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Establishing a title (2A2)

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Disclosure section (2A6); Ethical approval, funding, and other disclosure

Effect of Availability Bias and Reflective Reasoning on Diagnostic Accuracy Among Internal Medicine Residents

Authors
1. Silvia Mamede*, Department of Psychology, Erasmus University Rotterdam, The Netherlands
2. Tamara van Gog, Department of Psychology, Erasmus University Rotterdam, The Netherlands
3. Kees van den Borgh, Department of Internal Medicine, Erasmus Medical Centre, Erasmus University Rotterdam, The Netherlands
4. Remy M. J. P. Rikers, Department of Psychology, Erasmus University Rotterdam, The Netherlands
5. Jan L. C. M. van Saase, Department of Internal Medicine, Erasmus Medical Centre, Erasmus University Rotterdam, The Netherlands
6. Coen van Gulden, Department of Internal Medicine, Erasmus Medical Centre, Erasmus University Rotterdam, The Netherlands
7. Henk G. Schmidt, Department of Psychology, Erasmus University Rotterdam, The Netherlands

*Corresponding author: Silvia Mamede, MSc, Department of Psychology, Erasmus University Rotterdam, The Netherlands. Tel.: +31 10 408 4838. Mail: Mamede@erasmusmc.nl.

One-sentence bios
Silvia Mamede is associate professor at the Department of Psychology, Erasmus University Rotterdam, The Netherlands.
Tamara van Gog is associate professor at the Department of Psychology, Erasmus University Rotterdam, The Netherlands.
Kees van den Borgh is Head of the Department of Internal Medicine, Erasmus Medical Centre, Erasmus University Rotterdam, The Netherlands.
Remy M. J. P. Rikers is professor at the Department of Psychology, Erasmus University Rotterdam, The Netherlands.
Jan L. C. M. van Saase is associate professor at the Department of Internal Medicine, Erasmus Medical Centre, Erasmus University Rotterdam, The Netherlands.
Coen van Gulden, is a senior consultant at the Department of Internal Medicine, Amphia Hospital, Breda, The Netherlands.
Henk G. Schmidt is professor and head of the Department of Psychology, Erasmus University Rotterdam, The Netherlands.

Disclosure
Ethical approval: Ethical approval has been granted from the Erasmus MC Institutional Review Board for research involving human subjects (2 February 2009, EUR-IRB-02009-1).
Funding: None.
Other disclosure: None.
Structured abstract; Maximum 300 words; Purpose, method, results, and discussion (2B1–7)

Writing the Introduction (3A) and numbered section (1.8)

Citation in main text (5A)

Page number on each page, including the title page (1.6)

Abstract

Purpose. To investigate: (1) whether recent experience with clinical problems provokes availability bias (overestimation of the likelihood of a diagnosis based on the case with which it comes to mind), resulting in diagnostic errors, and (2) whether reflection (structured re-analysis of the case findings) counteracts this bias.

Method. Experimental study conducted in 2009 at the Erasmus Medical Centre, Rotterdam, with 18 first-year and 18 second-year internal medicine residents. Participants first evaluated the diagnoses of 6 clinical cases (Phase 1). Subsequently, they diagnosed 8 different cases through non-analytical reasoning, 4 of which had findings similar to previously evaluated cases, but different diagnoses (Phase 2).

Results. There were no main effects, but there was a significant interaction effect between “years-of-training” and “recent experiences with similar problems”. Results consistent with an availability bias occurred for the second-year residents only, who were more frequent in similar to those previously encountered (1.55% vs. 0.81%, mean frequency per resident, 1.44; 95% CI, 0.45–2.12) in Phase 2 cases they had previously encountered (mean frequency per resident, 1.44; 95% CI, 0.39–2.49).

Discussion. When faced with cases similar to previous clinical reasoning, second-year residents made errors in the application of diagnostic reflection tended to have a higher cognitive accuracy in both first- and second-year residents.

