

### Meeting 3.1: Replication in Science

#### Summary

In our first reading, Harry Collins emphasizes the importance of *tacit knowledge* in science and its centrality to the replication of scientific experiments. In his words, “Tacit knowledge is the name given by Michael Polanyi to our ability to perform skills without being able to articulate how we do them.” Many aspects of scientific knowledge and know-how, argues Collins, are tacit in nature, and therefore do not make it into documentation (either intentionally or unintentionally) for both the evaluation and preservation of scientific knowledge and experiments for the broader community. Collins further distinguishes between the *algorithmic model* of learning, which is based upon a set of formal instructions, and the *enculturational model*, which occurs over time through experience in the field. It is the latter model through which essential tacit knowledge is gained. The enculturational model is “capricious” (in Collins’ words) and relies on intricate social structures, and this presents a significant challenge to replication. He summarizes his case study of the TEA-laser with six propositions:

1. Transfer of skill-like knowledge is capricious.
2. Skill-like knowledge travels best (or only) through accomplished practitioners.
3. Experimental ability has the character of a skill that can be acquired and developed with practice. Like a skill, it cannot be fully explicated or absolutely established.
4. Experimental ability is invisible in its passage and in those who possess it.
5. Proper working of the apparatus, parts of the apparatus and the experimenter are defined by the ability to take part in producing the proper experimental outcome. Other indicators cannot be found.
6. Scientists and others tend to believe in the responsiveness of nature to manipulations directed by sets of algorithm-like instructions. This gives the impression that carrying out experiments is, literally, a formality. This belief, though it may occasionally be suspended at times of difficulty, re-crystallizes catastrophically upon the successful completion of an experiment.

Elsewhere, Collins refers to proposition five as “experimenter’s regress” - a good apparatus and a correct outcome are defined in terms of each other. Therefore, for Collins, no experimental results can ever be falsified, nor can it be replicated, since one can always appeal to the apparatus as the cause of the negative/positive result.

In the second reading, Franklin critiques Collins’ idea of the “experimenter’s regress”. Franklin argues that (1) calibration is not the decisive aspect of replication and (2) the experimenter’s regress can be broken by reasoned judgment. Unlike Collins, who relies on oral interviews conducted with the scientists themselves, Franklin makes his case based on journal articles and published discussions between research groups.

Franklin’s article analyzes the claims and criticisms of gravitational wave observation in the 1970s, a topic discussed by Collins in another chapter of his book which we did not read.

The dispute circled around the observation of a gravitational wave signal via a bar detector and whether or not the signal was an artifact of the data processing algorithm. Collins argues that the choice of processing algorithm could not be made by referencing experimental results alone. This was because, as noted above, a correctly functioning experiment is one that produces good results. At this point in time, good results were not agreed upon and the whole idea of a correctly functioning bar detector was unstable. Franklin argues against Collins. He notes that groups applied reasoned judgment and a process of elimination to critique certain data processing algorithms. By testing various processing algorithms on their own experimental bars, they were able to critique the results of the group that claimed positive observation.

The divide between the two of them is rooted in a simple assumption. Franklin assumes that the critical scientists have succeeded in materially replicating Weber's experiment. Collins, on the other hand, believes that material replication cannot truly occur and that convincing replications come out of social agreement.

### Discussion

- In his recounting of Bob Harrison's building of his second TEA laser, Collins recalls that during troubleshooting, "The point was to determine *what counted as a difference* for H[arrison] and what might subsequently be taken to account for failure of the laser." For Collins, part of the tacit knowledge one gains with experience is the intuition for what counts as a meaningful difference. This raises the question of what counts as replication in science in general: by definition, no two experiments are ever *exactly* the same (if you will: their results are distinct events in spacetime). Can some formal criterion be formulated for how similar two experiments must be (or in what pertinent ways they must be similar)? Does Franklin adequately address this?
- Is it true that certain aspects of scientific experiment will always come down to the "black art" as Collins says? Can't each of those undesired outcomes in the debugging process of the TEA laser be attributed to some physics simplification that is failing to hold in the experimental setup, but that is still accounted for by a more precise physical theory? And in principle, wouldn't perfect knowledge of the physics account for every detail of the debugging?
- Collins discusses the role of trust within scientific communities. How does trust relate to the replication process, and how might it impact the acceptance or rejection of scientific claims?
- What are the implications of Collins and Franklin's work for the open science movement and efforts to enhance transparency and replicability in research? Is there value to hiding the dirty details of replication to the public outside of the scientific community?
- In your research, do you find that scientific results are more often evaluated by epistemological criteria, or by the sorts of "breaks to the experimenters' regress" that Collins discusses, which are primarily sociological?