific community as a whole (as opposed to having only the views of a particular subset of scientists).

Depending on the social context surrounding Calabrese and Baldwin's dissemination of information, however, their failure to present a representative range of views might not hinder the ability of the *scientific community as a whole* to promote the informed consent of decision-makers. For example, if their paper were part of a symposium in which a number of eminent scientists with conflicting views on hormesis presented their distinctive viewpoints, Calabrese and Baldwin's rather one-sided presentation might actually aid the scientific community in promoting informed consent to regulatory decisions about hormesis. In actuality, however, their *Nature* paper stood alone. Because they presented only their preferred characterization of the frequency of hormesis and failed to acknowledge any alternative characterizations, there is a danger that decision-makers who read their article might get the false impression that the vast majority of the scientific community is firmly convinced of the TP characterization of hormesis. Admittedly, one might insist that even this danger might not be particularly serious as long as one could expect decision-makers to receive a representative understanding of the scientific community's views through other mechanisms. Nevertheless, there appear to be at least three reasons for thinking that Calabrese and Baldwin's selective disclosures are indeed likely to hinder decision-makers from receiving representative information about the views of the scientific community.

d. The responsibility to make decision-makers aware of alternative perspectives suggests another significant parallel between the responsibilities of scientific experts and the responsibilities of clinicians. Many thinkers are arguing in the biomedical context that the informed consent process should be more evidence-based. According to this perspective, clinicians arguably have a responsibility to present information about alternative treatments (even if they do not favor those treatments) if there is significant evidence supporting the efficacy of those treatments. This paper suggests that scientific experts like Calabrese have analogous responsibilities to present alternative scientific perspectives, even if they do not agree with those perspectives.

A first problem is that, according to the policy of the journal *Nature*, the editors do not accept responses to "Commentary" pieces.[e] Thus, other scientists are unable to formulate quick responses in the same venue in which Calabrese and Baldwin disseminated their own opinions. This policy makes it less likely that the other perspectives in the scientific community can receive a comparable hearing to Calabrese and Baldwin's views. One might still argue that there are plenty of other venues besides the journal *Nature* in which those with different opinions regarding hormesis can make their views known to the public. A second problem, however, is that Calabrese appears to hold such a dominant position in the field of hormesis research that his views are likely to have a significant impact on public discussions about the phenomenon.[f] Therefore, if he makes pronouncements regarding hormesis that fail to promote informed consent to regulatory decisions, his pronouncements are particularly likely to hinder the ability of the scientific community as a whole to provide information that promotes informed consent.

A third reason to think that Calabrese and Baldwin's selective dissemination of information may hinder the ability of the scientific community to promote informed consent is that vested interests seem to have a fairly successful record of using small, unrepresentative bodies of scientific information to influence government policy.[52-55] Thus, even if other members of the scientific community do emphasize characterizations of hormesis other than those presented by Calabrese and Baldwin, decision-makers may still receive a skewed understanding of the scientific community's perspectives if interest groups draw unwarranted attention to the views of Calabrese and Baldwin. In fact, there are several reasons to think that interest groups are likely to try to emphasize Calabrese and Baldwin's perspectives over the other views present in the scientific community. One reason is that, because industrial groups have already provided Calabrese with funding, they are very familiar with his work and therefore particularly likely to try to use it to further their interests.[g] Another reason is that the industry groups affiliated with Calabrese's work have already begun appealing to his research in order to change regulatory policy. For example, Kaiser reports that

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e. The author obtained this information from a colleague who attempted to write a reply to Calabrese and Baldwin's article but who was turned down based on the fact that the original article was a "commentary" piece.

