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## THE ANALYTIC TRADITION, RADICAL (FEMINIST) INTERPRETATION, AND THE HYGIENE HYPOTHESIS

### INTRODUCTION

Within philosophy of science in the analytic tradition, and in the public understanding of science more generally, there has been a tendency to view any political influence as a source of bias and error in scientific research.<sup>1</sup> As feminist studies of science throughout the 1980s and 1990s have documented, there have indeed been many cases where political influences, such as sexism and racism, have negatively affected the empirical adequacy of scientific studies.<sup>2</sup>

However, as feminist and other progressive scientists and philosophers of science have worked to address sexism and racism in science, they have found themselves in the awkward epistemic position of criticizing these political influences, while simultaneously offering prescriptions for better scientific research—prescriptions that are themselves explicitly aligned with yet another (e.g., feminist) set of political interests. What has become clear, though, is that in a number of well-documented cases, feminist-informed prescriptions for science have made improvements over sexist research.<sup>3</sup> Can it be, then, that while some political interests simply bias scientific research, some other political interests (such as feminist interests) can be used as effective resources for increasing the empirical adequacy of research? And if so, how? Much work in feminist science studies is aimed at answering precisely these questions.<sup>4</sup>

My own research is aimed at answering precisely these questions on three elements of these questions. The first identifies the particular political

interests at play in feminist science projects; the second addresses the empirical improvements to scientific research that these feminist interventions allow; and the third concerns how it is that we can evaluate the empirical adequacy of political interests at all. Each of these features is best addressed in the context of specific cases and I focus here on a compelling set of epidemiological and immunological studies that inform the “hygiene hypothesis”—a hypothesis made more empirically robust, I argue, by augmenting it with a particular set of feminist political interests.

As will be discussed in more depth, below, the hygiene hypothesis was developed to explain the correlation between increased sanitation, and increased prevalence and incidence of allergies, asthma, autoimmune diseases, and even certain kinds of depression. Especially in the industrialized nations of the North and West, it is hypothesized, our lower rates of exposure to certain kinds of bacteria and other microorganisms have had unintended negative consequences for our immune health. In the words of neuroscientists Rook and Lowry, as “a consequence of diminished exposure,” especially in childhood, to a variety of microorganisms once prevalent in the human evolutionary past, populations in developed countries have a “lack of appropriate levels of immunoregulatory pathways.”<sup>5</sup>

Over the last few years, support for the hypothesis has increased with the discovery that populations in those less industrialized areas of the rural South and East that are still regularly exposed to certain parasitic worms (helminthes), also have a lower incidence and prevalence of chronic inflammatory diseases such as Crohn’s, than do populations in the industrialized North and West that are not regularly exposed.<sup>6</sup> In India, the incidence of Crohn’s, while lower than in nations of the North and West, is on the increase, reliably tracking rates of industrialization and sanitation.<sup>7</sup> Most recently, a study of children in the Philippines found that increased exposure to microbes in childhood predicted increased immune health in adulthood.<sup>8</sup>

The hygiene hypothesis has also been suggested as a further piece of the causal story in some cases of depression,<sup>9</sup> although, as I discuss below, the documentation for this link is less robust than that between the hygiene hypothesis and the other pathologies mentioned. Briefly, the current literature shows that some kinds of depression can be linked to failures of immune regulation and higher levels of pro-inflammatory cytokines (signaling molecules produced by the immune system).<sup>10</sup>

To foreshadow my argument that feminist political interests can empirically strengthen the hygiene hypothesis, it is worth noting that in the indus-

trialized North and West, women are over-represented in all the relevant clinical populations, and *this pattern has received no critical attention by hygiene hypothesis researchers*. Women have higher rates than men of asthma, allergies, auto-immune disorders,<sup>11</sup> as well as depression.<sup>12</sup> The “feminization” of these diagnostic categories has been well-acknowledged by clinicians who treat and study these illnesses, but not by the immunologists and epidemiologists involved in studying the hygiene hypothesis.

Despite the fact that the clinicians who treat and study these illnesses have noticed sex differences in the populations they treat, their own explanatory weakness comes from a tendency to focus exclusively on reductionistic biomedical explanations for these differences, relying on physiological, hormonal, and genetic accounts, with little to no attention paid to the ways these biological processes are affected by complex environmental factors, such as patterns of hygiene and sanitation, or social factors, such as the interweaving of the effects of gender, race, and economic hierarchies.<sup>13</sup>

For example, sex hormones, such as the family of estrogens, have been hypothesized to account for the differential rates of auto-immune disorders in women compared to men, as have a variety of genetic phenomena, such as X-chromosome mosaicism.<sup>14</sup> Similarly, sex hormones have featured in explanations for the higher rates of depression in women.<sup>15</sup> To be fair, compared to the literature on asthma, allergies, and auto-immune disorders, the literature on sex differences in depression includes far more attempts, especially by feminist clinicians and researchers, to examine the role of more complex social factors such as the social and cognitive effects of sexism.<sup>16</sup> The fact remains, however, that in each attempt, biomedical or otherwise, to account for the differences in the relevant morbidity rates between women and men, a significant amount of variation is left unexplained.

This is precisely the explanatory gap that the hygiene hypothesis is suited to address, especially, I argue, when a feminist understanding of the gendered socialization of children is added to the epidemiological and immunological picture. As I discuss in more detail below, feminist social scientists have shown that standards of cleanliness are generally higher for girls than boys, especially under the age of five, when children are more likely to be under close adult supervision.<sup>17</sup> These gendered patterns form a robust phenomenon in industrialized nations, and some studies point to a cross-cultural pattern.<sup>18</sup>

Note that, while I attend to differentiations in nationality and socioeconomic status, I continue to use the gender categories “girls” and “boys”

as if they were unproblematic *within* categories of nation and SES. These coarse-grained gender categories will probably capture the relevant variation of interest, epidemiologically speaking. However, it is important to acknowledge that a broader discussion of gender identity and gender expression, including (data from) populations of people who are transgender/transsexual, though beyond the scope of this paper, has the potential to enrich the explanatory account.

In what follows, I review the case for the hygiene hypothesis.

