Popper Revisited – Epistemological Considerations on Psychoanalysis Regarding a Technical Model of the Psyche

Klaus Doblhammer[1,2], Matthias Jakubec[1], Samer Schaat[1], Dietmar Dietrich[1], Roman Widholm[1,2], Georg Fodor[3]

[1)] Institute of Computer Technology, Vienna University of Technology, Gusshausstr. 27-29, A-1040 Vienna, Austria; <surname>@ict.tuwien.ac.at
[2)] Vienna Psychoanalytic Association
[3)] Vienna Psychoanalytic Society; University of Cape Town; georg.fodor@gmail.com

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Abstract

In recent years, psychoanalytic theory has become interesting to research areas for which it was not primarily conceptualized, e.g. neuropsychoanalysis or artificial intelligence research. These areas of application of psychoanalytic theory were met with the same criticism, originally raised against psychoanalysis, namely its relation to philosophy of science and particularly its claim to be part of natural science.
In this paper these reservations will be reviewed as epistemological misunderstandings and preconceptions. It will be exemplarily demonstrated how a typical epistemological criticism of psychoanalysis, namely that by Popper, comprehends and classifies psychoanalysis. The paper intends to point out the incongruity between this criticism and the intention of psychoanalysis and its theory.
The second part of the paper then introduces the project SiMA with its interdisciplinary methodology and approaches as a project accepting the challenge of using psychoanalysis for computer engineering in a natural scientific way. The aim of the project is to utilize psychoanalytic theory technically for the purpose of modelling, simulating and planning applications in the field of artificial intelligence research.
For the first time this allows to put the psychoanalytic model to a test which follows the principles of computer engineering, i.e. a strictly natural scientific approach. Thereby making it accessible to a new mode of epistemological critique.

Keywords

Psychoanalysis, Critical Rationalism, Popper, Computer Simulation, Falsification, Artificial Intelligence

Introduction

In recent years, psychoanalytic theory[1] has become interesting to research areas for which it was not primarily conceptualized. Formulated in its classical shape by Freud as a metapsychology of psychoanalysis[2], it represents under consideration of the body a model of psychic functioning and thus a foundation for psychoanalytic practice and associated clinical psychoanalysis to this day. When turning to psychoanalysis, other sciences like psychoanalytic pedagogy (Bittner 1985), literary studies (Feldmann 2004) or psychoanalytic cultural science (List 2013) have generally only dealt with the results of psychoanalysis and applied its content and methodology to their field. Freud's metapsychology has hitherto rarely been scientifically absorbed as a holistic theory of the human psyche, however, in part because it was and still is considered a fringe or interstitial science with a lack of connectivity in the academic discourse (cf. Warsitz 1997, Schülein 2012) – and also due to doubts voiced against its legitimacy as a science in the first place (Popper 2002, Popper 2009). Furthermore, as a result of various reformulations by other psychoanalytic schools and currents it is no longer at the center of the psychoanalytic discourse itself.

Besides the many efforts to define a solid foundation in the philosophy of science for psychoanalysis (Schülein 1999), there have recently also been attempts to bring it into a relationship with other sciences. Examples of these approaches are neuropsychoanalysis (which compares neurological research results with Freudian psychoanalytic theory – see Solms 2001) or projects in information technology (e.g. project "SiMA"[3], a basic research project at the Vienna University of Technology incorporating psychoanalytic theory in its portfolio for research into artificial intelligence – see Dietrich 2000, Dietrich 2009, Dietrich 2014). Here the focus lies on transdisciplinary integration of psychoanalytic metapsychology into a different scientific area and finding new ways of description.

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[1] There are many psychoanalytical theories dealing with the functionality of the psyche (e.g. Klein, Bion, Lacan, etc.), but this paper deals with Freud's theory since it was the focus of Popper's examinations.

[2] The *Metapsychology of Psychoanalysis* is Freud's attempt, to formulate a general, holistic and natural scientific model of the structure and functionality of the psyche; he called this model the *psychic apparatus* (cf. Freud 1924, 84 and Freud 1915, 281). Metapsychology of psychoanalysis must be differentiated from psychoanalysis as a psychotherapeutic method, as well as psychoanalysis as a method for examining unconscious contents and processes (Freud 1923, 211).

