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# Ethical Ambiguity in Science

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**Abstract** Drawing on 171 in-depth interviews with physicists at universities in the United States and the UK, this study examines the narratives of 48 physicists to explain the concept of ethical ambiguity: the border where legitimate and illegitimate conduct is blurred. Researchers generally assume that scientists agree on what constitutes both egregious and more routine forms of misconduct in science. The results of this study show that scientists perceive many scenarios as ethically gray, rather than black and white. Three orientations to ethical ambiguity are considered—altruism, inconsequential outcomes, and preserving the status quo—that allow possibly questionable behavior to persist unchallenged. Each discursive strategy is rationalized as promoting the collective interest of science rather than addressing what is ethically correct or incorrect. The results of this study suggest that ethics training in science should focus not only on fabrication, falsification, and plagiarism and more routine forms of misconduct, but also on strategies for resolving ethically ambiguous scenarios where appropriate action may not be clear.

**Keywords** Ambiguity · Physics · Cross-national · Deontology · Consequentialism · Phronesis

## Introduction

Scholars who study misconduct in scientific work tend to focus on egregious cases, such as falsification of data, in which the distinction between legitimate and illegitimate behavior is black and white. Famous cases include Woo Suk Hwang, a professor of biotechnology who falsified stem cell data (Normile et al. 2005), Jan

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Hendrik Schön, a physicist who fabricated nanotechnology data (Service 2003), and Pattium Chiranjeevi, a chemistry professor who plagiarized research papers from western scientific journals (Schulz 2008). And while such cases of misconduct are seemingly rare, they continue to emerge. The most recent case is an unfolding wave of accusations surrounding the "star" plant scientist Olivier Voinnet, accused by his peers of falsifying data in over 30 publications (Schneider 2015). These and other cases (Anderson et al. 2013) represent black and white instances of misbehavior because the practices in question are so blatantly wrong and involve multiple forms of misconduct, meaning that everyone recognizes them as misconduct.

Although some researchers focus on more routine forms of misconduct (De Vries et al. 2006), it is worth considering whether a black and white view of misconduct—routine or egregious—is overly simplistic. From a sociological perspective, the presumed objectivity of what "misconduct" and "unethical" mean is challenged by the notion that cultural meanings are heterogeneous in content and function (DiMaggio 1997). And among moral philosophers, there is a growing focus on understanding ethical reasoning as practical rather than theoretical, particular rather than universal, and ambiguous rather than clear-cut (Nyberg 2008). In short, how scientists perceive the line separating ethical from unethical behavior is likely to exhibit a much more ambiguous character than existing research acknowledges.

This paper addresses the following questions: When do scientists perceive ethical ambiguity in their work? And what discursive strategies do they employ that enable potentially questionable conduct to exist unchallenged? Drawing on analysis of 171 interviews with physicists at universities in the United States and the United Kingdom, we examine the narratives of 48 physicists who mentioned ethically gray areas. Our analyses reveal when some physicists perceive research and interpersonal practices as ethically gray rather than black and white. Three orientations to ethical ambiguity that allow possibly questionable behavior to persist unchallenged are considered: altruism, inconsequential outcomes, and preserving the status quo. Each discursive strategy promotes the collective interest of science rather than addressing what is ethically correct or incorrect.

## Background

Existing research on ethical conduct in science takes for granted that scientists understand easily recognize, and completely agree upon what constitutes unethical behavior. This is driven in part by the tendency in past research to delimit scholarly focus to egregious and rare infractions of falsification, fabrication, and plagiarism. In the eyes of the US Office of Research Integrity, these are "actions that are unambiguous, easily documented, and deserving of stern sanctions" (Cohen 2005). Consensus that these behaviors are unethical is apparent because they undermine the advance of knowledge, discredit the profession in the eyes of the public, waste funding, and invite outside regulation of science (Chubin 1985). More recent research expands classification of unethical conduct in science by focusing on what scientists view as "normal misbehaviors" that occur more routinely in science (DeVries et al. 2006). These include behaviors such as withholding details of results in papers, exploiting colleagues, misusing research funds, cutting corners to complete a project, and keeping inadequate research records.

