1. Introduction

Disagreement among experts is a troubling phenomenon. We rely on experts to inform ourselves about unfamiliar topics and we treat consensus as an indicator of what has been definitively established. Indeed, this is one of the reasons that fostering or highlighting dissensus amongst experts is an effective means of preventing political action. For example, Oreskes and Conway (2011) have shown how companies in a variety of sectors from tobacco to fossil fuel have manipulated public opinion by cultivating a stable of sympathetic experts. Moreover, similar strategies have been identified in the fields of toxicology (Elliott, 2011) and medicine (Holman, 2015). While fostering dissensus can be a shrewd financial strategy for those facing regulation or litigation, dissensus is also a crucial part of scientific discourse. Thus, upon encountering expert disagreement, the novice must attempt to determine if the dissensus represents legitimate scientific disagreement or whether one of the so-called experts can be discounted as biased and/or on the fringe of accepted scientific knowledge.

Goldman (2001) dubs this the novice/two expert problem. While an individual may indeed confront only two experts, in practice this occurs any time there is dissent amongst experts. In such cases the novice is confronted with multiple viewpoints each upheld by some experts and rejected by others (i.e. expert disagreement). Essentially, the novice confronts a question that is outside his ken. If the novice attempts to read the primary literature, he encounters jargon he does not understand, required background knowledge he lacks, and may find that opposing positions turn on technical questions which he is as incapable of answering as the question that initially prompted expert consultation. It may seem that in the face of expert disagreement, the novice must either suspend judgment or become an expert himself.

Though Goldman discusses a number of strategies for choosing amongst expert opinions (e.g., assessing credentials, assessing the experts for potential bias, etc.,), perhaps the simplest is to accept the position held by the majority of experts. While a guru’s words don’t become more credible with each slavish follower, Goldman argues that so long as experts are relatively independent, we are justified in accepting the majority view. Of course, though falling short of the guru/follower dynamic, any real scientific community is going to be highly dependent. The act of publishing research, attending conferences, and sharing information informally leads to experts sharing much of the information that each expert uses to form her opinion.

A tacit assumption of Goldman’s novice/two expert problem is that consensus is the normative ideal of expert discourse. Goldman’s treatment assumes that expert consensus is
unproblematic, but that dissent poses a problem for the novice. In essence the resolution of the novice/two expert problem is to find a way to discount one of the competing positions, thus reducing it to a case of consensus. Indeed, such an assumption has been taken up by the vast majority of philosophers considering the topic (e.g., Coady, 2006, Conee, 2009; Martini, 2014; but see Miller (2013) for an explicit attempt to specify when consensus is reliable).

However as Solomon (2001) argues, consensus is not necessarily the normative ideal of scientific discourse. Dissent, and therefore expert disagreement, serves multiple functions from the point of view of social epistemology. Even if the minority opinion is incorrect, dissent can push forward discourse and force the majority to clarify and solidify their reasoning. Moreover, the minority position might be correct or each position might accurately capture different aspects of the phenomena. So long as each theory has empirical successes that the other theory lacks, then dissensus is the normatively appropriate state for the scientific community.

That dissensus is at times appropriate raises a number of both normative and descriptive questions. One may wonder, for example, how a novice is to proceed when it is unclear whether the current consensus in the scientific community is in fact normatively appropriate. Relatedly, if dissensus is desirable, how likely is widespread disagreement to occur in an epistemic community, and can dissensus be sustained for the normatively appropriate amount of time? We take on this latter question in what follows. In particular, we draw on a formal model of scientific inquiry first pioneered by Zollman (2007) to explore whether dissensus emerges in those cases where it is normatively appropriate. Section 2 is a primer on past work in network epistemology. In section 3 we introduce our model and state our results. In general, we find that while dissensus is a common feature of our epistemic communities, the kind of dissensus that arises is almost always sub-optimal (to be made precise below). Finally, in section 4 we conclude with some final thoughts on the use of formal modeling in addressing the dynamics of expert opinion and suggest how further work might shed light on the epistemology of trust in experts.

