How does the psychiatrist know?

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Abstract

An important question in the philosophy of psychiatry is: what is the proper method of psychiatric diagnostic reasoning? Let us call this the Methodological Question. In this paper, I criticize the answer that proponents of phenomenological psychiatry have given to this question and present an alternative. I argue that their answer fails to meet several adequacy conditions for a theory of psychiatric diagnostic reasoning. I then show how my own answer to the Methodological Question – the Model-Based Account of diagnostic reasoning – meets these adequacy conditions. I conclude that the Model-Based Account of diagnostic reasoning is preferable to the Phenomenological Account.

Keywords

Diagnostic reasoning · Epistemology of psychiatry · Model-based reasoning · Phenomenological psychiatry

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1   Introduction

Imagine you are worrying about someone you know because they suffer from severe mental distress. Who should they see to find out what their problem is? Most people might suggest consulting a psychiatrist. This seems reasonable, as psychiatrists undergo theoretical and practical training meant to ensure they are and remain experts in matters of psychiatric diagnosis. Given their training, it seems fair *prima facie* to assume that psychiatrists deserve this epistemic authority in determining someone's psychopathological status.[1] But even if one grants epistemic

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[1]I take the expert status of the psychiatrist to remain unharmed by a commonsensical *mild* skepticism towards current psychiatric diagnostics. This skepticism claims that there is room to improve

authority to psychiatrists, questions nevertheless arise. One of these questions concerns how psychiatrists, with all their epistemic authority, arrive at a diagnosis. This question is what I will call the *Methodological Question.*

> **The Methodological Question:** What is the method of psychiatric diagnostic reasoning?

The Methodological Question presumes that there is, indeed, some method of psychiatric diagnostic reasoning to describe. How plausible this presumption is depends on what one takes to be a method. Following Goldman (2000), I assume a method is a learned belief-forming procedure that shapes inquiry. Such procedures are specifiable on different levels of generality, ranging from general procedures like deduction or induction, to more specific ones like the philosophical method of phenomenological reduction or the scientific method of DNA sequencing. On this understanding of method, it appears *prima facie* plausible that, given the theoretical and practical training psychiatrists receive in diagnostics, there is some sort of methodology at work behind clinical psychiatric diagnostics that can be explicated.

The Methodological Question is not a clear-cut normative or descriptive question. To provide an adequate answer descriptive as well as normative adequacy conditions should be considered. An answer to the Methodological Question should be descriptively adequate, meaning that it be consistent with what we know about how well-trained psychiatrists engage in diagnostic reasoning in clinical diagnostics. But above that, explicating what should be considered the method behind these practices should also be constrained by widely shared normative commitments within the psychiatric profession. A proposal not considering such professional normative standards might present an answer that matches aspects of psychiatric practice but implies that diagnostic experts ignore their own explicit standards in practice. *Prima facie,* this seems less plausible and charitable than to assume that the normative standards that are regularly discussed in the literature and stressed in clinical training also affect diagnostic practice. As a result, both descriptive accuracy and normative commitments of

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the accuracy of diagnoses but does not doubt the expertise of the psychiatrist on account of this fact. Raising such doubts based on this fact would have absurd consequences: Most scientists should not be considered experts in their field, since many scientific methods are recognized as imperfect, and a lot of scientific vocabulary is left open to revision as research progresses. Expertise, as we usually speak about it, appears to be determined not in relation to an ideal system of theoretical reasoning that already gets everything completely right, but in relation to the skillful use of the currently established theoretical and practical resources for inquiry; these resources may, of course, be improved. Only the acceptance of *strong* skepticism towards psychiatric diagnostics would be a problem for recognizing the epistemic authority of psychiatrists. Such skepticism claims that psychiatric diagnostics is a through and through invalid activity that gets nothing right about patients. This view is often associated with Rosenhan (1973) and Szasz (1960). Addressing strong skepticism is beyond the scope of this paper, but see Spitzer (1975), Guze (1992), and Cahalan (2019).

clinical practice provide relevant constraints for answering the Methodological Question.

The Methodological Question is not only a fair question to ask, but also a significant one deserving philosophical attention. Indeed, addressing the Methodological Question is a vital matter for philosophy of psychiatry, and for several reasons. Answering the Methodological Question is necessary for gaining a systematic, comprehensive understanding of the epistemology of psychiatry, which includes not only the epistemology of psychiatric sciences but also that of clinical practice. Without an answer to the Methodological Question, it is impossible to address more specific epistemological and ethical questions. For example, without a proper understanding of the diagnostic, inferential practices of the clinical psychiatrist, it is impossible to evaluate the epistemic strengths and weaknesses of the ways in which psychiatrists justify their diagnoses. Or, to give another example, lacking an understanding of the method of psychiatric clinical diagnosis would make it impossible to explicate its internal standards so that it could be determined when diagnostic efforts violate these norms and constitute malpractice.[2]

While the importance of the Methodological Question for medicine in general is well recognized, asking this question specifically for psychiatry is a more recent development. In the past, work on the Methodological Question concerning medical diagnostic reasoning in general has been done by cognitive psychologists and medical education scientists, with only few notable exceptions among philosophers (e.g., Sober, 1979).[3] Only more recently has the Methodological Question as put in this paper – with focus on diagnostic reasoning in clinical psychiatry – came to greater attention. This time with philosophers of psychiatry as driving forces of the debate (e.g., Banner & Thornton, 2007; Cooper, 2007; Fuchs, 2010; Gupta et al., 2019; Murphy, 2006; Parnas et al., 2013; Reznek, 1998).

As a contribution to this development, this paper presents a new answer to the Methodological Question and shows its benefits over a competing account: the

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[2]By "internal standards", I mean the epistemic norms that psychiatrists ought to follow to arrive at permissible diagnostic conclusions. The conclusions are considered permissible insofar as they are justified by the standards of the expert community of clinicians. Being "objectively" well-grounded or reliable does not guarantee the acceptability of a diagnosis. The justification of a diagnosis is always also tied to matters of responsibility. If a psychiatrist's diagnosis is wrong but complies with the internal standards, she will not be considered culpable because she was justified in making this diagnosis. If, on the other hand, a psychiatrist guesses a diagnosis and thereby violates the internal standards of psychiatric diagnostics, she will be guilty of diagnostic malpractice. For a similar take on justification, see Pollock (1999, p. 125) and Adam & Littlejohn (2021, pp. 320–321).

[3]Some landmark cognitive science papers about clinical reasoning are Elstein et al. (2014); Nurcombe & Fitzhenry-Coor (1982); Beck & Bergman (1986); Schmidt et al. (1990); Magnani (1992); Charlin et al. (2000); Croskerry (2009); and Fernando et al. (2013). Good overviews with different emphases can be found in Gruppen & Frohna (2002); Norman (2005); Patel et al. (2012), and Higgs et al. (2019).

Phenomenological Account of psychiatric diagnostic reasoning.[4] To begin, section 2 presents the Phenomenological Account. Next, section 3 points out the difficulties faced by this account in meeting several normative requirements and empirical adequacy conditions that belong to a plausible account of psychiatric diagnostic reasoning. After raising these criticisms, section 4 introduces my explanation, the Model-Based Account of psychiatric diagnostic reasoning, and evaluates my account against the challenges brought up against the Phenomenological Account to show how the Model-Based Account deals better with those problems and is therefore the preferable theory.

2   The Phenomenological Account

The Phenomenological Account is an answer to the Methodological Question. It is defended by philosophers of psychiatry standing in the tradition of phenomenology stemming from Husserl (Husserl & Ströker, 1900/2013), first applied to psychiatry by the philosopher-psychiatrists Jaspers (1913/1973).[5] Among the defenders of the Phenomenological Account, we find some of the currently most influential exponents influenced by this line of tradition: Thomas Fuchs (2010), Josef Parnas, Dan Zahavi, and Louis A. Sass (2013). For simplicity, I will refer to these authors as phenomenologists.

I shall add briefly that what I present here as the phenomenological account is of course not all that this tradition of philosophy of psychiatry has to offer but will only focus on their epistemic proposal that can be taken to be their response to the Methodological Question. Beyond this aspect, phenomenological psychiatry has a rich tradition of discussing, e.g., the psychiatrist-patient relationship and its implication for care, as well as the relevance of the overall existential situation of patients. All this will not be part of what I discuss as the phenomenological account. Here I am only interested in the phenomenologists' proposal concerning how psychiatrists arrive at their diagnostic conclusions. Accordingly, my later presented criticism and proposed alternative account will only concern this aspect of phenomenological psychiatry. I remain agnostic regarding other topics discussed in phenomenological psychiatry.

To reconstruct the phenomenologists' answer to the Methodological Question, I begin by presenting some quotes indicating their understanding of diagnostic reasoning in psychiatry.

The most general statement of how psychiatrists engage in diagnostic reasoning according to the phenomenologists is provided by Fuchs (2010, p. 271), who claims that

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[4]I focus on one alternative proposal here due to limitations of space. A more detailed version of my proposal, as well as a comprehensive discussion of other alternative accounts will be provided in future work.

[5]For details on Husserl's influence on Jasper see Wiggins & Schwartz (1997).

> experienced clinicians do not diagnose and practice by ticking off the diagnostic criteria of the manuals. They work with the prototypal approach to diagnosis […] that help[s] to grasp the essence of a phenomenon as an organizing and meaningful 'gestalt' over particular details.

While the phenomenologists provide no details on how this process of the direct recognition of a clinical gestalt is taking place, they do flesh out why they believe that diagnostics must directly address the whole gestalt of a disorder. They do so by discussing the nature of a disorder's clinical gestalt and the epistemic constraints it puts on attempts to recognize a patient's psychopathology. On the nature of the clinical gestalt, Parnas et al. (2013) claim that it is "not a simple aggregate; the 'whole is more than the sum of its parts.' This unity emerges from the relations between component features and is influenced by the whole (part-whole relations)" (2013, p. 275), whereas these components are symptoms of these mental disorders. With regards to the epistemic access to these symptoms and the clinical gestalt of the disorder, they remark that symptoms of a disorder serve to elaborate "[a]spects of a Gestalt [that] […] may be focused on in diagnosis or research; but one must remember that these aspects are interdependent in a mutually constitutive and implicative manner" (2013, p. 275). So that "[w]hat, defines a given individual experience/expression as a specific symptom or sign, […] articulates itself from within an experiential expressive whole [of the gestalt]" (2013, p. 275).

How should we understand these remarks in relation to the Methodological Question as we have posed it here? Let me begin again with Fuchs' general point. According to him, the psychopathological feature recognized first and attributed to a patient is the whole gestalt of a disorder, existing over and above any of its details. That means that the psychiatrist does not first discern symptoms and signs, but rather directly recognizes a disorder based on its prototypical gestalt as it shows up in the patient's behaviour and reports. This is the first step of the diagnostic reasoning process: the psychiatrist directly recognizes the disorder (e.g., a major depression). However, not Fuchs nor Parnas et al. give details about how this is meant to happen. One interpretation of what the phenomenologists have in mind, suggested by Fuchs' and Parnas' et al.'s use of the term's "prototype" and "Gestalt," is that psychiatrists engage in a form of pattern recognition, namely prototype processing allowing them to recognise the clinical gestalt of a disorder. The prototype theory of pattern recognition in cognitive psychology is a model of pattern recognition, according to which different prototypes of objects are memorized by the system so that in the process of pattern recognition, outside simulation only needs to be compared with the prototype, and the sense to objects comes from the matching between input information and prototype. Once outside simulating information matches best with a certain prototype in the brain, the information can be ranged in the category of that prototype and recognized (Pi et al., 2008, p. 435).

An essential feature of this kind of pattern recognition is that it only contains top-down processing but no bottom-up processing (see Pi et al., 2008, p. 436), which means that recognizing the relevant object *begins with the matched prototype itself.* Given that phenomenologists emphasize the notion of Gestalt, it seems that this prototype occurring in the psychiatrist's mind and leading to ascribing a diagnosis has Gestalt quality. According to Ehrenfels – one of the founders of Gestalt psychology – that means it has a positive content of presentation bound up in consciousness with the presence of complexes of mutually separable (i.e., independently presentable) elements. That complex of presentations which is necessary for the existence of a given *Gestalt* quality we call the foundation of that quality (Ehrenfels 1890, in Smith & Ehrenfels, 1988, p. 93).

Keeping in mind the description of the process of prototype recognition, which entails an immediate matching between information input and prototypes, and the understanding of these prototypes as having gestalt quality (i.e., being necessarily complexes of elements), the following picture emerges: According to phenomenologists, the psychiatrist directly perceives the disorders as complex or gestalt in the patient after being confronted with diagnostic information without further explicit cognitive efforts.

This interpretation of Fuchs' general idea also matches with Parnas' et al.'s elaborations. As we saw, they claim (in their first quotation) that while the disorder and its symptoms are *ontologically* mutually constitutive, the clinical gestalt nevertheless enjoys *epistemic* primacy. As we saw in their last quote, they seem to believe that signs and symptoms are epistemically secondary insofar as the psychiatrist determines them after identifying the disorder. An interpretation following from their statement that only when the gestalt of the disorder is recognized a psychiatrist can proceed to identify the symptoms and signs of that disorder in the patient. The gestalt must be recognized first, as only the clinical gestalt of the psychopathology allows for a symptom or sign to "articulate itself" and therefore become epistemically accessible to the psychiatrist.

In sum, the phenomenological proposal to answer the Methodological Question is that the Method of psychiatric diagnostic reasoning is an automated form of prototype-based pattern recognition. This form of prototype-based pattern recognition leads psychiatrists to form cognitively unmediated (i.e., without explicit inferential reasoning) assumptions about the presence of a disorder in a patient occurring to the psychiatrist as a gestalt quality of their perception of this patient. Any details of the psychopathological state of the patients are thereby epistemically secondary.[6] Particular features of a disorder can only be accessible and become relevant to the psychiatrist if the disorder is already recognized. The proposal

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[6]To interpret the phenomenologists' proposal as the idea that psychiatrists can directly access patients' overall psychopathological mental condition by a quasi-perceptual process fits with other views held by authors from the phenomenological tradition. Zahavi (2019), for example, defends a similar position not in regard to psychopathological mental condition but for our overall interper-

of the phenomenologists therefore has the feature of being epistemically top-down. It is a *Disorder First, Symptoms Second* account to psychiatric diagnostic reasoning.