Insights from different scholarly literatures suggest, however, that whether scientists reach easy consensus about the meaning of unethical conduct in science is debatable. To take a common example from research on deviance and social control; whether killing someone takes on a meaning of right or wrong will vary across social circumstances such as country context or the social status of the parties involved (Cooney 2009). Research on boundary work—which emphasizes how social actors categorize practices, people, and objects—shows that boundaries that are thought to separate knowledge spheres or social groups are often porous and permeable (Lamont and Molnár 2002; Cadge et al. 2009; Ecklund 2010). Thus, while there is a literature on ethical boundary work in science that concerns the distinction between what research practices are ethically legitimate and those that are not (Hobson-West 2012; Wainwright 2006), it is likely that the same behavior can be open to different ethical interpretations based on the stakeholders who are involved and the intended or actual outcomes of the behavior. That is, what counts as unethical—even when it is a "normal misbehavior"—is much less likely to be a black and white and unambiguous matter than it is one of grays and ambiguities.

Beyond our own disciplinary perspective as sociologists, we recognize that ethical theorists who take a deontological, consequentialism, or virtue ethics approach to ethics have also generated insights that are applicable to how "gray" ethical scenarios in science can be understood.[1] Kantian deontological theories, for example, assert that ethical decision-making is generally a black and white matter because of the presence of a priori moral imperatives related to duty or obligation (Bouville 2008; Kovac 2004; Schmidt 2014). A deontologist might argue then, that scientists have an obligation to acknowledge the origins of their work. And the fact that science journals and organizations prohibit plagiarism imbues giving credit to others with a universal law-like quality. Yet, what constitutes plagiarism is not always intuitive (e.g., how far back in the literature should one cite prior work?) meaning one's obligation to acknowledge the origins of her work may not always be an obvious black and white issue.

According to consequentialism, "right" action should generally be black and white because a scientist can act ethically by measuring the benefit and harm of different options and selecting an action that produces the best outcomes for the most people (Kovac 2004; Rebera and Rafalowski 2014). Yet, it is questionable that scientists are in all instances able to evaluate whether an action would produce the greatest benefit for the greatest number of people. The consequentialist framework thus leaves limited room for ambiguity because outcomes can only be evaluated after the occurrence of a given action in question.

Whereas deontology and consequentialism leave little room for ambiguity (Chen 2015), virtue ethics acknowledges that ethical decision-making requires consideration of circumstances, situational factors, and one's motivations and reasons for

[1] We thank a reviewer for calling our attention to this literature. Our intention here is to highlight the relevance of these frameworks to the conceptualization of ethical ambiguity. The present study should in no way be understood as a test of these theories.

choosing an action, not just the action itself (Han 2015; Schmidt 2014). Central to virtue ethics is the Aristotelian concept of phronesis, or practical wisdom (Chen 2015) to discern the middle way when confronted with many options. As Nyberg (2008:589) explains, phronesis is “not the ‘right’ way of doing things in a particular community, but the ethically good action a practical wise person would take.”

In short, deontology, consequentialism, and virtue ethics vary in their ability to address ambiguity, but each framework points to ways ambiguity is present in the ethical scenarios that scientists face. Deontology invites ambiguity because science lacks absolute ethical rules that can be universally applied to all of the scenarios that scientists encounter beyond the technical decisions they make in their work. Consequentialism invites ambiguity because scientists are limited in their ability to weigh the outcomes of their actions. And virtue ethics suggest that ethical decision-making is always situated in particular circumstances and would thus rarely be black and white due to the need to evaluate what it means to be a good scientist in those particular situations.

The seeds of these insights from sociology and theories of ethics on ambiguity can be found in the casebook literature on practical research ethics (Kovac 2004) and, to a lesser extent, in studies of ethics among scientists. For example, DeVries et al. (2006) provide an example of a gray area in data interpretation, or the difficulty of finding the line between “cleaning” data and “cooking” data. Drawing on sociological forefather Emile Durkheim’s (1982) argument about the functional role of crime—which states that crime marks the boundaries of acceptable and unacceptable behavior in society—DeVries et al. (2006) suggest that scientists’ discomfort in such a gray area allows them to find ways to cope with the uncertainties of their work. While the study emphasizes that competition can lead to behaviors that are not “FFP but nevertheless are regarded by scientists as misconduct,” we argue that gray areas are insufficiently problematized in the literature on unethical conduct in science.

For one, through classification language such as “normal *misbehavior*” and claims that certain actions are *nevertheless* viewed as misconduct, the existing literature underemphasizes the theoretic possibilities that actions viewed as “bad” may in certain contexts take on notions of “good,” “right,” or “acceptable.” The actions themselves are less important than how scientists justify their status as legitimate. Therefore, we need to know more about the discursive strategies scientists employ to legitimate actions in particular contexts and the outcomes that justify such actions. Rather than asking, for example, whether unfair allocation of credit is unethical, we should be asking *when* unfair allocation of credit is unethical or ethical.