2. Network Epistemology

In order to begin to get purchase on the issue, we turn to ideal models of expert communities. Such modeling consists of a community of agents that gather information about the world and a communication structure that determines which other agents an individual shares her results with. For example, consider a group of medical researchers attempting to determine whether a drug, A, is more efficacious than a rival, B. Researchers are modeled as myopic Bayesian agents, meaning their assessment of the drugs is sensitive to new information and they only conduct research on the drug they think is superior. Since the goal of this model is to capture the behavior of real-world scientific communities, the individuals are said to be continually running a variety of experiments to test drug efficacy. Individuals note the resulting number of successful treatments and then share this information with their peers. Agents then update their beliefs regarding how efficacious both drugs are on the basis of the results they, as well as their peers, produce.
Zollman, and later Patrick Grim (Zollman 2007, 2010; Grim et al. 2013), have noted that the structure of the communication network vitally affects the likelihood of a true consensus. In particular, Zollman considers three canonical models of group structure (see figure 1). One might expect that maximal communication between experts would be superior to one that is more sparsely connected. Yet Zollman shows the reverse to be true. This is due to the fact that when connection density (i.e. the number of connections) is high, a convincing, but spurious, piece of evidence may be widely shared and thus lead the community to a false consensus. Indeed, Zollman (2010) points out that this seems to have happened in research on ulcer medication. Furthermore, and of special importance to the discussion here, Zollman’s model always results in a consensus. To properly explore the possibility of dissensus, then, we must modify this baseline model. We do precisely this in what follows.

3.1 Results: Dissociating consensus and truth

In this section, we utilize Zollman’s model of scientific inquiry to explore how likely a dissensus is to emerge when a dissensus is the normatively appropriate state of the community. We begin by dropping two vital assumptions from Zollman’s framework. In these models when agents ‘experiment’ with a particular drug, they are essentially drawing from a Bernoulli distribution (i.e., we assume that prescribing a drug either leads to a ‘success’ or a ‘failure’) with parameters $p$ and $n$. In other words, in each round individuals simply administer the drug they believe to be more efficacious a total of $n$ times and each application of the drug is successful with probability $p$.

Zollman assumes that whenever two scientists administer the same drug, they are in essence ‘drawing’ from the same Bernoulli distribution. Yet, there are good reasons to think that individuals do not in fact all draw from the same Bernoulli distribution. In many instances, clinicians and medical researchers service different subgroups of the overall population, and different subgroups need not respond to the drug in similar fashion.

Furthermore, if not all agents are drawing from the same Bernoulli distribution, then it is clear that in some instances a dissensus would be preferable to a consensus. Consider the following simple situation involving a clinical research community of ten agents. For six of these individuals, applications of drug A are successful 55% of the time, while drug B results in success only 45% of the
time. For the remaining four agents, drug A is more efficacious than drug B (55% to 45%). The ideal situation would be for all individuals in the former group to utilize drug A and agents in the latter group administer drug B. A consensus is obviously undesirable, as there would be some agents utilizing what is for them an inferior drug.¹

In what follows, we attempt to outline some conditions for when a group-beneficial dissensus is likely to emerge. Such a dissensus may be difficult to bring about due to the fact that individuals routinely share their data with peers. Agents may find it challenging, if not impossible, to converge on the drug that is superior for them while corresponding with those drawing from a different Bernoulli distribution. In such cases, information received from peers may not only contradict, but swamp the data they themselves produce. Thus on a static network (where individuals have no choice but to listen to the findings of all colleagues they are connected to), it appears very unlikely that a group-beneficial dissensus will ever emerge.

Accordingly, we relax a second assumption in Zollman (2007), and consider a dynamic network in which individuals can choose with whom to interact. A fluid network allows for the possibility that individuals with the same Bernoulli distribution find each other and share information, thereby allowing each group to converge to the correct drug. Here, we draw on a model of endogenous network formation first put forth in Holman and Bruner (2015). Briefly, the network formation rule is as follows. For any two agents, i and j, the closer agent j’s experimental results are to agent i’s beliefs, the more influence agent j has on agent i’s beliefs. In other words, agents discount (and may even come to ignore or completely disregard) the experimental results of those who appear to be unreliable (in the sense that their findings deviate drastically from what the focal individual expects).²

We now turn to our computer simulations. To simplify matters, we assume agents can only have one of two ‘profiles’ (call them α and β). Individuals with profile α achieve success 55% of the time with drug A, and success 45% of the time with drug B. For profile β these numbers are reversed (i.e., drug A is successful 45% of the time, while drug B is successful 55% of the time). We first consider a community of 12 individuals evenly split between agents with profile α and those with profile β. Each simulation was run for 5,000 rounds and the results of 100 simulations are displayed in figure 2.