I argue that *insofar as the hygiene hypothesis successfully identifies standards of hygiene and sanitation as mediators of immune health*, then, properly augmented by feminist analyses of the gendered standards of cleanliness in children, the hypothesis can account for the unexplained variation in the relevant morbidity rates between men and women. The augmented hygiene hypothesis also responds to a number of outstanding puzzles in current epidemiological and immunological research on allergens and parasites. I then present new sources of evidence for the hygiene hypothesis in the form of cross-cultural and other natural experiments involving gender differences.

The hygiene hypothesis as it stands already enriches, and indeed moves beyond, reductionistic biomedical approaches to immunological problems by attending to complex environmental factors such as sanitation and hygiene standards. Adding a feminist analysis of child-rearing practices, and the gendered standards of cleanliness—standards that are generally higher for girls than boys—imports important empirical resources to the explanatory picture.

The feminist-informed sociological and anthropological research makes clear that feminine gender-role socialization includes higher standards of cleanliness than does masculine gender-role socialization, and I argue that this difference in standards might play an important explanatory role in the sex differences between women and men reported in asthma, allergies, auto-immune disorders, generally, and depression.

I incorporate in the discussion of feminine gender-role socialization a presentation of the feminist political commitments (that is, my own feminist commitments and those of the feminist sociologists and anthropologists I cite) and show how these commitments make the link between gender and the hygiene hypothesis salient. I argue that, by making the link visible, these political commitments do not bias the immunological and epidemiological research. Instead, the political commitments I discuss, and indeed prescribe, have the effect of *increasing* the empirical

adequacy of that research, specifically by reconceiving relevant sources of evidence and opening up further avenues for study.

Traditional analytic philosophy of science has little to say about politically fueled scientific research like that modeled in the current study beyond discouraging it *tout court* as biased and subjective. Despite the paucity of traditional philosophical accounts regarding the potential benefits of political interests in science, however, there are some analytic philosophical tools available that feminists can use to provide such an account. I conclude by reviewing the case for a feminist use of Davidson's method of radical interpretation (hence radical [feminist] interpretation). I offer a feminist approach to Davidson's philosophy of language that shows how we can differentiate between those political interests that are beneficial in a particular scientific context and those that are not. This requires showing that political interests can be evaluated using the same sorts of empirical analyses that are deployed in other aspects of scientific decision-making.<sup>19</sup> I then show how this sort of evaluative process explains the improvements to the immunological and epidemiological research on the hygiene hypothesis that are made available by attending to a feminist political view of gendered child-rearing practices.

## THE HYGIENE HYPOTHESIS<sup>20</sup>

### Germs, Allergies, and Asthma

Industrialized nations of the North and West have experienced increasing rates of asthma and allergies. In a recent study, Maziak and his colleagues note that "There is a wide consensus that asthma and allergies are witnessing a rising trend among children in Western societies. In some Western countries asthma and allergies have reached alarming proportions, affecting up to one-third of children within the general population."<sup>21</sup> This increase has been explained by increased standards and practices of cleanliness and sanitation—the so-called "hygiene hypothesis."

Recent experimental support with mice has shown that a variety of allergic responses can be decreased via exposure to particular bacteria.<sup>22</sup> Support for the hypothesis also comes from studies of human populations which document the protective effects of farm environments for children.<sup>23</sup> Compared to children raised in urban settings, children raised on farms have lower rates of allergic rhinitis and/or conjunctivitis.

Kilpeläinen's research team concludes that "environmental exposure to immune modulating agents, such as environmental mycobacteria... could explain the finding."<sup>24</sup> A more recent study argues that exposure to two or more domestic pets has a similar protective effect: "exposure to 2 or more dogs or cats in the first year of life was associated with a lower prevalence of allergic sensitization at age 6–7 years."<sup>25</sup>

### Parasites and Inflammatory Diseases

Elliott, Summers, and Weinstock have theorized that the increase in other immune-system malfunctions such as inflammatory-bowel disease (IBD) and Crohn's disease may also be related to the hygiene hypothesis.<sup>26</sup> They observed that in contemporary urban environments where humans are largely free of contamination by parasitic worms, rates of these sorts of diseases have increased dramatically. In Israel, for example, Zvidi and colleagues report that "the prevalence rate rose from 25.53/100,000 in 1987 to 65.11/100,000 in 1997, and then to 112.99 in 2007."<sup>27</sup> Since some parasitic worms seem to have a "calming" effect on the immune system, it seems likely that the trends are related. Indeed, clinical trials have shown that exposure to the eggs of the *Trichuris suis* whip worm can reduce the severity of symptoms in patients with Crohn's.<sup>28</sup>

### Bacteria and Depression

That certain sorts of depression might be explained by the hygiene hypothesis<sup>29</sup> is the most recent and surprising finding in this collection of studies. As I have noted, the documentation for this link is less robust than that between the hygiene hypothesis and the other pathologies mentioned. Neuroscientists Rook and Lowry argue that "depression and anxiety are associated with markers of ongoing inflammation, even without any accompanying inflammatory disorder"<sup>30</sup> and that one effect of SSRIs (the most-commonly-prescribed form of antidepressant) is to lower the inflammatory response.<sup>31</sup> Whether the association between depression and clinically significant inflammatory response is a causal association is currently supported by clinical evidence that "proinflammatory cytokines can induce depression"<sup>32</sup> and that in an example of the inverse pattern, cancer patients who were treated with a harmless version of the bacterium *M. vaccae* reported "higher quality of life," even though the bacterium had no effect on their survival rates from cancer.<sup>33</sup> The relation between "quality of life" and depression is not well-examined in these studies.