Second, we need to know more about the structural and cultural contexts that give rise to ethical ambiguity. While there is a theoretic literature that seeks to explain the conditions that give rise to unethical behavior in science, attributing causes to structural strain, conflict, and individual pathology (Zuckerman 1988), there is a gap in knowledge of the conditions under which ethically ambiguous situations arise. These “gray” areas in scientific conduct are sociologically interesting because they represent contexts in which social control is weak. That is, everyone agrees that black and white issues such as fabrication, falsification, and fraud require punishment. Social control in such contexts is typically harsh and highly visible, as evidenced by the broad reporting of stem cell research falsification in South Korea and Japan. But when notions of right and wrong become ambiguous, mechanisms of social control (sanctions) are less likely to be operative because behavioral motives and outcomes may be less clear. In asking how scientists account for "gray" behaviors that are possibly or likely deviant, and examining the structural and cultural characteristics of these incidents such as status relations, professional culture, and stakeholders involved, we develop a better understanding of the properties of science that hinder social control.

## Data and Methodology

Data for this study are drawn from in-depth interviews conducted with American and British physicists who participated in the ethics among physicists in cross-national perspective study, an international comparative project that examines perceptions of ethics. Overall, we conducted in-depth interviews with 90 American physicists and 81 British physicists. As we explain below, for the purposes of this paper we focus exclusively on a subsample of 21 US and 27 UK physicists for whom ethical ambiguity emerged as a salient theme in the interview.

The broader study employed a cross-national sample; we utilized this methodological approach because global factors are thought to influence science policy and ethics (Bassett 2009; Gordin 2009). Differences between the United States and the United Kingdom in research funding and evaluation (Geuna and Martin 2003), university-industry relations (Owen-Smith et al. 2002), and demographics of the science workforce (Miller et al. 2014), for example, could plausibly result in country-specific conceptualizations of ethical conduct and the types of decision-making circumstances scientists encounter.

The US departments in this study were selected from departments listed in the National Research Council (NRC) 2010 assessment of doctorate-granting universities (Ostriker et al. 2010). The NRC evaluates departments according to 21 different criteria such as faculty publications, citation rates, grants, and awards. We selected top- and low-ranking departments with the aim of maximizing variation in the organizational contexts in which scientists work. We conceive of elite physicists as those found in top ranking departments, and operationalize this elite tier as any department found among the top 25 departments according to the above criterion. Our notion of non-elite emphasizes scientists at the opposite extreme—departments situated among the 50 lowest ranked departments according to the NRC. In the United Kingdom, we used the online Web of Science database (WoS), to create a sampling frame of all university physics departments that had published an article between 2001 and 2011.[2] To categorize departments as elite and non-elite, we

[2] In a supplemental analysis we conducted for a cross-national survey unrelated to the present study, we were able to compare the NRC and WOS rankings of physics departments and found that the systems similarly classified the elite universities as among the top 25. Whereas the NRC analyzed 161 universities and the five non-elites in our sample fell among the 50 lowest ranked departments (or bottom 31 %), in the WoS analysis the five non-elites in our sample fell among the bottom 50 %. However, the result of our triangulation process in which in-country experts classified the physics departments as elite or non-elite resulted in a perfect consistency with how we ranked each department for the present study.

triangulated three sources of information: research productivity (as indicated by WOS), rankings in the 2008 UK Research Assessment Exercise, and consultations with UK scientists on the study's International Advisory Board. From these bases, we selected enough universities to reach a target of 80 interviews in each country: nine universities in the US (4 elite and 5 non-elite) and 15 universities in Britain (4 elite and 11 non-elite).[3]

In each department we employed a random stratified sampling method by rank. In the US we interviewed 90 physicists (74 men, 16 women), with appointments as assistant, associate, and full professors. In the UK we interviewed 81 physicists (72 men, 7 women) with appointments as lecturers, senior lecturers, readers, and professors. Although US and UK academic ranks are not structurally equivalent in terms of titles, timing, and tenure, all of the positions share in common an emphasis on research and teaching. Note, for example, that in the UK lecturers lead research groups, whereas US lecturers tend to exclusively teach undergraduates. The interview samples are more or less equally divided between elite and non-elite physicists in each country. In both the US and the UK, about half of the interviews took place in person, with the remainder completed by skype or telephone. Interview length ranged from 28 min to over 2 h, with the average interview lasting 1 h. All interviews were audio-recorded and transcribed for analysis.

