

COMMENTARY

## Differences in Diagnostic Reasoning of Expert and Novice Residents: Underlying Reasons and Suggestions for Improvements

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### ABSTRACT

With concerns related to patient safety gaining global precedence, diagnostic errors are speculated as an important cause of harm to the patients. Strong diagnostic skills indeed develop on grounds of sound knowledge and experience, however an understanding of the cognitive processes underlying diagnosis, principles of expertise development and a commitment to lifelong learning add to a clinician's diagnostic reasoning paradigm. An exploration into the differences in diagnostic reasoning among expert and novice residents can yield practical insights into optimizing the diagnostic thought process. Awareness of the possible underlying factors leading to expertise in diagnostic reasoning, along with a repertoire of strategies to improve can be a starting point for novice residents towards developing this crucially important skill.

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### BACKGROUND

Transforming data obtained through clinical encounters into diagnoses is one of the most fundamental, yet error prone step during the patient care process and thus warrants due consideration as a focus of potential improvement from the very early stages. Errors may occur in the diagnostic process anywhere from the point of patient's initial assessment to performance and interpretation of diagnostic tests, and even during follow-up and patient referral. With concerns related to patient safety gaining global precedence, diagnostic errors are speculated as an important cause of harm to the patients.<sup>1</sup>

The burden of diagnostic errors is significant to the point that approximately 5% of adults who attended outpatient clinics endured diagnostic errors on an annual basis. Above 50% of these errors had detrimental consequences. This data reflects situation in a developed country and an even higher percentage of diagnostic errors is expected for developing countries, as access to resources and specialists is further limited there.<sup>1</sup> Considering this, explicit attempts by residents to improve their diagnostic accuracy can in the end increase patient safety standards, more so in a country where resources are scarce.

Strong diagnostic skills indeed develop on grounds of sound knowledge and experience, however an understanding of the cognitive processes underlying

diagnosis, principles of expertise development and a commitment to lifelong learning add to a clinician's diagnostic reasoning paradigm.<sup>2,3</sup> An exploration into the differences in diagnostic reasoning among expert and novice residents can yield practical insights into optimizing the diagnostic thought process.

#### Concept of illness scripts

A concept termed “script” introduced earlier by researches in cognitive psychology was used to explain how knowledge structure gets stored in the mind. This concept is based on the understanding that as soon as a medical student is exposed to clinical situations, mental scripts start getting constructed in his mind. Later when confronted with similar clinical scenarios such scripts are recovered. The diagnostic process thus depends on the quality and quantity of such mental scripts acquired by a medical student throughout the clinical exposure and hence have a direct linear relationship with expertise. With novices, even the type of task at hand can influence the activation of a different script, a phenomenon known as scattered knowledge. This means that all the knowledge related to diagnosing a clinical encounter is stored in the mind of a novice in a scattered manner i.e. they are saved separately from each other in a non-integrated manner and are thus not recovered simultaneously when confronted with clinical situations. Experts on the other hand have rich scripts wherein knowledge related to each clinical

condition is integrated strongly and retrieved simultaneously when needed and thus is not affected by the type of task at hand.<sup>4</sup> In addition to the cognitive basis of diagnostic reasoning discussed above, there are additional factors like context, affect and institutional factors which were earlier ignored, but are now gaining importance in relevance to diagnostic reasoning.<sup>5</sup>

### Diagnostic reasoning models

Diagnosis is seen as a fundamental component of a physician's task and thus its teaching and learning hold vital importance for medical education systems. However, the practical implications of teaching and assessing it are by no means straight forward. Attempts have been made to enhance knowledge on the subject and come up with different models that highlight factors contributing to diagnostic reasoning. Few of these models are hypothetic-deductive model, pattern recognition, a dual process diagnostic reasoning model, pathway for clinical reasoning, an integrative model of clinical reasoning and model of diagnostic reasoning strategies in primary care. The hypothetic-deductive model focuses on hypothesis generation as an initial step in the diagnostic process and hence talks about the analytical route to reasoning only. The next model i.e. the pattern recognition on the other hand only considered the rapid non-analytical mode employed by experts. Both analytical and non-analytical reasoning as well as their interplay is explained by the dual process model, wherein repeated attempts at analytical reasoning support the creation of knowledge structures, thus improving the reasoning related to that problem to expert levels (i.e. non analytical).

The next two models, pathway for clinical reasoning and the integrative model of clinical reasoning brought forward the role of environmental and contextual factors while hypothesis is being developed. The last model, Model of diagnostic strategies proposed stages for clinical reasoning and strategies of both analytical and non-analytical mode.<sup>6</sup>

### Possible reasons for differences in diagnostic reasoning of experts and novice

Reasons for difference in performance between an expert and a novice resident can be appreciated by considering in detail why experts outperform in their specific domains. Experts in a particular domain perform better than novices for a variety of reasons as discussed. They possess relevant background knowledge that enables them to attend to presenting problem more efficiently by activating the relevant

content schemata, utilize important information in a timely manner and assimilate new information with much less effort.<sup>7,8,11,12</sup> In the course of growth towards expertise, knowledge expands and is restructured from declarative, elaborate causal networks to encapsulated simplified causal models. This aids in interrelating signs and symptoms following exposure to patient scenarios. Extensive practice later leads to the formation of illness scripts that contain a rich database of knowledge for contextual or enabling conditions. This characterizes advanced levels of expertise followed by exemplars derived from experience.<sup>9,19</sup> Because of this assimilation of biomedical and clinical knowledge experts don't need to revert back to basic science concepts unless a difficult or ambiguous situation is encountered where they use it better than novices.<sup>10</sup>