Insofar as lower levels of bacterial loads generally can be linked to the standards and practices of cleanliness and sanitation found in industrialized nations, and insofar as the currently weak link between depression and immune health proves to be accurate, Rook and Lowry expect that depression rates too would differ between industrialized and non-industrialized nations. There is some data to support their expectation. They write:

Estimates of the incidence of depression in rich industrialized nations are consistently higher than in poor rural nations. Indeed, in young adults (15–29 year olds), the incidence of depression in men in the United States and Canada is estimated to be twice, while that in women is estimated to be three times, that seen in Africa, and within Europe depression tends to be more prevalent in urban than in rural communities.<sup>34</sup>

Rook and Lowry admit that the data from these latter studies is "fraught with problems in interpretation."<sup>35</sup> An examination of the studies they cite<sup>36</sup> reveals that while there has been some success at unifying diagnostic criteria across populations, problems in estimating prevalence and incidence across cultures remain and are well-acknowledged.<sup>37</sup> However, despite the problems in cross-cultural comparisons of this sort, what remains robust is the finding that no matter what population is being sampled, within that population, more women than men satisfy criteria for depression, and this is particularly the case in countries of the industrialized North and West. Additionally, as Bird and Rieker note, "it is now well-established that women's higher rates of depression reflect a real [sex] difference in health, rather than an artifact of help-seeking behavior or willingness to report symptoms."<sup>38</sup>

Rook and Lowry do not comment on this difference between women and men, a pattern that is well-documented within nations of the North and West. They focus instead on the less reliably documented differences in depression rates across societies, that is, for women and men from industrialized nations of the North and West, when compared to women and men of the more rural nations of the South and East. As supporters of the hygiene hypothesis, which predicts the latter pattern across societies, it makes sense that they would have nothing to say about the differences *within* societies—in contrast, my augmented hypothesis offers a cogent explanation for these latter differences within any society that has higher hygiene standards for girls than boys.

## FEMINIST POLITICAL INTERESTS AND THE HYGIENE HYPOTHESIS

What is required to make this gender link more salient is some level of feminist political commitment to the project of documenting, deconstructing, and ameliorating the varying social pressures that inform what it means to be a gendered body. Within this feminist political project is embedded a cluster of views that are at once both descriptive and prescriptive, for instance, the view that the content of the social roles assigned to boys and girls, men and women, is significantly driven by deeply held cultural commitments that are in some important sense: (a) arbitrarily assigned relative to features such as secondary sex characteristics; and (b) vigorously, though often unconsciously, enforced and rewarded from a very young age.

While this latter feature means that our current assignment of social roles is not easily modified, most feminists believe that the historical evidence regarding human flourishing shows us that there are more relevant criteria for assigning social roles, such as individual interest and/or skill. Indeed, when girls are given the same chances, training, and encouragement as boys, they seem to be just as capable as boys in a variety of tasks not often associated with femininity; the pattern holds similarly for boys and tasks not often associated with masculinity.

Social scientists with feminist commitments have amassed a great deal of empirical data supporting this cluster of political views, and, indeed, these political views might seem to many readers of this volume to be uncontroversial, straightforward matters of fact. However, the relationship between empirical evidence and feminist political theory often needs to be carefully explained, rather than assumed, since the view that gender-role assignments are less than arbitrary, perhaps “natural” or mandated by theological design is still widespread and often uncritically presupposed. Because of this, showing the relationship between empirical evidence and feminist political interests is an important project to undertake. In the penultimate section of this essay, I make use of Davidson’s philosophical theory of meaning in order to argue for and further clarify the empirical nature of feminist political interests.

The feminist political claim of particular relevance to my analysis of the hygiene hypothesis is that the masculine gender-role assignment, broadly construed, involves a social acceptance of playing in dirt and mud for those (typically boys) so assigned, an acceptance that does not extend to the feminine gender role, broadly construed (and typically

assigned to girls). These differential social expectations regarding cleanliness are reflected in and reinforced by gender differences in children’s clothing, participation in sports, and adult supervision of children’s play.

### Gendered Norms of Cleanliness

Feminist-informed sociologists in the industrialized North and West have documented that girls are dressed more often than boys in clothing that is not supposed to get dirty and that restricts the sorts of movements that would get one dirty in the first place.<sup>39</sup> Young girls do not participate in sports with the same frequency as young boys, and girls more often than boys play indoors.<sup>40</sup> Insofar as many sports, and outdoor play generally, increase the chances for exposure to the micro-organisms found in dirt—and there is abundant evidence to support this<sup>41</sup>—then boys will have greater rates of exposure to these micro-organisms than girls. Finally, parents structure and supervise the play of girls more than that of boys,<sup>42</sup> which is likely to result in girls being kept cleaner than boys.

Not surprisingly, given that girls receive more parental supervision and direction regarding cleanliness than do boys, girls more than boys are taught to police themselves—to be vigilant about their appearance and cleanliness. In a 1938 Boston study of the content of preschool children’s speech, psychologist Shirley found marked gender differences with respect to the concepts of cleanliness and clothes. Shirley noted that these two concepts are mentioned in conversations “about twice as often by girls as by boys.”<sup>43</sup> Even by preschool, traditional strictures about cleanliness have been differentially absorbed by girls.

While these gender differences in hygiene standards might seem a relic of a distant sexist past, research suggests otherwise. As recently as 1991, research showed that a significant number of students training to be preschool teachers in the United Kingdom expected the children in their classes to conform to fairly standard gender roles, including gendered norms of cleanliness. In one study, over 25% of preschool student teachers “expected boys, but not girls to be reckless, untidy, cheeky, brave, noisy and naughty; and expected girls, but not boys to be tidy, lean, quiet, sensible, obedient, passive and well-behaved.”<sup>44</sup>

Many parents continue to reinforce traditional gendered norms of hygiene in their preschool children, as expressed, for example, in how children are dressed. In a 1998 study of American children in a preschool setting,<sup>45</sup> one-third of the five-year-old girls came to school in dresses *each day*. Of relevance to the question of cleanliness, Martin, the study’s

author, noted that being in a dress limited the girls' "physicality." She added, "it is not only the dress itself, but knowledge about how to behave in a dress that is restrictive. Many girls already knew that some behaviors were not allowed in a dress. This knowledge probably comes from the families who dress their girls in dresses."<sup>46</sup> One particular observation of five-year-old girls in Martin's study is worth quoting at length:

Vicki, wearing leggings and a dress-like shirt, is leaning over the desk to look into a "tunnel" that some other kids have built. As she leans, her dress/shirt rides up exposing her back. Jennifer (another child) walks by Vicki and as she does she pulls Vicki's shirt back over her bare skin and gives it a pat to keep it in place. It looks very much like something one's mother might do.<sup>47</sup>

These young children have already internalized the rule that when wearing a dress, even a dress-like tunic with leggings, they must constantly monitor their decorum—who knows what immodesty might otherwise result, what dirt (metaphorically and literally) might cling.