Although the interview guide focused on conceptions of responsibility and experiences of unethical conduct, no direct questions about ethical ambiguity were asked in the US. The notion that certain behaviors in science are ethically unclear or ambiguous became apparent to both authors during the process of conducting interviews and was frequently noted in research memos written by the interviewers. The research memos completed immediately after interviews offer an initial pass at interpretation and the authors independently identified ambiguity as a salient theme in the narratives of many scientists. Analysis of the first 33 interviews in the UK revealed a similar theme, leading us in subsequent interviews to probe with the following question when ethical ambiguity did not independently come up: "Do you find yourself confronting any ethical gray areas in your own research, where you're not sure what's the responsible thing to do?"

The results that follow are based on an inductive analysis of interviews with a total of 48 (21 US, 27 UK) physicists who reported instances of ethical ambiguity in their work. Final coding was completed by the first author. The first phase of coding focused on identifying instances of ambiguity, using qualitative analysis software to identify passages in which scientists employed terms such as "gray," "unclear," and "ambiguous" and related terms such as "black and white" and "ambiguity." Based on the combination of research memos written by both authors and the software assisted coding of the predominant terms that connote ambiguity, we are confident that all cases of ethical ambiguity were identified in the data. Subsequent

[3] In 14 of the 15 departments in the UK sample, there was no ambiguity in the classification of departments as elite or non-elite. In the one case that was unclear, WoS ranked the department high as a result of publication productivity, there was disagreement among experts regarding the elite or non-elite status of the university, and the 2008 RAE ranked the department relatively low. In light of these latter two factors, and because the department in question had many faculty but WoS does not account for department size, we classified the department as non-elite.

analysis of each case of ambiguity focused on three questions: What action or outcome is being justified? How do scientists legitimate the behavior in question? What features of the circumstances described permit the behavior being considered?

Given the relevance of theories of ethical decision-making to ambiguity in science, where possible we note examples of the different ethical perspectives of scientists. Yet, it is critical to understand that scientists themselves do not understand potentially ethical scenarios in the language of deontology, consequentialism, and virtue ethics. Indeed, in our interviews we asked scientists whether any philosophical or religious perspectives influenced how they apply an ethical perspective in science. Of the 171 scientists we interviewed, only six indicated that philosophy was relevant to their ethical perspective. Of these, one identifies as a "consequentialist utilitarian,"[4] another indicated that he embraced virtue ethics,[5] and the remaining four referenced an interest in the philosophy of science.

## Results

It is striking that we found no differences in circumstances of and reactions to ethical ambiguity between the two national contexts. As we discuss in the conclusion, the fact that such differences do not exist points to the possibility that the ambiguous scenarios we uncover are universal across countries with science infrastructures similar to the US and UK. We begin by addressing the range of behaviors across these two national contexts that the physicists deem as ethically gray. The noteworthy pattern present here is the *breadth* of behaviors that, in the eyes of the respondents, are not clearly black and white issues in which conduct is clearly ethical or unethical. For example, when discussing whether a need exists for training in research ethics, a female assistant professor[6] notes that:

> There's actually a lot of subtle ethical issues, and it's not an easy problem. If its always black and white, it would be written in law. Oftentimes ethical questions are dealing with gray areas…[C]ertain things are ethical and…ethical standards [keep] getting refined. So I just—I think there's a lot of subtle issues there.

Here one observes the limitations of the deontological approach. The lack of clearly codified definitions of misconduct outside of the fabrication, falsification and plagiarism (FFP) paradigm imposes a subjective structure on the ethical issues physicists confront, meaning that more often than not, notions of legitimate and illegitimate practices are characterized by ambiguity rather than clarity. While there are standards and obligations for which wide consensus exists (and which are thus codified in policy) such as honesty in the reporting of data, there are numerous scenarios in which absolute ethical standards are too difficult to apply.

[4] UK41, February 25, 2014.

[5] UK53, March 6, 2014.

[6] US34, May 2, 2013.

Indeed, the range of practices that comes up in physicists' discussions of ethically gray scenarios included: accepting funding for military research, misuse of research funds, plagiarism, allocation of credit and authorship, cronyism, overhyping research results, and exploitation of subordinates (graduate students and postdocs). This list of behaviors is important because the general assumption in the literature is that many of the practices that appear in the list are considered "normal misbehaviors." As DeVries et al. (2006, p. 6) note, some of these practices "do not quite reach the threshold of FFP but nevertheless are regarded by scientists as misconduct." By contrast, we find that scientists do not unequivocally regard these behaviors as instances of misconduct.

Consider one of the potentially more egregious examples: plagiarism. The perspective of official policy (Cohen 2005) that emphasizes unambiguous misconduct is not necessarily shared by scientists. As one associate professor[7] explains:

> There are a lot of flowing boundaries having to do with plagiarism. So for instance, if you compare all the papers that I have written, we certainly have cut and pasted generic descriptions of apparatus and methods from one to the other…[T]here are only so many ways to say, "the neuron encased an electron and neutrino and an anti-neutrino" …There's a real issue there, but I think a lot of it is portrayed in the media as a very black and white issue, and I think there is actually a pretty big gray area.