Keywords: Availability bias; Diagnostic accuracy; reasoning;

Maximum of five keywords, separated by semicolon (2C)

Indentation each paragraph

A major aim of every clinical teacher is to foster the quality of students’ and residents’ clinical reasoning, one of the most important factors affecting individual physicians’ performance. Diagnostic errors constitute a substantial proportion of preventable medical mistakes, and they have been attributed to a large extent to faulty clinical reasoning. The development of educational strategies to minimize flaws in clinical reasoning depends on a better understanding of their underlying cognitive mechanisms.

Cognitive biases are one source of flaws in reasoning processes. At least 40 types of biases that may affect clinical reasoning have been described. A prime example is the biased use of the availability heuristic (the tendency to weigh likelihood of things by how easily they are recalled), which may erroneously lead a physician to consider a diagnosis more frequently and judge it as more likely if it comes to mind more easily. Relying on availability is often helpful during reasoning, because things that come to mind easily generally do occur more frequently. However, a serious problem may arise when this first impression is wrong, because physicians often become anchored in their initial hypothesis, looking for confirming evidence to support their initial diagnosis, underestimating evidence against it, and therefore failing to adjust their initial impression in light of all available information.

The scientific literature on the availability bias in medicine is mainly descriptive. Some correlational studies suggest that it occurs, but these do not allow causal inferences to be made. Experimental research is required to provide direct evidence for availability bias in medical diagnosis, but, to the best of our knowledge, is lacking. Moreover, if documented, it is perhaps even more important to medical education and practice to investigate ways in which availability bias can be counteracted.
Expertise might play a role in bias. Experienced physicians tend to rely more on non-analytical (or System 1) reasoning based on pattern recognition to diagnose routine problems; this is a rapid, largely unconscious diagnostic approach. Although effective (and highly efficient) in most cases, it might be more easily affected by biases. One way to counteract biases suggested by studies in psychology is to induce physicians to adopt more reflective (or analytical, also referred to as System 2) reasoning, which comprises careful, effortful consideration of findings in a case, or to combine non-analytical and analytical reasoning.

We therefore investigated whether availability bias occurs when physicians diagnose cases that have clinical manifestations similar to those of recently encountered cases, and, if so, whether reflection could counteract this bias. Because non-analytical reasoning develops in association with clinical experience, we also investigated whether there would be a difference in the degree of bias between residents in the first and second year of the residency program. We hypothesized that (1) more experienced residents would show an availability bias when physicians non-analytically reason about common diseases; (2) more experienced residents would show an availability bias; and (3) more experienced residents would show an availability bias that would counteract this bias and improve diagnostic accuracy.

2.1 Overview
This experiment consisted of 3 phases: Phase 1, exposure, required participants to evaluate 6 different cases. Phase 2, non-analytical diagnosis, required participants to diagnose 6 different cases, 4 of which had clinical manifestations that could be encountered in Phase 1. This was expected to influence participants' thinking about the cases and reduce diagnostic accuracy. Phase 3, effective diagnosis, required participants to reflect on the diagnosis of the 4 cases that could have been influenced by an availability bias in Phase 2. This was expected to overcome the bias and lead to more accurate diagnoses.

2.2 Participants
Thirty-six out of 42 eligible internal medicine residents (participation rate = 86%) from the Erasmus Medical Center, Faculty of Medicine, Erasmus University Rotterdam (mean age, 29.50 years; SD, 2.10) in their first (n = 18) or second (n = 18) year of the residency program volunteered to participate in this study. It took place during an educational meeting held in September 2009; the academic year starts in January for the majority of the residents. Participants did not receive any compensation or other incentives. The nonparticipants were either doing shifts or on holidays. The ethics review committee from the Department of Psychology, Erasmus University Rotterdam, provided approval for this study. Because the nature of the study prevented prior disclosure of its objectives, oral consent was obtained after informing participants about their tasks. Debriefing was provided later.

2.3 Materials
In total, 16 written clinical cases were used in this study (Table 1). Cases consisted of a brief description of a patient’s medical history, signs and symptoms, and test results (example case shown in Appendix A). All cases were based on real patients with a confirmed diagnosis. They were prepared by experts in internal medicine and used in previous studies with internal medicine residents. The cases were presented to participants in a booklet (one for each phase), in a random sequence.