The linking of dirt and immorality is a robust phenomenon historically in the industrialized North and West. In the schools and playgrounds of nineteenth-century Britain and the United States, education about physical cleaning was meant to introduce moral cleanliness as well, especially for the immigrant and working classes.<sup>48</sup> For girls in general, though, education about keeping clean and tidy was not just important for physical hygiene, it also helped them to "adopt particular [feminine] ways of carrying and presenting their bodies."<sup>49</sup>

Returning to the present day, sociologist Thorne documents gender norms in children's play at the elementary school level in her book, *Gender Play*.<sup>50</sup> Of particular relevance is her discussion of "cooties" and other "pollution rituals"—concerns that are especially prevalent, she notes, in children ages six to nine. The term "cooties" here refers to invisible "germs" that children play at passing on to others through touch, or more pointedly, that children play at *avoiding* by ostracization of those assigned as carriers. Thorne's observations, taken from field work in the late 1970s and early 1980s at schools in Michigan and California, show that girls are far more likely than boys to be associated with cooties and to be ostracized as carriers of cooties.<sup>51</sup> The clear message is that, unlike boys, girls need to guard against these and other forms of pollution: "Girls as a group are treated as an ultimate source of contamination."<sup>52</sup> While individual boys are sometimes also so marked, she notes that in these

cases, it is the boy's ethnicity or physical ability that is used to set him up as a source of pollution rather than his gender per se. She also notes a common pattern in this research, namely, that boys, more often than girls, played outdoors.<sup>53</sup>

As a final note regarding research about girls policing their own hygiene, it seems unlikely to be a coincidence that among sufferers of Obsessive Compulsive Disorder, hand washing and cleaning compulsions are far more common in women than men.<sup>54</sup>

### Women and Immunological Disorders

As noted earlier, there are a number of immunological health outcomes in adults that attention to gender and hygiene in children might help explain: the fact that women far more than men suffer from asthma, allergies, as well as many auto-immune disorders, including rheumatoid arthritis, multiple-sclerosis, Graves' disease, Lupus, as well as IBDs and Crohn's disease. In the case of Crohn's disease, the sex difference is less marked; at the other extreme—Lupus—women patients outnumber men as much as 9:1.<sup>55</sup> Insofar as depression too can be tied to hygiene, then the alarming fact of women's high rates of depression might also fall, at least partially, under the explanatory umbrella of the augmented hygiene hypothesis.

Beginning with the case of asthma, age complicates the issue in a way that is consistent with my augmented hygiene hypothesis regarding the gender socialization of children. Before puberty, boys have higher rates of asthma than girls.<sup>56</sup> After puberty, the gender difference reverses, with women having higher rates than men. Osman reports that the reasons for the age link remain unclear.<sup>57</sup> As mentioned, there are certainly a number of competing biomedical explanations for the "over-active" immune systems of women relative to men;<sup>58</sup> however, there are no accepted explanations available (biomedical or otherwise) for the over-active immune systems of boys relative to girls. The augmentation to the hygiene hypothesis that I have offered suggests an explanation. It might be that there is a critical period involved, a developmental period during which the immune system, properly exposed to potential allergens, responds with asthmatic symptoms, and after which shows a "settling effect." Those children, typically boys, who are properly exposed during the critical period, respond with asthmatic symptoms early on, but then their symptoms abate. Those children, typically girls, who are not exposed during the critical period, respond with asthmatic symptoms later, and for the rest of their lives.

In fact, a critical period of just this sort was found in the study mentioned earlier that showed that two or more pets in the home at infancy protected children against allergies at six years of age.<sup>59</sup> The positive effect was not found if the pets were introduced later than infancy. And, in what the authors note as a “puzzling” aside, the protective effect of pets in the home was significantly more marked for boys than girls.<sup>60</sup>

That women are over-represented among the clinically depressed across numerous cultures is, as reported above, another well-supported finding.<sup>61</sup> Debates continue about the causal explanation of this gender difference. Altemus believes that the robust cross-cultural effect requires a biomedical explanation appealing to, for example, estrogen or genetics, though she admits that such an explanation has proven elusive.<sup>62</sup> Completing a meta-analysis of the literature, Kuehner argues for the importance of linking biological arguments with appeals to well-documented social “risk factors”: “Consistently, intrapsychic and psychosocial gender role related risk factors have been identified which may contribute to the higher depression risk in women. Gender role aspects are also reflected in endocrine stress reactions and possibly influence associated neuropsychological processes.”<sup>63</sup> A hygiene hypothesis that takes into account the differential gender-role socialization of boys and girls might be able to provide the missing link between the biological and social risk factors called for by Kuehner. But, of course, the link has to be made salient before it can be evaluated by epidemiologists and immunologists.

### INCREASING THE EMPIRICAL ADEQUACY OF THE HYGIENE HYPOTHESIS

Recall that I began with the general question regarding whether and how it is that while some political interests can bias scientific research, other political interests (such as some feminist interests) can empirically strengthen research. Particular interests and particular case studies are needed to defend this claim, and as promised, I began by identifying a particular case study, the hygiene hypothesis, and the particular feminist political interests that strengthen that hypothesis. The next feature of my project is to address in more detail the improvements to scientific research that attention to feminist interests allow, and it is to this second feature that I now turn.

The hygiene hypothesis is currently well-supported, but, as I noted, there remains a “puzzle” concerning the interaction of age and sex

differences in rates of some auto-immune disorders, I have argued that feminist-informed research regarding the differential socialization patterns of girls and boys and their relationship to dirt and germs suggests a solution to the puzzle.

Thinking in terms of gender differences in hygiene also helps identify new relevant sources of evidence for the hygiene hypothesis and opens up further avenues for study. While epidemiologists and immunologists have not yet linked gendered norms of cleanliness to morbidity rates for allergies, asthma, immune disorders more generally, and/or depression, there are some epidemiological studies of children that mention gender differences in exposure to dust, dirt, and germs, and these studies, not previously believed to be relevant, could be used to provide support for and point toward the further development of the hygiene hypothesis.