This emphasis, and the broader pattern of which it is indicative, implies that ethical ambiguity is a routine feature of scientific work. Consequently, what some view as illegitimate practices in science—n the context of research or in interpersonal interactions—take on an air of legitimacy, or at least assume an accepted and unpunished state. To understand how physicists perceive ethically ambiguity, we consider three "dispositions" to such practices that allow questionable conduct to persist: altruism, inconsequential outcomes, and preserving the status quo.

## Altruism

In focusing on FFP, scholars generally agree that research misconduct is bad for science. When scholars fake data, it potentially leads to a misallocation of resources and time, and when fabrication comes to light it is bad for the public image of science. Scientists would agree that this is a bad thing. But as we move from these rare egregious acts to how physicists discuss ethically gray behaviors, we observe that potentially unethical behavior is actually legitimated as altruistic and good for science. We highlight two types of examples to illustrate this point: allocation of credit and the use of funding.

One of the most persistent circumstances of ethical ambiguity rests in the allocation of credit in large collaborations. In the physics community, this is particularly the case among particle physicists. For example, a full professor[8] spoke of a colleague who designed a material with numerous research applications who

[7] US29, April 30, 2013.

[8] US10, March 26, 2013.

received authorship on any paper associated with his invention: "Was that unethical? I don't know. He didn't know anything about the science in the papers really. All he'd done was provide a chip of material important to the instrument. Again, I think it's a gray area." An assistant professor[9] similarly spoke of a "gray area, and that's when, like, when you use a computer code, for example, the person that developed the original code, you know, do you keep putting them on the author list sort of years after they wrote the program?" Ethical ambiguity arises from the lack of guidelines governing what constitutes adequate contribution and adequate recognition through authorship. In the face of such uncertainty, the field response is characterized more by generosity and promotion of the collective good than by stinginess. As the physicist just considered continued: "In our field, the ethos is: if you touched the work with a barge pole, you should probably have your name on the paper."

Misuse of research funding, or the use of grant dollars for reasons other than the goals and objectives identified in federal research grants, is another area in which altruism shapes perceptions of ethical ambiguity. When asked to consider unethical behavior outside of FFP, a male professor of physics[10] responds:

> There's a gray area where somebody gets a large grant for some activity and they use those funds to support another activity…[Y]our students have got to eat and when the government can't produce a budget and the agencies can't disperse funds and you've got no money coming in the door. …I think it's – it's reasonable to, to use what resources one has to try and – try and keep them…one tries to abide by the rules, but it's very hard.

In this example, questionable behavior is legitimated by the uncertainty that results from organizational inefficiency on the part of funding agencies and the career concerns of one's graduate students. According to another male professor of physics[11]:

> There are lots of little gray areas…Think about funding sources, right?…[Y]ou, as PI on the grant, have to think about…is it really appropriate for you to use this money to go to a conference on a completely different subject? Is it appropriate to use that money to send a student on a trip?…So there is a great temptation, of course, to say 'Well, loosely speaking, these research areas are related, so it's justified.'

This pattern is not unique to the US. A number of British physicists similarly emphasized the connection between ethical ambiguity and altruism, such as this female lecturer[12] who explains:

[9] US34, May 2, 2013.

[10] US63, August 5, 2013.

[11] US90, December 13, 2013.

[12] UK66, April 22, 2014.

> There are gray areas, where people are tempted to behave slightly—well, to exaggerate or to hype…in order to keep funding going [and] keep the people they're responsible for employed.

Whether scientists are discussing allocation of credit, misuse of funding, or overstating the importance of research results, the circumstances in such narratives commonly trace back to structural issues in science: an abundance of trainees and a scarcity of opportunities, and an abundance of grant applications and a scarcity of funding. Although scientists benefit from the work and success of their students, the underlying moral justification employed is altruistic in the sense that the use of funds for reasons other than specified in a grant is to promote the careers of others, or to promote knowledge more generally. In these instances, scientists appear to cope with ambiguity through phronesis, as their decisions emphasize *being* good over the "right" way of doing things. The virtue pointed out in these circumstances is altruism, which informs what a good scientist would do when faced with ambiguity.

