

The Case of Modern Science

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Introduction

Two aliens, Alpha and Beta, have just visited the ten planets where they placed UGFN students 10,000 years ago. They found that only one of the ten planets, Planet 10, developed modern science. They had a conversation after the visits.

Dialogue

ALPHA: Wow, I wouldn't have guessed that only Planet 10 would develop the science we saw on Planet Earth in the 21st century, or "modern science," as humans called it.

BETA: Why do you think it was so difficult for modern science to develop?

ALPHA: Good question. Let's analyze the inhibiting factors, necessary conditions, and sufficient conditions for modern science and see if we can produce an answer afterwards.

BETA: I do not object, but first we should agree on the defining aspects of modern science.

ALPHA: Why?

BETA: So we can simplify modern science into simple characteristics. Then we can simply examine why these characteristics failed to develop.

ALPHA: Right.

BETA: Ernst Gellner believed that truth value was the utmost value in modern science (Sivin 237). This should be one of the defining aspects, correct?

ALPHA: Sure.

Beta: How about the scientific method, of which observations, hypotheses, experiments and deduction are important principles (Jevons 265–266; Weatherall 3–4)?

ALPHA: This is important as well.

BETA: Now we can try to examine why it was so difficult for truth value to stand as the utmost value or why it was so difficult for the scientific method to develop.

ALPHA: Awesome! Let's look at Planet 1 first. There, the civil service examination system in society left no room for the likes of Galileo Galilei to appear. Besides, the government showed no mercy in putting down new ideas and punishing dissenters.

BETA: So?

ALPHA: Truths were dismissed when they contradicted with governmental views. As you can see, an oppressive government is an inhibiting factor to modern science as people are forced to value governmental views more than the truth.

BETA: What if truth value was originally the utmost value to an oppressive government?

ALPHA: Would it make a difference?

BETA: Though hating different ideas, the government itself would nevertheless be constantly trying to falsify its own views to seek truth, right?

ALPHA: You may say so.

BETA: Then the oppressive government would even be leading scientific development, no?

ALPHA: That's just a specific case.

BETA: Is that so? By concluding that an oppressive government is an inhibiting factor, you must prove as well that scientific development would have gone further without it (Sivin 232–233). However, only one of the remaining nine planets developed modern science even without oppressive governments. How would you explain this?

ALPHA: They must've lacked necessary conditions.

BETA: What necessary conditions?

ALPHA: For example, Planet 2 lacked complex mathematics, which is clearly a necessary condition. Mathematics allows scientific theories to be expressed quantitatively, adding precision to theories and allowing more accurate predictions (Cohen 62; Weatherall 4). Without it, the scientific method, along with science as a whole, would be much less powerful. Consequently, the scientific method might not even develop.

BETA: Is complex mathematics a necessary condition for science or is it the other way round?

ALPHA: Please explain.

BETA: Sir Isaac Newton developed calculus to solve problems in physics (Christianson 26–27; Cohen 49). Yet, the Scientific Revolution started before Newton's time (Gellner; qtd. in Sivin 237). When you look at it from this aspect, was it not science which became the necessary condition for the development of complex mathematics?

ALPHA: True, but don't forget that Gottfried Wilhelm Leibniz developed calculus solely for mathematical purposes (Boyer 202). Besides, by complex mathematics, I didn't mean something as complex as calculus.

BETA: Then tell me, what level of mathematics is necessary? Basic algebra? Euclidean geometry?

ALPHA: I don't know, but at least simple mathematics is needed.

BETA: Then how about curiosity and oral language?

Alpha: What are you even talking about?

BETA: Curiosity, oral language, and, maybe surprisingly, simple mathematics such as basic arithmetic are all innate to humans (Pinker and Bloom; Silverstein; Wynn).

ALPHA: So?

BETA: We are studying necessary conditions on the presumption that the absence of them would disallow the development of modern science. Since the above would never be absent in a human society, they are irrelevant for today's discussion.

ALPHA: Then let's move on. I think written language, which was absent in Planets 3 to 5, is a necessary condition. As we saw on Planet 10, large groups of people agreed on the same principles of the scientific method only with the help of written language.

BETA: We should not confuse a culture's way of doing something with a necessary condition (Sivin 233).

ALPHA: I haven't finished! Even if the scientific method develops without

written language, experimental methods cannot be easily scrutinized by peers or later generations. Hence, the reliability of the scientific method in an environment without written language is low.

