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Editorial

IS 'HYPOTHESIS' HYPERTELIC IN SCIENCE ?

It appears today that scientific research primarily progresses through generating and testing hypothesis. 'Well, what is the hypothesis?' or 'this is mere throwing arrow in the dark' are very common expressions to listen in any scientific deliberation. It is as if there can be no scientific research without any hypothesis-driven approach. Indeed there has been a long legacy of hypothesis-driven deductive logic process in the Western philosophy and theory of knowledge, initiated even prior to Aristotle (384 BC – 322 BC). In the recent times, it has been championed by Karl Popper (1902-1994) and Peter Medawar (1915-1987) in the arena of scientific research. In *The Logic of Scientific Discovery*, Popper rejected induction as a valid form of logic in the practice of science (1). Albeit some science philosophers think that Popper was misinterpreted (2), none but Peter Midawar argued in the line of Popper's thought and placed strong view against induction as a legitimate method for practicing science (3). Medawar shared with Frank Macfarlane Burnet the 1960-Nobel Award in Physiology/Medicine. Both Karl Popper and Peter Medawar were knighted in 1965. Popper was also elected a Fellow of the Royal Society in 1976. Understandably, the impact of their thought has lasting effect.

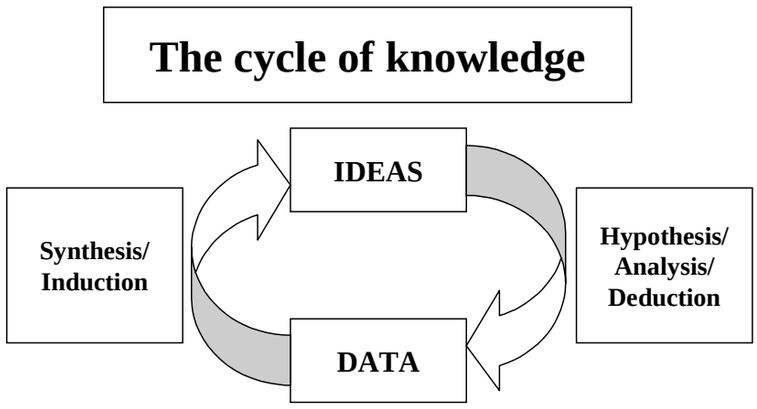
Recently, there has been some serious resentment to anti-induction thinking in biomedical research. There is however no doubt to the fact that induction as legitimate logic in practice of science had been recognized quite early; in fact, Francis Bacon (1561–1626) employed induction as a method of practicing modern science (4). With the advent of new post genomic research and systems biology approach, a group of scientists and science philosophers are again trying hard to push the case of pure observation-based hypothesis-free inductive science. In this process, they - maybe unwittingly – are pulling down the relative merit of hypothesis-driven deductive science.

Irving Rothchild in his brilliant essay on *Induction, Deduction, and the Scientific Method* recalls a story of a chimp and an orangutan originally recounted by Vickie Hearn (5). In the story, there were a chimpanzee and an orangutan housed separately. They were individually given a small hexagonal block and an assortment of differently shaped openings into only one of which the block would fit. If they could solve the problem, they knew, would be rewarded. The chimp examined every details of the floor, walls, and ceiling of the house, and then all the openings; and then all sides of the block; he

smelled and tasted it in all possible ways. After trying one opening after another, he finally found out the right opening for the block into which the block fitted. The orangutan, on the other hand, scratched his back with the block, and sat away with a far away look in his eyes for what seemed to the human observer like forever. He then walked up to the right opening and put the block into the hexagonal opening. Can we question which one was the scientist or who was the better scientist? Was Vesalius less of a scientist than Mendel because Vesalius only dissected while Mendel conducted experiments?

While a healthy polemics about relative significance of deductive and inductive science is welcome, undertaking an either-or-position in this regard is unwarranted. We believe that one needs not to be a Nobel scientist to understand that whole gamut of approaches in science ranging from observation-based induction to hypothesis-driven deduction to intuition-based abduction play their roles in the complex networks of processes in the sojourn of science; there is no pure exclusivity in its process. Douglas Kell and Stephen Oliver (6) have discussed this point quite succinctly in their article, and it is shown in the Inset.

In the history of biomedical science, there are innumerable examples where observations made in entirely different platforms coupled with the Midas touch of



Scientific advance may be seen as an iterative cycle linking knowledge and observations. The hypothetico-deductive mode of reasoning uses background knowledge to construct a hypothesis that is tested experimentally to produce observations. This is only half the story, however, as the inductive mode of reasoning is based purely on generalising rules (or hypotheses) from examples, i.e. it is purely data-driven (and the hypothesis is the end, not the beginning). Because of high dimensionality of typical data, computer-intensive methods are required to turn the data into knowledge. Science advances in reality employing both deductive and inductive modes of reasoning in an iterative cycle.