Eating dirt—geophagia—is a very reliable way to ingest microorganisms, and in a study from rural Guinea that examined the ingestion of parasites via geophagia, boys under the age of ten are significantly more likely than girls to be infected by these parasites.<sup>64</sup> Studies of children with bloodstream infection (BSI) from *Acinobacter* species show similar results.<sup>65</sup> For adults in the industrialized North and West, exposure to *Acinobacteria* is generally associated with a hospital stay. New research has shown that in children, the pattern is different—for children, infection is significantly more likely to be developed in the home and by patients who are male. That is, consistent with my augmented hypothesis, under the gendered supervision of parents in home settings, more boys than girls are exposed to this bacteria.<sup>66</sup>

Consider also studies of the transmission of *Ascaris lumbricoides* (a harmful intestinal roundworm) among rural populations in Southern Ethiopia.<sup>67</sup> The transmission route typically involves “ingestion of infective eggs from soil contaminated with human feces or uncooked vegetables contaminated with soil containing infective eggs.”<sup>68</sup> In Southern Ethiopia, homes typically have dirt floors, infants are often accompanied by domestic dogs throughout the day, and livestock are brought into homes at night. The dogs and livestock as well as the dirt floors are all sources of the eggs. Children are the primary victims of roundworm infection.<sup>69</sup> At one clinic, “70% of all outpatients treated for helminthiases [intestinal parasites] were children under fourteen years of age,”<sup>70</sup> with infection rates highest among one- to four-year-olds. Of note here is the sex difference: 20.5% of males in this age group, as opposed to only 13.5% of females, had Ascariasis infection. The researchers remarked

that this gap closes in later ages, that is, five- to fourteen-year-olds, where rates lower—in males to 8.9% and females to 11.3%—“making it difficult to establish statistically significant sex-differences in worm infection.”<sup>71</sup>

However, the change across age groups might be explained by differential hygiene expectations for boys and girls (more on the cross-cultural strength of these expectations below). Both male and female infants are likely to be under greater parental supervision than are older children, and for females more than males, greater supervision is likely to come with increased restrictions on how and where they play. Perhaps these gendered facets of parental supervision explain the fact that in the one to four age group, significantly fewer girls than boys were found to have parasites. In addition, the reported decrease in parasitic load with age might be similar to the decrease in asthma rates with age that is reported in boys and girls in countries in the industrialized North and West. Again, a critical period for exposure to the relevant parasites might be at work, disadvantaging those children, typically girls, who have fewer opportunities for exposure.

If the modalities of exposure to harmful micro-organisms such as *Acinetobacter* species and the *Ascaris lumbricoides* parasite are similar to those for the more helpful micro-organisms that calm over-active immune systems (such as *M. vaccae*, and the *Trichuris suis* whip worm), then epidemiological studies like these, attending to gendered norms of cleanliness, could serve as further sources of evidence in support of the hygiene hypothesis. If the augmented hygiene hypothesis is correct, that is, if increased hygiene negatively affects immune health, and immune health differs by sex (as research shows it does), then we should see sex differences in the morbidity rates for these illnesses. And here we do.

The epidemiological research in rural Guinea and Southern Ethiopia, cited above, introduces another avenue of study that could provide evidence for the hygiene hypothesis. Such research, outside the industrialized North and West, provides the opportunity for a number of cross-cultural natural experiments.

The first sort of experiment would evaluate whether the gender norms that place higher standards of cleanliness on girls than boys hold across different cultures. Some of the sociological and anthropological research on gendered norms of cleanliness in the nonindustrialized settings of the South and East suggests that this is the case.

In her field work in Bengal, India, anthropologist Lamb found that women and girls are expected to bathe more often than men and boys—expectations that are related to views of women and girls as naturally



dirtier than men and boys.<sup>72</sup> For these women and girls, the practice of bathing, often two or more times daily, consists mostly in a ritual rinsing with water, rather than wringing one's hands with anti-bacterial soap or guarding against cooties, but the gender differences in cleanliness here clearly run parallel to the purity notions associated with femininity in the North and West. A similar trend was found in the Caribbean country of Guyana where sociological research on parental socialization preferences showed that parents rated neatness and cleanliness as "more desirable for girls [than boys] in all age groups."<sup>73</sup>

One difference between the activities of children in nations of the industrialized North and West and children in the more rural settings of the South and East is that in the latter societies, children are typically given far greater freedom from parental supervision through their assigned chores, such as minding cattle and sheep.<sup>74</sup> It remains to be examined whether and how this freedom affects standards of hygiene for boys and girls. One might expect that in this case, girls are under less parental supervision and have more freedom to play in the dirt. Are they also more healthy, immunologically speaking, as adults? Research on this question would be helpful.

A second kind of natural experiment involves examining whether those studies of the rural South and East that reported higher levels of ingestion of micro-organisms in boys also reveals this to be correlated with those boys having a lower incidence of allergies, asthma, IBD, and depression. We already know that the incidence and prevalence of these diseases is lower in the more rural nations of South and East, relative to the industrialized North and West, but we do not know whether morbidity patterns in the South and East feature the same sex differences that are found in the North and West. Insofar as the gendered socialization patterns that have been well-identified in the industrialized North and West continue in the nonindustrialized, primarily rural settings of the South and East, we can expect that there will be sex differences in the relevant morbidity rates.

One study comes close to confirming this expectation. Researching allergies among the Hiwi settlements of Venezuela, an anthropology team led by Hurtado noted that, consistent with the hygiene hypothesis, these populations had lower rates of allergies than are typically found in populations of the industrialized North and West.<sup>75</sup> They also noted that Hiwi girls spend significantly more time than do boys engaging in "grooming behaviors," and that these behaviors "serve to eliminate ectoparasites."<sup>76</sup> What they did not note in their study was whether there were

any sex differences in parasite exposure between Hiwi boys and girls, though the grooming behavior suggests there is. They also did not note whether there were any sex differences in incidence and prevalence of allergies in either children or adults. However, the presentation of their data suggests that they have this information available (they present data comparing Hiwi girls and women to girls and women from Western populations, for example). In the absence of attention to the socialization processes that differentially affect hygiene expectations for boys and girls, it is likely that the researchers did not think that sex differences within the Hiwi populations were relevant for analysis and presentation. Paying attention to gender differences in hygiene provides a means of recognizing potential evidence for the hygiene hypothesis that might be otherwise ignored.