A few notes are in order. First, ideal dissensus is surprisingly never achieved. In other words, there is always at least one individual experimenting with a drug that is inferior for them. More encouragingly, the dynamic nature of the network appears to assist the agents in correctly identifying the superior drug. Not surprisingly, then, for dynamic networks there is a positive correlation between use of the superior drug and the level of connectivity between those with the same profile. When individuals are able to differentially interact with those similar to themselves, they are more likely to have true beliefs.

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¹ Because in many cases we consider no drug is superior simpliciter, “superior/inferior drug” should be understood as the drug that is superior/inferior for the particular agent.
² For further details on the formation rule we utilize in this paper, see section 5 of Holman and Bruner, 2015.
3.2 Minorities in epistemic communities

As we have seen, allowing individuals with the same profile to interact helps ensure that agents can correctly identify the correct drug. Yet when only a few others have a similar profile (i.e., one is an ‘epistemic minority’), forging strong connections between like-minded individuals may be difficult and thus the likelihood that a member of the minority uses the superior drug is diminished.

For example, in a small six-person community in which half the community has profile $\alpha$ and the remaining three members have profile $\beta$, a dissensus is achieved 94% of the time (once again, it is never the case in our simulations that ideal dissensus is reached). When only two individuals have profile $\alpha$ (while 4 have $\beta$), 82% of the time a dissensus is achieved, and dissensus is attained only 57% of the time when a sole individual has profile $\alpha$. Dissensus is less likely in these latter two cases because members of the epistemic minority are more likely to be initially influenced by the experimental results of the epistemic majority. Not only does this mean they are inclined to administer the wrong drug initially, but they will also decrease their connectivity to fellow minority members. Once the ties to fellow minority members has been cut, the agent is then locked into administering the inferior drug.

Figure 3 further speaks to the disadvantage epistemic minorities face. In this case, a network consisting of 12 individuals is considered. When the population is split evenly between profile $\alpha$ and $\beta$, around 60% of the time individuals learn to prescribe the superior drug. Dissensus is expected, but individuals quite frequently converge on the inferior drug. As the number of individuals with profile $\alpha$ decrease, members of the epistemic majority are more likely to correctly identify the more efficacious drug, but members of the minority are much less likely to do so. In the extreme (where only one member has profile $\alpha$), this lone epistemic minority is able to identify the more efficacious drug only 12% of the time.

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Note that we run only 100 simulations for each parameter setting, meaning that our analysis may not pick-up on extremely unlike simulation outcomes.
Figure 3: Proportion of members of the epistemic majority (triangle) and minority (diamond) that administer the drug which is superior for them and population average (square) of individuals administering the superior drug. Proportion of runs where more than half of the total experts administered the superior drug for the epistemic majority (x).

3.3 Inappropriate Dissensus

We now briefly consider a slightly different situation in which six agents again have one of two profiles, but now both profiles rank drug A above drug B. Since the two profiles are in agreement, a group consensus in which all utilize drug A is desirable. Yet dissensus is nonetheless attainable. Consider profile $\alpha'$ and $\beta'$. Individuals with profile $\alpha'$ achieve success 60% of the time with drug A, and success only 50% of the time with drug B. Agents with profile $\beta'$, however, are not so fortunate. For them, success is possible 40% of the time with A, and 30% of the time with B. When the same number of agents utilize $\alpha'$ and $\beta'$ in the community, a dissensus occurs 86% of the time. Moreover, only 68% of individuals are utilizing the superior drug. Thus, just as consensus is possible when dissensus is normatively appropriate, dissensus can easily arise when a community-wide agreement is called for.