Experts dedicate more time to problem identification, a very crucial stage in the problem-solving process. Careful reflection on the nature of a problem and considering a number of solutions before deciding on a final solution are decisive to successful problem solving.<sup>11</sup> Experts can identify and focus on relevant information resulting in considerable reduction of problem space, thus enabling the utilization of resources to understanding the relationship between relevant pieces of information.<sup>11</sup> The way problems are categorized also differs between experts, who tend to use deep structure principles based on their background knowledge and experience, and novices who tend to rely on surface structure features.<sup>11,13</sup>

After years of experience in a specific domain, experts have a rich bank of algorithms and heuristics to use when faced with a problem. More importantly they are skilled in choosing the right one for the presenting problem.<sup>11,13</sup> This hard-earned clinical experience is what defines the real expert and enables him to recognize and deal with varied patient presentations.<sup>14</sup>

According to psychological literature heuristics and rules of thumb are efficient mental strategies which may help clinicians cope with uncertain situations and overcome the limitations of time and data. They serve as powerful tools to cope up with the diagnostic challenges and usually lead to accurate decisions, though at the cost of predictable error reflecting the inherent biases associated with them.<sup>15,16</sup>

Experts are more likely to use means-ends analysis in contrast to trial and error used by novices, wherein they break problems into sub goals and work towards the desired ending.<sup>11,13</sup> They plan ahead of time and display a coordinated approach to the entire problem-solving sequence.<sup>11,13</sup>

Experts choose, use, shift, evaluate and discard strategies and reach workable solutions more efficiently than novices. This is because of the great deal of procedural knowledge they have gained from experience.<sup>11-13</sup>

They also have built repertoires of automated cognitive processes allowing them to perform complex cognitive tasks smoothly, quickly and without undue attention to details.<sup>11</sup> Moreover experts judge the difficulty of problems more accurately than novices and ask more appropriate questions at all stages of the problem-solving process.<sup>11,13</sup>

Research also suggests individual cognitive differences such as working memory capacity in predicting expert performance, after controlling the effects of deliberate practice. Though the extent to which it occurs may be influenced by the nature of the task under study and the cognitive processes used by experts for that particular task. The importance of working memory capacity is higher for non-routine or functionally complex tasks.<sup>17</sup>

Thus, the senior resident is faster, more competent and more insightful because he has accumulated extensive domain specific knowledge.<sup>17,18</sup> This along with the reasons discussed above make him a strategic and efficient problem solver.<sup>11-14,18,19</sup>

### Suggestions for improvement

Based on the above discussion the following may aid the junior residents in becoming more adept and efficient professionals. They should try to acquire as much expert knowledge as quickly as possible, as this is the most important factor in achieving expertise and there is no substitute for it.<sup>7-9,11,17,18</sup>

They should also ask an expert for help whenever it is difficult to comprehend a particular problem and try to get an insight into which strategy the expert is using to solve such problems.<sup>11,19</sup>

An enhanced understanding of the basic processes of problem solving does help in achieving expertise and can turn a person into a better problem solver. Novices need to be trained to employ a reflective approach to problem solving. Studies have shown that if problem solving training is coupled with metacognitive training or other kinds of instruction, such as questioning it further enhances the problem-solving abilities of the student. Only a self-directed, strategic, reflective learner can become a flexible, effective problem solver.<sup>11</sup> They can also reflect and elaborate upon the clinical cases encountered, preferably with a small group of peers and coached by a senior. This can help the novice learner better comprehend where and why he was wrong and how can he improve in future.<sup>9,11</sup>

Discussing errors with colleagues facilitates effective learning and accountability as identified in studies by Wu et al and supported by later studies also.<sup>20</sup>

They can also learn expert strategies and try to mimic them but at the same time taking utmost caution to use them at the right time and place.<sup>11</sup> Awareness has to be developed by providing detailed and thorough characterization of known cognitive biases. Provide multiple clinical examples on the constructive as well as detrimental effects of cognitive biases on the diagnostic process. This will help them reflect on the specific effects of heuristics on clinical decisions.<sup>15,16,24</sup>

Novice residents must dedicate more time to problem discovery and identification when confronted with a patient scenario because this is one area where experts spend significant time before solving a problem and it does significantly improve outcomes.<sup>11</sup> Novices may find a structured search useful, while pattern recognition skills are under development e.g. aiding clinical decision making by using the search-inference framework, by the time a sizeable repertoire of illness scripts is developed.<sup>21</sup>

## CONCLUSION

An awareness of the possible underlying factors leading to expertise in diagnostic reasoning, along with a repertoire of strategies to improve can be a starting point for novice residents towards developing this crucially important skill. To further complement the effective development of diagnostic reasoning among medical students, a curriculum with less of memorization and more of exploration of speculative ideas within safe limits, along with early introduction to typical clinical cases is recommended.<sup>22</sup> Further for teaching and assessing reasoning skills focus should be on the process through which a plausible diagnosis is arrived at, rather than reaching a correct one in the first attempt.<sup>23</sup>

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