Adapted from Kell and Oliver (6)

intuition [and maybe occasionally that of, what Edward Wilson connects as, *consilience* (7)] led to the emergence of a new hypothesis or theory and it was then tested. A few examples are given in the box of Additional Note. It is therefore worthwhile to recognize that science is what a scientist does. And what does a scientist do? In the saucer of continuum, a scientist conjures up a process of thought with creativity, commitment and connectivity using induction, abduction and deduction in the required proportionality in order to find out solution to his problem. And this process yields science.

Irving Rothchild (8) puts it quite lucidly:

Additional Note

Story 1: Gustav Born (1851-1900) was a renowned anatomist. He studied the reports of Sobotta and conducted histological studies on early mouse development, and mouse and rabbit corpora lutea during 1893-1898. Based on his large scale observations he intuitively theorized that corpora lutea secreted hormone and it was essential for establishment and maintenance of pregnancy. Born however could not test his hypothesis because of his poor health and he died in 1900. His two students, Ludwig Fraenkel and Wilhelm Magnus tested his hypothesis in different laboratories, at Breslau and Oslo, respectively, and reported the veracity of the Born's hypothesis. It is a near-ideal case to explain the cycle of knowledge discussed by Kell and Oliver (6). The case story has been given elsewhere (9).

Story 2: The main aim of both Darwin and Wallace was to catalogue all the living organisms on the planet, and certainly not to examine *any* hypothesis. They could get onto the *Theory of Evolution* only when they were through some way to organize and classify their specimens and data. Prior to them, Steno (a seventeenth century anatomist) observed and reported resemblance between live specimen and fossil specimen. The idea of geologic and biological evolution existed long before Darwin and Wallace. It is believed that Mathus' theory (about the population growth and food production) triggered an idea in Darwin's mind leading to the *Theory of Natural Selection in Evolution*. Mendel however performed experiments and employed hypothesis-driven approach to explore the Laws of Inheritance. Mayr's discussion on this issue is revealing (10).

Story 3: Despite Erwin Chargoff had discovered that the ratio of G to C and A to T in DNA was unity, Rosalind Franklin had X-ray diffraction data, and Watson and Crick were using these data to elucidate DNA structure, none of them had any specific hypothesis to test. This story may be read from Watson's *The Double Helix* (11)

Story 4: The knowledge that hormone prolactin stimulates milk production in mammary glands of mammals, in crops of several birds, in skin exudates of many amphibians and fish, allowed to hypothesize that prolactin may be involved in maternal behaviour in general. Subsequent experiments proved it as a strong conjecture. However, it is wrong to theorize that prolactin is integral to all kinds of maternal or parental behaviour. There is a brief recollection of this story in Rothchild's essay (8).

‘Science is a process of learning to know the nature of everything in the material world...science deals only with those elements in the universe that can be shown, at least potentially, to exist. Science, therefore, is never-ending and always changing. Although its goal is knowledge, it is more than and different from knowledge itself, for knowledge is its product not its essence. Its essence is to doubt without adequate proof. Science is the offspring of philosophy, differs from it mainly in the methods used in learning to know.... In many respects, history is a science but it is poorly endowed with or even lacks the ability to predict, one of the important things that separates science from other forms of learning’.

In final analysis, science is essentially ‘eureka’- an embodiment of humanized form of pleasure in finding out an unknown and in solving a problem. It has been running through the largest and widest avenue of the history of mankind ever since. There is absolutely no issue in taking stance for either hypothesis-loaded or hypothesis-free science for they are only complementary to each other in science.

REFERENCES

1. Popper KR. (1959) *The Logic of Scientific Discovery*. Basic Books, New York.
2. Popper KR. (1992) *Conjectures and Refutations: the Growth of Scientific Knowledge*, 5th ed. Routledge & Kegan Paul, London.
3. Medawar P. (1982) *Pluto’s Republic*. Oxford University Press, Oxford.
4. Bowen CD. (1993) *Francis Bacon: The Temperature of a Man*. Fordham University Press: New York.
5. Hearn V. (1995) Can an ape tell a joke? In: Kidder T (ed.), *Best American Essays of 1994*. Ticknor & Fields, New York.
6. Kell DB, Oliver SG. Here is the evidence, now what is the hypothesis? *BioEssays* 2004; 26: 99–105.
7. Wilson EO. (1998) *Consilience – The Unity of Knowledge*. Abacus, London.
8. Rothchild I (2006) Induction, deduction, and the scientific method. *www.ssr.org/Induction/shtml*.
9. Ghosh D. Born a hundred years ago. *Indian J Physiol Pharmacol* 2000; 44: 235–236
10. Mayr E. (1982) *The Growth of Biological Thought: Diversity, Evolution and Inheritance*. Bellknap, Harvard.
11. Watson JD. (1968) *The Double Helix. A Personal Account of the Discovery of the Structure of DNA*. Elsevier, Amsterdam.