3   Problems for the Phenomenological Account

The Phenomenological Account faces problems that make it an implausible answer to the Methodological Question. Some of these problems stem from empirical research about diagnostic reasoning that the Phenomenological Account does not accommodate, but that an empirically informed philosophical theory of psychiatric diagnostic reasoning should be constrained by. Other problems stem from some absurd consequences of the Phenomenological Account. Both sets of problems shall be presented here, beginning with those emerging from empirical research.

Cognitive psychologists and medical education researchers investigating the modes of cognition employed by diagnosing clinicians identify two types of processing: bottom-up pattern recognition (e.g., Coderre et al., 2003; Groves et al., 2003) and analytic reasoning (e.g., Croskerry, 2009). These types of processing have become widely recognized, and so a theory of diagnostic reasoning that wishes to draw on empirical research should therefore make sure that these results cohere with their proposal. However, neither cognitive process has a place in the Phenomenological Account.

Although one might suspect that gestalt recognition could be understood as pattern recognition, it cannot – at least not in the sense of the term usually employed in medical cognition research. In the context of that research, pattern recognition is generally understood as a highly automatic, cue-based, feature-outcome associating process. The cues are usually assumed to be signs and symptoms on the basis of which the pattern – the illness or disorder – is recognized (e.g., Loveday et al., 2013). This understanding of pattern recognition, however, does not square with the Phenomenological Account. Pattern recognition, as understood by medical cognition researchers, treats the symptoms and signs as cues that must be individuated before the pattern itself is recognized. Pattern recognition therefore requires following a symptom first, disorder second approach. The Phenomenological Account turns this process upside down, since it maintains that the disorder is recognized by a clinician *prior* to the elements making up the patter.[7]

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sonal access. In his view, also our everyday knowledge about each other's minds, e.g., if someone is angry, is won in a direct quasi-perceptual manner without cognitive mediating processes.

[7] One might wonder if there is an inversion in the process of disorder-symptoms recognition or if one could not say instead that what is described by bottom-up pattern recognition is an implicit part of what happens in the process described by the phenomenologists. In my view, this would be too much of a stretch. As we saw in the passages quoted earlier, the epistemic primacy of recognizing the whole over its parts is central for the phenomenologist. We should take them seriously in this claim.

Analytic reasoning also plays no role in the Phenomenological Account. Analytic reasoning involves the explicit and careful consideration of the patient's presentation, identifying symptoms given certain background knowledge, and carefully weighing what diagnostic options are most plausible based on the available evidence. While pattern recognition is often used in simple diagnostic tasks (e.g., diagnosing a flu), analytic reasoning is commonly employed when medical experts face complex or ambiguous diagnostic scenarios (see Croskerry, 2009). Such complexities and ambiguities often appear in psychiatric cases. On the Phenomenological Account, by contrast, the disorder is first recognized as a whole gestalt, and symptoms are only individuated after the gestalt of the disorder has been recognized in the patient. It therefore seems that analytic reasoning plays no part in the actual diagnostic reasoning process that identifies a disorder. If such reasoning is exercised at all, it would provide only a circular form of post-hoc justification for the diagnostic intuitions by which the clinician recognized the patient's disorder in the first place as it is this initial diagnosis based on that the confirming symptoms would be recognized and not on independent grounds. As the phenomenologists claimed earlier: symptoms are only epistemically individuated in the context of the previously recognized gestalt. If psychiatrists really diagnosed in the manner described by the Phenomenological Account, it seems that they would not engage in analytic diagnostic reasoning.[8]

The Phenomenological Account fails to consider not only empirical research on the cognitive processes of practicing clinicians, but also Critical Diagnostic Reasoning. Critical Diagnostic Reasoning is a technique in which clinical professionals are trained and expected to practice, no matter their specialization (e.g., Harjai & Tiwari, 2009; Mamede et al., 2007). Engaging in Critical Diagnostic Reasoning

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[8]Defenders of the Phenomenological Account may claim that such empirical constraints generated from medical cognition and education science do not mean anything to psychiatry. The argument might go as follows: since psychiatry is a special medical discipline and psychiatric diagnosis is unique, its diagnostic reasoning is also different from that belonging to any other medical field. A theory that explains psychiatric diagnostic reasoning consequently should not be constrained by the empirical findings of researchers who investigated diagnostic reasoning across different branches of medicine. By making this move, however, defenders of the Phenomenological Account try to free themselves of the need to show that psychiatry is special insofar as it does not employ pattern recognition or analytic reasoning. But the burden of proof remains on them, since medical education and cognition research has so persuasively established these two modes of cognition as belonging to diagnostic reasoning across *all* branches of medicine. If the universality were not widely recognized, we should see considerable debate among researchers in that those more particular concerned with diagnostic reasoning in psychiatry speak up. Given the lack of debate, it seems fair to assume that psychiatry is not in this respect distinct from internal medicine, neurology, or dermatology. Consequently, we should assume that the constraints discussed here apply to psychiatry and other branches of medicine until there is good reason to think differently. However, there might be other things crucial to diagnostic reasoning in psychiatry, less critical in different branches of medicine, making psychiatry unique because it has something additional, more specific about it. This possibility does not undermine the relevance of the plausibly shared constraints.

means critically examining one's own or another's diagnostic judgments in order to avoid making mistakes in diagnostics due to biases or other errors in reasoning. Questions like "Why exactly should I draw this diagnostic conclusion?", "What could be an alternative explanation?", "Did I consider all available and potentially relevant information?" are questions typically asked when engaging in this kind of reasoning. Critical Diagnostic Reasoning can take place intrapersonally (by critically evaluating one's own diagnostic judgments) or interpersonally (by evaluating the diagnoses of others, as a clinician who supervises or works on a team might). To engage in critical reasoning about the justification of one's diagnosis in a non-circular way however, analytical diagnostic reasoning is a prerequisite.

The problem here for the Phenomenological Account is that if a psychiatrist were to diagnose in the manner it prescribes, this intra- and interpersonal Critical Diagnostic Reasoning would be impossible, or at least unnecessary. Intrapersonal critical reasoning is not required, since considerations of a more plausible alternative diagnosis, given the symptoms and signs of disease, could not be found. It is the initial diagnosis that determines what signs and symptoms the clinician will be able to individuate in the patient. It follows that any attempt to evaluate one's own diagnosis will, by the logic of the Phenomenological Account, lead to a necessarily self-confirming result. To get out of this vicious circle the identification of signs and symptoms have to be archived analytically as described above.

There is a related problem when it comes to interpersonal critical evaluation. Part of the critical interpersonal discussion of diagnoses involves explaining why one has given a diagnosis to other clinical experts. These experts suggest potential alternatives in order that they may eventually come to an agreement on the best diagnostic decision. If, however, all symptoms and signs that the clinicians recognize depend on their initial diagnoses, pointing out other symptoms or signs to them would be hopeless because they would not be able to individuate those symptoms or signs independently of their original diagnosis. Interpersonal disagreements about diagnoses would become unresolvable and farcical, since any one participant could never rationally convince the other participants who disagree with him. This is because it would be impossible for both sides to recognize the symptoms and signs that could serve as counterevidence to their own diagnostic proposal, given that those symptoms and signs would not fit the gestalt they recognized. The symptoms and signs individuated by each side in the disagreement would, at least in principle, be epistemically inaccessible to the other.

4 The Model-Based Account of diagnostic reasoning

It seems desirable to develop an alternative theory of psychiatric diagnostic reasoning that does not face the same problems as the Phenomenological Account.

My proposed alternative is what I call the *Model-Based Account* to psychiatric diagnostic reasoning.[9]

The basic idea behind this proposal is that we can best understand the diagnostic activities of psychiatrists as a kind of modelling process. It is a modelling process not in the sense that all cognition may be a form of modelling on some level of description, as psychologists and philosophers have claimed (e.g., Hohwy, 2013; Johnson-Laird, 1983). The point rather is that the diagnostic reasoning of psychiatrists is a modelling process akin to the epistemic activity of modelling in the (applied) sciences. However, in order to make this claim intelligible and interesting, an understanding of modelling must be established that is sufficiently specific so that its application to psychiatric diagnostics can offer an informative answer to the Methodological Question and such application must be shown to be plausible.

To specify my understanding of modelling and apply it to psychiatric diagnostic reasoning I will (in section 4.1) spell out the general modelling I have in mind and provide and discuss the specifics kind of modelling I claim to be present in psychiatric diagnostic reasoning, namely qualitative and compositional diagnostic modelling. I will then (in section 4.2) present the core elements of clinical psychiatric diagnostics and argue (in section 4.3) that the kind of modelling I discuss provides a good blueprint for these diagnostic efforts. Finally (in section 4.4), I will show that my Model-Based Account is superior to the Phenomenological Account insofar as it holds up better against the challenges.

4.1 Modelling

My general understanding of modelling takes up a currently prominent proposal in philosophy of science made by Godfrey-Smith (2006) and Weisberg (2013, 2007).[10] Their basic idea is that modelling follows a certain strategy of theorizing, called the *Indirect Strategy of Representation*, that can be contrasted with another approach to theorizing, called the *Abstract Direct Strategy of Representation*. The difference between these two approaches can be stated as follows.

Following the Abstract Direct Strategy, means to begin with a detailed investigation of the representational target at the beginning of the theorizing process and follow a data-driven approach: First, collect large amounts of data about the system of interest before beginning to theorize. Then, based on the analysis of

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[9]The idea that diagnostics in general or psychiatric diagnostics in particular might be some sort of modeling is not entirely new but has not yet been spelled out in detail. Upshur & Colak (2003) mentioned this option briefly in regards to general medical reasoning, and Murphy (2006, pp. 205–206, and 265-266) develops it only briefly, and in a much more abstract and substantively different way than I do here. Discussing Murphy´s approach is beyond the scope of this paper.

[10]This proposal was developed by them from their own case studies on modeling in science (especially evolution and population biology), as well as from lessons from previous debates on modeling in the philosophy of science (especially physics and economics) e.g., by Giere (1988, 1999), Cartwright & Nordby (1983), Wimsatt (1987), and Boumans (1999).

that data, determine what are the properties of the system and how certain properties of the system account for other properties. Then, based on these findings, a theoretical structure is developed, encompassing the findings to arrive at an overall theoretical structure meant to represent the properties of the target systems as faithfully as possible.

With the Indirect Strategy of Representation, by contrast, theorists do not begin by *directly* investigating the representational target. Instead, they set up a theoretical structure to represent the target system with little previous knowledge about it, analyse the dynamics and predictions of this structure, and only then turn to the actual real-world system. Then they test whether the developed structure suits the representational interests of the modeler well enough to be used as a model of the target. These interests include, for example, representing relevant dynamics or allowing predictions of interest about the behaviour of the actual system. The core difference between this strategy and the Abstract Direct Strategy consists in the indirect way by which the process arrives at a representational structure for a given target. Instead of directly addressing the target in order to set up a theoretical structure, a theorist first comes up with a theoretical structure and only then turns to the task of evaluating the fit of the theoretical structure to the real-world target. It is this later strategy that, according to the case studies of Godfrey-Smith and Weisberg, is the modelling strategy followed in (applied) science.

Now that the core difference is clear, let me focus on the details of the Indirect Strategy of Representation. It follows a three-step procedure. These three steps of the procedure may be referred to simply as the *construal* of the model, its *analysis*, and finally, the *model-world comparison*. Understanding the details of each step will be important later when considering whether diagnostic reasoning involves this kind of modelling.

In the construal step, the theorist sets up the theoretical structure that is intended to serve as a model of the target system. This structure might be quantitative, as is most often the case in scientific models, but it may also be qualitative. Mathematical formulas, graphical presentations, or a set of interrelated propositions expressed by sentences – all these theoretical structures can form the basis of models. By setting up such structures, the theorist determines the scope of the model (i.e., what aspects of the empirical system are to be targeted by the model) and assigns the elements of the structure to specific aspects of the empirical systems that have been included within the model's scope, or what aspects of the world the model shall be a model about. The choice of how to specify a model's structure is governed by the modeler's expectations of what theoretical structure would best target those aspects of the real-world system they are interested in modelling. To come up with such a model structure, modelers can draw on different sources. Sometimes modelers come up with a new model structure based on their intuitions and past experiences in modelling; this has led philosophers of science to talk about the "art" and the "know-how" of modelling (Godfrey-Smith, 2006; Morrison, 1999). But, more often, background knowledge and past experi-

ences with modelling play a chief role in setting up a model structure. In such cases models can be based on background theories[11], the cross-contextual reuse of model structures from other disciplines[12], or the reuse of model structures to model other targets within the same discipline.[13] A number of these sources may be drawn upon in order to puzzle together a useful model structure.[14]

The second step in the Indirect Strategy of Representation is the analysis of the model. Here the modeler investigates the dynamics of the model structure. Which changes in what parameters of the model would lead to what kind of changes in other parameters? What predictions does the model make? This step of the process is independent of the final step, the model-world comparison, since it is for now only concerned with discovering regularities within the model itself, not with the real-world phenomenon. What is discovered in this analysis might then lead the model to be useful in later epistemic and practical applications.

In the last step, the model-world comparison, the results of the analysis are compared to the real-world system in order either to see how well the model simulations match the behaviour of the system, or at least to predict occurrences in it. After comparing the model with the real-world target, it is decided whether this model should be accepted or rejected based on fidelity criteria – criteria stipulated by the modeler concerning how good the model must fit the real-world target's behaviour in order to be deemed acceptable. These criteria usually include a certain error tolerance. If the model meets the fidelity criteria, it will be accepted. If not, the model may be rejected and alternative models might be tested; or, alternatively, the existing structure of the model may be revised.

Given this general procedure of modelling, let me specify the instances of modelling that provide the relevant blueprint for understanding psychiatric diagnostics, namely: *Qualitative Modelling* and *Compositional Diagnostic Modelling*.

It is necessary to consider diagnostic reasoning as qualitative modelling in order to make my proposal realistic. For although most cases of modelling in the

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[11]For a detailed discussion of such cases, see Morrison's (2007) insightful discussion of the relationship between theories and models, and Giere's (1999) famous showcase of classical mechanics and how it can inform modeling of real-world systems like the pendulum.

