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BIAS, FATIGUE AND OTHER FACTORS AS POTENTIAL SOURCE OF ERRORS IN MEDICAL PRACTICE AND FORENSIC MEDICINE

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Abstract: Confirmation bias is cognitive tendency to favor, information that supports or is in accordance with one's existing beliefs in process of acquisition or evaluation. This cognitive fallacy is common in everyday decision decision-making including among experts and professionals. Decision making forms a substantial part of work process in different medical specialties. Particularly in diagnostic disciplines preliminary information about case can significantly impact medical professional's judgment. This can affect patient outcome, and in alleged malpractice cases have legal consequences for medical practitioners.

This paper examines various cognitive and physiological factors that can contribute to errors in medical practice. It also discusses strategies to mitigate these biases and improve decision-making processes.

Keywords: bias, confirmation bias, cognitive fallacy, decision making, fatigue, medical practice, forensic medicine, expert witness.

INTRODUCTION

Conformation bias the cognitive tendency to give greater weight to data and information supporting pre-existing opinions, or, in case of medical professionals, their diagnosis [1]. Some scholars add that this bias also involves disregarding evidence that contradicts these beliefs [2]. Manifestations of such behavior is present across various disciplines including social psychology, politics, economy and others [3]. Its impact in the medical field is particularly significant [4].

Although the scientific method, is considered a prototype of objective approach, research suggests that in can too be subject to cognitive distortions [5-8]. Such biases undermine one of the fundamental pillars of modern science: objective evaluation of evidence, free of subjective influences [3].

SCIENTIFIC APPROACH

Various philosophical perspectives address hypothesis testing. Popper (2005) proposed two main approaches – falsifying and verifying. Verifying in the terms of hypothesis testing/experiment involves seeking the proof of concept/hypothesis by the means of experiment, while falsifying involves looking for evidence that disproves or invalidates it. Popper argued that scientist should prefer the concept of falsification, because verifying or finding the proof for hypothesis will not rule out alternative hypotheses that can predict the evidence [5, 9].

Question of using the falsifying approach amongst the people was tested and researched by Wason (1960). Wason proposed specific „2-4-6 task", where participants were asked to identify a rule governing sequences of three numbers after being told that triplet 2,4,6 conforms to the rule. The results showed, that rather than using falsifying strategy, people were more likely to test numbers that were predicted by their current hypothesis [5, 10].

Koslowski, on the other hand, argues that confirmation is not always bias; it can be considered an effective reasoning strategy in some situations, particularly when errors in the data are possible [11].

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Examples of confirmation strategy in sciences are numerous. Jeng in his article presents selection of such historical cases [6].

Confirmation bias has been shown to affect peer-review process. In his study, Mahoney (1977) sent manuscripts to different reviewers. The manuscripts were describing the same method but with different results. Reviewers gave significantly better ratings when results supported their beliefs [12].

CONFIRMATION BIAS IN MEDICINE

The reasoning process in clinical medicine can be divided into different stages. Initially, within a short time, various diagnostic hypotheses can be proposed. Then, a slower and more laborious process of testing them follows [1].

There are many different types of biases. According to studies, the most common cause of premature closure on an incorrect diagnosis among young physicians is confirmation bias and anchoring bias (bias based on initial data that point to a particular outcome). Other biases affecting clinical reasoning include availability bias (favoring diagnoses that come readily to mind), omission bias (tendency to omit facts or action due to the tendency to judge harm from omission less negatively as harm from commission) or sunken cost bias (tendency to sticking with a concept due to the effort already spent on it) [1, 13].

Confirmation bias is not always single point error – it can lead to a chain of incorrect decisions, which can be potentially fatal. Confirmation bias as a source of misdiagnosis can be found in all medical specialties. In their study, Mendel *et al.* (2011) compared psychiatrists and medical students and their susceptibility to confirmation bias. Thirteen percent of psychiatrists and 22% of medical students showed confirmation bias when searching for new information. There was a significant difference in making correct diagnosis between those conducting confirmatory information search and those who were making dis-confirmatory or balanced search. The prescribed treatment that followed was differed [14, 15].