[3] See: sima.ict.tuwien.ac.at. SiMA = Simulation of the Mental Apparatus and Applications. Until January 2015, the project was named ARS (Artificial Recognition System).

As was to be expected, these new areas of application of psychoanalytic theory were met with the same criticism and reservations, which were originally raised against psychoanalysis, namely its situation in relation to the philosophy of science and particularly its claim to be part of natural science.[4] Despite his complex methodology and his representational delimitation towards biology, Freud was able to uphold this natural scientific standard throughout his scientific career: psychoanalysis is a natural science dealing with the psyche – what else?[5]

In this paper the above-mentioned reservations, the epistemological misunderstandings and preconceptions will be reviewed, which have become standard in the scientific discourse over the past decades and are often thoughtlessly parroted in critical assessments of the new fields of application of psychoanalysis. The goal is to show in what ways and contexts the classical psychoanalytic models of the human psyche were established by Freud, how he delimited them from other areas of psychoanalysis as a *metapsychology*, and what requirements he himself placed on them. For today, psychoanalytic metapsychology is all too often equated with psychoanalysis.

Furthermore, the paper intends to demonstrate by way of example how a typical philosophical criticism of psychoanalysis, namely that by Popper, comprehends and classifies psychoanalysis and it intends to point out the incongruity between this criticism and the intention of psychoanalysis and its theory.

The second part of the paper then introduces project SiMA with its interdisciplinary methodology and approaches as a project accepting the challenge of using psychoanalysis for information theory, i.e. in a natural scientific way from the perspective of computer engineering, and to then utilize it technically for the purpose of modelling, simulating and planning applications in the field of artificial intelligence research. For the first time ever this allows us to subject the psychoanalytic model to a test which obeys the principles of computer engineering, thus following a strictly natural scientific approach and thereby making it accessible in a new way to epistemological criticism.

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[4] Besides the criticism by Popper discussed below, that of Grünbaum (1988) should also be mentioned here.

[5] Cf. the following quotes: "Psychoanalysis is a part of the mental science of psychology. … Psychology, too, is a natural science. What else can it be?" (Freud 1938, 141)
"The hypothesis we have adopted of a psychical apparatus extended in space, expediently put together, developed by the exigencies of life, … has put us in a position to establish psychology on foundations similar to those of any other science, such, for instance, as physics." (Freud 1938, 126)
"… the other view, which held that the psychical is unconscious in itself, enabled psychology to take its place as a natural science like any other." (Freud 1938, 80)

Part 1: Psychoanalysis and Critical Rationalism

1. The Claim of Psychoanalytic Theory

According to Freud, psychoanalysis is a multi-layered scientific project. Originating in the therapeutic treatment of neuroses and the detailed study of dreams, blunders (so-called Freudian slips), and human sexuality, there developed from the very start – as a by-product of sorts[6] – a scientific model describing the structure and functionality of the human psyche which Freud termed *metapsychology*. This model was intended to make the psychic phenomena that psychoanalysis dealt with, abstractly understandable and explainable in a natural scientific sense. The core proposition of Freud's conception is that psychic processes and the resulting phenomena in clinical practice, in the individual and also in culture as a whole operate primarily with unconscious processes and contents. In connection with the body, the psyche is divided into various areas and functions which process contents according to different principles and eventually transform them to the areas of conscious thinking, feeling and acting.[7]

Psychoanalytic metapsychology is developed from the experiences made in psychoanalytic clinical practice and the results of the psychoanalytic method of investigation. This means generalizing and abstracting the (usually) clinical experience so that consistent models of the so-called *psychic apparatus* and its functionality can be established. In its classical form, Freud speaks of three perspectives on metapsychology from which the functioning of the psyche can be viewed: the topographical, economical and dynamic point of view.[8]
In parallel to his clinical practice and his work in cultural science, Freud worked his entire life on developing and continually reformulating these models of the psychic apparatus,

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[6] For example in 1915 Freud notes: „I demand that theories shouldn´t be made – they have to fall in someone´s house as uninvited guests, when you are engaged in detail investigations." Freud, Ferenczi (1996), 138

[7] A compilation of Freud's models can be found e.g. in: List. Psychoanalyse, Vienna 2009, 65-136.