[12]A classic example of the reuse of theoretical model structures across disciplines are the Lotka-Volterra equations. The equations consist of a pair of first-order nonlinear differential equations which have been used as model structures in different scientific contexts. The equations were first used to model autocatalytic chemical reactions (Lotka, 1910), later to model predator-prey interactions in ecology (Lotka, 1925; Volterra, 1926), and have even been applied in economics to model economic fluctuations (Goodwin, 1967). More examples of model structure reuse across contexts can be found in Knuuttila & Loettgers (2016).

[13]As an example for this kind of model reuse, Godfrey-Smith (2009) proposes an occasion in which scientists develop a detailed model of how one particular trait became selected in the evolutionary process, and then apply the same structure they used to model the selection of this trait to model another trait's selection.

[14]Boumans (1999) spelled out some of these puzzle cases in the context of modeling in economics, where different sources – e.g., economic models, phenomenological laws, and assumed economic "laws" – are integrated into business-cycle models.

(applied) sciences are quantitative, it would be implausible to expect the same for diagnostic reasoning. Case studies used to explicate diagnostic reasoning for pedagogical purposes in psychiatry (see, e.g., Wright et al., 2017) characterize diagnostic reasoning as verbal, with the occasional use of folk-mathematical talk of likeliness used to guide diagnostic inferences. These characteristics of diagnostic reasoning are confirmed by the findings of medical cognition research whose studies involve speaking out loud the protocols of medical experts (Pinnock et al., 2015).[15] Diagnostic reasoning in medicine seems to take place *qualitatively,* not quantitatively. Psychiatrists do not *calculate* their diagnoses; they think about them verbally, and in qualitative terms. Accordingly, if diagnostic reasoning in psychiatry is a form of modelling, it should be expected to be a form of qualitative modelling.[16]

What, then, are qualitative models, and how do they differ from quantitative ones? The core difference between quantitative and qualitative models lies in the number of parameters and the discrete nature of the values these parameters and their relationships take. Since qualitative models are often used in contexts in which the resulting models are meant to stay cognitively tractable, the number of parameters is often limited to a cognitively manageable maximum, and the values of these parameters, rather than being continuous parameters, are discrete in nature and in most cases also very limited in number – such as "present," "absent," or "neutral." The same goes for the relationships between these elements that likewise take the form of qualitative values such as "increases," "decreases," or "irrelevant," rather than indicating the influences between parameters in quantitative terms (Forbus, 2008).

Because the values in the model structure are discrete, a qualitative model can be understood as symbolic and presented in various formats, including box and arrow diagrams, logical formulas, or a collection of interrelated, linguistically specified propositions. For my purposes this last format, which philosophers have called *propositional models* (Thomson-Jones, 2012), is of particular interest. Given that most diagnostic reasoning takes place in terms of verbal reasoning, as demonstrated in speak out loud protocols, it is natural that a cognitively realistic inter-

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[15] To produce speak out loud protocols, clinicians are presented with a diagnostic task and asked to say aloud what goes through their minds while they engage in diagnostic reasoning.

[16] The literature on qualitative modeling shows that it is not only a plausible approach to understanding expert reasoning in the context of diagnostic reasoning. It has also helped cognitive psychologists in their efforts to understand how we think about physical systems in everyday life, or how other technical experts think about the systems they handle, build and repair. It has also helped artificial intelligence researchers develop expert systems that support these experts in their tasks by mimicking their reasoning via qualitative models. The most intensely researched field related to qualitative models has been "qualitative physics," which tries to understand the nature and use of qualitative models by engineers and other technical experts to think about artifacts they develop, use, or repair, in addition to the insights offered by quantitative models (see, e.g., Bobrow, 1984; Falkenhainer & Forbus, 1991; Weld & De Kleer, 2013). Beyond its application in qualitative physics, qualitative modeling has been used to understand expert reasoning in economics and engineering (Farley, 1987) and, more recently, as a tool to develop highly idealized (but tractable) working models of complex marine ecosystems (Reum et al., 2015).

pretation of the mental efforts in diagnostic reasoning would treat those mental efforts as a form of propositional, qualitative modelling.

Let me now turn from the characteristics of qualitative model structures to the act of developing and using qualitative models. The most important difference here is that qualitative modelling intentionally represents real-world systems in terms of discrete qualitative states, even though the corresponding aspect of the real-world system may not be discrete but continuous. Though we know that water temperature can be described continuously, e.g., by the Celsius temperature of the water, a qualitative model may only contain three values for the parameter of water temperature: cold, warm, and hot. This discretized type of representation is closer to everyday human reasoning about system features such as quantities, motion, space, time, causation, or frequencies. Such everyday reasoning does not bother with differential equation and covariation analysis, nor with any other formal quantitative means of representation and modelling (Forbus, 2008).[17] Given the importance and pervasiveness of discretized parameters, qualitative modelling involves a higher degree of idealization than quantitative modelling.[18]

The high degree of idealization in qualitative modelling usually prevents it from being the first choice of modelers who intend to develop a model that maximizes representational fidelity – the degree to which the model truly represents processes in the modelled system. However, in a context where representational fidelity is not a central requirement or not achievable, qualitative modelling can be highly beneficial. The main benefit of these models is, as already mentioned, that they allow cognitively tractable representations of the system that might be sufficient given the modeler's interests and the model's practical application. A qualitative

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[17]Note here that this understanding of qualitative theorizing differs from the understanding found in Weisberg (2004), as well as from the discussion of qualitative theorizing in chemistry, e.g., in the work of Hoffmann (1998). Those qualitative models share many features with the account presented here, since Weisberg also discusses, e.g., a high degree of idealization, and a typically restricted number of variables. But the qualitative models discussed here are not considered numerical, while Weisberg explicitly states that, on his view, the difference of "qualitative and quantitative models is not about the use of numbers; both types of models can be numerical" (Weisberg, 2004, p. 1071).

[18]To be precise, the limitations of parameters introduces a high degree *Aristotelian Idealization* (Batterman, 2002): the act of stripping away the real-world system by limiting the scope of aspects of the real-world system considered in it. A discrete set of parameter values, on the other hand, leads to what is called *Galilean Idealization* (McMullin, 1985): the act of intentionally distorting the representation of aspects of the real-world system by simplifying them. In principle, qualitative models *could* have infinitely many elements and discrete qualitative states so that the degree of idealization could be decreased. However, in practice this would undermine one of the main reasons why someone may choose this way of modeling: its computational simplicity and cognitive tractability. Accordingly, when we talk about expert reasoning in terms of qualitative models, it seems right to expect them to be simpler given the limited computational power of humans.

model of a system might also be preferred when attempts to provide a quantitative model fail owing to a lack of suitable quantitative data about the target system.[19]

Let me now turn to diagnostic compositional modelling. As mentioned earlier, the approximated representations of real-world system behaviours in models can serve various epistemic and pragmatic purposes. They can, for example, be useful for predicting system behaviour, simulating aspects of its processes, or guiding interventions. Models can also help indicate the presence of specific types of dysfunctions or irregularities in a modelled system. Models set up for this latter purpose are the result of what is called *diagnostic modelling*.[20]

The standard approach to diagnostic modelling follows the assumption that the diagnosis of a systems error shall be identified by "the comparison of the observed system behaviour and the one which can be predicted with the use of the knowledge about the system model," which itself requires "knowledge about the *system model* allowing for the prediction of its normal correct behaviour […] a model which can be used to simulate the normal work of the system in the case of lack of any faults" (Falkenhainer & Forbus, 1991, p. 140).

But often our theoretical knowledge about systems is limited, and consequently our models based on those theoretical assumptions will be incomplete. Nonetheless, it is still possible to use modelling to come to some diagnostic conclusions about real-world systems. This requires, however, deviating from the above-described standard approach. Qualitative diagnostic modelling that starts with a less than fully-fledged and fine-grained model of the target system that it intends to diagnose is *compositional* diagnostic modelling (Falkenhainer & Forbus, 1991, p. 140).

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[19]What has been said so far should make clear the principal idea of qualitative modeling rather than its boundaries: qualitative models *can* be more complex and AI researchers and mathematicians have worked out frameworks to give more technically rigorous representations of qualitative modeling through qualitative algebra (see Forbus, 2008). Due to the limited space here, I will not discuss any of these specific formal frameworks for qualitative models, but will instead stay with the understanding provided so far. What follows is therefore only handwaving in the direction of the relevant work in work in AI and mathematics. For concrete examples of proposals for formalized qualitative models of complex systems, one may look at the examples of two-valued models used to diagnose malfunctions in aircraft engines (Abbott et al., 1988) or photocopiers (Bell et al., 1994). A framework for employing three-valued formalizations based on positive (+), negative (-), or zero (0) values (on an ordinal scale) in order to model physical systems of varying levels of complexity can be found in De Kleer & Brown (1984). Moreover, proposals have been made for the formalization of monotonic relationships (e.g., If A goes up, B goes up) between model elements and for compositional relationships (e.g., If A goes up, B goes up *iff* C goes down), as well as for how change over time can be considered in a time series of qualitative models. For discussion, see Forbus (1984).

[20]Historically this form of modeling was of special interest to cognitive scientists trying to understand how an expert reasoner (often an engineer) diagnoses failures in artificial systems. This approach to understanding their diagnostic reasoning started with the first formal proposals by Reiter (1987). The approach is relatively young in comparison to attempts to apply hypothetical deductive, inductive, or abductive reasoning (Ligęza & Górny, 2017) theories to it. Its more formal presentation has seen several modifications and extensions since Reiter's work (see, e.g., Falkenhainer & Forbus, 1991; Hamscher, 1992/1995; Weld & De Kleer, 2013).

Compositional modelling is "a strategy for organizing and reasoning about models of physical phenomena that addresses the following problem: given an artifact description and a query, produce a model of the artifact that is commensurate with the needs of the query" (Falkenhainer & Forbus, 1991, p. 96). Applied to diagnostic modelling, the needs of the query are to look at some real-world system's outputs and decide whether these outputs qualify as system errors, and, if so, what kind of error it is, based on models of sub-processes in the system that, as far as we know, can be responsible for the error. This does not necessarily require a full-fledged and exact theory of all interactions in the system, but leaves room for some idealization of the responsible processes, abstracting away aspects of the system less relevant for answering the particular diagnostic question it must answer. As Falkenhainer and Forbus put it, "answering questions about the through-put of a pump in a power plant requires neither consideration of the plant's turbines and condensers, nor use of a quantum mechanical model of the pump's parts and fluid" (Falkenhainer & Forbus, 1991, p. 96).

Let me make this procedure more concrete. Instead of starting from complete, detailed models of systems, compositional modelling takes existing theories, models, or assumed principles (called Domain Theories) and uses them to develop models for the relevant aspects of the real-world system that the modeler is interested in. Models set up this way are called "model fragments." In the case of compositional diagnostic modelling, this would mean coming up with model fragments for specific dysfunctional or error outputs of the system. This description allows the modeler to capture reliable indicators in the modelled system, which are helpful for deciding whether a system's output should be interpreted as a dysfunction of a certain type. This decision presupposes a taxonomy of errors in the system that is mapped onto the models – e.g., if it is an error of type A or type B. When the fragmented diagnostic models are found to apply to the system's behaviour, all these applied models are considered together as a set of models for the aspects of the system's behaviour that the modeler is interested in. The resulting set of models is called the Scenario Model (Falkenhainer & Forbus, 1991, p. 96).[21]

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[21]The reader may recall the "puzzling" approach to model construal mentioned on p. 10. While there is, indeed, a similarity insofar as different theoretical sources may be used to set up a model structure, there is also an important difference. In the cases of puzzling, a whole model is constructed and tested in order to address all aspects of the system in *one* model. In this way the model can be evaluated for its performance, for example, in making predictions or simulating the system. But the Scenario Model does not have this quality. The Scenario Model is only constructed after its elemental models are tested and deemed capable of predictions or simulations. This feature of the model elements does not, however, carry over to the Scenario Model. To assume this would be to commit a mereological fallacy. Indeed, the Scenario Model is the product of post-hoc theorizing that only brings together the previously gained information. But it itself does not add any epistemic value in terms of prediction or simulation to the contribution of the model fragments.

4.2   Clinical psychiatric diagnostics

Having completed my discussion of modelling, it is time to consider the diagnostic practices of clinical psychiatrists that I propose to be best understood as such modelling. For this I will focus on the core practices of clinical diagnostics: the Mental Status Examination, the Psychiatric Interview, and, in certain contexts, Cognitive and Biological Testing.

While most clinicians agree that all these practices are central to clinical diagnostics, some might object that other widely used approaches are omitted – especially questionnaires and structured diagnostic interviews. The reason I do not discuss these is that I do not count them as constitutive core practices of proper, contemporary psychiatric diagnosis. Discussing them is therefore unnecessary for my purposes.[22] However, I will discuss in turn these other, truly constitutive practices of clinical diagnosis.

Two means of diagnostic information gathering are carried out in a face-to-face examination of the patient: the Mental Status Examination and the Psychiatric Interview. The purpose of the Mental Status Examination is to evaluate the different domains of cognitive functioning, such as perception, memory, thinking, affect, time-orientation, and thought-order, for the sake of identifying potentially psychopathological anomalies. This is done by the psychiatrist observing the patient's behaviour as well as listening to the patient's self-reports in response to concrete questions about his current experiences (Casey & Brendan, 2019; Trzepacz & Baker, 1993).

The general idea behind the Psychiatric Interview is to seek a broader scope of self-report-based information about the current and past psychological and social functioning of the patient. This involves, for example, gathering information about employment, friendships and other relationships, housing situation, forensic history, substance abuse, sex drive, eating behaviour, sleeping habits, as well as other background information about family history, education, previous medical problems, and so forth (Boland et al., 2022; Poole & Higgo, 2017).

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[22]By proper and contemporary clinical psychiatric diagnosis, I mean clinical diagnostics carried out in psychiatry today and insofar as it is done so in accordance with the standards of the community of clinical professionals, as articulated by the most relevant expert communities within that group (e.g., the American Psychiatric Association). When I say that some diagnostic practices of contemporary proper psychiatric diagnostics are constitutive and others are not, I mean that they are necessary and sufficient for a procedure to count as a proper contemporary clinical diagnostic procedure. This way I try to address what is at the heart of diagnostic practice rather than spending time discussing what is (at least currently) accidental to it.