f. A recent search in the ISI Web of Knowledge database indicated that Calabrese authored roughly 16% of the articles about hormesis that were written between 2000 and July of 2005. Moreover, of the articles that *others* have written on the topic of hormesis, Calabrese was cited by 59% of them. Specifically, there were 65 total articles published between 2000 and July of 2005 that were listed under "Calabrese" as author and that had "hormesis" in the title, keyword, or abstract fields. The *total* number of articles published between 2000 and 2005 that had "hormesis" in the title, keyword, or abstract fields was 419; thus, authors other than Calabrese published 354 of those articles. Examination of the citation lists in those 354 articles indicated that 248 of them (59%) cited one or more articles written by Calabrese.

g. Texas Institute for the Advancement of Chemical Technology (TIACT) provided funding for Calabrese and Baldwin's original literature search of hormesis.[45] The Biological Effects of Low-Level Exposures (BELLE) advisory council, which Calabrese chairs and which publishes a newsletter and organizes conferences related to hormesis, also receives funding from industry groups (see http://www.belleonline.com).

TIACT "put out a flyer in 1998 citing examples of hormesis such as dioxin, mercury, and the pesticide lindane; the brochure declared sunnily that hormesis could allow 'society to enjoy the benefits of many chemicals that have been banned."[45(p.377)] A final reason is that U.S. policy regarding *toxic chemicals in particular* is an issue on which industry groups have been very successful in influencing government agencies. Beder,[52] Fagin et al.,[53] Markowitz and Rosner,[54] and Wargo[55] have argued that industry groups have been able to bring the regulatory process for chemicals such as alachlor, atrazine, formaldehyde, and perchloroethylene to a virtual standstill, arguably without evidentiary justification for such regulatory policies.

Thus, there appear to be several reasons to think that Calabrese and Baldwin's selective dissemination of information in their *Nature* article[34] may hinder the ability of the scientific community as a whole to promote public informed consent to decisions over the regulation of toxic chemicals. Unless they can appeal to more important responsibilities that overrode their duties under the EOE-IC principle, they appear to have disseminated information in an ethically questionable manner. This case study therefore illustrates how the theoretical framework developed in section II can provide practical guidance for specifying and weighing the principles suggested by Hardwig in his earlier EOE. Moreover, this case study also illustrates the extent to which, in applying the EOE-IC principle to actual cases, one needs to evaluate the details of the situations in which scientists provide information. In the case of the *Nature* article, for instance, it is not merely the failure of Calabrese and Baldwin to disclose all material information that is problematic but also the fact that their unrepresentative perspective may be blown out of proportion by various interest groups.

IV. Conclusions

This article developed an ethics of expertise based on the concept of informed consent, suummarizing how the extensive literature on informed consent in biomedical ethics can provide a set of ethical considerations and guidelines for scientific experts. The paper then applied this ethics of expertise to a case study involving the dissemination of information about the biological hazards of low-dose exposure to toxic chemicals and carcinogens. Three avenues for future research appear to be particularly promising. First, it would be helpful to use the theoretical framework developed in section II to evaluate Hardwig's[5] preliminary list of maxims, perhaps providing guidance for specifying and prioritizing them in particular situations. Second, as section II acknowledged, it seems important to consider how the differences between the situations in which clinicians facilitate informed consent and the situations in which scientific experts facilitate informed consent may result in different ethical responsibilities for the two groups. Third, in order to apply the EOE-IC principle effectively in actual cases, it seems crucial to develop a list of the relevant variables (e.g., one's age, career history, institution, and format of dissemination) that may affect scientists' responsibilities when providing information to the public. Using a list of this sort, scientific experts could not only avail themselves of helpful maxims, but they could also receive guidance concerning the special conditions that might alter their typical responsibilities.