[8] According to Laplanche (1972, 357/125/503) the following are at the focus of observation of the psychic apparatus: (a) for the economical point of view: the mobility of cathexes, the change in their intensity and the oppositions that are created between them (cf. 357), (b) for the dynamic point of view: the conflicts and power connections originating from the pressure of the drive, and (c) for the topographical point of view: the differentiation into a certain number of ordered systems with properties of functions. To these three Freudian points of views, Rapaport (1960) adds several others, which are not considered significant for this paper, however.

from his first theories in 1895 ("Project for a Scientific Psychology") all the way to "An Outline of Psychoanalysis" in 1939.[9] What was his methodology in doing so? His topmost priority was the idea that a theory should provide a consistent and contradiction-free model of the experiences with reality.[10] He believed that the scientist worked "like a sculptor at his clay model, who tirelessly alters his rough sketch, adds to it and takes away from it, till he has arrived at what he feels is a satisfactory degree of resemblance to the object he sees or imagines."[11] This however required terms which possess a character of permanent tentativeness and "it is only after more thorough investigation of the field of observation that we are able to formulate its basic scientific concepts with increased precision, and progressively so to modify them that they become serviceable and consistent over a wide area. Then, indeed, the time may have come to confine them in definitions."[12]
Despite the vehemence with which Freud worked on the establishment of his models, his attitude towards metapsychology remained critical. He saw in it an elaborated modern mythology with which one could explain many things – often even things outside of psychoanalytic experience (cf. Freud 1937, 68: "the witch metapsychology"). Such mythologies can also be found in other natural sciences (cf. Freud 1915b, 22 – here he mentions physics). What mattered to Freud, however, was the immediate experience and the evidence of the material he was able to determine in clinical practice and in culture using the psychoanalytic method.
Hence from an epistemological point of view Freud employed a comparatively simple methodology, a constructive self-conception, which nevertheless produced astonishing results.[13] Freud's metapsychology – despite all of the inconsistencies it contains – remains to this day one of the most precise and comprehensive holistic theories on the functioning of the human psyche[14], establishing the psychical in the body and taking it into the social and cultural while factoring in the time-relatedness of the human situation – i.e. the individual and collective past into the here and now of the individual´s action. It also still forms the basis for many practical applications: from psychoanalytic psychotherapy all the way to cultural criticism and advertising psychology. And, as mentioned above, it is used to extend the frontiers of neighboring areas of knowledge which are unambiguously

[9] Cf. Freud (1895) and Freud, S. (1938)
[10] Cf. Freud 1922, 228
[11] Freud 1933, 188
[12] Freud 1915, 210-232
[13] Cf. Schülein 2012, 606
[14] This is conceded even by scientists who are not immediately native to psychoanalysis. Cf. Kandel (1999): "Of all these sciences, only psychoanalysis offers a holistic model."

oriented around natural science: neurology, neuropsychoanalysis[15] or computer engineering[16].

What makes Freudian metapsychology so interesting for the field of natural sciences?

(1) The methodological approach of engineering-oriented natural sciences to the comprehension of phenomena of reality happens along the same lines as the modelling of Freud. Motivated by the problem of how the psyche works in a first step the researcher observes, and later establishes hypotheses based on his knowledge and experience.
(2) On the basis of these hypotheses the researcher develops a model which represents and describes reality as closely as possible so that interrelations can be understood and eventually reconstructed. This first model will necessarily contain discrepancies with reality, thus requiring adaptation and alteration until a sufficient approximation of the real phenomena has been achieved. The model description relies on an absence of contradictions and progressive axiomatic establishment of terms.
(3) Although Freudian metapsychology deals with psychic phenomena, it is explicitly based on the body and can therefore be linked with biology and physics. Freud speaks of *psychic representatives*, meaning representations of biophysical processes of the body within the psyche, e.g. when the biologically defined *drive* presents an action requirement to the psyche in the form of organic tension. In addition to these internal correlations, however, the body itself can also become an object of the psyche when the latter perceives the former quasi from the *outside*. Freud established this relation e.g. by stating in his theory of the id and the ego that "the ego is first and foremost a bodily ego"[17]. This makes Freud's model not only a layered model as encountered in information theory of computer engineering (Tanenbaum 1990), but also means that it takes into consideration an immediate embodiment (Damasio 1999).
(4) Freudian metapsychology attempts to comprehend psychic phenomena holistically by systematically subdividing and describing psychic functionality.[18] This differentiates it methodologically from empirical-behavioristic psychology which examines human behavior selectively, extracting individual psychic phenomena