Of course, in the industrialized North and West it is not just sanitation policies and practices that have decreased children's exposure to micro-organisms. Sociologists who study play behaviors have noticed a marked decrease in the rates at which both boys and girls play outdoors in the dirt. This change in play pattern is yet another evidential link that could be used to support the hygiene hypothesis, a link that becomes relevant when gender roles are taken into consideration.

In a study of American playgrounds in the United States, Frost notes that, increasingly, children in the United States find "their places for play dominated by manufactured equipment, regimented games, and paved surfaces," and he ties this trend directly to support for the hygiene hypothesis.<sup>77</sup> He also notes that public schools are increasingly deleting recess, and that even public playgrounds are being visited less often as parents fear injury and violence.<sup>78</sup>

The hygiene hypothesis is used to explain the increased rates of immune-related morbidity in populations of the industrialized North and West as a whole. The morbidity rates at issue have increased for both women and men, girls and boys. Given the relatively recent decrease in access to outdoor play, a number of natural experiments suggest themselves once gender roles are made salient. Especially in the suburbs of cities in the industrialized North and West, boys are more likely to have been affected by these restrictions in the type and place of play than are girls. In these populations, have the relevant morbidity rates increased more markedly among boys than girls? One would expect so if my augmented hygiene hypothesis is correct. These are just a few of the natural experiments on the hygiene hypothesis that become obvious once gender socialization is made salient.

## FEMINIST POLITICAL INTERESTS AND THE PHILOSOPHY OF LANGUAGE

I conclude now with the third aspect of my project, a review of the case for “radical (feminist) interpretation”—a feminist approach to Davidson’s philosophy of language that shows how political interests, like the feminist political interests I have identified as important to the hygiene hypothesis, are related to empirical evidence and can themselves be empirically evaluated. It is this sort of evaluative process that can be used to differentiate between those political interests that have a negative, biasing effect on research and those that can empirically strengthen research.<sup>79</sup>

One of the ways that feminist and other progressive philosophers of science have tackled the problem of bias in science has been to document the frequency with which a variety of political interests present in early stages of the discovery of a scientific hypothesis can, and do, go on to bias hypothesis testing and results.<sup>80</sup> It seems clear from this careful documentation that political interests are ubiquitous in all aspects of scientific activity. But it should also be clear by now that not all political interests are of a piece. As I have argued, some political interests can actually increase the empirical adequacy of scientific research in a variety of ways.

For many readers of this volume, the relationship between empirical evidence and the feminist political interests of relevance to the hygiene hypothesis might seem obvious, and the inclusion of such political interests in a scientific study, uncontroversial. However, accepting that (some) political interests can play a positive role in science runs contrary to the value-free ideal prescribed by analytic philosophy of science, and, as I noted at the outset, contrary to the public idealization of science more generally.

One of the reasons for this ideal is the long-standing and widely held belief that it is only straightforwardly factual claims that stand in relation to empirical evidence and that while we have well-known methods for empirically adjudicating between competing factual claims, these methods cannot be used when adjudicating between competing value claims, including those claims informed by feminist political interests. If claims informed by political interests are not themselves capable of empirical adjudication, then it seems difficult to imagine that those claims could be used to build the empirical adequacy of a particular descriptive hypothesis within a scientific setting.

Anderson is one of the few analytical feminist philosophers who has argued that in particular cases, political interests, in particular feminist

interests, can increase the empirical adequacy of scientific research.<sup>81</sup> In her discussion of social science research on divorce, Anderson argues that feminist approaches to this research make for empirically stronger results.<sup>82</sup> The feminist political interests at play in this research are represented in the claim that women, like men, cannot be adequately defined by exclusive attention to their relationships to their spouses and children. Both women and men have needs, desires, and concerns that focus on aspects of their lives other than their families and homes.

Again, the truth of this latter sort of claim might seem obvious because it is a statement of empirical fact rather than value, but alas, it is not an uncontroversial claim and there are many in the contemporary United States, for example, who would see it as being shot through with feminist values, and reject it on those grounds. So it is important that Anderson shows that, by including feminist claims of this sort, the feminist researchers she discusses were encouraged to frame questions for the participants in their study that allow for a wider range of responses and hence arrived at a more *empirically accurate description* of the phenomenon of divorce. As a result of starting from empirically informed feminist political interests, they were able to see what traditional researchers did not, namely, that divorce might not always be seen as a negative life event.<sup>83</sup>

My only concern with Anderson’s account is that she maintains that value judgments, such as those reflected in feminist and other political interests, *have no empirical content*, but they can be used to help shape and support those factual judgments that do. The problem is that while she believes that value judgments can be evaluated, without viewing them as bearers of empirical content, it is difficult to see how the evaluation might proceed.

At this point my account diverges from hers: I make the Davidsonian argument that, like factual judgments, value judgments have empirical content, and this content can be evaluated using the same sorts of empirical analyses that are deployed in other more straightforwardly factual aspects of scientific decision-making.<sup>84</sup> Insofar as we can make distinctions between those factual judgments that are better supported by the empirical evidence and those that are not, so too we can make such distinctions in the case of value judgments.<sup>85</sup> Where relevant, political interests that are empirically supported can play a positive role in science.

On Davidson’s view, the evaluative symmetry between judgments of fact and value is possible because value judgments are, first and foremost, beliefs, the semantic content of which is formed no differently from the

content of factual beliefs. Together, all of our beliefs form a holistic web of meaning, to use the Quinean metaphor. Factual and value judgments might be used for different rhetorical purposes in our explanations and research, but that is different from saying that one kind of judgment has empirical content and the other does not.

While a complete review of Davidson's philosophy of language does not fall under the scope of this essay, some of the basics can be teased out by focusing on the question, "How are our beliefs, political or otherwise, formed in the first place?" Davidson's model of belief formation is based on the holistic epistemology of Quine, and concerns the interpretational strategies of a "radical interpreter"—an adult who finds herself in the midst of speakers of a language completely foreign to her.<sup>86</sup> In the absence of a translation manual or any collateral information about the new language, Davidson asks how this idealized interpreter should proceed to cope with her radically unfamiliar world. Davidson notes that initially all she has to go on, and, indeed, all she needs, is the development of a triangular relationship between (i) the beliefs of native speakers expressed as sentences, (ii) the features of the world to which the sentences refer, and (iii) her attention to (i) and (ii).<sup>87</sup> As I have argued elsewhere,<sup>88</sup> there are two important implications of this model of belief formation for analytic feminists studying the effects of political interests on scientific knowledge. These two implications are discussed below and then applied to the feminist political interests of relevance to the hygiene hypothesis.

