might call it a principle or law. The latter is a process that can increase our confidence in what we know, even if the result is not so general as to be judged a "law". That's what science is about [34].

Feynman: on The Reality of Reflection All Ways

There are many cases where the claim to reality and direct fitness to the world is not essential, but physics is a field where the claim to reality is central. Feyman's explanation of how a diffraction grating can scatter a flood of particles in a way formerly only comprehensible through the wave theory of light shows the power of the QED formulation. It also supports the reality claim of his central principle -- that the orderliness of light phenomena emerges as a function of the individual probabilities of masses of photons going all possible ways.

To illuminate the cases where "interference" occurs, Feynman proposes an experiment -- to examine a case where reflection "shouldn't happen" -- far out on a mirror from the center line between a light source and photon counter. He selects the slices A and B from the left hand side of the mirror in figure 2 and turns to examining the case in a finer grain of detail.

> "... In this experiment I am going to make a more detailed calculation by taking intervals on that left-hand part of the mirror that are much closer together—fine enough that there is not much difference in time between neighboring paths (see Fig. 7). With this more detailed picture, we see that some of the arrows point more or less to the right; the others point more or less to the left. If we add all the arrows together, we have a bunch of arrows going around in what is essentially a circle, getting nowhere."

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[34] Although this statement may strike some readers as insufficiently rigorous, it reflects in short compass the view advanced by C.S.Peirce in *The Fixation of Belief* and *Lessons from the History of Science*.

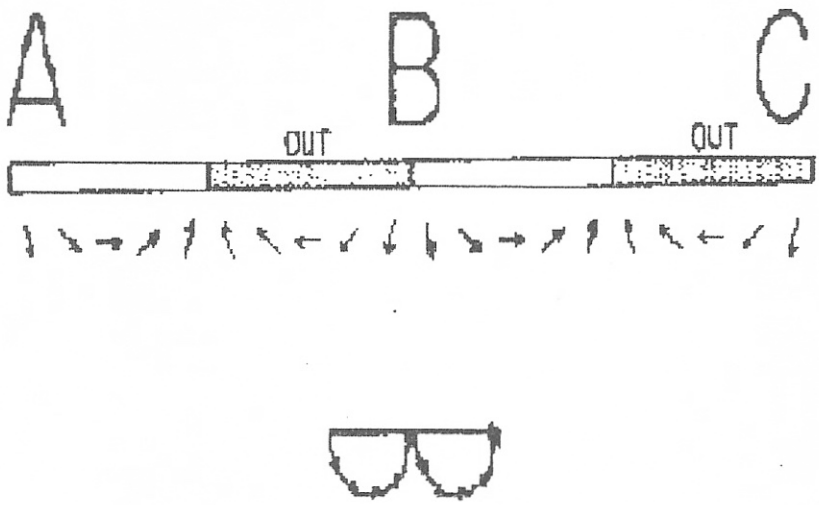

Figure 7

"But let's suppose we carefully scrape the mirror away in those areas whose arrows have a bias in one direction—let's say, to the left—so that only those places whose arrows point generally the other way remain (see Figure 7). When we add up only the arrows that point more or less to the right, we get a series of dips and a substantial final arrow—according to the theory, we should now have a strong reflection! And indeed, we do—the theory is correct! Such a mirror is called a diffraction grating, and it works like a charm.

"Isn't it wonderful—you can take a piece of mirror where you didn't expect any reflection, scrape away part of it, and it reflects! ... So a grating shows that we can't ignore the parts of a mirror that don't seem to be reflecting; if we do some clever things to the mirror, we can demonstrate the reality of the reflections from all parts of the mirror and produce some striking optical phenomena...

"More importantly, demonstrating the reality of reflection from all parts of the mirror shows that there is an amplitude—an arrow—for every way an event can happen. And in order to calculate correctly the probability of an event in different circumstances, we have to add the arrows for every way that the event could happen—not just the ways we think are the important ones!..."

This simple explanation marks Feynman's triumph, for it permits assimilation of diffraction-grating related phenomena -- which had been the forte of the

wave theory of light -- to the quantum theory.[35] For psychologists, the import of this specific example may be somewhat sobering. Lewin was right, after all. Although our statistical techniques may help up locate and describe mass phenomena we can feel confident about, the cases that are remote from those of the average case may lead to more profound insights into phenomena of mind. The careful analysis of particular cases -- more in the style of ethological observation than laboratory experiment[36]-- can better focus our work on the issues and the appropriate grain of detail for understanding human behavior and the character and role of learning in it. Such studies will not, themselves, produce theory, but they will help us identify clearly those issues that <u>must</u> be confronted in the construction of an improved theory.

Lawler: The Internalization of External Processes

> "...The internalization of socially rooted and historically developed activities is the distinguishing feature of human psychology, the basis of the qualitative leap from animal to human psychology. As yet, the barest outline of this process is known..."
>
> L. S. Vygotsky

If the psychological processes to which Vygotsky refers characterize productive intelligence in all forms, the development of self-control and the

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[35] If one wanted to find a scheme to give meaning to McCulloch's delphic pronouncement "...even Schroedinger and Heisenberg... have had their Dirac," here is one way. By suggesting how human-scale physical phenomena could be seen as a special case of quantum phenomena, Dirac established that the incompatibilities no longer needed to be regarded. The challenge changed from explaining apparent phenomenal differences (based on human-scale model differences) to rooting explanation in quantum level phenomena and theories.

[36] This suggested is put forward in a discussion of Ethology by Medawar and Medawar (1983), p.84 . What specifically such a study should look like might be open to discussion. Barker and Wright (1951) provide one sort of answer, Lawler (1985) another.