By taking this approach I draw on Tyler Burge, who considers the explication of the constitutive conditions of a phenomenon as a matter of presenting the necessary and or sufficient conditions for something's being what it is: "A constitutive question concerns conditions on something's being what it is, in the most basic way. Something cannot fail to be what it is, in this way, and be that something. Constitutive conditions are necessary or sufficient conditions for something's being what it is in this basic way. To be constitutive, the conditions must be capable of grounding ideal explanations of something's nature, or basic way of being" (Burge, 2010, xv).

Cognitive Testing is employed by a psychiatrist in order to evaluate the cognitive performance of patients, whereas Biological Testing is used to evaluate the presence or absence of biological markers that suggest the presence of disorders. Cognitive tests are structured examinations consisting of questions posed to the patients (e.g., "what day is today?") and cognitive-behavioural tasks to be executed (e.g., "please remember and repeat the following words," "pick up the pen with your right hand and draw this clock"). The outcomes are scored and compared to cut-off criteria to decide whether anomalies are present. The *Cambridge Cognitive*

To explain further how I distinguish what is constitutive and what not, let me say the following: Employing questionnaires and structured interviews (as opposed to the discussed diagnostic means) is not necessary for comprehensive psychiatric assessment, nor is it sufficient to gather the diagnostic information required for a comprehensive diagnostic process. Rather than counting as core diagnostic practices, questionnaires and structured diagnostic interviews are useful complements to those practices. Since questionnaires or structured interviews are complements, including them in my presentation would be unnecessary given my focus on core procedures of psychiatric diagnostics.

I do not claim that questionnaires or structured interviews are useless or irrelevant. Questionnaires such as the Beck Depression Inventory (Beck et al., 1961) can be useful for screening, and structured interviews such the Structured Clinical Interview for DSM-5 (First et al., 2016) can help attain lots of important diagnostic information. All I want to say is that a look at psychiatric practice shows that diagnostic information gathering by questionnaires and structured interviews plays a subordinate role in clinical diagnostics. They are practices done in the context of psychiatric diagnostics, but they do not individuate it. Consider questionnaires. A responsible clinician would not make a categorical disorder diagnosis solely based on the answers to a questionnaire, nor can a diagnostic case formulation be provided based on them. However, drawing diagnostic conclusions without using questionnaires is not improper to diagnostic practice in psychiatry. Questionnaires can contribute to a diagnosis, but only when interpreted in the context of an overall clinical impression, generated from what I consider to be the three core procedures. Now consider structured interviews. At face value, they are not a necessary component of psychiatric diagnostics. We find them rarely used outside of research contexts, though there are some contexts in that they are used more often than in others – e.g. in autism diagnostics (Tarbox et al., 2016). Rather than being essential for proper clinical diagnostics, they are an essential tool to clinical research (Aboraya, 2009; Bruchmüller et al., 2011; Mueller & Segal, 2015).

That these practices are not sufficient to make a diagnosis can also be shown along two lines. First, structured interviews do not yield the information necessary for providing a case formulation (discussed in the next section). A case formulation must be provided as part of the diagnostic proposal, and it needs to include, among other things, biographical and psychosocial data from patients that are not obtained in typical structured interviews, but only in the Psychiatric Interview. Second, structured interviews usually ask questions that explicitly mention symptoms relevant for categorical diagnoses. Such interviews thereby hope to attain answers that allow one to make a diagnosis based on those answers. However, as research suggests, experienced clinicians do not just consider the answers to these question in evaluating patients. They also consider a wide range of patient behaviors they observe in their contact with the patient (Nakash & Alegría, 2013). That sort of information is usually gathered instead by the Mental Status Examination. Such examinations are an important aspect of diagnostic practice for clinicians. Research suggests, for example, that SCID interviews carried out by laypeople who cannot perform the Mental Status Examination have relatively low validity when measured against the diagnostic judgments of expert clinicians (Nordgaard et al., 2012). In conclusion, using a structured interview does not make up for the Psychiatric Interview nor does it make superfluous a Mental Status Examination.

Examination Revised (Roth et al., 1986) or the *Alzheimer Disease Assessment Scale* (ADAS) (Hodges, 2018) are examples of such tests, and they are mostly relevant for diagnosing dementia and other neurodegenerative disorders.

Biological Testing uses specific biological markers that indicate the presence or absence of specific conditions that in turn can inform (differential) diagnoses. Such testing includes serological testing, genetic testing, as well as radiological examinations. Here are some examples of how such testing informs diagnoses: Liquor analysis can reveal levels of β-amyloid, total tau, and phospho-tau-181, which indicate the presence of irreversible forms of dementia (Reitz & Mayeux, 2014). Genetic testing can show whether patients are carriers of ultra-high-risk genes for developing Huntington (Myers, 2004). Neuroimaging data can be important for identifying strokes or major structural alterations of brain substances that may be responsible for cognitive and behavioural changes (First et al., 2018; Power et al., 2016). Neuroimaging data also allows for subtyping in prefrontal lobe dementia over Alzheimer's dementia, indicated by atrophy in the prefrontal lobe depicted in neuroimaging data (Rohrer & Rosen, 2013).[23] Again, such testing mainly supports the diagnoses of neurodegenerative diseases, but it can also be relevant for reaching differential diagnostic conclusions that render a psycho-behavioural condition into a non-psychiatric case. For example, if the patient is found to have a brain tumour or brain lesion, that can be assumed to cause their condition.[24]

These three domains of diagnostic evaluation – Mental Status Examination, Psychiatric Interview, and Cognitive and Biological Testing – make different contributions to the process of psychiatric diagnosis. This process itself can be divided into three steps: the *screening procedure*, the diagnostic *in-depth evaluation,* and the *drawing of diagnostic conclusions.* The Mental Status Examination as well as the Psychiatric Interview contribute to both the screening procedure as well as the in-depth evaluation. In the current state of psychiatry, the Cognitive and Biological Testing, if they are used, only contribute to this second, evaluative step.

But what exactly is the purpose of these two steps in the diagnostic process? The purpose of screening is to arrive at a list of patient *complaints* which, after be-

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[23]I am aware that success in this domain of diagnostics is still limited. The method is not very good at differentiating between Alzheimer's disease and other forms of dementia (e.g., Lewy Body-, frontal temporal-, and vascular dementia) (Maclin et al., 2019). Moreover, the method has not yet been able to diagnose Parkinson's disease (He et al., 2018; Miller & O'Callaghan, 2015); Huntington (Silajdžić & Björkqvist, 2018) or amyotrophic lateral sclerosis (Verber & Shaw, 2020).

[24]By talking about neurodegenerative diseases as psychiatric disorders, and by regarding psychological abnormalities caused by brain lesions as not being psychiatric disorders, I do not want to take a stance in the ongoing ontological debate as to whether mental disorders are brain disorders (e.g., Boorse, 1977; Graham, 2021; Insel & Cuthbert, 2015; Insel & Quirion, 2005; Jefferson, 2020; Miller, 2010; Olbert & Gala, 2015; Papineau, 1994; Schramme, 2013). Nor do I want to take a stance in the related debate as to whether we should distinguish between neuropsychiatric or psychiatric disorders in clinical contexts (e.g., Baker, 2002; David & Nicholson, 2015; Price et al., 2000). I instead adopt the current standard in psychiatry of regarding neurodegenerative disorders as part of its responsibility, but not the psychological conditions resulting from brain tumors or lesions.

ing subject to more *in-depth evaluation*, can be classified as psychiatric symptoms and signs (or not). The list of complaints is formed by paying attention to *prima facie* obstructed aspects of the patient's psychology and behaviour. These aspects appear sufficiently similar to psychopathological phenomena so as to warrant spending more time carefully examining whether they are, indeed, psychopathological symptoms or signs. If such complaints are discovered in the initial screening, an in-depth evaluation of the candidates usually follows in the same face-to-face interview. The clinician does this by asking further questions or conducting simple psycho-behavioural tests. If it is decided that cognitive and biological tests are necessary for the in-depth evaluation, this will, for practical reasons (e.g., getting material to take samples for the lab, or preparing the cognitive test) take place during another encounter.[25] An example of one such in-depth evaluation will be discussed later.

Conducting an in-depth evaluation usually allows the clinician to draw two sorts of diagnostic conclusions. The first kind of conclusion concerns whether the enumerated complaints should be regarded as psychopathological symptoms or signs, or whether they instead indicate some sort of psycho-behavioural problem caused by a psychopathological condition. In the first case, it may be concluded that the complaints derive from a medical but non-psychopathological problem. Or it may be that the psychological or behavioural complications turn out to be of no diagnostic relevance.[26] If this is decided, the next step is to decide which diagnosis, if any, should be given to the evaluated patient. To do this is to make a diagnostic proposal. According to the standards of psychiatric expert associations like the American Psychiatric Association (2013), such a proposal shall consist of

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[25]Often the Mental Status Examination and the Psychiatric Interview – and therefore the screening procedure and the bulk of the in-depth evaluation – are carried out by one clinician in a single encounter with the patient. In principle, it is also possible first to do a complete screening, and on another occasion to do an in-depth evaluation. That is, it is possible to do the Mental Status Examination on one occasion and the Psychiatric Interview on another. But it is very handy to do both at the same time because many observations important for the Mental Status Examination (e.g., regarding language production) can basically be made on the sideline of the Psychiatric Interview. The two are therefore often lumped together.

[26]Why should two hypothetically similar token behaviors or mental states be typed as psychiatric symptoms or signs on one occasion, but as non-psychiatric ones on another? That is not due to some strong metaphysical distinction, but rather due to the special place that psychiatric symptoms and signs currently have in medical semiology (Altable, 2012). In medicine symptoms are traditionally considered manifestations of a disease, or, to put it in more philosophical terms, they are representations of the presence of disease, and therefore of physiological alterations considered causally responsible for their presence. If a symptom or sign is caused by a disease condition that is not considered a mental disorder, it is, for the purpose of providing diagnoses of psychiatric disorders, not considered to be a psychiatric sign or symptom. This does not mean that, in the end, research might show that part of the causal pathways responsible for the occurrence of the symptoms is shared by a psychiatric disorder and a disease with similar psychological or behavioral symptoms. For an alternative view of medical semiotics in psychiatry, see Borsboom (2017).

a *diagnostic case formulation* and a *manual based diagnostic classification.*[27] Both parts shall be discussed in turn.

A case formulation is put forward based on the diagnostic information gathered in the diagnostic assessment and the in-depth evaluation. The formulation essentially presents the psychiatrist's "analysis and integration of information" (Gelder, 2000, p. 73). As such, it contains a careful clinical history of the patient, a list of the patient's complaints gathered in the diagnostic process, and the psychiatrist's decisions concerning which of the patient's complaints should be interpreted as psychiatric symptoms and signs, and which should not. In addition to presenting a list of initially suspected and endorsed symptoms, the case formulation will present the information that contributed to the decision as to which of the complaints are deemed symptoms or signs. The case formulation thereby identifies the "social, psychological, and biological factors that may have contributed to developing a given mental disorder" (American Psychiatric Association, 2013, p. 19). By organizing diagnostic information this way and relating it to complaints, the case formulation intends to provide a structured presentation of diagnostic information that explains the patient's complaints. The structure of the presentation allows a case formulation to present the justificatory grounds for attributing the psychopathologically relevant features to the patient.[28]

The other part of the diagnostic proposal is the diagnostic classification. One approach to diagnostic classification that has been around since the *Diagnostic Statistic Manual (DSM) III* (American Psychiatric Association, 1986) and the International Classification of Disease (ICD) 10 (World Health Organization, 1992) – a classification still prevalent among the most recent editions of most diagnostic manuals – is based on the presence or absence of clusters of symptoms. These clusters consist in necessary criteria plus further diagnostic criteria from a fixed list which, in combination, are sufficient to diagnose a disorder. The diagnostic criteria for major depression (American Psychiatric Association, 2013, p. 160), for example, allow for 50 different combinations of signs of symptoms. Diagnostic criteria can be either fulfilled (symptom present) or not fulfilled (symptom absent).

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[27]Note however that not only the APA requires the case formulation to be a proper part of psychiatric diagnostics in addition to the more widely discussed categorical diagnosis (outside the United States sometimes called Clinical Formulations). Case Formulations are widely recognized as diagnostic standard in psychiatric diagnostics as a look at proclamations and education guidelines of various expert societies show, that consider it a core competence in diagnostics, and part of good psychiatric practice. See for example American Board of Psychiatry & Neurology (2011); Royal College of Psychiatrists (2013); Royal Australian and New Zealand College of Psychiatrists (2014); Royal College of Psychiatrists (2013); Royal College of Psychiatrists (2017); Royal College of Physicians and Surgeons of Canada (2019).

[28]While approaches differ in how exactly a case formulation should look, what has been said here appears to representative of the core idea assumed across the literature on case formulations. To compare, see e.g., Meyer & Turkat (1979); Varghese & Mellsop (1983); Weerasekera (1996); McHugh & Slavney (1998); Butler (1998); McWilliams (1999); Eells (2010)); Kuruvilla & Kuruvilla (2010); Chisolm & Lyketsos (2012); Goldman & Greenberg (2015)); Kirk & Werbrook (2016); Ryan (2020).

In some cases, further criteria such as temporal qualifications (e.g., the condition must be present for at least two weeks) or environmental factors (e.g., the experience of a life-threatening, dangerous, or significantly abusive circumstance for post-traumatic stress disorder) are explicitly mentioned.

