# MODULE 6

## Scientific Research and Scientific Mistakes

## PART I

## What Happens When Scientists Get It Wrong?

**Warm-up**

**Ex.1 In his book 'Fact and Fraud: Cautionary tales from the Front Lines of Science' David Goodstein gives some statements:**

"A scientist should never be motivated to do the science for personal gain."
"Scientists should always be objective and impartial when gathering data."|
"Scientists must never believe dogmatically in any idea."
"Scientists should never permit their judgments to be affected by authority."

**Do you think all these statements are true? In your opinion, do scientists always follow these principles? Why?**

**VOCABULARY**

**Ex.2 Match the following words with their meaning:**

| | |
|---|---|
| 1. to appreciate | a. permanent |
| 2. a bias | b. a situation when some related events happen by chance |
| 3. a claim | c. words that smb uses as their rule for behaviour |
| 4. a consequence | d. smth unobjective |
| 5. a coincidence | e. to look at, to study again |
| 6. to confirm | f. to take, to accept |
| 7. an evidence | g. not to lose or break under some trying circumstances |
| 8. to frown upon | h. smth that is said but isn't proved, thus can be wrong |
| 9. ineradicable | i. to increase greatly and rapidly |
| 10. a motto | j. to disapprove of smth |
| 11. to revise | k. to prove smth |
| 12. a variable | l. a result of smth |
| 13.to skyrocket | m. a quantity which can take any number of values |
| 14. to withstand | n. anything you experience which tells you that smth is true |

**READING**

**Ex.3 Read the Introduction to the article and fill in the gaps with the words from ex.2. Change their form if it is necessary.**

**How science is learning to admit mistakes**

**Part 1. Introduction**

Why should we trust science? If you ask scientists, it's because science is based on a careful study of the outside world—not guesses, hunches, philosophizing, or rumors—and because science is a self-correcting system, continually 1) _________ theories and updating facts to reflect new 2) _________.

When the British Royal Society was founded in 1660, its mission was to "improve natural knowledge" and its 3) _________ was nullius in verba — Latin for "take nobody's word for it." In the Society's view, it was wrong to accept any 4) _________ based simply on the authority of who said it—the church, the king, the ancient philosophers. Their principle was "to 5) _________ the domination of authority and to verify all statements by an appeal to facts determined by experiment."

This idealized vision of science has been with us ever since: claims are true or false because of what experiments say, not what a particular person says. Reality, however, tells a different story. Experiments are conducted by human beings who then tell everyone else about what they found. Scientific knowledge is the accumulation of people's claims about the results of their experiments.

More people claiming to find the same thing can increase confidence in the conclusion, but some amount of trust is 6) _________ in science, because nobody has the time to personally check every fact they might see or rely on. If scientists have no reason to doubt a study on its face—it comes from a credible author, it's published in a peer-reviewed journal, and it's not obviously crazy—they may simply accept it and build on its conclusions.

Scientific careers are built by finding new discoveries to publish, not redoing other people's experiments. Meanwhile, well-documented publication biases means that journals are more likely to publish studies that report positive results, rather than boring "null" results.

This means that, even to the extent that scientists are testing each other's work, they are more likely to hear about experiments that 7) _________ their results than experiments that failed to do so.

Even more troubling, the pressure to find new discoveries seems to increase the 8) _________ toward finding positive results. Researchers know that journals want positive results, so they search their data to find something "statistically significant" to publish about.

But statistical significance (the likelihood of a result being a 9) _________) depends on researchers not gaming the system. If a relationship only had a 5% (or 1 in 20) probability of happening by chance, but researchers tested 20 or 200 possible connections, the odds that they were going to find something go way up. With modern computer programs, researchers can now easily test connections between thousands of 10) _________.

This is called “p-hacking” or “data fishing,” and it is officially 11) _________, but scientists often do it unconsciously, without intending to mislead anyone, simply because they are naturally making choices about where to look for data and how to analyze it. They are often guided by unconscious biases about what “works” to find results.

The 12) _________ of biases and practices like this were not well 13) _________ for most of the 20th century, while the number of PhDs, scientific journals, and research papers were 14) _________. Unfortunately, this rapidly accumulating body of knowledge was about to be cast into doubt, once again.

**Ex.4 Read the second part of the test. Can you explain the use of the articles *a/an, the* or *no article* in the underlined places?**

## Part 2. The Reproducibility Crisis

In 2005, John P.A. Ioannidis published a shocking paper in the journal PLOS Medicine, titled “Why Most Published Research Findings Are False.” Ioannidis argued that biases from scientists and journals in publication, research methods, and study design strongly implied that the majority of published biomedical research studies are false—and other, less rigorous fields were likely to be worse.

This bombshell accusation spurred many scientists to try to replicate important studies in their field. Over half of published psychology studies in top journals couldn’t be replicated in one 2015 re-testing effort. In another, only 6 out of 53 “landmark” cancer studies were found to be replicable. In another social science replication study, even when experiments confirmed the original finding, the effect sizes were about half as large as those reported in the original paper.

This “reproducibility crisis” has sprawled out over dozens of academic disciplines, and now fills a large and growing entry on Wikipedia.

Recently, image search programs scanning top scientific journals have found a large number (over 6%) of biomedical studies containing manipulated, duplicated, or mislabeled images. According to one study, as many as 35,000 medical papers may need corrections or retractions over “inappropriately duplicated images.”

And images are just one easily detectable type of problem. Coding mistakes (misplacing a variable in a spreadsheet or making a typo in a formula) are easy to make and hard to detect without the original data. Coding mistakes have undermined landmark research by top scholars on hot-button topics as the effects of discrimination on health, abortion on crime rates, and government debt on the economy.

In retrospect, this shouldn’t have been a surprise to anyone who had bothered to ask scientists themselves. In a survey of 1,500 scientists conducted by the journal Nature, over 50% admitted that they had failed to replicate some of their own work, and 70% reported failing to replicate a colleague’s experiment.

And reasons why aren't hard to understand, either. In a meta-analysis of 18 surveys asking about scientific misconduct, 2% of scientists admitted that they had personally falsified or fabricated data, and about 14% reported seeing a colleague do so.

A 2012 survey asking about less serious research mistakes (so-called "questionable research practices" or QRPs) found that admitted rates of QRPs were high across all disciplines. "Even raw self-admission rates were surprisingly high," the authors, concluded, "and for certain practices, the inferred actual estimates approached 100%, which suggests that these practices may constitute the de facto scientific norm." In other words, everyone's doing it.

**Ex.5 Answer the questions:**

Part 1

1) Why is science considered to be trustworthy?

2) What did the British Royal Society believe to be its mission?

3) How does reality differ from the ideal image of science?

4) Why do scientists have no reason to doubt published researches?

5) How are positive results connected with untrustworthy publications?

6) What is "data fishing"?

Part 2

7) What paper was published by John P.A. Ioannidis in 2005?

8) What did replication of many published biomedical research show?

9) What is discussed concerning the problem with images?

10) What is coding mistake? How did these mistakes effect some significant studies?

11) What statistics can be found in a survey done by the journal Nature?

12) What conclusion does the author make?

**SPEAKING**

**Ex.6 Work in pairs or small groups to talk on the following topics:**

a) Have you heard about any false publication cases?

b) Would scientists actually stop their own research to check if another lab's studies are credible?

c) What is the danger of such 'false publications'?

d) Can you think of any counter-measures for publication of studies which aren't trustworthy?