The first is Davidson's argument that whatever there is to the meaning of any of our beliefs, must, in principle, be available from the radical interpreter's external, third-person perspective. We can all imagine and/or have experienced successful immersion experiences in completely unfamiliar language communities. On what can this success depend? Surely not on some internal private stock of beliefs about, or expressed in, the new language that are then tested, since initially in these situations, we, as radical interpreters, have no such semantic content available to us in the new language. Yet eventually we can learn the new language, or at least we know people who have done so. The reason is that in at least the simplest cases, the content of the beliefs of the native speakers can be publicly accessed through radical interpretation.

Although beliefs are held by individuals and are in some sense idiosyncratic and/or a product of particular social forces such as gender or nationality, still, the content of any belief must in principle be publicly accessible and communicable, for it is the public process of communication that gives rise to those beliefs in the first place. And if the content of

a belief can be publicly communicated, then through triangulation, the relationship between the content of the belief and the empirical features of the world to which it refers, more or less directly, can be evaluated by anyone who cares enough to take the time to do so.

The second important implication for analytical feminist work in science is that Davidson's holistic model shows there is no principled, substantive difference in the triangulation process by which we form beliefs concerning basic descriptive features of the world and beliefs concerning evaluative features of the world, such as those that inform our political interests.<sup>89</sup> That is, just as with descriptive beliefs, feminist and other political interests get their semantic content from their relationship to the world—a relationship that can, in principle, be empirically adjudicated.

While it is certainly possible that some of the more complex feminist political beliefs that make up our belief webs might be more geographically remote from the simpler perceptual beliefs at the edge of our belief webs, the holism of Davidson's model indicates that, insofar as they have any meaning at all, the complex beliefs are still connected by some semantic threads to those simpler beliefs. The case is similar for the more geographically remote beliefs that make up the theories of, say, high energy physics. The links to the empirical content of any complex set of feminist interests are as available for empirical evaluation as are the complex descriptive beliefs of physics (which is to say, not immediately available to any given undergraduate student, for example, but still empirically accessible—indeed, that's why the students attend class).

Returning to the feminist political interests of relevance to the hygiene hypothesis, recall that these include the beliefs that (a) the social roles assigned to boys and girls, and men and women, are significantly driven by deeply held cultural commitments that are arbitrarily assigned relative to features such as secondary sex characteristics, rather than being assigned relative to the interests or skills of the individuals involved; and (b) that these social roles are vigorously, though often unconsciously, enforced and rewarded from a very young age. The features of gender-role socialization affecting the hygiene hypothesis most directly include the further belief that masculine gender-role assignment, broadly construed, involves a social acceptance of playing in dirt and mud for those (typically boys) so assigned, an acceptance that does not extend to the feminine gender role, broadly construed (and typically assigned to girls).

This set of feminist political interests is layered and complex. However, if we take Davidson's semantic holism seriously, then even

these more complex political beliefs are importantly linked in publicly accessible ways to our more simple perceptual beliefs and, more generally, to our everyday shared experiences about and in the world. We appeal to our students' experience of sexism, and other social constraints and prejudices, to draw out inferences to the more complicated aspects of feminist theory that have been developed in response to these experiences. It is these complicated but, in principle, publicly accessible set of inferential links that give our more complex feminist political beliefs their meaning. Conversely, by tracing the inferential relationship between our political interests and our everyday shared experiences, we can begin to adjudicate the empirical adequacy of our more complex political interests. Such evaluation is possible, though often, of course, difficult.<sup>90</sup> Again, compare these beliefs with the theories of high energy physics that are similarly layered and complex, and similarly removed from more immediate empirical experience. There is little doubt that the beliefs contained in the theories of physics can be connected to empirical experiences and then evaluated for the viability of those connections. Our current working theories of both high energy physics and feminist politics require careful examination and training to be properly evaluated.

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## CONCLUSION

While feminist researchers have amassed a great deal of empirical data supporting the cluster of political interests that I have shown to be relevant to the hygiene hypothesis, we should not assume that this empirical support is obvious, nor that the connections between more or less straightforwardly empirical claims and feminist political interests is clear, easy to follow, and in no need of further argument. In this essay, I have gone some way to providing such an argument.

I have argued that hygiene hypothesis researchers have not sufficiently attended to, or accounted for, the "feminization" of the morbidity rates they seek to explain, a lapse that is especially problematic as these sex differences are very well-documented in nations of the industrialized North and West. While clinicians who treat and study these illnesses have noticed sex differences in the populations they treat, they have tended toward reductionistic biomedical explanations for these differences that put the focus on physiological, hormonal, and genetic accounts. This is a second kind of lapse that has resulted in little to no attention being paid

to the ways these same physiological, hormonal, and genetic phenomena are affected by complex environmental factors, such as patterns of hygiene and sanitation, or social factors, such as the interweaving of the effects of gender, race, and class hierarchies.

The problem with the first lapse is that important sources of evidence for the hygiene hypothesis have been ignored, a number of natural experiments remain unpursued, and a number of interaction effects, such as age by sex, remain unaccounted for. The problem with the second lapse is that the reductionistic focus on biomedical processes continues to leave large amounts of variation unexplained.

Having conducted an interdisciplinary review of feminist research on the gender socialization of children, I have argued for an augmented hygiene hypothesis informed by feminist political interests. In particular, I have argued that insofar as social preferences for cleanliness are enforced more aggressively for girls than boys, this gender difference leaves girls with lower rates of exposure than boys to an array of micro-organisms. The feminist political interests that inform the augmented hypothesis help fill in some of the explanatory gaps in our current understanding of why it is that, in industrialized nations of the North and West, at least, women are more likely than men to suffer from allergies, asthma, autoimmune diseases, and depression. These political interests also respond to a number of outstanding puzzles in the hygiene hypothesis research, make available new sources of evidence, and suggest designs for a number of cross-cultural and other natural experiments.