A similar study on medical trainees and their reasoning was conducted by Arocha *et al.* (1993). The results showed that participating students predominantly used forward reasoning and confirmatory strategies [15, 16].

When a physician approaches patient to take their medical history, early judgments can influence the questions asked later in the interview, potentially leading to omission of key data. In general, the interpretation of data obtained towards the end of diagnosis work-up may be biased by earlier judgments [15, 17].

Several strategies exists to minimize effect of different biases on medical reasoning. Croskerry is proposing a three-step process: First, physicians must be aware of the existence of bias-related errors in medicine and their impact on decision-making. Second, they must recognize that such errors can be avoided and are not inevitable. Third, physicians should be confident and optimistic that solutions to reduce bias are effective [18, 19].

Croskerry also suggests using cognitive forcing strategies. These strategies involve actively considering alternative diagnosis beyond those that first come to mind intuitively – for example continuing search other fractures or pathologies on radiography after identifying the most evident ones [18, 20]. This effect is called "satisfaction of search" and its negative effect was examined by Berbaum *et al.* (1990). They proved that providing a tentative diagnosis using simulated nodular lesions reduces accuracy in perception of native, non-simulated lesions [21].

EFFECT OF PRIOR INFORMATION

According to Lesgold *et al.* (1988), it is not unusual for radiologists, after finding evident pathology (e.q. tumor on chest X-ray), to identify previously unreported findings on prior radiographs when reviewing them. Thus, the knowledge of existing pathology can affect the view and interpretation of the image. A similar effect can be caused by information in reference (request) note. There are different approaches; some radiologists prefer not to read the note in advance, before seeing the picture/scan first [22, 23].

Several studies have addressed this topic – Berbaum *et al.* (1986) demonstrated in their study that providing of tentative diagnosis, in the form of appropriate clinical history and information improved true-positive rates for detection of various chest pathologies. Schreiber *et al.* (1963) found similar results, where providing clinical information improved true-positive rates, but at the cost of slight increase in false-positive rates. A similar effect on true-positive and false-positive rates were observed by Doubilet and Herman (1981). The effect was noted in group of residents and group of experienced staff radiologists. In case of fractures reporting, Berbaum *et al.* (1988) found similar effect on true-positive rates without an increase in false-positive findings [22, 24–27].

Confirmation bias can also lead to errors in trainee-consultant relationship. According to study by Nanapragasam *et al.* (2018), the pre-existing trainee report may result in attentional blindness on the part of the checking consultant [28].

OTHER TYPE OF BIASES THAT CAN AFFECT DECISION MAKING

Cognitive biases arising from heuristic-based thinking are not the only type of reasoning errors that can influence human decision-making [29]. Different types of biases can result from the interplay of reasoning, emotion and social context. Affective biases arise from person's emotions affecting the decision-making process. For example, anxiety and depression can lead to more negative judgments and more negative interpretation of the stimuli compared to someone not suffering of them [29–33]. The fundamental attribution error is described as tendency to overestimate personality traits or dispositional causes and underestimate situational causes when making judgments about the behavior of others [29, 34–37]. Stereotyping bias results from cognitive over-generalization about the qualities and characteristics of members of a group or social category, which are not revised even after personal encounters prove that the individual does not have qualities proposed by stereotype [29, 38]. There are many more biases – such as sex biases, gender biases and race biases. The psychological processes that results in biases are complex, but as Featherston *et al.* found in their study (2020), biases have the potential to seriously impact the quality, consistency and accuracy of decision-making in allied health practice [29].

A bigger problem with biases exists in medical practice. There is a need for serious research about possible interventions, as the current situation is unsatisfactory. When Galvin *et al.* conducted a systemic review of potential intervention strategies for cognitive bias in audiology, they found no scientific studies testing strategies to reduce the impact of cognitive biases on the decision-making [39]. Identical results for eye care professionals, was found in 2019 systematic review by Shlonsky *et al.* [40].