[15] Cf. Solms (2006)
[16] Cf. Dietrich (2009)
[17] Freud 1923, 253
[18] For example, in the first topographical model (unconscious, preconscious, conscious) or the structural model (ego, id, super-ego).

with statistical methods without describing the functions they are based upon. A holistic theory, on the other hand, allows modelling in a top-down approach which represents a standard in technology in the sense of engineering science.

(5) In his metapsychology, Freud placed great emphasis on the contradiction-free definition and honing of terms and – since he was dealing with a new field of knowledge – continued to rework it constantly in his writings. This represents a basic[19] axiomatic approach as applied by natural scientists and computer engineers in particular in their theory formation. Hence metapsychology operates to a certain degree in accordance with natural scientific principles.

2. Popper's Criticism of Psychoanalytical Theory

Critics of Freud's psychoanalysis often quote Sir Karl Popper, who dealt with psychoanalysis in two major publications: firstly, in his detailed criticism of dream interpretation (Popper 2002), in which he saw a particularly typical "case of verificationism", and secondly in the first chapter of his "Conjectures and Refutations" (Popper 2009).

Popper mentions that he had developed his demarcation criterion for scientific theories to a large extent through his examination of Sigmund Freud's dream interpretation. He argues as follows: according to Freud's theory, all dreams are wish fulfilment. The existence of anxiety dreams appears to contradict this notion, but Freud recognizes the problem and promises to reveal the latent contents of anxiety dreams as wish fulfilment. Popper accuses him of not having kept that promise, but instead to have secretly given it up, and views Freud's assertion that anxiety dreams are not a dream problem but rather a fear problem as a typical "conventionalistic turn" or *immunization* of the theory as opposed to an explanation. The accusation levelled by Popper is that the use of such methods means that every arbitrary case could become *verification* for the theory. Any imaginable human behavior would be proof of Freud's theories, or by the same token for example Adler's theories. Popper goes on to note that Freud interprets both of the inherently oppositional phenomena, namely *counter-wish dreams* and *obliging dreams*[20], as verification for his

[19] The authors use the term "basic" since Freud did not consistently follow this approach the way it is intended in the SiMA project.

[20] *Counter-wish dreams* are dreams whose manifest content is the denial of a wish or the occurrence of something apparently undesired. An *Obliging dreams* is a dream in the therapeutic context whose content is flattery of or courtesy towards the therapist, i.e. contents which the patient assumes the therapist would like to hear.

theory without any further justification "with good reason" (as there is no justification) (Popper 2002).
In "Conjectures and Refutations", Popper once more offers up his falsification criterion as a demarcation between what does, and what does not, constitute science. He criticizes the use of the empirical method as an inadequate characteristic of the scientific method. His point of departure is the "great explanatory power" of psychoanalysis (and other "pseudosciences"). Every possible result seems to affirm the theory, to "verify" it. He could think of no human behavior, Popper claimed, that could not be interpreted in terms of psychoanalysis – whereas scientific theories like Einstein's theory of relativity specified distinct possible measurement results which would contradict the respective theory. Verifications should only be taken seriously if they were "the result of risky predictions". Immunizations of falsified theories were always possible, but necessarily decreased the scientific value of the theory. Finally, Popper also declared Freud's later structural model[21] as a myth ("epic of the ego, the id and the super-ego"), but nevertheless conceded the possibility of its "development towards testability" (cf. Popper 2009).