In addition to this long-time standard approach, the recent editions of the DSM and the upcoming ICD-11 include a new approach. They include dimensional ratings as part of categorical diagnostics.[29] The general idea behind dimensional ratings is to evaluate the presence of at least some psychopathological features on an ordinal severity rating scale rather than as simply being present or absent. Dimensional ratings have been introduced as mandatory in the evaluation of diagnostic criteria for some mental disorder categorizations in the DSM-5 (e.g., autism spectrum disorder, intellectual disability) and as optional for others (e.g., primary psychotic disorder and personality disorders). Dimensional ratings have also been made mandatory in some disorders categorized by ICD-11 (e.g., autism spectrum disorder, personality disorder) and optional for others (e.g., primary psychotic disorders). While the basic idea is always the same, the use of dimensional diagnostics can have different faces. In some instances, dimensional rating systems are simply used as add-ons to the specification of present symptoms (e.g., whether the delusions present are clinically mild, moderate, or severe). In other cases, as in the personality disorder diagnostics in ICD-11, significant changes accompanied the implementation of dimensional diagnostics. In the case of personality disorder diagnostics, for example, this change was a deflation of the rich personality disorder taxonomy present in ICD-10 in favour of one general personality disorder category that is then further specified by severity (none, difficulty, mild, moderate, or severe) in light of dimensional ratings of the patient's self- and social functioning.

Although the The American Psychiatric Association does not explicitly make a statement on the relationship between the Diagnostic Case Formulation and the Diagnostic Classification, it provides some remarks regarding what is necessary and sufficient to make a psychiatric diagnosis. In so doing, it introduces a notion of diagnostic "clinical judgment" that allows us to reconstruct the relationship in question. The state that for reaching a categorical diagnosis "[...] it is *not sufficient* to simply check off the symptoms in the diagnostic criteria to make a mental disorder diagnosis" (American Psychiatric Association, 2013, p. 19, my emphasis). For, in addition, the "relative severity and valence of individual criteria and their

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[29]These changes were introduced following the increased interest in psychiatric research in the idea that at least some psychopathological features as occur on a spectrum. Proposals along this line have been made already, for example, for personality disorders (Trull & Durrett, 2005) and psychosis (Cuthbert & Morris, 2021; Esterberg & Compton, 2009). They were adopted in one way or another by relevant research movements in the field, such as the National Institutes of Mental Health RDoC-Project (National Institute of Mental Health, 2013), or the HiToP Research Consortium (Kotov et al., 2017). Discussing the scientific and clinical motivations for a dimensional understanding of mental disorders is beyond the scope of my project. For discussion of these motivations, see, e.g., Helzer & Association (2008); Krueger & Bezdjian (2009); Adam (2013); Reed et al. (2019).

contribution to a diagnosis requires clinical judgment" (2013, p. 19). Clinical diagnostic judgment, however, is a capacity that "requires clinical training" to acquire. Once acquired, it enables a psychiatrist "to recognize when the combination of predisposing, precipitating, perpetuating, and protective factors has resulted in a psychopathological condition" (2013, p. 19).

This description of diagnostic clinical judgment necessary for determining which patient complaints qualify as symptoms and signs and with what severity turns out to be the reasoning process by which the psychiatrist develops their case formulation. The case formulation sets down the results of the psychiatrist's analysis of the diagnostic information. It records which complaints are psychiatric symptoms or signs. This identification of symptom and signs in a case formulation allows for a quicker application of the proposed diagnostic categories and the justification of their application. The profiles of categories, consisting in lists of signs, symptoms, and their severity, can be compared to the psychopathological conditions determined to be present by the diagnostic case formulation. This allows for a diagnostic category to be chosen. When presented alongside the categorical diagnosis, the case formulation makes transparent the reasons for which a specific categorical choice was made.

4.3   Clinical psychiatric diagnostics as modelling

After giving this brief overview of the core components and usual steps in the process of clinical diagnostics – both in accordance with the standards of the clinical expert community – the next step is to map these components and processes onto the account of modelling presented earlier.

As discussed in section 4.1, modelling usually starts from relatively little initial information about the modelled system. This information does little more than inform the modeler about the specific features of the system that will be modelled. In the context of clinical diagnostics, this step is the initial screening procedure, since its task it is to inform the psychiatrist about the specific features of the patient, i.e., the system he encounters given his professional interest in clinical diagnostics. The patient complaints are, according to the aforementioned modelling framework, the systems features that will be modelled.[30]

Based on the initially gathered information about the patient's complaints, the psychiatrist begins to theorize about the potential psychopathological, general medical, or non-medical reasons that might lead to the presentation of those complaints. This theorizing is based on the psychiatrist's background knowledge

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[30]Please note that "complaints," as the term is used here, are not necessarily subjective. Complaints may entail aspects of patients' behavior or mental life coming up in the screening procedure, though the patient is not reporting suffering from it. This is the case if these aspects are potentially psychiatric-relevant symptoms. If e.g., in the screening phase of diagnostics, a patient says they only sleep three hours a night, but that is fine for them, sleep problems will none the less be added to the list of complaints.

about psychopathology, medicine, and folk psychology. The psychiatrist then determines the conditions that should be present in the patient if the presented complaint were a certain psychopathological, medical, or non-medical condition. That condition might subsequently be evaluated in a closer examination of the patient. In the language of modelling, this means that the psychiatrist sets up multiple diagnostic models for the identified complaints. Those models are based on domain-specific background knowledge about the potential conditions that might be responsible for the presented complaints. This process corresponds in the modelling process to the construal step. This has implications for the model's dynamics: the absence or presence of a parameter, along with the degree of severity of that parameter, has consequences for other parameters in the model. In the application of this model to the real-world system, i.e., in the in-depth evaluation of patient complaints, the goodness of fit can be assessed by the psychiatrist. This corresponds to the analysis step in the modelling process.

Models set up this way in the process of diagnostic reasoning are usually qualitative ones. They present the psychiatrist's thought as a set of propositions that express the model's structure and implications. The models are qualitative, since they are non-numeric but symbolic, and with parameters that are usually discrete. They are symbolic because they appear in the form of linguistic thought. Their parameters are discrete because their values are usually determined either on a presence/absence dichotomy scale, or an ordinal scale indicating the degree of expression of the trait in the patient (e.g., a three-step absent-mild-severe scale). Setting up these models and becoming aware of their implications through analysis is often a simple task frequently practiced by highly trained diagnostic experts who know the relevant background theories by heart and have used such models in the past. To develop new theories or gain new insights might, however, demand extra effort.

The next step of the diagnostic procedure is the in-depth evaluation, which corresponds to the model-world comparison step in the modelling process. For every potential psychopathological condition, the psychiatrist engages in an in-depth evaluation of the patient in order to assess which of their theorized reasons for the presence of the complaint best fits the overall presentation of the patient.[31] This confirms that the clinical diagnostics is a form of diagnostic and compositional modelling. For every complaint suspected to be of potential psychopathological relevance, models are established for determining whether the complaint is a psychopathological condition (i.e., a psychiatric symptom or sign). Also established are models indicating whether the complaint derives from a non-psychiatric medical condition, or does not qualify as a medically relevant condition at all. The best-fitting model will be selected while the other models will be rejected. The selected models indicate how the evaluated complaints are to be interpreted. If,

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[31]It might not always be possible to make such decisions unambiguously, and this leads to the well-known problem of diagnostic ambivalence. Due to lack of space, I cannot discuss this problem here.

for example, a model is selected whose structure is provided by a theory about a certain psychiatric symptom, the condition will be determined to be an instance of that symptom. These selected models indicating the correct diagnostic evaluations of the complaints do not constitute an overall model of the patient as a whole system, nor do they constitute a model of the relationships between the different psychopathological complaints. Instead, they are model fragments which, in accordance with what has been said about compositional modelling earlier, are brought together in what has been called a Scenario Model.

This brings me to the last step of the diagnostic procedure: the drawing of diagnostic conclusions. When it comes to drawing such conclusions, psychiatrists do two things: (i) they develop a Scenario Model based on the model elements presented verbally in the diagnostic case formulation, and (ii) they make a categorical disorder diagnosis based on the symptoms and signs indicated by the accepted models. In the first step, the psychiatrist sets up a case formulation, whether it be only for themselves or to present to other clinicians. In the case formulation they bring together all diagnostic information relevant for the evaluation of the complaint, and they do so in a way showing how that information supports the chosen evaluation. Sometimes other plausible diagnostic options might also be mentioned, and the model needed for that alternative option is spelled out and shown to fit less well than the one the psychiatrist accepted in the end. Based on this evaluation, the psychiatrist then extracts the list of psychiatric symptoms and signs and, if relevant, the severity of those symptoms and signs based on the Scenario Model. The psychiatrist matches this list with the taxonomy of the relevant diagnostic manual used in order to provide a categorical disorder diagnosis based on the defined criteria. This brings an end to the diagnostic process, which turns out to be a model-based inference to the presence of one or more psychiatric disorders. This last step of the process does not necessarily require the psychiatrist to look up diagnostic categories in books. In fact, this last step often takes place rapidly for experienced clinicians who know by heart the criteria of most if not all the disorders they regularly encounter in their field.

To make all this a bit more tangible, let me provide a brief example of what is perhaps the most elusive part of this procedure: the process from screening to the selection of the adequate model element or, in other words, the diagnostic classification of a specific psychopathological condition. Consider a patient who shows an atypical kind of formal language production behaviour (as opposed to the atypical production of language content) that stands out to the clinician as potentially indicating a psychiatric condition. To illustrate how the abnormality may appear, consider the following table:

Noticeable	Normal
Psychiatrist: Good morning, Mr. X. What can I do for you?	**Psychiatrist:** Good morning, Mr. X. What can I do for you?

Noticeable	Normal
Patient: You can help me.	**Patient:** Good morning, Doctor. I came to you because I have some problems that I think I need help with...
Psychiatrist: And I will try my best to do so. Can you tell me something about the reason you reached out for help?	**Psychiatrist:** And I will try my best to do so. Can you tell me something about the reason you reach out for help?
Patient: Yes	**Patient:** Well, thanks. I feel sad and empty, and I do not know what I should do about it. It started...

What can be recognized in the patient is a presentation of reluctant speech – a presentation which, on closer examination, may turn out to be "poverty of speech," a form of Alogia. Alogia is a psychiatric symptom which can take the form of poverty of language with respect to the quantity of speech. It is considered present in various mental and neuro-psychiatric disorders such as dementia, schizophrenia, severe depression, or schizotypal personality disorders (American Board of Psychiatry & Neurology, 2011, p. 817). Whether the patient indeed suffers from this condition will depend on a closer evaluation that must take place in order to decide whether the objective complaint of reluctant speech is, indeed, best diagnosed as Alogia. To do so, the psychiatrist must consider different models that might be applied to the patient and evaluated.

Let us look at some of the theoretical considerations and the models that can be set up based on them that, if they apply, would lead to different evaluations. A first consideration might be that the behaviour of the patient is not psychopathologically relevant but part of their usual premorbid behaviour. As discussed in the psychiatric literature, sometimes people who are found to be unusually pedantic in their speech may evoke the impression of poverty of speech. This is a problem that has been observed in the case of administrators, politicians, scientists, and (guess what) philosophers (Andreasen, 2016). If this were the case here, the complaint would not seem to qualify for the diagnosis of Alogia.

Another reason the patient may show reluctant speech is that they feel uncomfortable or have anxiety in the interview situation. The patient may consequently choose his words carefully and sparingly, for example, because they fear the psychiatrist may "take them in." Again, if this would be the case, the complaint would not seem to qualify as a case of Alogia.

Let me now come to a strain of theorizing that can lead to a model whose successful application would support a diagnosis of Alogia. The chief cognitive impairment behind Alogia in psychiatric cases involves an impairment of *control retrieval* – part of the executive functioning that enables the retrieval of information from memory. Alogia occurs when the information is not automatically re-

trieved, or when there is more than one potential piece of information matching the search profile (Docherty et al., 2011; Doughty & Done, 2009; Wagner et al., 2001). If a test of speech production, conducted on a cooperative patient, shows patterns indicating this kind of cognitive impairment, diagnosis of Alogia seems warranted.

In order to evaluate these different options and decide whether the complaint should be evaluated as a psychiatric symptom, the psychiatrist has to come up with a more precise idea as to what diagnostically attained information would support which of these assumptions. That is, the psychiatrist needs to set up models that can be evaluated during the in-depth evaluation. This will usually lead the psychiatrist to consider a set of interrelated propositions for each of his different diagnostic hypotheses.

The psychiatrists may for example test the hypothesis that the patient's reluctant speech is not Alogia, but simply a feature of her premorbid style of communication. She might be philosopher used to providing information as densely as possible – not only in papers for *Analysis*, but also in verbal communication. For this purpose the psychiatrist may set up and evaluate the following set of propositions:

I) The patient can elaborate their answers if asked to.

II) The patient recognizes that their answers are unusually short and can justify their manner of speaking by explaining their motivation (e.g., wanting to save the doctor's time, or wanting to be as precise as possible).

III) The patient can report that her way of presenting information is nothing that has developed recently, but is rather her normal way of conveying information.

If possible, the psychiatrist also speaks to relatives, friends, or other medical professionals in order to verify this last statement so that:

IV) People who know the patient report that the patient always tended to speak this way.

To evaluate the hypothesis that the patient's reluctant speech might be due to a lack of motivation or mistrust in speaking to the psychiatrist, the psychiatrist will seek further information about the patient in the in depth-evaluation interview. This information would suggest the following:

I) The patient has little to no intrinsic motivation to speak with the > psychiatrist.

II) If the patient comes to appreciate the potential help that treatment > could offer, her speech pattern changes.

> And if it is possible to speak to relatives, or if personal contacts of the patient can be contacted, the psychiatrist may reach out to them and evaluate:

III) If relatives or other personal contacts who have recently seen her > report either that she has not shown laconic speech previously or > that it is typical for her to behave that way in certain > circumstances.

Finally, let us come to the propositional model which the psychiatrist may set up and which suggests a positive evaluation of the presence of Alogia as a psychiatric symptom. This will require saying a bit more about how the psychiatrist evaluates this condition based on their psychopathological insights. As already mentioned, Alogia is considered a condition deriving from a disorder of the cognitive function of *control retrieval* – a part of the executive function that enables the retrieval of information from memory when either that information is not automatically retrieved or when there is more than one potential piece of information matching the search profile. This cognitive function can be tested with verbal fluency tasks. Such tasks require subjects to follow a production rule in voicing words. They may be required, for example, to say words beginning with a certain letter (testing word-letter fluency) or falling into a category, such as animals (testing word fluency). More specifically, when tested for Alogia, an individual would be asked to produce lexical items for a certain span of time. If an individual suffers from a cognitive impairment of control retrieval, there is an increased mean response latency between each reported word when asked to produce words of a category. If the individual does not show this deficit, that suggests the impairment of other language-related cognitive functions that, in principle, could also lead to the clinical presentation. These other impairments include disorganized semantic memory – which would lead to poorer performance in category fluency relative to letter fluency – or context processing – which should lead to a decrease in the proportion of correctly reported semantically-related words (Docherty et al., 2011). If verbal fluency testing of the patient meets this prediction, it may be reasonably concluded that the patient's complaints are an instance of the symptom of Alogia.

