Was Fleming’s discovery of penicillin a paradigmatic case of serendipity, or not?

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Serendipity is generally conceived as a kind of discovery denoted by the intersection of chance and wisdom: something unexpected is observed, and the observer is wise to perceive its potential value. The twofold definition of serendipity as a discovery that happens by ‘accidents and sagacity’, along with the word itself, was famously coined by Walpole in 1754. Describing a chance discovery he had made himself, Walpole related his own experience to those of the Princes of Serendip, characters in a collection of fairy tales who had made chance observations along their way that unexpectedly turned out to be very valuable. Thus the word ‘serendipity’ was introduced to the English language; it has recently gained in popularity (Merton & Barber), and is now a live topic in the philosophy of science (Kantorovich, Thagard, also van Andel, Campanario, Silver, Michener) and other fields (e.g.: information sciences: McBirnie, Erdelez, Foster & Ford; organization theory: de Rond). Further, ‘serendipity in science’ has been the subject of several collections of anecdotes of scientific discoveries and inventions (Roberts, Meyers, Kennedy).

The discovery of penicillin by Fleming is consistently given as a paradigmatic example of serendipity in science, from newspaper commentaries to volumes of historical anecdotes. The mould, \( P. \text{notatum} \) by chance took root in one of Fleming’s petri dishes and killed off the staphylococcal bacteria that had been cultivated in the dish. Fleming, in turn, was wise enough to further experiment with the mould in the dish, rather than throw the contaminated dish out, thereby enabling the discovery of the lifesaving antibiotic penicillin. For his chance—but wise—role in this so-called serendipitous discovery, Fleming was awarded part of a Nobel Prize.

This paper examines the case against the general assumption that Fleming’s discovery of \( P. \text{notatum} \) was indeed a serendipitous discovery. I conclude that, rather than question the paradigmatic status of Fleming and his chance discovery, an alternative account of serendipitous discovery in science than the one given by Walpole’s original two terms—“accidents and sagacity”—is needed. In its place, I propose a tripartite account of serendipity that considers the necessity of a valued outcome when categorizing a discovery as serendipitous. One implication of this tripartite account is that serendipity ought to be regarded as a social-epistemological concept, and not as a descriptor for individualized experiences of discovery.

The status of Fleming’s serendipitous discovery

One aspect of Fleming’s observation is not under dispute: the presence of that specific mould in the relevant petri dish was indeed a chance event. Fleming’s former assistant Ronald Hare is well known for explicating just how much chance was involved: it is well known that \( P. \text{notatum} \) floated into Fleming’s lab (up a stairwell, rather than through an open window) and onto a discarded petri dish that had not yet been cleaned, while Fleming was on vacation for a length of time sufficient for the mould to cultivate. Further, the mould cultivated as it did only because the temperature fluctuations that September were both unusual for London and perfect for \( P. \text{notatum} \)—even further, the \( P. \text{notatum} \) arrived at the right time and grew faster than the staphylococcal bacteria, which was necessary for producing the observed effects (Diggins). Given these and other facts about the circumstances in which Fleming’s observation occurred, the observation itself was a chance event.

According to the Walpolian interpretation of serendipity, what is important for the categorization of Fleming’s observation of this chance event as serendipitous—as more than lucky—is the inclusion of ‘sagacity’ or wisdom as an essential ingredient. The wisdom involved is the wise perception that an observation, despite its being made by chance (or brought about by chance), reveals something of value—the perceiver is both wise to perceive the observation in unexpected circumstances, and wise to perceive the value of the observation. In other words, this chance observation may not have been noted by someone less wise than Fleming—someone else may have discarded the dish without looking closely, or failed to note the potential importance of what she was seeing. This twofold wisdom thus combines chance with perception intimately, and not just contingently. That is, serendipity is thought to be the result of what is often called a ‘eureka!’ moment: not only the event, but also the perception of its value comes as a surprise to the observer (unexpected insight).

I now consider two arguments commonly raised against the categorization of Fleming’s observation as a serendipitous discovery.

A. ‘Serendipitous’

The first argument concerns the status of Fleming’s observation as serendipitous, and is generated from Royston Roberts’ coinage of a companion term,
‘pseudoserendipity.’ Pseudoserendipity is meant to capture discoveries that occur with the help of chance, and that required wisdom to be perceived, but that were not— unlike instances of ‘true’ serendipity—completely unexpected by their discoverers. Some have argued that Fleming was not actually serendipitous, because it was not by chance that he happened to notice the antibacterial effects of the mould in his dish (de Rond). Rather, Fleming’s mind had been suitably prepared by his own interests and by previous experiences—as scientists’ minds are generally thought to be—to make a predictable observation.

Because Fleming was already interested in the antibiotic and lysosomal effects of other substances, he perceived the potential value of *P. notatum* because of this previous interest he had already in mind, and so it was not a serendipitous discovery. Judging between pseudo- and so-called ‘true’ serendipity, however, is both pedantic and impractical. First, it is too difficult to draw the fine line between being sufficiently prepared (or wise) to note the potential value of an observation at all, and the active pursuit of that value in one’s work. Second, unless the context is seriously constrained—to a particular experiment, designed to produce specific and intended results, for example—it is impossible to say that even a directed research program has such a limited scope. That is, Fleming was a bacteriologist: it is unreasonable to expect him to be only interested in certain bacteria and to ignore all others. Finally, while he may have had lysosome in mind in general, at the time of the observation of *P. notatum* in his petri dish, Fleming was at least not in active pursuit of an antibacterial discovery. Therefore the argument from pseudoserendipity is too general: it would hold for almost all instances of serendipity in science, and is therefore a weak argument against the paradigmatic status of Fleming’s observation.