FATIGUE AND WORKLOAD AS SOURCE OF ERROR

Medicine is not "nine-to-five job". Given that accidents and acute diseases can occur at any time of day and clinical state of the patient can change every hour, medical practice requires 24-hour working shifts and other working schedules during evenings and nights. This type of work regimen can affect and disrupt synchronicity between the body's internal diurnal rhythm and external environment and time. Beside impacting the mental and physical health of healthcare workers, this can have negative affect their working capability [41-43].

This effect has been studied in various fields of medical profession. In experimental study designed to test neurocognitive impairment due to sleep deprivation, using computerized tests on anesthesiologists - one group after normal night's rest and another following an overnight call, both at 6:30 in the morning - Chang *et al.* (2013) found, that performance in learning and memory was significantly reduced [44].

Arnedt *et al.* (2005) compared results for sustained attention, vigilance, and simulated driving performance between two groups of pediatric residents: one during heavy call rotation and one after alcohol ingestion - 0.04 to 0.05 g% per 100 mL of blood. The impairment in mentioned tests was comparable in both groups [45].

Although Ruutiainen *et al.* (2013) found very low discrepancies (1%) in 8062 preliminary records by radiology residents, the number of discrepancies increased significantly during the final two hours of consecutive 12-hour overnight call shifts [46].

The effect of fatigue impact not only mental capabilities but also eyesight. After a full day of clinical reading, radiologists exhibit significantly higher accommodative error, suggesting they become more myopic and experience more visual strain by the end of their workday [47].

In the case of surgery, Rothschild *et al.* (2009) did not find a higher number of complications in operations performed by surgeons the day after they worked during night shift, provided they had sleep opportunities of 6 hours or more. However, when sleep opportunities were less than 6 hours, the rate of complications was higher (odds ratio 1.72) [48].

Workload is another important factor affecting work quality and potential source of errors. A paper by Berlin (2000) is describes a case in which radiologist was sued for missing the tumor on a mammogram. During the hearing, the radiologist admitted to evaluating 162 cases that day –three times more than standard workload for a radiologist, which multiple studies suggest is 50 to 60 cases per day. Plaintiff's attorney referred to this intentional work overload as "reckless behavior". In his paper, Berlin references a study by Oestmann *et al.* which found that the lesions detectability decreases considerably as viewing time is reduced to less than 4 seconds. However, even with unlimited viewing time a substantial proportion of subtle lung lesions were still missed [49, 50].

BIAS IN FORENSIC PRACTICE

Forensic medicine (which is, in general, diagnostic discipline) and forensic sciences as a whole are not exempt from cognitive fallacies mentioned above. The potential of cognitive biases to influence the decision-making process it not new and had been studied in multiple forensic specialties, as maintaining the maximum objectivity is crucial aspect of forensic practice. In forensic anthropology, study by Nakhaeizadeh *et al.* (2014) tested the effect of prior information on decision-making of non-novice experts on determining sex, ancestry and age at the death. Two groups were given different extraneous contextual information and one group no contextual information. The results revealed a significant biasing effect within the three groups, demonstrating strong confirmation bias in the assessment of sex, ancestry and age at death [51].

Littlefair *et al.* (2016) provided evidence that increased clinical information affects the performance of radiologists. Radiologists who received information that images have been reported as normal, but whose patients were later diagnosed with lung tumors on a subsequent radiograph 6 months later, showed a significant difference in location-based sensitivity (W = -45, P = 0.02) compared their initial interpretation based only on general clinical history. This effect may also bias expert witnesses in radiological malpractice litigation.[52] A similar effect may be presumed in the interpretation of histopathology or cytology slides.

DNA analysis is considered the gold standard of forensic science. At first glance, DNA analysis appears to be an objective method, free from potential subjective bias. However in certain complex situations, such as cases involving DNA mixtures, the analyst requires human examiners to make a variety of subjective judgments making it susceptible to bias [53, 54]. Dror and Hampikian tested the effect of prior information on 17 experts in cases involving DNA mixtures. In the group with no contextual information, the majority of experts disagreed with the laboratory's pre-trial conclusions. This suggests, that the extraneous case context may have influenced the interpretation of the DNA evidence, demonstrating a biasing effect of contextual information in DNA mixture interpretation [55].