Insofar as adding a gender analysis increases the empirical adequacy of the hygiene hypothesis, and insofar as this analysis requires a particular set of feminist political interests to be in play, then we have a case where the addition of political interests to a scientific project proves empirically beneficial. While traditional philosophy of science is unable to explain this type of case, a feminist application of Davidson's philosophy of language provides us with the analytic resources we need to show how the inclusion of particular feminist political interests can play a legitimate role in scientific research.

## Notes

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1. See, for example, the public views surveyed in Steel et al. (2004).

2. Many of these cases are reviewed by Fausto-Sterling in *Myths of Gender: Biological Theories about Women and Men* (1992 [1985]); Schiebinger in *The Mind Has No Sex? Women and the Origin of Modern Science* (1989); Tavis in *The Mismeasure of Woman* (1992); Harding in *The "Racial" Economy of Science* (1993); and Spanier in *Im/partial Science: Gender Ideology in Molecular Biology* (1995).
3. Fausto-Sterling (2000); Anderson (2004).
4. Beginning, of course, with Harding (1986); see also Antony (1993), Intermann (2001), Clough (2003), Wylie and Nelson (2007), and de Melo-Martin and Intermann (2007) for more recent reviews of this work.
5. Rook and Lowry (2008, 150).
6. Elliott, Summers, and Weinstock (2007).
7. Desai and Gupta (2005).
8. McDade et al. (2009).
9. Rook and Lowry (2008).
10. *Ibid.*
11. Bird and Rieker (2008).
12. Hankin and Abramson (2001).
13. See Bird and Rieker (2008); Epstein (2007); and Barker (2005, esp. ch. 2) for a critical discussion of the trend toward the reductionistic biomedicalization of these diagnoses.
14. For a critical discussion of these biomedical approaches to immune health in women, see Beeson (1994) and Richardson (2008).
15. E.g., Altemus (2006).
16. E.g., Kuehner (2003); Nolen-Hoeksema (2001).
17. E.g., Pomerleau et al. (1990).
18. Lamb (2005).
19. A case I have made in a number of places, e.g., Clough (2006a; 2006b; 2008).
20. My presentation of the hygiene hypothesis case study was published originally in *Social Science and Medicine* (Clough 2011a).
21. Maziak et al. (2003).
22. Zuany-Amorim et al. (2002) and Ricklin-Gutzwiller et al. (2007).
23. Kilpeläinen et al. (2000).
24. *Ibid.*, p. 201.
25. Ownby, Johnson, and Peterson (2002, p. 969).
26. Elliott et al. (2007).
27. Zvidi et al. (2008).
28. E.g., Summers et al. (2005); Elliott, Summers, and Weinstock (2007); Erb (2009).
29. Rook and Lowry (2008); Lowry et al. (2007); Spiga et al. (2006).
30. Rook and Lowry (2008, p. 150).
31. *Ibid.*, p. 153.
32. *Ibid.*, p. 150, 152.
33. O'Brien et al. (2004).
34. Rook and Lowry (2008, p. 153).
35. *Ibid.*
36. Chisholm et al. (2004); and Ayuso-Mateos et al. (2001).
37. See Horwitz and Wakefield (2007) on problems comparing, for example, the diagnostic criteria of the DSM and the ICD—the International Statistical Classification of Diseases and Related Health Problems, published by the World Health Organization.
38. Bird and Rieker (2008, p. 32).
39. Martin (1998). Certainly equity policies such as Title IX in the United States have increased the participation of girls in sports, but this is a fairly recent change, and has had the greatest effect on girls' participation in sports in high school and college, well beyond the early childhood period when exposure to pathogens seems to be key.
40. Pomerleau et al. (1990).
41. E.g., Lamphar and Roghmann (1997).
42. Caldera, Huston, and O'Brien (1989).
43. Shirley (1938, p. 336).
44. Sikes (1991).
45. Martin (1998).
46. *Ibid.*, p. 498.
47. *Ibid.*
48. Gagen (2000, p. 225); Tomes (1998).
49. Gagen (2000, p. 225).
50. Thorne (1993).
51. *Ibid.*, pp. 73–75.
52. *Ibid.*, p. 74.
53. *Ibid.*, p. 91.
54. Castle and Groves (2000); Bogetto et al. (1999); Lensi et al. (1996); Minichiello et al. (1990); Rachman and Hodgson (1980).
55. See, for example, U.S. Department of Health and Human Services, Office on Women's Health (2009); Jacobson et al. (1997); Walsh and Rau (2000).
56. Osman (2003); Johnson, Peterson, and Ownby (1998).
57. Osman (2003).
58. For a critical discussion of these explanations, see Howes (2007); Bird and Rieker (2008).
59. Ownby, Johnson, and Peterson (2002).
60. *Ibid.*, p. 970.
61. See Kuehner (2003) for a review of this literature.
62. Altemus (2006, p. 364).
63. Kuehner (2003, p. 169).
64. Glickman et al. (1999).
65. Segal et al. (2007).
66. *Ibid.*
67. Vecchiato (1997).
68. *Ibid.*, p. 241.

69. *Ibid.*, p. 245.
70. *Ibid.*
71. *Ibid.*, p. 246.
72. Lamb (2005, p. 213).
73. Wilson, Wilson, and Berkeley-Caines (2003, 217).
74. Punch (2000).
75. Hurtado et al. (1997).
76. *Ibid.*, p. 63.
77. Frost (2007, p. 24).
78. *Ibid.*, pp. 17–18.
79. E.g. Clough (2006a; 2006b; 2008).
80. E.g. Okruhlik (1984); Longino (1987).
81. E.g. Anderson (2004).
82. *Ibid.*, pp. 12–18.
83. *Ibid.*, p. 13.
84. For more detail on my differences with Anderson, see Clough (2006b).
85. I acknowledge that my argument here hinges on an undefended assumption that empirical adjudication is efficacious for factual judgments.
86. E.g. Davidson (1990; 1991a; 1991b).
87. This characterization of radical interpretation comes from Clough (2001, p. 82).
88. Clough (2011b).
89. Davidson ([1995a] 2004); Clough (2006a, 2006b, 2008); Clough and Loges (2008).
90. See Davidson ([1995b] 2004); see also Clough (2010), for a discussion of the practical problems involved in this sort of evaluation.

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