

The precise role of heuristics, which are mental short cuts in reasoning, in diagnosis remains unclear due to conflicting opinions about this role. On one hand, they have been claimed to facilitate diagnostic reasoning (1,2) while on the other they have been implicated as a major source of diagnostic errors (3) In this paper, we shall study the role of heuristics in diagnosis with a view to define it precisely.

The word 'heuristic', which is derived from its Greek root 'heuriskein' that means 'to discover', indicates a non-analytic method of discovery that has a long history of being employed in science to develop fruitful hypotheses. The most celebrated example of heuristic reasoning, in our view, is provided by Einstein's development of his hypothesis of particle nature of light in his 1905 paper, "On a heuristic viewpoint concerning the production and transformation of light" (4). This hypothesis was developed to explain the exchange of energy between atoms, which are discrete entities, and light, which consists of a continuous wave. It was put forward, in part, due to a resemblance of the thermodynamic behavior of an ideal gas to that of light in the form of black body radiation (5). This hypothesis, developed by reasoning which employed the heuristic of resemblance was verified to be correct by the experimental studies of Millikan and Compton many years later (6).

At a more mundane level, an example of heuristic reasoning in science is provided by the physicist Richard Feynman's investigation of the cause of explosion of space shuttle Challenger in 1986 (7). He developed the hypothesis of the explosion being caused by malfunction of rubber seals in the shuttle due to cold weather due to resemblance of this malfunction to malfunction of rubber seals in a car carburetor in cold weather. He verified this hypothesis to be correct with his famous experiment, performed on television, of dipping a replica of the rubber seal in a glass of ice cold water which caused it to lose its resilience.

Thus a heuristic, usually of resemblance, is a powerful tool that is often employed in scientific reasoning to find a plausible cause or explanation for a problem and formulate it as a hypothesis which is then verified to be correct or not by experiments. We wish to emphasize that heuristic reasoning in science is always a

method of discovery that only leads to generation of a fruitful hypothesis. Specifically, a heuristic is never a method of verifying a hypothesis, which is done by experiments.

We shall now examine the role of heuristics in diagnosis in practice in a patient who presents to us, say with chest pain. We would suspect acute myocardial infarction (MI) from this presentation as a plausible cause of illness in this patient from resemblance of this patient to patients with similar presentation seen by us in the past, who had acute MI (exemplars) (8). We would formulate this suspected disease as a hypothesis which we would evaluate by a test such as an EKG. We would verify this hypothesis to be correct only if a highly informative test result, such as acute ST elevation EKG changes, is observed. We note, the process of diagnosis in this patient consists of hypothesis generation and verification (9) which is identical to the scientific method (10). The heuristic of resemblance plays a role in diagnosis which is similar to its role in science, which is, to generate a fruitful hypothesis.

Very often, the generation of a disease hypothesis by heuristic reasoning in diagnosis is straightforward, but occasionally it is subtle as we see in a real patient discussed in a clinical-pathologic conference (CPC) (11). The patient is a retired 65 year old grandfather with history of being a salesman who presents with dyspnea and bilateral pulmonary infiltrates. In this patient, with no obvious risk factors for HIV disease, the discussing physician suspects Pneumocystis pneumonia due to HIV disease, because as she says, "It is Arthur Miller's play 'Death of a Salesman' that suggested to me a risk factor in this retired salesman; he is human and affairs are common". It is the resemblance of the given patient who is a salesman to the salesman character in Arthur Miller's play which, we believe, leads to HIV disease being suspected heuristically and formulated as a hypothesis that is verified to be correct by subsequent testing.

In brief, a heuristic, especially of resemblance plays the same important role in diagnosis in practice that it does in science, which is to generate a fruitful hypothesis. Without such heuristic reasoning, we believe, diagnosis would not be

possible. A heuristic does not play any role in verifying or passing a judgment about whether a hypothesis is correct, which is done only by testing.

We shall now examine the widespread notion of heuristics as an important source of diagnostic errors in practice. This notion is based almost entirely, we find, on application of results in experimental studies of Tversky and Kahneman (12), in which subjects made errors in probability judgments due to heuristics, to the process of diagnosis. We shall now examine their well-known engineer-lawyer experiment (12) and application of its results to diagnostic reasoning.