In accordance with these insights into the underlying psychology of Alogia, the psychiatrist will construe a model consisting of a simple proposition that can be evaluated during an in-depth evaluation in Cognitive Testing, as described above:

I) The patient has an impaired capacity for controlled retrieval leading to the phenomenological presence of reluctant speech.[32]

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[32]Besides this etiology of Alogia, it is also possible for patients to suffer from a phenomenologically similar condition due to traumatic brain injury (TBI). This option has to be evaluated as well. There is, therefore, need for an additional model requiring in-depth evaluation as part of the Psychiatric Interview and the Mental Status Examination. Further evidence may be needed from Biological Testing – in this case, by computed tomography (CT) or magnetic resonance imaging (MRI). These tests would potentially support the case for a brain lesion that, if present,

When all these models are evaluated against the information collected during the in-depth evaluation, the psychiatrist must decide which model best applies to the patient's case. The psychiatrist thereby makes a decision as to whether the patient's complaint should be evaluated as a psychopathologically relevant symptom. With this decision, in combination with all other similarly achieved decisions about the other complaints of the patient, the psychiatrist will have a selection of model elements at hand. Each model element indicates whether a particular complaint should be evaluated as a psychopathological symptom or not, and, if yes, which one. These results will then be used to provide a case formulation for the Scenario Model in which, to continue with our example, the description of the patient will contain a sentence like: "When first meeting the patient, he showed a significant abnormality in verbal behaviour: a noticeable reluctance of speech. For example, when the patient was asked […] they answered […]" Later in the case formulation, the formulation will come back to potential complaints like this one and state how it has been evaluated based on the accepted model for the patient's condition. For example, the case formulation may state: "based on a cognitive evaluation (verbal fluency tasks), it is most plausible to assume that the patient's reluctant speech qualifies as psychiatrically relevant Alogia." The psychiatrist may also spell out other diagnostic hypotheses and why they failed to apply. The case formulation might state: "The speech behaviours do not appear to be a feature of the patient's premorbid personality, nor to result from reservations regarding the use of psychiatric service." Such a statement would be followed by the negatively evaluated propositions comprising the particular diagnostic model.

The case formulation will ultimately provide a list of psychiatric symptoms or signs that then can be used to decide which diagnostic categories would apply to the patient's case, if any. Since the rest of the case has not been spelled out, in this simplified example it would remain open whether the patient may fulfil criteria supporting any of the following diagnoses for which Alogia is a potential feature, namely: dementia, schizophrenia, severe depression, or schizotypal personality disorders (American Psychiatric Association, 2013, p. 817).

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can but need not show up in neuroimaging data (National Academies of Sciences, Engineering, and Medicine, 2019). To consider this option, the psychiatrist would evaluate whether:

- The patient recently took some sort of blow to the head (e.g., by falling or having an accident).

- If the patient did suffer some such blow, if the patient lost consciousness or has any loss of memory of events immediately before or after the accident.

- If there were any alterations of mental state at the time of the accident (e.g., feeling dazed, disoriented, or confused).

- If lesions that indicate traumatic brain damage can be seen in a neuroimaging test.

If this model fits, it might turn out to be more plausible to consider the present language impairment not as a symptom of a psychiatric disorder, but rather the psychological symptom of a brain disorder that should not be considered when diagnosing a psychiatric disorder like schizophrenia.

4.4   Assessing the Model-Based Account of psychiatric diagnostic reasoning

How good does this Model-Based Account of psychiatric diagnostic reasoning perform against the Phenomenological Account? To answer this question, let me once more bring up the four problems that beset the Phenomenological Account. First, pattern recognition plays a significant role in diagnostic reasoning, but it has no place in the Phenomenological Account. Second, analytic reasoning also has an important place in diagnostic reasoning, but it is not to be found in the Phenomenological Account. Third, the Phenomenological Account leaves no room for meaningful intrapersonal critical diagnostic reasoning. Fourth, the Phenomenological Account also denies the need for the critical interpersonal diagnostic reasoning we find, for example, in expert teams. Does my Model-Based Account acknowledge or accommodate these features of diagnostic reasoning? It does. It uses pattern recognition in the inference from symptoms to disorder, analytic reasoning for model choice, and analytic reasoning to enable interpersonal and intrapersonal conflict.

In the diagnostic process described by the Model-Based Account, pattern recognition occurs in the last step of the diagnostic procedure. It involves the inference from the present symptoms to the disorder diagnosis. Based on the identified symptoms of the patient, a well-trained psychiatrist who knows the nosology of their field by heart can make rapid inferences to the right categorization of the disorder. The inference is a form of pattern recognition that takes the identified symptoms as cues for identifying a pattern assigned to a disorder category. In this way the Model-Based Account includes pattern recognition for experienced clinicians. It does so, moreover, in the same way pattern recognition in diagnostic reasoning is usually described. My account is, in this respect, in line with common sense medical thinking and medical education research.

Analytic reasoning also plays a significant role in the Model-Based Account of diagnostic reasoning. Analytic reasoning in the process of diagnosis involves weighing the evidence carefully in order to determine which diagnostic conclusions are most plausible given all available evidence. Such reasoning clearly takes place in the Model-Based Account, and in particular in the step involving the evaluation of different potential models that may apply to patients. Here again, the Model-Based Account is in keeping with common sense thinking and medical education research.

The Model-Based Account also regards critical diagnostic reasoning as an intra- and interpersonal process. Recall that critical diagnostic reasoning is the activity by which the clinician actively questions their own diagnostic conclusions (or that of another) and makes transparent to themselves (or others) why they made the particular diagnostic decision they did. In contrast to the Phenomenological Account, the Model-Based Account acknowledges that critical diagnostic reasoning takes place. Psychiatrists can reconsider for themselves why they have made the diagnostic decision regarding a certain symptom or sign. They can do this by expli-

cating not only all the models they have considered and tested during the in-depth evaluation, but also why they think the model they prefer best suits the patient's case. In further contrast to the Phenomenological Account, it may be possible that by going through one's own reasoning, the psychiatrist may discover an error. Maybe there is another model they forgot to evaluate? Maybe there is new evidence that suggests a change in the models considered? Or maybe the patient's reports actually support the proposition of a model that had been refuted? Such considerations can then lead to re-evaluating a diagnostic conclusion about a symptom or sign. As a result, it can also lead to a modified diagnosis.

The same goes for the intersubjective level at which clinical experts engage in critical discussions about one another's diagnostic conclusions. By discussing the case formulation and the reasoning standing behind it, clinicians critically reflect on the models their colleagues have adopted and tested. They may argue, for example, that a model is inadequate given more recent evidence, or that a model that should have been tested was not considered. Or maybe by reporting what a patient did or said, a colleague might be able to argue in favour of a proposition that was initially rejected. Such discussions may similarly lead to the re-evaluation of some complaints of the patient and may, as a result, change the diagnosis. In conclusion, it appears that the Model-Based Account can handle all the problems that beset the Phenomenological Account of psychiatric diagnostic reasoning. The Model-Based Account also appears to capture more closely the actual process of psychiatric diagnoses, as opposed to the rather vague statements by phenomenologists about how psychiatrists in practice arrive at their conclusions.

5   Conclusion

The starting point of this paper was what I called the Methodological Question: what is the method of psychiatric diagnostic reasoning? I briefly discussed the relevance of this question. After that, I introduced one of the more widely recognized answers that have been given to this question: the Phenomenological Approach. I then pointed out four problems, some of them empirical, others theoretical, that this account faces and that motivated the need for an alternative answer to the Methodological Question. I then introduced and illustrated one such alternative: the Model-Based Account of psychiatric diagnostic reasoning. This model drew an analogy between clinical psychiatric diagnostics and modelling – more precisely: qualitative, diagnostic, compositional modelling. After spelling out this account in some detail, I came back to the initially presented problems faced by the Phenomenologist Account, arguing that the same problems do not plague the Model-Based Account. In conclusion, it appears that the Model-Based Account of psychiatric diagnostic reasoning is a preferable answer to the Methodological Question.

Acknowledgments

References

Abbott, K. H., Schutte, P. C., Palmer, M. T., & Ricks, W. R. (1988). *Faultfinder: A diagnostic expert system with graceful degradation for onboard aircraft applications.* https://ntrs.nasa.gov/citations/19880018634

Aboraya, A. (2009). Use of structured interviews by psychiatrists in real clinical settings: Results of an open-question survey. *Psychiatry (Edgmont (Pa.: Township))*, *6*(6), 24–28.

Adam, D. (2013). Mental health: On the spectrum. *Nature*, *496*(7446), 416–418. https://doi.org/10.1038/496416a

Altable, C. R. (2012). Logic structure of clinical judgment and its relation to medical and psychiatric semiology. *Psychopathology*, *45*(6), 344–351. https://doi.org/10.1159/000337968

American Board of Psychiatry & Neurology. (2011). *American Board of Psychiatry & Neurology: Neurology core competencies outline.* American Board of Psychiatry; Neurology Inc. https://www.abpn.com/wp-content/uploads/2015/02/2011_core_N_MREE.pdf

American Psychiatric Association. (1986). *Diagnostic and statistical manual of mental disorders: DSM-3* (3rd ed).

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed). https://doi.org/10.1176/appi.books.9780890425596

Andreasen, N. C. (2016). Thought disorder. In S. H. Fatemi & P. J. Clayton (Eds.), *The medical basis of psychiatry* (pp. 497–505). Springer New York. https://doi.org/10.1007/978-1-4939-2528-5_25

Baker, M. G. (2002). The wall between neurology and psychiatry. *BMJ*, *324*(7352), 1468–1469. https://doi.org/10.1136/bmj.324.7352.1468

Banner, N. F., & Thornton, T. (2007). The new philosophy of psychiatry: Its (recent) past, present and future: A review of the Oxford University Press series international perspectives in philosophy and psychiatry. *Philosophy, Ethics, and Humanities in Medicine*, *2*(1), 9. https://doi.org/10.1186/1747-5341-2-9

Batterman, R. W. (2002). Asymptotics and the role of minimal models. *The British Journal for the Philosophy of Science*, *53*(1), 21–38. http://www.jstor.org/stable/3541639

Beck, A. L., & Bergman, D. A. (1986). Using structured medical information to improve students' problem-solving performance: *Academic Medicine*, *61*(9), 749–756. https://doi.org/10.1097/00001888-198609000-00019

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*, 561–571. https://doi.org/10.1001/archpsyc.1961.01710120031004

Bell, D., Bobrow, D., Falkenhainer, B., Fromherz, M., Saraswat, V., & Shirley, M. (1994). RAPPER: The copier modelling project. *Proceedings of the Eighth International Workshop on Qualitative Reasoning about Physical Systems*. https://www.qrg.northwestern.edu/papers/files/qr-workshops/qr94/Bell_1994_RAPPER.pdf

Bobrow, D. G. (1984). Qualitative reasoning about physical systems: An introduction. *Artificial Intelligence*, *24*(1-3), 1–5. https://doi.org/10.1016/0004-3702(84)90036-5

Boland, R. J., Verduin, M. L., Ruiz, P., Shah, A., & Sadock, B. J. (Eds.). (2022). *Kaplan & Sadock's synopsis of psychiatry 12th edition* (Twelfth edition). Wolters Kluwer.

Boorse, C. (1977). Health as a theoretical concept. *Philosophy of Science*, *44*(4), 542–573. https://doi.org/10.1086/288768

Borsboom, D. (2017). A network theory of mental disorders. *World Psychiatry: Official Journal of the World Psychiatric Association (WPA)*, *16*(1), 5–13. https://doi.org/10.1002/wps.20375

Boumans, M. (1999). Built-in justification. In M. S. Morgan & M. Morrison (Eds.), *Models as mediators* (1st ed., pp. 66–96). Cambridge University Press. https://doi.org/10.1017/CBO9780511660108.005

Bruch, M., & Bond, F. W. (Eds.). (1998). *Beyond diagnosis: Case formulation approaches in CBT*. Wiley.

Bruchmüller, K., Margraf, J., Suppiger, A., & Schneider, S. (2011). Popular or unpopular? Therapists' use of structured interviews and their estimation of patient acceptance. *Behavior Therapy*, *42*(4), 634–643. https://doi.org/10.1016/j.beth.2011.02.003

Burge, T. (2010). *Origins of objectivity*. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199581405.001.0001

Butler, G. (1998). Clinical formulation. In *Comprehensive clinical psychology* (pp. 1–24). Elsevier. https://doi.org/10.1016/B0080-4270(73)00186-3

Cahalan, S. (2019). *The great pretender: The undercover mission that changed our understanding of madness* (First edition). Grand Central Publishing.

Carter, J. A., & Littlejohn, C. (2021). *This is epistemology: An introduction*. Wiley-Blackwell.

Cartwright, N., & Nordby, J. (1983). How approximations take us away from theory and towards truth. *Pacific Philosophical Quarterly*, *64*(3), 273–280. https://doi.org/10.1111/j.1468-0114.1983.tb00200.x

Casey, P. R., & Kelly, B. (2019). *Fish's clinical psychopathology: Signs and syptoms in psychiatry* (4th ed). Cambridge University Press.

Charlin, B., Tardif, J., & Boshuizen, H. P. A. (2000). Scripts and medical diagnostic knowledge: Theory and applications for clinical reasoning instruction and research. *Academic Medicine*, *75*(2), 182–190. https://doi.org/10.1097/00001888-200002000-00020

Chisolm, M. S., & Lyketsos, C. G. (2012). *Systematic psychiatric evaluation: A step-by-step guide to applying the perspectives of psychiatry*. Johns Hopkins University Press.

Coderre, S., Mandin, H., Harasym, P. H., & Fick, G. H. (2003). Diagnostic reasoning strategies and diagnostic success. *Medical Education*, *37*(8), 695–703. https://doi.org/10.1046/j.1365-2923.2003.01577.x

Cooper, R. V. (2007). *Psychiatry and philosophy of science*. McGill-Queen's University Press.