3. Reservations against the Exclusion of Psychoanalysis by Popper

As fundamental as Popper's demarcation criterion was for the development of philosophy of science, the damage caused by its undifferentiated application – especially in regard to the potential of psychoanalysis – was significant. As mentioned above, Freud himself was to a certain degree quite aware of the methodological limitations of his metapsychological efforts and knew how to describe the difficulties that arose from those limitations.[22] One must also keep in mind that Freud obviously could not make use of Popper's methodological suggestions in his work, as they were only published after he had died. Popper's accusations against psychoanalysis, however, could have been levelled just as well against the theory of evolution[23]: it is based almost exclusively on verification, and the lack of so-called "missing links" is generously argued away with reference to gaps in the fossil records. Nevertheless, the theory of mutations and natural selection has become an accepted foundation of natural science.
The same applies to the basic elements of psychoanalytic metapsychology. The insight that human behavior is fundamentally determined by unconscious psychic functions and contents – revolutionary in Freud's time – has since become so natural to us that we

[21] Freud (1923)
[22] Cf. e.g. Freud 1900, 555 and Freud 1924, 84
[23] Indeed, Popper recognised the difficulties with Darwin's theory and mentions them in "The Myth of the Framework" (Popper, 1994, 4.IV)

apparently no longer notice or wish to notice it. The existence of the unconscious is confirmed and accepted on a very basic level and is routinely made use of in applied psychology (e.g. in advertising). The universal proposition induced therefrom could theoretically be falsified by the (not to be expected and difficult to prove) appearance of a human being without unconscious personality parts (similar to a Mr. Spock). And yet research into artificial intelligence has hitherto focused almost entirely on conscious cognitive capabilities, ignoring the unconscious processes for the most part.
There is of course plenty of cause for criticism of metapsychological concepts. One example is the differentiation of mental contents into thing presentations and word presentations. Freud's theory that rational thought was only possible based on word presentations[24] (Freud viewed word presentations as mental representations of words through sound, reading, writing and motor images – see Fig. 1 – i.e. of words in a narrower sense) is quite strong, and it can be considered falsified by the fact that deaf people are equally capable of rational thought. This narrow notion of word presentations must therefore be replaced with a broader one (e.g. of symbol presentations).[25] But would this not constitute a process of immunization? And if so, is the replacement of the simple addition theorem for speeds with the Lorenz formula not likewise an immunization of Newton's mechanics? What types of extensions to theories are permissible at all under these circumstances? Certainly, such extensions which continue to guarantee their testability (falsifiability for universal propositions, verifiability for existential propositions). Popper discusses this question in detail in "The Logic of Scientific Discovery" (Popper 1994, see especially pp. 50ff, English edition: p. 61ff).

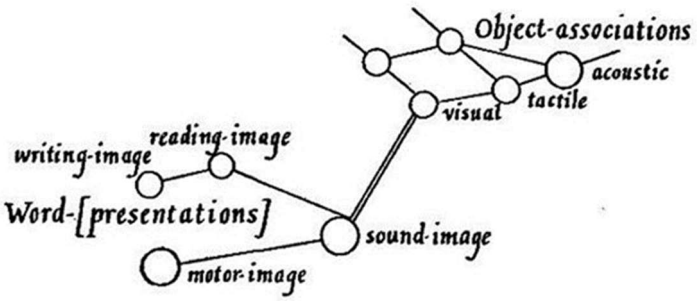

Fig. 1: Word-[presentations] and Object-associations according to Freud (1915). The Unconscious. Standard Edition Vol. XIV, p.213

[24] Cf. Freud 1915, 300
[25] This was discussed by cognitive biologists at the conference SOMACCA – The Syntax of Mind (Vienna, April 17-19, 2014). See: https://somacca.univie.ac.at/home/ (Accessed 07 February 2018) und https://somacca.univie.ac.at/the-syntax-of-mind-international-conference/ (Accessed 07 February 2018)

It must also be said with regard to the reception of dream interpretation that Popper appears not to have fully understood Freud and cites him only superficially: for in his central thesis on dreams, Freud does not actually claim that all dreams are wish fulfilment. Popper cites Freud's wish fulfilment hypothesis as follows (Popper 2002, 190, English edition p. 164): He (Freud) states "[…] that, in their essential nature, dreams represent fulfilments of wishes." (GW II/III, 132). This citation, however, does not represent the precise phrasing of Freud's theory. More accurately worded, it reads: "*When the work of interpretation has been completed*, we perceive that a dream is the fulfilment of a wish." (GW II/III, 126 – emphasis by Author).

