INFECTION AND IMMUNITY, Sept. 2008, p. 3835–3836 Vol. 76, No. 9
0019-9567/08/$08.00+0 doi:10.1128/IAI.00743-08

GUEST COMMENTARY

Descriptive Science▽

Arturo Casadevall[1]* and Ferric C. Fang[2]

Department of Medicine, Albert Einstein College of Medicine, Bronx, New York 10461-1975,[1] and Departments of Laboratory Medicine and Microbiology, University of Washington School of Medicine, Seattle, Washington 98195-7242[2]

"Certainly no developed science is merely descriptive in the narrower sense of the word—it seeks to explain."

—Ernest Albee (2)

The Instructions to Authors for *Infection and Immunity* state that "IAI will not consider papers that are . . . purely descriptive" (3). When applied to science, the word "descriptive" has acquired dismissive or pejorative connotations and is frequently provided as justification for rejection of a manuscript or grant application. Given the widespread use of this adjective and its profound implications, it is worthwhile to reflect on what is right or wrong with descriptive science.

The word "descriptive" is defined as "referring to, constituting or grounded in matters of observation or experience" (4). Since practically all laboratory-based biological science is based on recording evidence from experimentation, it might be argued that all science is in some sense "descriptive." However, scientists distinguish between "descriptive research," in which information is collected without a particular question in mind, and "hypothesis-driven research," designed to test a specific explanation for a phenomenon. In this dichotomy, "descriptive" has numerous synonyms, including "observational," "inductive," or "fishing expedition," while "hypothesis driven" may also be referred to as "hypothetico-deductive" or "mechanistic." When scientists favor hypothesis-driven science over descriptive science, they are really saying that they prefer work that is explanatory or provides insights into causation.

In considering this issue, it is noteworthy that many esteemed scientific disciplines, such as astronomy, archaeology, and paleontology, are almost entirely descriptive sciences (8). Newton's laws of motion can be considered descriptive, and there is nothing mechanistic about the gravitational constant. Nevertheless, we hold these laws in great esteem because they are able to predict the behavior of the natural world. One cannot perform an experiment in which a stellar variable or a geological epoch is altered. Moreover, the descriptive sciences of taxonomy, anatomy, botany, and paleontology have been central to the development of evolutionary theory, which remains the linchpin of all biological sciences. Hence, there is nothing fundamentally wrong with descriptive research, with the caveat that a scientific field may demand more from an investigator once it becomes an experimental science.

In microbiology and related medical sciences, the transition from descriptive research to hypothesis-driven research has generally reflected the maturation of these fields. In the early stages of a field, descriptive studies may "represent the first scientific toe in the water" (9). Initial observation and induction give rise to novel hypotheses, which subsequently can be experimentally tested to provide a progressively detailed mechanistic understanding. Specific hypotheses allow a more discerning interrogation of complex data sets, something recognized by Darwin when he noted, "Without speculation there is no good and original observation" (6). On the other hand, a descriptive approach may be less prone to bias (11). "It is a capital mistake to theorize before you have all the evidence," Sherlock Holmes once remarked. "It biases the judgment" (7).

Microbiology and immunology are presently being transformed by a number of powerful technological advances; methods such as large-scale sequencing, microarrays, bioinformatics, and proteomics are generating enormous databases that provide invaluable resources for the research community. While these methods can certainly provide potent means to answer mechanistic hypotheses, in many cases they are initially being used solely in a "descriptive" sense. In other words, some aspects of biological science have returned to an observational phase, in which research is primarily "discovery driven" rather than "hypothesis driven" (1). Such research is clearly important when it leads to the recognition of novel phenomena or the generation of novel hypotheses. However, microbiology and immunology are now experimental sciences and consequently investigators can go beyond simply describing observations to formulate hypotheses and then perform experiments to validate or refute them.