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REFERENCES

1. Kitcher, P. (2001) *Science, Truth, and Democracy*. Oxford University Press, Oxford.
2. Pimple, K. (2002) Six Domains of Research Ethics: A Heuristic Framework for the Responsible Conduct of Research. *Science and Engineering Ethics* **8**: 191-205.
3. Resnik, D. (1998) *The Ethics of Science*. Routledge, London.
4. Shrader-Frechette, K. (1994) *The Ethics of Scientific Research*. Rowman and Littlefield, Lanham, MD.
5. Hardwig, J. (1994) Toward an Ethics of Expertise, in: Wueste, D. ed. *Professional Ethics and Social Responsibility*. Rowman and Littlefield, Lanham, MD.
6. Resnik, D. (1996) Critical Study: Kristin Shrader-Frechette, *Ethics of Scientific Research*. *Noûs* **30**: 133-143.
7. Segerstrale, U. (2001) Judging 'Good Science': Toward Cooperation between Scientists and Lawyers, in: Weil, V. ed. *Trying Times: Science and Responsibilities after Daubert*. CSEP & ISLAT, Chicago: 48-61.
8. Fiorino, D. (1990) Citizen Participation and Environmental Risk: A Survey of Institutional Mechanisms. *Science, Technology, and Human Values* **15**: 226-243.
9. Shrader-Frechette, K. (1991), *Risk and Rationality*. University of California Press, Berkeley.
10. Shrader-Frechette, K. (1993) Consent and Nuclear Waste Disposal. *Public Affairs Quarterly* **7**: 363-377.
11. Wigley, D. and K. Shrader-Frechette (1996) Environmental Justice: A Louisiana Case Study. *Journal of Agricultural and Environmental Ethics* **9**: 61-82.
12. Beauchamp, T. and J. Childress (2001) *Principles of Biomedical Ethics*, 5th ed. Oxford University Press, Oxford.
13. Taylor, J. (2004) Autonomy and Informed Consent: A Much Misunderstood Relationship. *Journal of Value Inquiry* **38**: 383-391.
14. National Research Council (1996) *Understanding Risk: Informing Decisions in a Democratic Society*. National Academy Press, Washington, D.C.
15. Turner, S. (2003) *Liberal Democracy 3.0*. SAGE Publications, London.
16. Faden, R. and T. Beauchamp (1986) *A History and Theory of Informed Consent*. Oxford University Press, New York.
17. May, T. (2002) *Bioethics in a Liberal Society*. The Johns Hopkins University Press, Baltimore.
18. Mazur, D. (2003) *The New Medical Conversation*. Rowman and Littlefield, Lanham, MD.
19. Wear, S. (1993) *Informed Consent: Patient Autonomy and Physician Beneficence within Clinical Medicine*. Kluwer, Dordrecht.
20. Longino, H. (2001) *The Fate of* Knowledge. Princeton University Press, Princeton.
21. Longino, H. (1990) *Science as Social Knowledge*. Princeton University Press, Princeton.
22. Solomon, M. (2001) *Social Empiricism*. MIT Press, Cambridge, MA.
23. Rowe, G. and L. Frewer (2000) Public Participation Methods: A Framework for Evaluation. *Science, Technology, & Human Values* **25**: 3-29.
24. Wilkinson, T. (2001) Research, Informed Consent, and the Limits of Disclosure. *Bioethics* **15**: 341-363.
25. Kitcher, P. (1985) *Vaulting Ambition*. MIT Press, Cambridge, MA.
26. Roth, A., Dunsby, J., and L. Bero (2003) Framing Processes in Public Commentary on US Federal Tobacco Control Regulation. *Social Studies of Science* **33**: 7-44.