BETA: You mean to say that many easily falsifiable theories might exist?

ALPHA: Yes.

BETA: Would these theories give inaccurate predictions?

ALPHA: Most likely.

BETA: Then would people be satisfied with them?

ALPHA: Most probably not.

BETA: Then people will seek to falsify them?

ALPHA: Yes, but the new theories might be wrong, too.

BETA: Would correct theories arise if the above procedures are repeated many times?

ALPHA: Even if they do, it might take a long time.

BETA: Exactly. We can only conclude that written language is a favorable condition, as it quickens the development of modern science, but not a necessary condition.

ALPHA: Okay. Well, I think there are no sufficient conditions for modern science, as conditions on Planets 6 to 9 seemed favorable, but modern science still failed to develop.

BETA: Wait a minute. Even with favorable conditions, modern science did not develop further on Planets 6 to 9 than on Planet 1. Then do you still think an oppressive government is an inhibiting factor?

ALPHA: Okay, you win.

BETA: Do not say that. We are both learning.

ALPHA: Then apparently modern science developed by chance. We saw that people in Planets 6 to 8, by chance, valued other things more than the truth. To them, the main tests for new knowledge were “Is it conventional?”, “Is it morally improving?” and “Is it beautiful?” respectively.

BETA: Did societal conditions affect the questions they asked?

ALPHA: Likely.

BETA: Then it was not all due to chance after all?

ALPHA: I think chance and societal conditions acted together. Yet, societal conditions are so complex that it would be difficult for us to find a sufficient societal condition for modern science.

BETA: I agree. How about Planet 9?

ALPHA: People on Planet 9 valued truth. However, some people there were like Plato, and they tried to acquire truth through philosophical reflection without bothering to consult their senses (Lindberg 14). Others were like Shen Kua, who used an observation of a chemical reaction as evidence of transmutation (Needham 205), in the fact that they too overlooked experimentation. Anyhow, the scientific method was unable to develop on Planet 9.

BETA: Can we say that an individual genius who felt the need for experimentation to explain truth is a sufficient condition for modern science?

Alpha: Maybe not, as the genius's findings must be astounding in order to encourage society to support, with capital, the development of modern science. Besides, a normal person can, by chance, realize the need for experimentation as well.

BETA: Well, it seems like sufficient conditions are difficult to find after all.

ALPHA: That's what I said from the start!

BETA: Yes, but was it not better to examine that claim more closely?

Conclusion

BETA: Back to the original question: Why was it so difficult for modern science to develop?

ALPHA: Though the conditions that bring about modern science are so complex that we cannot easily find exact inhibiting factors, necessary

conditions, or sufficient conditions for it, we can observe that written language helps the rise of modern science. However, written language cannot be taken for granted: it is believed that humans on Planet Earth took at least 30,000 years after the evolution of spoken language to develop written language (“Writing and Reading”).

BETA: Yes, and the question “Is it true?” is not necessarily the most natural question for humans to ask either. Even after the Scientific Revolution, Leo Tolstói valued morality when selecting facts to study, while Henri Poincaré valued beauty (Poincaré 161, 165–166).

ALPHA: As for the roles of oppressive governments, complex mathematics, and individual geniuses in the birth of modern science, we could not make conclusions without further investigation.

BETA: I agree. Do you think we can answer our question now?

ALPHA: Try!

BETA: I think it is difficult for modern science to develop in a human society because: first, the absence of written language in human society, which is quite unfavorable for the birth of modern science, is common; second, truth value does not naturally gain an edge over other values, so a multitude of societal conditions plus luck is possibly required for its rise as the most important value.

ALPHA: Bravo!

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Teacher’s comment:

What is this thing that we call “modern science”? Is it a natural consequence of development of human cultures? Or only a consequence of “Western culture”? Or neither of those cases?

Perhaps only since last century we have started to become aware of the nature of that specific approach to the acquisition of knowledge that we call

“modern science”. And we have started to realize that its beginnings, about four hundred years ago, defy easy explanations.

Stanley Ngai provides a remarkably accurate, complete, and humorous account of the difficulties that we face when trying to look for causal explanations for the emergence of “modern science” or lack of it. Elaborating Nathan Sivin’s arguments on the flaws in the search for historical necessary or inhibiting factors, he presents his own stance on the birth of “modern science” through a dialogue between Alpha and Beta, extraterrestrial Socrates and Glaucon. (Klaus Colanero)