Why, then, the proscription against "descriptive" science? Editors and reviewers distinguish between descriptive science that significantly advances the field and "mere" descriptive science that does not further understanding. The former might be appropriate for publication in *Infection and Immunity*, but the latter will almost always be returned to the authors as too preliminary. An example of a rejected descriptive manuscript would be a survey of changes in gene expression or cytokine production under a given condition. These manuscripts usually fare poorly in the review process and are assigned low priority on the grounds that they are merely descriptive; some journals categorically reject such manuscripts (5). Although survey studies may have some value, their value is greatly enhanced when the data lead to a hypothesis-driven experiment. For example, consider a cytokine expression study in which an increase in a specific inflammatory mediator is inferred to be

* Corresponding author. Mailing address: Golding 701, 1300 Morris Park Avenue, Bronx, NY 10461-1975. Phone: (718) 430-3665. Fax: (718) 430-8701. E-mail: casadeva@aecom.yu.edu.

▽ Published ahead of print on 14 July 2008.

important because its expression changes during infection. Such an inference cannot be made on correlation alone, since correlation does not necessarily imply a causal relationship. The study might be labeled "descriptive" and assigned low priority. On the other hand, imagine the same study in which the investigators use the initial data to perform a specific experiment to establish that blocking the cytokine has a certain effect while increasing expression of the cytokine has the opposite effect. By manipulating the system, the investigators transform their study from merely descriptive to hypothesis driven. Hence, the problem is not that the study is descriptive per se but rather that there is a preference for studies that provide novel mechanistic insights.

When a manuscript is rejected by *Infection and Immunity* for being "merely descriptive," the reviewer is essentially saying that the work has not revealed novel phenomena, has failed to generate interesting novel hypotheses, or has failed to adequately follow up such hypotheses with further experimentation. The most common reason for a paper to be assessed as "merely descriptive" is that more in-depth investigation is required. A reviewer who recommends that a paper be rejected because it is "merely descriptive" can provide a great service to the authors by clearly and unambiguously explaining the additional studies required for the paper to become more significant and therefore more interesting.

Descriptive observations play a vital role in scientific progress, particularly during the initial explorations made possible by technological breakthroughs. At its best, descriptive research can illuminate novel phenomena or give rise to novel hypotheses that can in turn be examined by hypothesis-driven research. However, descriptive research by itself is seldom conclusive. Thus, descriptive and hypothesis-driven research should be seen as complementary and iterative (10). Observation, description, and the formulation and testing of novel hypotheses are all essential to scientific progress. The value of combining these elements is almost indescribable.

Editor: J. B. Bliska

REFERENCES

1. **Aebersold, R., L. E. Hood, and J. D. Watts.** 2000. Equipping scientists for the new biology. Nat. Biotechnol. **18:**359.
2. **Albee, E.** 1907. Descriptive and normative sciences. Philos. Rev. **16:**40–49.
3. **American Society for Microbiology.** 2008. Instructions to authors. Infect. Immun. **76:**1–20.
4. **Anonymous.** 2008. Merriam-Webster online dictionary. http://www.merriam-webster.com/dictionary/descriptive.
5. **Bassler, B., S. Bell, A. Cowman, B. Goldman, D. Holden, V. Miller, T. Pugsley, and B. Simons.** 2004. Editorial policy on genome-scale analyses. Mol. Microbiol. **52:**311–312.
6. **Darwin, C., F. Burkhardt (ed.), and S. Smith (ed.).** 1985. The correspondence of Charles Darwin. Cambridge University Press, Cambridge, United Kingdom.
7. **Doyle, A. C.** 1986. A study in scarlet. Bantam, New York, NY.
8. **Grimaldi, D. A., and M. S. Engel.** 2008. Why descriptive science still matters. Bioscience **57:**646–647.
9. **Grimes, D. A., and K. F. Schulz.** 2002. Descriptive studies: what they can and cannot do. Lancet **359:**145–149.
10. **Kell, D. B., and S. G. Oliver.** 2004. Here is the evidence, now what is the hypothesis? The complementary roles of inductive and hypothesis-driven science in the post-genomic era. Bioessays **26:**99–105.
11. **Marincola, F. M.** 2007. In support of descriptive studies; relevance to translational research. J. Translat. Med. **5:**21.