B. ‘Discovery’

The second argument concerns the status of Fleming’s observation as a discovery. For one, several cases have been raised against the priority of Fleming’s observation of antibacterial properties, in general and specifically in regard to *P. notatum* itself. He was not the only person to observe these properties. In his Nobel Prize speech, for instance, Fleming remarked that the “inhibition of one microbe by another was commonplace”—bacteriologists of his generation were both taught about such inhibitions and observed them often in practice. As well, to give just one example of an alternate history, Fleming himself once noted that his contemporary and ‘good friend’ André Gratia “but for circumstance…might well have been the discoverer of Penicillin” (de Scoville et al). Gratia’s mistake was in not preserving and distributing his own sample of the mould he had observed.

Further, the original paper published by Fleming went virtually unnoticed for a decade or more (and its presentation at the Royal Society was not well attended). Fleming himself went on to use a medium made with penicillin to isolate bacteria (influenza, acne) in his research on vaccines. Florey and Chain came upon the mould because of Fleming’s standing in the scientific community: one of his students used his ‘mould juice’ in an experiment witnessed by Florey; a fellow laboratory director was using a sample of the mould in his lab at Oxford.

It is thus true Fleming’s role in the discovery had less to do with his perceptive wisdom and more to do with the epistemic and social scientific context of his time. Others could have been credited with the discovery, and if Fleming had been just as perceptive but not as active in the scientific community, his observation would have remained obscure. However, this does not distinguish his case from other instances of serendipity in science: no scientific discovery occurs in isolation from the scientific community, and the agency of an individual within that community (whether at the time or even posthumously, which is something we can discuss in the question period) is what determines how and whether their observations are taken up into a process of discovery by that community. Thus, arguing that Fleming’s observation is not a case of serendipitous discovery because of its contingency is akin to arguing there is no serendipitous discovery in science.

A tripartite account

I suggest that what is needed is a new account of serendipity in science that explains how the case of Fleming and penicillin, despite—or rather because of—the issues raised above, is in fact a paradigmatic case. In contrast with Walpole’s original depiction of serendipity, serendipitous discovery in science is community-based and describes a process, rather than a single event.

Consider the pre-Walpolian history of serendipity, given by Sean Silver: Silver has shown that Walpole got the idea from Bacon’s reading of the fable of Pan. According to the myth, Pan found Ceres when she went missing in despair, but not because he was looking for her (unlike the other gods, Pan was not involved in the search for Ceres, but was hunting for deer when he came across her unexpectedly). Silver points out that the “Hunt of Pan” played a key role in Bacon’s writings on scientific discovery: he recognized a gap between knowing what to look for, and finding that which one did not even know was wanted. In particular, *useful things (the arts) are generally discovered by “chance, or anything else, rather than … Logic*” (Bacon, in Silver). Despite his desire to systematize science, so that discoveries of even useful things could be made via method rather than by chance, Bacon frequently wrote of discovery in the language of the hunt, and notes that discovery in not
only the arts but also the sciences involves a “winding and intricate” path (Bacon, in Silver). Walpole, then, coined an original term for an idea that was already familiar to science.

It is Merton, father of the sociology of science, in the 1940s, who best makes the connection between the chance origin of discoveries and their contribution to knowledge. Merton describes the ‘serendipity pattern’ as the “fairly common experience of observing an unanticipated, anomalous and strategic datum” that results in a change or advancement of theory. The right person not only perceives the unexpected itself, but also its potential value. It is not only the moment of origin that counts when categorizing an unexpected discovery as serendipitous, but also its valued outcome.

Serendipity research in the information sciences has called attention to one important implication of the need for a valued outcome for a discovery to be serendipitous. The category of serendipity can be and is only ever applied in hindsight—at the moment of observation, neither Fleming nor anyone else perceives fully the value of that observation. Rather, the serendipitous perception is first to see that the unexpected is potentially valuable (Makri & Blandford).

Thus, serendipity does not represent only a ‘Eureka’ moment, experienced by a singular individual, but rather captures the nature of a kind of discovery process, originating in chance and wise perception. It represents a discovery that begins at the intersection of the imposition of the empirical world with the theory-laden perception of the observer. The wisdom involved then includes both the ability to see beyond and through the knowledge one already has at one’s disposal.

More than this, as the case of Fleming shows, this wise perception must be situated within the scientific community to explain how it initiates a process of discovery. To achieve the necessary valued outcome—to make a contribution to theory, or to practice—and to thereby be recognized as serendipitous, an observation must be taken up by that community. The wisdom involved in serendipity is thus also a kind of epistemic agency, representing the role an observer plays within their community and not only the knowledge in their head.

Therefore, a tripartite account better describes serendipitous discovery as it actually occurs in science. It successfully accommodates two facts about serendipity in science and research: serendipitous discovery in science occurs within a community, and such discoveries are only recognized as serendipity retrospectively. That is, the tripartite account explains the contextual and contingent nature of serendipitous discovery in science.

In conclusion, the tripartite account not only provides a more robust account of how Fleming’s role in the discovery of penicillin was indeed serendipitous, it also shows the value of a social-epistemological approach to the nature of discovery in science in general.

References