27. Shrader-Frechette, K. (1997) Hydrogeology and Framing Questions Having Policy Consequences. *Philosophy of Science* 64 (Supplement 1997): S149-S160.
28 Donnelly, M. (2002) *Consent: Bridging the Gap Between Doctor and Patient*. Cork University Press, Cork.
29. Gert, B., C. Culver, and K. Clouser (1997) *Bioethics: A Return to Fundamentals*. Oxford University Press, New York.
30. Friedberg, M., B. Saffran, T. Stinson, W. Nelson, and C. Bennett (1999) Evaluation of Conflict of Interest in Economic Analyses of New Drugs Used in Oncology. *Journal of the American Medical Association* **282**(October 20): 1453-1457.
31. Krimsky, S. (2003) *Science in the Private Interest*. Rowman and Littlefield, Lanham, MD.
32. Colborn, T., D. Dumanoski, and J. Myers. (1996) *Our Stolen Future*. Dutton, New York.
33. Krimsky, S. (2000) *Hormonal Chaos: The Scientific and Social Origins of the Environmental Endocrine Hypothesis*. Johns Hopkins University Press, Baltimore.
34. Calabrese, E. and L. Baldwin (2003) Toxicology Rethinks Its Central Belief. *Nature* **421**(13 February): 691-692.
35. Calabrese, E. and L. Baldwin (1998) *Chemical Hormesis: Scientific Foundations*. Texas Institute for the Advancement of Chemical Technology, College Station, TX.
36. Calabrese, E. and L. Baldwin (1997) The Dose Determines the Stimulation (and Poison): Development of a Chemical Hormesis Database. *International Journal of Toxicology* **16**: 545-559.
37. Calabrese, E. and L. Baldwin (2001) The Frequency of U-Shaped Dose Responses in the Toxicological Literature. *Toxicological Sciences* **62**: 330-338.
38. Calabrese, E. (2001) Overcompensation Stimulation: A Mechanism for Hormetic Effects. *Critical Reviews in Toxicology* **31**: 425-470.
39. Crump, K. (2001) Evaluating the Evidence for Hormesis: A Statistical Perspective. *Critical Reviews in Toxicology* **31**: 669-679.
40. Elliott, K. (2000) A Case for Caution: An Evaluation of Calabrese and Baldwin's Studies of Chemical Hormesis. *Risk: Health, Safety, and Environment* **11**: 177-196.
41. Jonas, W. (2001) A Critique of 'The Scientific Foundations of Hormesis'. *Critical Reviews in Toxicology* **31**: 625-629.
42. Menzie, C. (2001) Hormesis in Ecological Risk Assessment: A Useful Concept, a Confusing Term, and/or a Distraction? *Human and Experimental Toxicology* **20**: 521-523.
43. Rodricks, J. (2003) Hormesis and Toxicological Risk Assessment. *Toxicological Sciences* **71**: 134-136.
44. Gerber, L., G. Williams, and S. Gray (1999) The Nutrient-Toxin Dosage Continuum in Human Evolution and Modern Health. *Quarterly Review of Biology* **74**: 273-289.
45. Kaiser, J. (2003) Sipping from a Poisoned Chalice. *Science* 302(17 October): 376-379.
46. Elliott, K. (2000) Conceptual Clarification and Policy-Related Science: The Case of Chemical Hormesis. *Perspectives on Science* **8**: 346-366.
47. Vichi, P. and T. Tritton (1989) Stimulation of Growth in Human and Murine Cells by Adriamycin. *Cancer Research* **49**: 2679-2682.
48. Roberts, S. (2001) Another View of the Scientific Foundations of Hormesis. *Critical Reviews in Toxicology* 31: 631-635.
49. Thayer, K., R. Melnick, K. Burns, D. Davis, and J. Huff (2005) Fundamental Flaws of Hormesis for Public Health Decisions. *Enviromental Health Perspectives* 113: 1271-1276.
50. Davis, J. M. and W. Farland. (1998) Biological Effects of Low-Level Exposures: A Perspective from U.S. EPA Scientists. *Environmental Health Perspectives* 106:380-381.
51. Renn, O. (2002) Hormesis and Risk Communication. *BELLE Newsletter* 11: 2-24.
52. Beder, S. (2000), *Global Spin*, rev. ed. Chelsea Green, White River Junction, VT.
53. Fagin, D., M. Lavelle, and the Center for Public Integrity (1999) *Toxic Deception*, 2nd ed. Common Courage Press, Monroe, ME.
54. Markowitz, G. and D. Rosner (2002) *Deceit and Denial: The Deadly Politics of Industrial Pollution*. University of California Press, Berkeley.
55. Wargo, J. (1996) *Our Children's Toxic Legacy*. Yale University Press, New Haven.