## Consequences

The potential consequences of ethically ambiguous behavior in science is another important factor that shapes physicists' perception' of what constitutes illegitimate behavior. That is, physicists are willing to allow what they believe—but do not know for sure—to be unethical behavior because the outcomes for themselves or science are perceived as inconsequential. Here we thus see an emphasis on consequentialism in ethical decisions of scientists. There are a number of circumstances that give rise to this perception. A broad reason particular to physics is the fact that commercial possibilities are not at stake. When asked about his observations of stealing and scooping ideas, for example, a British lecturer[13] responded by explaining:

> It's a very gray area. I'm not paranoid. I know colleagues who are rather paranoid about intellectual property and all these things…Certainly in physics, patenting things is not really a productive enterprise. It may be in biochemistry where things are more commercially valuable. In physics it's a world of ideas.

The low likelihood of any specific individual financially profiting from the fruits of research contributes to a climate in which some physicists have little concern about "black and white" notions of idea theft. And while the physicists do care about achieving priority in discovery, the consequences of not receiving credit for a contribution or having an idea stolen are perceived as so minimal that physicists rarely engage in policing the line between legitimate and illegitimate conduct, thereby allowing a climate of ethical ambiguity.

Alternatively, physicists may question whether they have been wronged by a colleague but give little effort to determining whether someone crossed the line because little is perceived as at stake. A professor of astronomy,[14] for example, described circumstances in which he felt his work was not properly acknowledged through authorship:

13 UK40, February 25, 2014.

14 US61, July 24, 2013.

> It's such a gray area that you kind of, I guess don't – I never felt it was so critical I had to confront people about it. I probably at that point wasn't going to do a lot more work with those people if I felt that that was going to happen.

Note that the scientist does not unequivocally identify the scenario as unethical. Though the scientist implies that his colleagues' conduct was questionable, electing to allow such behavior to continue uncontested—in effect—legitimates such conduct.

Consider another scenario in which seemingly questionable conduct goes uncontested. A professor of theoretical physics[15] describes an incident in which a graduate student from a foreign country visited his group and later published a paper based on a discovery (a mathematical calculation) from the host research group:

> It was a gray area in a sense. He [the visitor] didn't steal the idea in the sense of pretending that he came [up] with it entirely on his own. He acknowledged our influence, just the way he did it was perhaps not I think the way it should have been done…I had a feeling that this was an isolated incident; that [it] wasn't something that was a pattern of behavior that was going to continue…The most important thing was that I didn't feel that my student suffered, particularly.

What makes theft gray and not black and white? On one hand, the physicist identifies the action as theft in referencing the fact that the visiting student stole the idea. On the other, the way the visiting student went about it seems to straddle the inappropriate (not clearly identifying the origins of the idea) and the appropriate (some acknowledgment of the origins of the idea). When the line between ethical and unethical is blurred, the factor mitigating dynamics of social control is whether the conduct is substantively consequential.

## Status quo

Hypothetically, if a group exhibited near-universal adherence to ethical norms, then unethical conduct would (in most cases) be highly visible due to its contrast to existing practices. In a group characterized by variable adherence to ethical norms, by contrast, unethical conduct is more difficult to unambiguously identify because departure from ethical norms is part of the status quo. In science, given its competitive nature, the fact that "everyday" misbehavior is not uncommon (DeVries et al. 2006) creates a constant state of ambiguity in which it is difficult to separate competitive behavior from unethical behavior. Consider, for example, the comments of a senior lecturer[16] who, after describing a concrete example of misconduct, then stated:

> Then there's sort of things that are more in the gray area. So when you have this very frantic time where you're trying to cross check everything and you're trying to get something out. Is it ethical to be asking people to work twelve

[15] US01, March 21, 2013.

[16] UK73, May 1, 2014.

> hours a day and not give them any break? Is it ethical in a meeting to be pointing out a mistake in a very undiplomatic way? Shouting at people?

Here we see an emphasis on phronesis in how ambiguity is framed, as the narrative implies that ethical evaluation needs to be contextualized. The scientist focuses not on the consequence of the action, but the need to understand how and why a person acted in a specific situation. A similar narrative is found in the comments of another British physicist,[17] whose response to a question about gray areas in her work, focused on interpersonal relationships:

> [T]he way one treats postdocs and students and the extent to which they are colleagues and the extent to which they are slaves…I'm aware of a particular physicist who holds group meetings at 2AM…He may have the best of reasons for doing that…That's treating…his group abysmally. Someone ought to tell him…Is it unethical? I don't know.