This effect of prior information can be even more pronounced in disciplines that rely more on subjective perception – such as handwriting analysis. There is a need to eliminate, if not all, then as much irrelevant information as possible as it can serve as potential source of bias in expert opinions. This could be achieved through relevant information management. Found and Ganas (2013) presented a scheme for a context management procedure that helps strip away all irrelevant information in cases submitted for Document Examination Unit at Victoria Police Forensic Services Department. Since its implementation in 2009, no negative outcomes were recorded [56].

In medical malpractice cases, an expert witness must evaluate the decision-making of medical professionals concerning the diagnosis and treatment of a patient at a particular moment in the past. Moravansky *et al.* discussed the effect of additional information available to forensic experts. At the critical time of decision-making, a medical professional has only certain and limited amount of information. However, for the forensic expert the course of disease, the treatment, the case outcome and sometimes even autopsy findings are already known. An expert lacking proper training unintentionally incorporate all available information into their analysis biasing their opinion with knowledge that was simply not available at the critical time (e.g. – concluding that set of test should have been performed because the patient later died of tuberculosis). This methodologically incorrect approach is called an "ex post" expert opinion. The only acceptable approach is to build an expert opinion solely on the information that was available - and should have been available - to the medical professional at the critical moment of decision-making. This is known as an "ex ante" expert opinion [57, 58]. Additional information typically removes the uncertainties and doubts the medical professional faced at the time, making the decision appear easier and more straightforward in hindsight.

Similar bias potential has been observed in another common forensic sciences – odontology analysis, fingerprint analysis, bullet comparison and many others [59-61]. Understanding the problem is only one part of the challenge; the other is finding a solutions. Several approaches have been proposed. One, already mentioned, involves context management to limit the irrelevant information. Page *et al.* aslo recommend limiting contextual information, and evaluating the quality of evidence by identifying ambiguous and poor quality data before analysis. Dror and Rosenthal (2008), in their meta-analysis conclude that experts are neither totally reliable nor completely free from bias. They appeal to experts themselves to strive for maximum objectivity by focusing solely on data, ignoring all irrelevant information, making consistent decisions when presented with the same under identical circumstances, and ensuring internal consistency [62].

A more comprehensive approach to reducing bias was provided by Kassin *et al.* (2013), who proposed various measures at both the laboratory and courtroom level. At the laboratory level, they recommend:

- A "linear" working scheme – first, to thoroughly analyze crime scene evidence before comparing it to the target;

- Using blind testing whenever it is possible and appropriate;

- Conducting verification of findings should in a "double-blind" manner whenever feasible;

- Using technology as an aid rather than the potential source of error;

- Including training in basic psychology relevant to forensic work into forensic science education and certification.

At the courtroom level, authors suggest that legal decisions-makers should be educated on the procedures forensic examiners use to reach their conclusions and the information available to them at that time. According to the authors, it is important for court to pose the question: "What did the examiner know and when did he or she know it?" [63].

In conclusion, medicine, including the forensic medicine and other forensic sciences relies on the human factor, which is susceptible to multiple sources of error. Given the that the decision-making process is crucial part of medical and forensic expert practice, it is important for professionals to understand the potential sources of bias and errors from psychological and physiological perspectives. We have presented the scientific bases for bias, particularly cognitive bias in human thinking as well as its specific implications in medical and forensic practice according to current literature. Additionally, we have highlighted fatigue and work overload as other common source of errors in diagnostic medical disciplines. Since the human factor cannot be entirely eliminated – whether in medicine,or in forensic practice- it is essential to recognize there limitations and explore new approaches to minimize the impact of human subjectivity and physiological constraints on decision-making.

Conflict of interest

The authors declare that they have no conflict of interest.

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