2.4 Procedure
In Phase 3, participants were asked to again diagnose the 4 cases from Phase 2 that could have been influenced by previous exposure to similar cases (Table 1). They followed instructions aimed at inducing reflective reasoning: (1) read the case; (2) write down the diagnosis previously given for the case; (3) list the findings in the case description that support this diagnosis; (4) list the findings that speak against this diagnosis; (5) list the findings that would be expected to be present if this diagnosis were true but that were not described in the case. Participants were subsequently asked to list alternative diagnoses assuming that the initial diagnosis generated for the case had proved to be incorrect, and to follow the same procedure (steps 3–5) for each alternative diagnosis. Finally, they were asked to draw a conclusion by ranking the diagnoses in order of likelihood and selecting their final diagnosis for the case.

2.5 Analysis

All cases had a confirmed diagnosis that was provided as the gold standard for the accuracy of the diagnoses provided by the participants. Two independent raters (the main investigator and CCG) independently assessed the diagnoses that were provided. The diagnosis was scored as correct, incorrect, and partially correct, scored as 1, 0.5, or 0 points, respectively, whenever the core diagnosis was either by the gold standard or if the core diagnosis was not mentioned but a constituent diagnosis was, for example, in the case of the Box, “celiac disease” as partially correct.

3. Results

Table 1 presents the mean diagnostic accuracy scores obtained by first-year and second-year residents when cases were solved through non-analytical reasoning (Phase 2). The ANOVA showed no significant main effects, but there was a significant interaction effect between “years of training” and “recent experiences with similar cases” (F(1, 14) = 10.35, MSE = .68, P = .003, η² = .33). Mean scores for the second-year residents were consistent with an availability bias. They obtained significantly lower diagnostic scores on the cases similar to those encountered in Phase 1 than the other cases (on 0-4 scale, 1.55; 95% confidence interval [CI], 1.15-1.96 vs 2.19; 95% CI, 1.73-2.66; P = .03).

Place Table 1 about here

Among the 8 Phase 2 cases potentially similar to Phase 1, second-year residents more frequently gave the Phase 1 diagnosis when they had encountered the cases in Phase 1 compared with when they had not (mean frequency per resident, 1.44; 95% CI, 0.93 – 1.96; vs 0.72; 95% CI, 0.28 – 1.17; P = .04). See Figure 1. Even when the participants had not encountered the similar cases in Phase 1, they sometimes incorrectly provided the Phase 1 diagnosis to the related cases, but this occurred less frequently than when they had been previously exposed to the Phase 1 cases.

Place Figure 1 about here

In contrast, this pattern was not seen for the first-year residents, who had a higher score on the cases similar to those encountered in Phase 1 than on the other cases (Table 2).

Having encountered similar cases in Phase 1 did not lead to more frequently giving this
The diagnostic scores obtained through reflective reasoning (Phase 3) on the cases similar to the diseases that had been encountered in Phase 1 (those cases subject to an availability bias in Phase 2) are presented Table 4. A significant main effect of “type of reasoning” was found in the ANOVA (F(1,34) = 8.46, MSE = .30, P = .006, η² = .20), indicating that reflection improved all participants’ diagnoses compared to non-analytical reasoning. The percentage of Phase 1 diagnoses that were corrected or adhered to after reflection is shown in Table 3.

4. Discussion

This study demonstrated that an available case in Phase 1 can influence the reasoning approach used by residents even though similar, diseases. In emergency rooms or nursing homes, it is common to see (often close in time) several patients with similar symptoms. In many clinical settings, therefore, conditions and availability bias prevail.

Appendix A

Example of a medical case

A 27-year-old woman presented with 11-month duration of complaints of diarrhea and flatulence and episodes of abdominal cramps. She has had stools 5-6 times a day, and has often woken up during the night for defecation. The feces are voluminous and soft without mucus, blood, or pain. The abdominal cramps are more severe just before defecation, after which they become less painful. The patient is fatigued and has experienced a 5-kg weight loss over the past 11 months. She also noticed red spots on her skin. She says that she has not had fever or joint pains. The patient consulted a doctor four months ago as well. The doctor prescribed ferrous sulphate for anemia, which she has been using until now. Family history: her father was treated for lung tuberculosis 20 years ago.