It is possible that ambiguity in how physicists treat their research teams may be unique to the most elite research universities. Some research indicates that professional aspirations and the quest for peer recognition are highest in elite contexts of science (Hermanowicz 2009). Thus, one can imagine that work intensity norms at premier universities contribute to a sense of permissiveness or ambiguity surrounding acceptable treatment of subordinates than, for example, a low-ranked regional state university with less of a reputation for research, where holding group meetings at unusual hours would appear as unjustifiable.

Competition tends to legitimate unethical conduct because it frequently goes unchallenged as part of the status quo. More often than not, this orientation comes up when physicists discuss circumstances in which they believe another scientist in the field has stolen an idea from them. Consider the perspective of an assistant professor[18] who, when asked whether he had experienced anything unethical in the course of his work as a scientist, explained that knowing whether someone has taken an idea involves:

> A sense that, that, that's how science works…to me it doesn't, it's never made a lot of sense to kind of be all possessive about ideas, again because if it were, in my field you don't typically go from an idea to a billion dollar patent so it's not that important.

Here again we encounter the role that consequences of questionable conduct play in shaping perceptions of legitimate practices in science, alongside an emphasis on the notion that "that's the way it is." Many of the scientists we interviewed suggested it was better to be open about ideas at the risk of exploitation than to be secretive.

The notion that one's ideas are "taken" in a questionable, but albeit "standard practice" manner, is particularly likely to emerge in the context of relationships between senior scientists and those they are responsible for. When asked why he

[17] UK73, May 1, 2014.

[18] US28, April 29, 2013.

characterized the appropriation of work of junior people by senior people as a "shade of gray," a professor[19] explained:

> Where it goes wrong is where the role of the people who…not only did the work but made quite often it's questions, ideas and discoveries…[W]here the people who did that…are, sort of the end of the food chain and the boss gives the presentation and presented the results and such it's associated with the boss. Now, just let me extend that you know…this is you know, part of the structure of being science. If you're doing a part of physics and so I'm concerned, and you know, you're the boss and you're the one give the – but there are mechanisms, which are duly respected.

Another professor[20] similarly explains that "good ideas are often taken from other people's proposals and gone forward with…It is a very gray area." Speaking about his own experience, an associate professor[21] states that:

> Part of this…is just endemic to [science]….There are temptations and there are even pressures…I've felt those pressures…to do things that are sort of ethically gray. Where not everyone around the table would agree that this is the correct course of action.

This perspective is important because it illustrates two important points. The first is that scientists lack consensus about where to draw the line between ethical and unethical conduct, which implies that there are circumstances in which, and perspectives from which, practices viewed by some as inappropriate are considered by others, appropriate. The second is that this ethical ambiguity is endemic to, or part of the status quo of science.

## Conclusion

We have argued that existing research on ethics in science maintains a conceptualization of misconduct that underemphasizes or even overlooks the ambiguous character of misconduct that scientists encounter in everyday situations in their work. This is observed in both the overemphasis on egregious cases of misconduct and the tendency to assume that scientists view even more routine forms of questionable conduct as indeed being misconduct. Drawing on a dataset of in-depth interviews with 171 physicists in the US and UK, we conducted an inductive analysis of data from in-depth interviews with 48 physicists who reported scenarios of ethical ambiguity in their work. Overall, the analysis showed a broader range of practices than recognized in previous research in which the line between acceptable and unacceptable assumes an unclear form. This is important because some scientists are reluctant to universally designate behaviors such as plagiarism, idea

[19] US63, August 5, 2013.

[20] US65, August 5, 2013.

[21] US89, December 13, 2013.

appropriation, or misuse of research funding as wrong or unethical. This finding stands in contrast to existing research in this area.

Why does it matter that physicists view the ethics of particular practices as gray rather than black and white? The primary reason is that the gray or ethically ambiguous scenarios invite morally questionable conduct that appears to go unpunished. By the physicists' accounts, these circumstances are much more persistent than black and white, unambiguous scenarios of fabrication, falsification, and plagiarism.

And in contrast to these highly egregious forms of misconduct, social control of questionable behavior is low in circumstances of ethical ambiguity. Although it may be considered unethical to misuse research funding or give a student or colleague undue credit for minimal contributions to research, altruism leads physicists to see such practices as legitimate. Whereas it may be considered inappropriate to steal an idea from a competing group or from a colleague presenting at a conference, physicists tend to legitimate ethically ambiguous practices when the consequences seem minimal, or have difficulty classifying them as inappropriate because they are a feature of competition in science.