In this experiment, subjects were shown brief personality descriptions of several individuals, allegedly sampled at random from a group of 100 professionals—engineers and lawyers. The subjects were asked to assess for each description the probability that it belonged to an engineer rather than to a lawyer. In one experimental condition, subjects were told that the group from which the description had been drawn consisted of 70 engineers and 30 lawyers. In another condition, subjects were told that the group consisted of 30 engineers and 70 lawyers. In both conditions, subjects evaluated the probability that a particular description belonged to an engineer rather than to a lawyer by the degree to which the description was representative of the two stereotypes, with little or no regard for the prior probabilities (base rates) of the two categories.

This error in probability judgment was interpreted by Tversky and Kahneman as being due to the heuristic of representativeness (resemblance). Based on this and other similar experiments about representativeness conducted by them, this heuristic has been claimed to be an important source of diagnostic errors in practice. We shall now examine if this claim is correct or not.

We note the manner in which the heuristic of resemblance is claimed to be employed in the engineer-lawyer experiment is very different from the manner in which this heuristic is employed in diagnosis in practice. In the experiment, this heuristic is claimed to be involved in making a probability judgment, while in diagnosis, as we saw above, it leads to generation of a hypothesis. Due to its very different roles in the experiment and in diagnosis, the finding of this heuristic

causing an error in probability judgment in the experiment is not applicable, we believe, to say that it is a source of error in diagnosis.

During diagnosis in practice, we never make a probability judgment from a presentation directly due to the heuristic of resemblance as is implied by application of result of engineer-lawyer experiment. Thus we never make a probability judgment about acute MI directly from the presentation in a patient with chest pain due to this heuristic. Instead, we employ this heuristic, as discussed above, to suspect acute MI and formulate it as a hypothesis which is evaluated by testing. This scientific approach of hypothesis generation and testing prevents us from committing a diagnostic error due to this heuristic.

There does not appear to be any clear cut evidence about heuristics being a source of diagnostic errors in studies about this issue in the literature. Most of these studies, as noted by Blumenthal-Barby and Krieger (13) are based on hypothetical vignettes which raises concern about the applicability of their findings to diagnosis in practice. Even in these hypothetical vignettes, the process of diagnosis is portrayed to be very different from what it actually is in practice as we see in following example about the heuristic of resemblance being a cause of diagnostic error (14).

A 65 year old man presenting with bi-temporal headache and aching neck/shoulders in winter is diagnosed with giant cell arteritis rather than influenza due to apparent strong pattern match to arteritis despite greater prevalence of influenza. This diagnosis is considered to be erroneous as it is a faulty probability judgment in which base rate is neglected due to heuristic of resemblance. But this is not how arteritis would be diagnosed in practice in this patient as a probability judgment about arteritis would not be made, we believe, directly from the presentation. Instead, arteritis would be suspected from this presentation and formulated as a hypothesis which would be evaluated by tests which may include temporal artery biopsy. Arteritis would be diagnosed in practice, we believe, only if this hypothesis is verified to be correct after testing.

In our view, the engineer-lawyer and other experiments of Tversky and Kahneman are not about scientific reasoning as there is no hypothesis generation or

hypothesis verification by testing in these experiments. Instead, these experiments, we believe, are about unscientific, day to day reasoning in which probability judgments are made directly from information that is available or provided. Therefore the results in these experiments about heuristic reasoning are not applicable, we believe, to diagnosis, in which scientific reasoning is employed.

It is of interest, the experimental findings of Tversky and Kahneman have not been applied to a discipline such as physics, chemistry or biology, which is clearly recognized as being scientific, to implicate heuristics as a source of inferential errors in these disciplines. Perhaps, the application of these findings to diagnosis arises from a failure to appreciate that diagnostic reasoning, with its hypothesis generation and verification approach, is essentially scientific in nature.

We believe, based on the above discussion, the notion of heuristics as a source of diagnostic errors in practice is not defensible. We suggest this notion should be discarded as continued belief in it may inhibit novice physicians from employing heuristics to generate fruitful hypotheses, which is essential for diagnosing diseases accurately.

In conclusion, we have argued in this paper that diagnostic reasoning is essentially scientific in nature in which heuristics play a key role in generating fruitful hypotheses as they do in all scientific disciplines. The scientific approach is employed in diagnosis, because it is the most highly reliable method of finding a cause or explanation for a problem situation in any discipline (15). The experimental studies of Tversky and Kahneman, on which the notion of heuristics as a source of diagnostic errors, is based, are not applicable to process of diagnosis in practice as these studies are about day to day, unscientific reasoning, while diagnosis in practice employs scientific reasoning. There is no clear cut evidence about heuristics being a source of diagnostic errors in practice from studies about this issue in the literature. We suggest abandoning this unsupported notion as a continued belief in it may hinder accurate diagnosis in practice especially by novice physicians.

References

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