Croskerry, P. (2009). A universal model of diagnostic reasoning. *Academic Medicine: Journal of the Association of American Medical Colleges*, *84*(8), 1022–1028. https://doi.org/10.1097/ACM.0b013e3181ace703

Cuthbert, B. N., & Morris, S. E. (2021). Evolving concepts of the schizophrenia spectrum: A research domain criteria perspective. *Frontiers in Psychiatry*, *12*, 641319. https://doi.org/10.3389/fpsyt.2021.641319

David, A. S., & Nicholson, T. (2015). Are neurological and psychiatric disorders different? *British Journal of Psychiatry*, *207*(5), 373–374. https://doi.org/10.1192/bjp.bp.114.158550

De Kleer, J., & Brown, J. S. (1984). A qualitative physics based on confluences. *Artificial Intelligence*, *24*(1-3), 7–83. https://doi.org/10.1016/0004-3702(84)90037-7

Division of Clinical Psychology. (2001). *The core purpose and philosophy of the profession*. The British Psychological Society. https://www.liverpool.ac.uk/media/livacuk/doctorateinclinicalpsychologyprogramme/docs/Core_purpose_and_philospohy_of_the_profession.pdf

Docherty, A. R., Berenbaum, H., & Kerns, J. G. (2011). Alogia and formal thought disorder: Differential patterns of verbal fluency task performance. *Journal of Psychiatric Research*, *45*(10), 1352–1357. https://doi.org/10.1016/j.jpsychires.2011.04.004

Doughty, O. J., & Done, D. J. (2009). Is semantic memory impaired in schizophrenia? A systematic review and meta-analysis of 91 studies. *Cognitive Neuropsychiatry*, *14*(6), 473–509. https://doi.org/10.1080/13546800903073291

Eells, T. D. (2010). History and current status of psychotherapy case formulation. In T. D. Eells (Ed.), *Handbook of psychotherapy case formulation* (2. ed., paperback ed, pp. 3–33). Guilford Press.

Elstein, A. S., Allal, L., Gordon, M., Hilliard, J., Jordan, R. D., Kagan, N., Loupe, M. J., Shulman, L. S., & Sprafka, S. A. (2014). *Medical problem solving: An analysis of clinical reasoning*. https://0-doi-org.pugwash.lib.warwick.ac.uk/10.4159/harvard.9780674189089

Esterberg, M. L., & Compton, M. T. (2009). The psychosis continuum and categorical versus dimensional diagnostic approaches. *Current Psychiatry Reports*, *11*(3), 179–184. https://doi.org/10.1007/s11920-009-0028-7

Falkenhainer, B., & Forbus, K. D. (1991). Compsitional modeling: Finding the right model for the job. *Artificial Intelligence*, *51*(1-3), 95–143. https://doi.org/10.1016/0004-3702(91)90109-W

Farley, A. M. (1987). Qualitative modeling of economic systems. *IFAC Proceedings Volumes*, *20*(10), 41–44. https://doi.org/10.1016/S1474-6670(17)59029-1

Fernando, I., Cohen, M., & Henskens, F. (2013). A systematic approach to clinical reasoning in psychiatry. *Australasian Psychiatry*, *21*(3), 224–230. https://doi.org/10.1177/1039856213486209

First, M. B., Drevets, W. C., Carter, C., Dickstein, D. P., Kasoff, L., Kim, K. L., McConathy, J., Rauch, S., Saad, Z. S., Savitz, J., Seymour, K. E., Sheline, Y. I., & Zubieta, J.-K. (2018). Clinical applications of neuroimaging in psychiatric disorders. *The American Journal of Psychiatry*, *175*(9), 915–916. https://doi.org/10.1176/appi.ajp.2018.1750701

First, M. B., Williams, J. B. W., Spitzer, R. L., & Karg, R. S. (2016). *User's guide for the SCID-5-CV structured clinical interview for DSM-5 disorders: Clinician version*. American Psychiatric Association Publishing.

Forbus, K. D. (1984). Qualitative process theory. *Artificial Intelligence*, *24*(1-3), 85–168. https://doi.org/10.1016/0004-3702(84)90038-9

Forbus, K. D. (2008). Chapter 9 Qualitative modeling. In *Foundations of Artificial Intelligence* (Vol. 3, pp. 361–393). Elsevier. https://doi.org/10.1016/S1574-6526(07)03009-X

Fuchs, T. (2010). Subjectivity and intersubjectivity in psychiatric diagnosis. *Psychopathology*, *43*(4), 268–274. https://doi.org/10.1159/000315126

Gelder, M. G. (Ed.). (2000). *New Oxford textbook of psychiatry* (1nd ed). Oxford University Press.

Giere, R. N. (1988). *Explaining science: A cognitive approach* (8. [repr.]). Univ. of Chicago Pr.

Giere, R. N. (1999). Using models to represent reality. In L. Magnani, N. J. Nersessian, & P. Thagard (Eds.), *Model-based reasoning in scientific discovery* (pp. 41–57). Springer US. https://doi.org/10.1007/978-1-4615-4813-3_3

Godfrey-Smith, P. (2006). The strategy of model-based science. *Biology & Philosophy*, *21*(5), 725–740. https://doi.org/10.1007/s10539-006-9054-6

Godfrey-Smith, P. (2009). Models and fictions in science. *Philosophical Studies*, *143*(1), 101–116. https://doi.org/10.1007/s11098-008-9313-2

Godwin, R. M. (1967). A growth cycle. In C. H. Feinstein (Ed.), *Socialism, capitalism and economic growth: Essays presented to Maurice Dobb* (pp. 54–59). Cambridge University Press.

Goldman, A. (2000). Can science know when you're conscious? *Journal of Consciousness Studies*, *7*(5), 3–22.

Goldman, R. N., & Greenberg, L. S. (2015). *Case formulation in emotion-focused therapy: Co-creating clinical maps for change.* American Psychological Association. https://doi.org/10.1037/14523-000

Goodwin, R. M. (1967). A growth cycle. In C. H. Feinstein (Ed.), *Socialism, capitalism and economic growth* (pp. 54–59). Cambridge University Press.

Graham, G. (2021). *The disordered mind* (Third edition). Routledge, Taylor & Francis Group.

Groves, M., O'Rourke, P., & Alexander, H. (2003). The clinical reasoning characteristics of diagnostic experts. *Medical Teacher*, *25*(3), 308–313. https://doi.org/10.1080/0142159031000100427

Gruppen, L. D., & Frohna, A. Z. (2002). Clinical reasoning. In G. R. Norman, C. P. M. van der Vleuten, D. I. Newble, D. H. J. M. Dolmans, K. V. Mann, A. Rothman, & L. Curry (Eds.), *International handbook of research in medical education* (Vol. 7, pp. 205–230). Springer Netherlands. https://doi.org/10.1007/978-94-010-0462-6_8

Gupta, M., Potter, N., & Goyer, S. (2019). Diagnostic reasoning in psychiatry: Acknowledging an explicit role for intersubjective knowing. *Philosophy, Psychiatry, & Psychology*, *26*(1), 49–64. https://doi.org/10.1353/ppp.2019.0003

Guze, S. B. (1992). *Why psychiatry is a branch of medicine.* Oxford University Press.

Hamscher, W. (Ed.). (1995). *Readings in model-based diagnosis* (4. print). Morgan Kaufmann Publ. (Original work published 1992)

Harjai, P. K., & Tiwari, R. (2009). Model of critical diagnostic reasoning: Achieving expert clinician performance. *Nursing Education Perspectives*, *30*(5), 305–311. https://journals.lww.com/neponline/Abstract/2009/09000/Model_of_Critical_Diagnostic_Reasoning__Achieving.10.aspx

He, R., Yan, X., Guo, J., Xu, Q., Tang, B., & Sun, Q. (2018). Recent advances in biomarkers for Parkinson's disease. *Frontiers in Aging Neuroscience*, *10*, 305. https://doi.org/10.3389/fnagi.2018.00305

Helzer, J. E., & Association, A. P. (Eds.). (2008). *Dimensional approaches in diagnostic classification: Refining the research agenda for DSM-V* (1st ed). American Psychiatric Association.

Higgs, J., Jensen, G. M., Loftus, S., & Christensen, N. (Eds.). (2019). *Clinical reasoning in the health professions* (Fourth edition). Elsevier.

Hodges, J. R. (2018). *Cognitive assessment for clinicians* (Third edition). Oxford University Press.

Hoffmann, R. (1998). Qualitative thinking in the age of modern computational chemistry—or what Lionel Salem knows. *Journal of Molecular Structure: THEOCHEM*, *424*(1-2), 1–6. https://doi.org/10.1016/S0166-1280(97)00219-4

Hohwy, J. (2013). *The predictive mind* (First edition). Oxford University Press.

Husserl, E., & Ströker, E. (2013). *Logische Untersuchungen* (2. Aufl.). Meiner. (Original work published 1900)

Insel, T. R., & Cuthbert, B. N. (2015). Brain disorders? Precisely. *Science*, *348*(6234), 499–500. https://doi.org/10.1126/science.aab2358

Insel, T. R., & Quirion, R. (2005). Psychiatry as a clinical neuroscience discipline. *JAMA*, *294*(17), 2221–2224. https://doi.org/10.1001/jama.294.17.2221

Jaspers, K. (1973). *Allgemeine Psychopathologie* (9., unveränd. Aufl). Springer. (Original work published 1913)

Jefferson, A. (2020). What does it take to be a brain disorder? *Synthese*, *197*(1), 249–262. https://doi.org/10.1007/s11229-018-1784-x

Johnson-Laird, P. N. (1983). *Mental models: Towards a cognitive science of language, inference, and consciousness.* Harvard University Press.

Johnstone, L., & Dallos, R. (Eds.). (2014). *Formulation in psychology and psychotherapy: Making sense of people's problems* (Second edition). Routledge.

Kirk, K. H., & Werbrook, D. (2016). Assessment and formulation. In H. Kennerley, J. Kirk, & D. Westbrook (Eds.), *An introduction to cognitive behaviour therapy: Skills and applications* (3rd edition, pp. 67–109). SAGE Publications Ltd.

Knuuttila, T., & Loettgers, A. (2016). Model templates within and between disciplines: From magnets to gases – and socio-economic systems. *European Journal for Philosophy of Science*, *6*(3), 377–400. https://doi.org/10.1007/s13194-016-0145-1

Kotov, R., Krueger, R. F., Watson, D., Achenbach, T. M., Althoff, R. R., Bagby, R. M., Brown, T. A., Carpenter, W. T., Caspi, A., Clark, L. A., Eaton, N. R., Forbes, M. K., Forbush, K. T., Goldberg, D., Hasin, D., Hyman, S. E., Ivanova, M. Y., Lynam, D. R., Markon, K., … Zimmerman, M. (2017). The hierarchical taxonomy of psychopathology (HiTOP): A dimensional alternative to traditional nosologies. *Journal of Abnormal Psychology*, *126*(4), 454–477. https://doi.org/10.1037/abn0000258

Krueger, R. F., & Bezdjian, S. (2009). Enhancing research and treatment of mental disorders with dimensional concepts: Toward DSM-V and ICD-11. *World Psychiatry*, *8*(1), 3–6. https://doi.org/10.1002/j.2051-5545.2009.tb00197.x

Kuruvilla, K., & Kuruvilla, A. (2010). Diagnostic formulation. *Indian Journal of Psychiatry*, *52*(1), 78. https://doi.org/10.4103/0019-5545.58905

Ligęza, A., & Górny, B. (2017). Model-based diagnosis. In L. Magnani & T. Bertolotti (Eds.), *Springer handbook of model-based science* (pp. 435–461). Springer International Publishing. https://doi.org/10.1007/978-3-319-30526-4_20

Lotka, A. J. (1910). Contribution to the theory of periodic reactions. *The Journal of Physical Chemistry*, *14*(3), 271–274. https://doi.org/10.1021/j150111a004

Lotka, A. J. (1925). *Elements of mathematical biology* (Williams and Wilkins.). Dover.

Loveday, T., Wiggins, M., Festa, M., Schell, D., & Twigg, D. (2013). Pattern recognition as an indicator of diagnostic expertise. In P. Latorre Carmona, J. S. Sánchez, & A. L. N. Fred (Eds.), *Pattern recognition - applications and methods* (Vol. 204, pp. 1–11). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-36530-0_1

Maclin, J. M. A., Wang, T., & Xiao, S. (2019b). Biomarkers for the diagnosis of Alzheimer's disease, dementia Lewy body, frontotemporal dementia and vascular dementia. *General Psychiatry*, *32*(1), e100054. https://doi.org/10.1136/gpsych-2019-100054

Magnani, L. (1992b). Abductive reasoning: Philosophical and educational perspectives in medicine. In D. A. Evans & V. L. Patel (Eds.), *Advanced models of cognition for medical training and practice* (pp. 21–44). Springer. https://doi.org/10.1007/978-3-662-02833-9_2

Mamede, S., Schmidt, H. G., & Rikers, R. (2007). Diagnostic errors and reflective practice in medicine. *Journal of Evaluation in Clinical Practice*, *13*(1), 138–145. https://doi.org/10.1111/j.1365-2753.2006.00638.x

Mandin, H., Jones, A., Woloschuk, W., & Harasym, P. (1997). Helping students learn to think like experts when solving clinical problems: *Academic Medicine*, *72*(3), 173–179. https://doi.org/10.1097/00001888-199703000-00009

McHugh, P. R., & Slavney, P. R. (1998). *The perspectives of psychiatry.* Johns Hopkins University Press.

McMullin, E. (1985). Galilean idealization. *Studies in History and Philosophy of Science Part A*, *16*(3), 247–273. https://doi.org/10.1016/0039-3681(85)90003-2

McWilliams, N. (1999). *Psychoanalytic case formulation.* Guilford Press.

Merleau-Ponty, M. (2018). *Phenomenology of perception* (C. Smith, Trans.). Franklin Classics.