4. Concluding Remarks

One possible objection to results presented above is that we are not considering a case of “genuine disagreement.” Feldman (2007) outlines a number cases that might appear to be disagreement, but fail to be “genuine.” For example, if a doctor with an $\alpha$ profile maintained drug A is best and a doctor with a $\beta$ profile maintained drug B is best, there would be only apparent disagreement if we understood them to mean “best for my patients.” Similarly, we are considering

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4 When there are not the same number of agents with profile $\alpha'$ and $\beta'$ in the community, consensus is not surprisingly more likely, although dissensus is still a significant possibility.
cases where not all evidence is shared and so the doctors might be said not to be peers in the peculiar sense intended by philosophers. Yet whether this is a genuine case of disagreement or not is in some sense irrelevant to the situation encountered by novice. From her perspective the cases we consider here would be indistinguishable from instances involving ‘genuine disagreement.’ Accordingly, if we are to concern ourselves with understanding actual cases of expert disagreement and what novices can infer from the state of expert opinion, philosophical analysis will need to address cases where the reasons for the disagreement are obscured and not all the evidence is shared.

Moreover, one might note that while we interpreted our model as representing a case where drugs were differently efficacious depending on the population, this interpretation is stylistic and the models actually pertain to a wide variety of situations where unrecognized differences lead experts to obtain conflicting results (e.g. subtle differences in experimental paradigms, ambiguous criteria for measurements, etc.). In such cases, divergent results will persist until and unless these differences come to light. Thus, these models capture phenomena relevant to significant swaths of situations actually faced by epistemic communities.

In line with Solomon’s (2001) claim regarding epistemic communities, our results show that a group of rational agents can—and often do—achieve dissensus when dissensus is normatively appropriate. But note, as discussed in 3.1, agents are more likely to do so when they stop listening to agents that disagree with them! In these instances acquiring true beliefs is actually inhibited by an open discourse.

Our results from section 3.2 show that communities can reach consensus even when dissensus is the normative state of the community. Furthermore, this result becomes far more likely as the epistemic minority becomes a smaller portion of the overall group. The consequences of such a consensus may be epistemically disastrous, especially when the model is taken to apply to situations where the various profiles correspond to different experimental paradigms or measurement techniques. As noted earlier, one of the justifications for maintaining dissensus is that the minority might be right. If we presume that in the case where a consensus occurs, debate ceases, so does the chance for the community to recognize their error.

Just as communities can reach a mistaken consensus, our results from section 3.3 show that communities can reach dissensus even when consensus is normatively appropriate. In fact in the case reported above, dissensus is the likely outcome (occurring 86% of the time) and there is generally a sizable group dissenting (roughly one third of the community on average). Together, sections 3.2 and 3.3 show that states of dissensus are no more problematic than consensus.

Returning to Goldman’s novice/two expert problem, we see that the novice is not in some special epistemic situation in cases of expert disagreement. When experts disagree, the novice must determine whether either one of the positions may be discounted (i.e. whether the dissensus is legitimate). The novice is in the same position when encountering consensus, viz., the novice must still determine whether the consensus is legitimate. Thus, regardless of whether experts agree or disagree, the novice must make an inference from the state of the expert community to the actual state of the world. Such a judgment is facilitated by knowing what possible states of the world might lead to the observed state of the expert community.

That being said, we do find qualified support for Goldman’s recommendation to defer to the majority opinion when there exists widespread disagreement. In figure 3, the line “maj. drug” graphs the percentage of simulations where the majority of agents administer the superior drug for the epistemic majority. These results show that, especially as the minority group gets small,
deferring to the majority is a reliable strategy for the “average” novice. Of course, for novices with a profile of the epistemic minority, such deference will be to one’s detriment.

Finally, one additional cautionary note is that such results may not hold when other factors are at play. For example, while Zollman (2007) found that independence of experts increased the probability of the group arriving at a true consensus, we (2015) have previously shown that independence has the reverse effect when some of the members of the group are “intransigently biased” (i.e. not truth seeking). Whether the results we obtain here (and the corresponding morals such as defer to the majority) would hold if similar pressures were incorporated into the model is a matter to be settled by investigation, not speculation.


Miller B When in Consensus Knowledge Based? Distinguishing Shared Knowledge from Mere Agreement. Synthese 190: 1293-1316.