In her research on ethical boundary work, Hobson-West (2012, p. 661) emphasizes that scholars should investigate how actors separate "what is a matter of ethics and what is a matter of something else, such as politics, religion, or science." The present analysis has shown that, when confronted with scenarios of ethical ambiguity, while the lines between ethical and unethical may be blurred, physicists draw a distinction between what is a matter of ethics and what promotes the collective interests of science. Emphasizing the virtue of altruism, physicists will, for example, imbue misuse of research funds with legitimacy when that funding seeds a new project or funds a graduate student who would not otherwise be funded. Acknowledging that actions must be evaluated according to situational and contextual factors, some of the physicists we interviewed reframe abusive treatment of subordinate postdoctoral scientists and graduate students as having notions of acceptability in a competitive work environment. They tolerate possible unethical conduct and idea appropriation because science should not be *too* secretive. This tendency is best summed up in the words of a reader at a British university[22] who stated: "I don't see anything as black and white…[T]here are situations where you might engage in…there are gray areas…[S]ometimes you have to do white lies for the greater good."

Given that the perceived incidence of misconduct is generally low (Martinson et al. 2006; Fanelli 2009), future research may provide a more detailed picture of ethical issues in science if research begins to measure the incidence of ethical ambiguity. Survey research in particular would help develop a more systematic understanding of the origins of ambiguity and the degree to which perceptions of ambiguity vary across tasks. A useful step in that direction would be to present survey respondents with various practices that could be evaluated on a continuum ranging from "Always unethical," to "Unethical in most cases, with exceptions," "Ethical in most cases, with exceptions," and "Always ethical."

[22] UK16, September 30, 2013.

Future research should also examine more directly the ethical frameworks scientists employ in ambiguous scenarios. Existing scholarship nicely illustrates the value of various ethical frameworks to science ethics (cf. Chen 2015; Rebera and Rafalowski 2014), but we know much less about the moral philosophy of scientists themselves when confronting ambiguity. The present study makes a step toward that goal. Overall, we find that deontological reasoning is primarily limited to fabrication and falsification. This is likely due to the fact that actual policies exist regarding these practices, in effect codifying honesty as a universal obligation of the scientist. Consequentialism is commonly employed in ambiguous circumstances in a way that emphasizes the absence of suffering and negative consequences. That is, scientists employ consequentialism in ethically ambiguous scenarios in which questionable behavior is perceived as minimal. Finally, phronesis tends to be employed both in how scientists classify particular ambiguous scenarios and how they respond. Scientists employ phronesis in their embrace of altruism towards others as a virtue, particularly when it relates to the careers of their students. Phronesis informs their classification of ambiguous situations when they evaluate questionable behavior of their colleagues. This entails an assumption that there may be good intentions in particular situations that do not appear "right" at first blush. While these observations offer a step towards better understanding of the ethical reasoning of scientists in ambiguous circumstances, much could be learned from interdisciplinary research integrating sociological and philosophical approaches to studying ethics among scientists.

Finally, it is worth noting that although many studies emphasize the relationship of organizational context to experiences of the scientific role (Hermanowicz 2009; Long and Fox 1995), the 48 physicists reporting ethical ambiguity were distributed relatively equally across elite and non-elite contexts and with little apparent difference in narratives. Nor did we observe strong differences between the narratives of US and UK physicists. Given that differences did not emerge across these comparative dimensions, one might speculate that the ethically ambiguous scenarios we identified—and scientists responses to them—are not likely to be context specific. That is, they could be pervasive features of science in countries like the United States and the United Kingdom. Had we known of the importance of ethical ambiguity at the outset of the study, it is possible that more direct and detailed interview questions would reveal organization and country specific differences not present in our inductive analysis. Future research may be better equipped to address such comparisons and survey research would provide a valuable tool to determine how pervasive ethical ambiguity is in science. Cross-disciplinary research would also be valuable because ambiguity is likely to differ between the physical sciences and the life sciences. The circumstances that give rise to ethical ambiguity and the forms it takes are likely to be different in the biosciences, for example, where research is closer to issues such as commercialization and ethical questions related to working with living organisms.

Apart from the importance of these findings for how we conceptualize ethical and unethical behavior in science, these findings have implications for ethics training. Based on our findings, we argue that it is important to demonstrate to students that what some scientists may view as black and white issues of science ethics can be highly ambiguous. Case studies—such as those focusing on moral dilemmas and "white lies" related to "trimming data", misrepresenting the status of a publication, and confidentiality agreements, for example (Kovac 2004:28, 40, 56)—as well as different approaches to dealing with such ethically gray scenarios would be useful, as would formal and informal mentoring that focuses on everyday ethical issues in science. More generally, steps taken to eliminate ambiguity in particular contexts—such as the recent call in *Science* for comprehensive rules for sharing of data and methods (Alberts et al. 2015)—will be important for making ethical decision closer to black and white than gray.

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