Physical examination:

Young, somewhat enfeebled woman of otherwise healthy appearance. BP: 110/70; pulse: 80/min; temperature: 36°C. Mucocutaneous pallor (+/4). No other abnormalities.

Lab tests:

Hemoglobin: 9 g/dL; Hematocrit: 34%; MCV: 74 fL; serum iron: 45 mg/dL (normal 50-170); calcium: 9.1 mg/dL (normal 8.6-10.5); albumin: 3.2 g/dL (3.4-4.8); ALT: 34 U/L; AST: 25 U/L; PT 24 sec (12-22 sec). Feces: no worm eggs, no parasites, no white cells; stool fat level: 12g/24h (>5g/24h); D-Xylose test: positive. HIV antibodies: negative. PPD skin test: 5 mm.

Imaging tests:

Chest X-ray: no abnormalities; Colonoscopy: no abnormalities.
Acknowledgments

The authors are thankful to Júlio César Penaforte, M.D. (Hospital Geral de Fortaleza, Brazil) and João Mauro Cezinho Filho, M.D., Ph.D (Faculty of Medicine, Federal University of Ceará, Brazil) for their permission to use the clinical cases that they prepared for previous studies, without compensation.

References

Table 1. Clinical cases used in each phase of the study.

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
</tr>
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<tbody>
<tr>
<td>Exposure (diagnosis evaluation)</td>
<td>Non-analytical diagnostic reasoning</td>
<td>Reflective diagnostic reasoning</td>
</tr>
<tr>
<td>Set 1</td>
<td>Case A: Acute peripheral neuropathy</td>
<td>Case similar to case A: Liver cirrhosis, Primary addressing cholestasis</td>
</tr>
<tr>
<td>Case B: Inflammatory bowel disease</td>
<td>Case similar to case B: Celiac Disease, Intestinal inflammation</td>
<td></td>
</tr>
<tr>
<td>Case C: Acute leukocytosis</td>
<td>Case similar to case C: Anemia, Vitamin B12 deficiency, Vitamin B12 deficiency</td>
<td></td>
</tr>
<tr>
<td>Neutral case 1: Malignancy</td>
<td>Case similar to case D: Acute renal failure, Acute renal insufficiency</td>
<td></td>
</tr>
<tr>
<td>Neutral case 2: Pneumonia</td>
<td>Case similar to case E: Acute renal failure, Acute renal insufficiency</td>
<td></td>
</tr>
<tr>
<td>Neutral case 3: Pneumonia</td>
<td>Case similar to case F: Acute renal failure, Acute renal insufficiency</td>
<td></td>
</tr>
<tr>
<td>Neutral case 4: Hyperthyroidism</td>
<td>Case similar to case G: Acute renal failure, Acute renal insufficiency</td>
<td></td>
</tr>
</tbody>
</table>

| Set 2 | Case A: Acute peritonitis | Case similar to case A: Liver cirrhosis, Primary addressing cholestasis |
| Case B: Appendicitis | Case similar to case B: Celiac Disease, Intestinal inflammation |
| Case C: Acute leukocytosis | Case similar to case C: Anemia, Vitamin B12 deficiency, Vitamin B12 deficiency |
| Neutral case 1: Malignancy | Case similar to case D: Acute renal failure, Acute renal insufficiency |
| Neutral case 2: Pneumonia | Case similar to case E: Acute renal failure, Acute renal insufficiency |
| Neutral case 3: Pneumonia | Case similar to case F: Acute renal failure, Acute renal insufficiency |
| Neutral case 4: Hyperthyroidism | Case similar to case G: Acute renal failure, Acute renal insufficiency |

* Cases potentially subject to bias
* Cases not subject to bias

Figure 1. First and second year residents' mean diagnostic accuracy scores (range from 0 – 4) in Phase 2 (non-analytical diagnostic reasoning) as a function of previous exposure to similar cases in Phase 1.