Meyer, V., & Turkat, I. D. (1979). Behavioral analysis of clinical cases. *Journal of Behavioral Assessment*, *1*(4), 259–270. https://doi.org/10.1007/BF01321368

Miller, D. B., & O'Callaghan, J. P. (2015). Biomarkers of Parkinson's disease: Present and future. *Metabolism*, *64*(3), S40–S46. https://doi.org/10.1016/j.metabol.2014.10.030

Miller, G. A. (2010). Mistreating psychology in the decades of the brain. *Perspectives on Psychological Science*, *5*(6), 716–743. https://doi.org/10.1177/1745691610388774

Morgan, M. S., & Morrison, M. (Eds.). (1999). *Models as mediators: Perspectives on natural and social science* (1st ed.). Cambridge University Press. https://doi.org/10.1017/CBO9780511660108

Morrison, M. (2007). Where have all the theories gone? *Philosophy of Science*, *74*(2), 195–228. https://doi.org/10.1086/520778

Morrison, M. (1999). Models as autonomous agents. In M. S. Morgan & M. Morrison (Eds.), *Models as mediators* (1st ed., pp. 38–65). Cambridge University Press. https://doi.org/10.1017/CBO9780511660108.004

Mueller, A. E., & Segal, D. L. (2015). Structured versus semistructured versus unstructured interviews. In R. L. Cautin & S. O. Lilienfeld (Eds.), *The encyclopedia of clinical psychology* (pp. 1–7). John Wiley & Sons, Inc. https://doi.org/10.1002/9781118625392.wbecp069

Murphy, D. (Ed.). (2006). *Psychiatry in the scientific image*. MIT Press.

Myers, R. H. (2004). Huntington's disease genetics. *NeuroRX*, *1*(2), 255–262. https://doi.org/10.1602/neurorx.1.2.255

Nakash, O., & Alegría, M. (2013). Examination of the role of implicit clinical judgments during the mental health intake. *Qualitative Health Research*, *23*(5), 645–654. https://doi.org/10.1177/1049732312471732

National Academies of Sciences, Engineering, and Medicine. (2019). Diagnosis and assessment of traumatic brain injury. In *Evaluation of the disability determination process for traumatic brain injury in veterans* (pp. 23–56). National Academies Press. https://doi.org/10.17226/25317

National Institute of Mental Health. (2013). *Research Domain Criteria (RDoC)*. https://www.nimh.nih.gov/research/research-funded-by-nimh/rdoc/nimh-research-domain-criteria-rdoc

Nordgaard, J., Revsbech, R., Saebye, D., & Parnas, J. (2012). Assessing the diagnostic validity of a structured psychiatric interview in a first-admission hospital sample. *World Psychiatry*, *11*(3), 181–185. https://doi.org/10.1002/j.2051-5545.2012.tb00128.x

Norman, G. (2005). Research in clinical reasoning: Past history and current trends. *Medical Education*, *39*(4), 418–427. https://doi.org/10.1111/j.1365-2929.2005.02127.x

Nurcombe, B., & Fitzhenry-Coor, I. (1982). How do psychiatrists think?? Clinical reasoning in the psychiatric interview: A research and education project. *Australian & New Zealand Journal of Psychiatry*, *16*(1), 13–24. https://doi.org/10.3109/00048678209159466

Olbert, C. M., & Gala, G. J. (2015). Supervenience and psychiatry: Are mental disorders brain disorders? *Journal of Theoretical and Philosophical Psychology*, *35*(4), 203–219. https://doi.org/10.1037/teo0000023

Papineau, D. (1994). Mental disorder, illness and biological disfunction. *Royal Institute of Philosophy Supplement*, *37*, 73–82. https://doi.org/10.1017/S135824610000998X

Parnas, J., Sass, L. A., & Zahavi, D. (2013). Rediscovering psychopathology: The epistemology and phenomenology of the psychiatric object. *Schizophrenia Bulletin*, *39*(2), 270–277. https://doi.org/10.1093/schbul/sbs153

Patel, V. L., Arocha, J. F., & Zhang, J. (2012). *Medical reasoning and thinking*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199734689.013.0037

Pi, Y., Liao, W., Liu, M., & Lu, J. (2008). Theory of cognitive pattern recognition. In P.-Y. Yin (Ed.), *Pattern recognition techniques, technology and applications*. InTech. https://doi.org/10.5772/6251

Pinnock, R., Young, L., Spence, F., Henning, M., & Hazell, W. (2015). Can *Think aloud* be used to teach and assess clinical reasoning in graduate medical education? *Journal of Graduate Medical Education*, *7*(3), 334–337. https://doi.org/10.4300/JGME-D-14-00601.1

Pollock, J. L., & Cruz, J. (1999). *Contemporary theories of knowledge* (2nd ed). Rowman & Littlefield Publishers.

Poole, R., & Higgo, R. (2017). *Psychiatric interviewing and assessment* (2nd ed.). Cambridge University Press. https://doi.org/10.1017/9781316676554

Power, B. D., Nguyen, T., Hayhow, B., & Looi, J. (2016). Neuroimaging in psychiatry: An update on neuroimaging in the clinical setting. *Australasian Psychiatry*, *24*(2), 157–163. https://doi.org/10.1177/1039856215618525

Price, B. H., Adams, R. D., & Coyle, J. T. (2000). Neurology and psychiatry: Closing the great divide. *Neurology*, *54*(1), 8–8. https://doi.org/10.1212/WNL.54.1.8

Rao, V., Spiro, J. R., Schretlen, D. J., & Cascella, N. G. (2007). Apathy syndrome after traumatic brain injury compared with deficits in schizophrenia. *Psychosomatics*, *48*(3), 217–222. https://doi.org/10.1176/appi.psy.48.3.217

Readings in qualitative reasoning about physical systems. (1990). Elsevier. https://doi.org/10.1016/C2013-0-08298-9

Reed, G. M., First, M. B., Kogan, C. S., Hyman, S. E., Gureje, O., Gaebel, W., Maj, M., Stein, D. J., Maercker, A., Tyrer, P., Claudino, A., Garralda, E., Salvador-Carulla, L., Ray, R., Saunders, J. B., Dua, T., Poznyak, V., Medina-Mora, M. E., Pike, K. M., … Saxena, S. (2019). Innovations and changes in the ICD-11 classification of mental, behavioural and neurodevelopmental disorders. *World Psychiatry*, *18*(1), 3–19. https://doi.org/10.1002/wps.20611

Reiter, R. (1987). A theory of diagnosis from first principles. *Artificial Intelligence*, *32*(1), 57–95. https://doi.org/10.1016/0004-3702(87)90062-2

Reitz, C., & Mayeux, R. (2014). Alzheimer disease: Epidemiology, diagnostic criteria, risk factors and biomarkers. *Biochemical Pharmacology*, *88*(4), 640–651. https://doi.org/10.1016/j.bcp.2013.12.024

Rejón Altable, C. (2012). Logic structure of clinical judgment and its relation to medical and psychiatric semiology. *Psychopathology*, *45*(6), 344–351. https://doi.org/10.1159/000337968

Reum, J. C. P., McDonald, P. S., Ferriss, B. E., Farrell, D. M., Harvey, C. J., & Levin, P. S. (2015). Qualitative network models in support of ecosystem approaches to bivalve aquaculture. *ICES Journal of Marine Science*, *72*(8), 2278–2288. https://doi.org/10.1093/icesjms/fsv119

Reznek, L. (1998). On the epistemology of mental illness. *History and Philosophy of the Life Sciences*, *20*(2), 215–232. http://www.jstor.org/stable/23332102

Rohrer, J. D., & Rosen, H. J. (2013). Neuroimaging in frontotemporal dementia. *International Review of Psychiatry*, *25*(2), 221–229. https://doi.org/10.3109/09540261.2013.778822

Rosenhan, D. L. (1973). On being sane in insane places. *Science*, *179*(4070), 250–258. https://doi.org/10.1126/science.179.4070.250

Roth, M., Tym, E., Mountjoy, C. Q., Huppert, F. A., Hendrie, H., Verma, S., & Goddard, R. (1986). CAMDEX: A standardised instrument for the diagnosis of mental disorder in the elderly with special reference to the early detection of dementia. *British Journal of Psychiatry*, *149*(6), 698–709. https://doi.org/10.1192/bjp.149.6.698

Royal Australian and New Zealand College of Psychiatrists. (2014). *Clinical examinations: Formulation guidelines for trainees (Formulation guidelines 0304).* https://psychiatry-training.wiki.otago.ac.nz/images/6/6c/RANZCP-Formulations-Guide.pdf

Royal College of Physicians and Surgeons of Canada. (2019). *Objectives of training in the specialty of psychiatry. Version 2.0.* http://www.royalcollege.ca/rcsite/education-strategy-accreditation/pgme-training-programs/accreditation-residency- program

Royal College of Psychiatrists. (2017). *Using formulation in general psychiatric care: Good practice.* https://www.yumpu.com/en/document/view/56758061/using-formulation-in-general-psychiatric-care-good-practice

Royal College of Psychiatrists. (2013). *A competency based curriculum for specialist core training in psychiatry: Core training in psychiatry CT1–CT3.* https://www.rcpsych.ac.uk/docs/default-source/training/curricula-and-guidance/curricula-core-psychiatry-curriculum-april-2018.pdf?sfvrsn=881b63ca_2

Ryan, P. (Ed.). (2020). *Enhancing clinical case formulation: Theoretical and practical approaches for mental health practitioners* (1st ed.). Routledge.

Schmidt, H. G., Norman, G. R., & Boshuizen, H. P. (1990). A cognitive perspective on medical expertise: Theory and implication [published erratum appears in Acad Med 1992 Apr;67(4):287]. *Academic Medicine*, *65*(10), 611–621. https://doi.org/10.1097/00001888-199010000-00001

Schramme, T. (2013). On the autonomy of the concept of disease in psychiatry. *Frontiers in Psychology*, *4*. https://doi.org/10.3389/fpsyg.2013.00457

Silajdžić, E., & Björkqvist, M. (2018). A critical evaluation of wet biomarkers for Huntington's disease: Current status and ways forward. *Journal of Huntington's Disease*, *7*(2), 109–135. https://doi.org/10.3233/JHD-170273

Smith, B., & Ehrenfels, C. (Eds.). (1988). *Foundations of Gestalt theory.* Philosophia Verlag.

Sober, E. (1979). The art and science of clinical judgment:: An informational approach. In H. T. Engelhardt, S. F. Spicker, H. T. Engelhardt, S. F. Spicker, & B. Towers (Eds.), *Clinical judgment: A critical appraisal* (Vol. 6, pp. 29–44). Springer Netherlands. https://doi.org/10.1007/978-94-009-9399-0_3

Spitzer, R. L. (1975). On pseudoscience in science, logic in remission, and psychiatric diagnosis: A critique of Rosenhan's "On being sane in insane places". *Journal of Abnormal Psychology*, *84*(5), 442–452. https://doi.org/10.1037/h0077124

Szasz, T. S. (1960). The myth of mental illness. *American Psychologist*, *15*(2), 113–118. https://doi.org/10.1037/h0046535

Tarbox, J., La Cava, S., & Hoang, K. (2016). Types of assessment. In J. L. Matson (Ed.), *Handbook of assessment and diagnosis of autism spectrum disorder* (pp. 11–26). Springer International Publishing. https://doi.org/10.1007/978-3-319-27171-2_2

Thomson-Jones, M. (2012). Modeling without mathematics. *Philosophy of Science*, *79*(5), 761–772. https://doi.org/10.1086/667876

Trull, T. J., & Durrett, C. A. (2005). Categorical and dimensional models of personality disorder. *Annual Review of Clinical Psychology*, *1*(1), 355–380. https://doi.org/10.1146/annurev.clinpsy.1.102803.144009

Trzepacz, P. T., & Baker, R. W. (1993). *The psychiatric mental status examination.* Oxford University Press.

Upshur, R. E. G., & Colak, E. (2003). Arguments and evidence. *Theoretical Medicine and Bioethics*, *24*(4), 283–299. https://doi.org/10.1023/A:1026006801902

Varghese, F. T., & Mellsop, G. W. (1983). Formulating a psychiatric case. *Bulletin of the Royal College of Psychiatrists*, *7*(3), 48–50. https://doi.org/10.1192/S0140078900008002

Verber, N., & Shaw, P. J. (2020). Biomarkers in amyotrophic lateral sclerosis: A review of new developments. *Current Opinion in Neurology*, *33*(5), 662–668. https://doi.org/10.1097/WCO.0000000000000854

Volterra, V. (1926). *Variazioni e fluttuazioni del numero d'individui in specie animali conviventi.* Società anonima tipografica "Leonardo da Vinci".

Wagner, A. D., Paré-Blagoev, E. J., Clark, J., & Poldrack, R. A. (2001). Recovering meaning. *Neuron*, *31*(2), 329–338. https://doi.org/10.1016/S0896-6273(01)00359-2

Weerasekera, P. (1996). *Multiperspective case formulation: A step towards treatment integration* (Original ed). Krieger Pub. Co.

Weisberg, M. (2013). *Simulation and similarity: Using models to understand the world.* Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199933662.001.0001

Weisberg, M. (2007). Who is a modeler? *The British Journal for the Philosophy of Science*, *58*(2), 207–233. https://doi.org/10.1093/bjps/axm011

Weisberg, M. (2004). Qualitative theory and chemical explanation. *Philosophy of Science*, *71*(5), 1071–1081. https://doi.org/10.1086/428011

Weld, D. S., & De Kleer, J. (2013). *Readings in qualitative reasoning about physical systems*. Morgan Kaufmann.

Wiggins, O. P., & Schwartz, M. A. (1997). Edmund Husserl's influence on Karl Jaspers's phenomenology. *Philosophy, Psychiatry, &Amp; Psychology*, *4*(1), 15–36. https://doi.org/10.1353/ppp.1997.0011

Wimsatt, W. C. (1987). False models as means to truer theories. In M. H. Nitecki & A. Hoffman (Eds.), *Neutral models in biology* (pp. 23–55). Oxford University Press.

World Health Organization. (1992). *The ICD-10 classification of mental and behavioural disorders: Clinical descriptions and diagnostic guidelines.*

Wright, B., Dave, S., & Dogra, N. (2017). *100 cases in psychiatry* (Second edition). CRC Press/Taylor & Francis Group.

Zahavi, D. (2019). *Phenomenology: The basics* (Original edition). Routledge, Taylor & Francis Group.

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