The not insignificant difference between these two statements is that Freud differentiates between manifest and latent content in the dreams of grown-ups to which he refers in his dream interpretation. In contrast to the dreams of children, which often represent pure and direct wish fulfilment, the meaning of grown-ups' dreams cannot be immediately determined from the manifest content. They must instead be interpreted in a manner that deciphers their latent contents. This deciphering can be achieved only with the associations of the dreamer via the manifest dream content and requires a particular methodology, the psychoanalytic method, which recognizes the workings of the primary process.[26] Hence the latent dream content cannot be directly established using secondary process logic and becomes accessible only through the application of analytical methods. These methods, however, are by no means arbitrary – instead they follow clear rules which are gained from psychoanalytic experience and are founded in metapsychology. Thus, the process of dream interpretation does in fact follow the logic of rational science as stipulated by Popper.

The unconsciously determined dreams of grown-ups always pose mysteries which can be more or less easily solved,[27] but – and this is Freud's theory – if their interpretation, i.e. their methodical deciphering, proceeds successfully, the fulfilment of a wish will eventually be found in a rationally traceable way in the latent dream content, in the same way in which it is apparent in children's dreams.

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[26] In contrast to the secondary process, the primary process knows no negation and no temporal or causal order, only immediate presence via association.

[27] It is noteworthy that Freud assumes at least one spot in every dream of a grown-up "at which it is unplumbable – a navel, as it were, that is its point of contact with the unknown" (Freud 1900, 116). He also states that "the dream-thoughts to which we are led by interpretation cannot, from the nature of things, have any definite endings; they are found to branch out in every direction into the intricate network of our world of thought. It is at some point where this meshwork is particularly close that the dream-wish grows up, like a mushroom out of its mycelium." **(**Freud 1900, 530)

Freud even explicitly modifies "the formula in which we have sought to express the nature of dreams"[28] to represent this fact: "a dream is a (disguised) fulfilment of a (suppressed or repressed) wish"[29]. Popper ignores this fact in his criticism.
In view of the momentousness of Popper's verdict placing psychoanalysis in the realm of "pseudoscience", we will try to briefly retrace and summarize the way Popper arrived to his generalized conclusion which – as stated above – has so severely and unjustifiably influenced, and continues to influence, the scientific reception of psychoanalysis in general and the psychoanalytic theories in particular.

(1) It must be emphasized that Popper's abovementioned examination of Freud's dream theory *does not* in fact pertain to the theory of psychoanalysis, i.e. metapsychology. Popper is merely dealing with a product of psychoanalytic methodology when he argues against Freud's wish fulfilment hypothesis. Freud distils the sentence "*When the work of interpretation has been completed,* […]" quoted above, from a myriad of his own and others' dreams which he analyzed using his psychoanalytic method. This statement is not an immediate statement from Freud's metapsychology.
(2) Popper criticizes a simplified form of this statement without taking into consideration Freud's further elaborations in the same context and his efforts to improve the definition[30] – in the sense of "working on a clay model".
(3) In his attempt to deal critically with Freud's dream interpretation hypothesis, Popper apparently neglects to read and discuss chapter 7, in which Freud develops a model of the psychic apparatus, the so-called first topographical model of psychoanalysis, on 110 pages in an exceedingly compact, abstract and terminologically differentiated fashion. As a metapsychology, it postulates the existence of an unconscious in the psyche, developing its functionality from the preceding 500 pages of analysis of dream material.
(4) If Popper can be said to make reference to metapsychology at all, then only briefly by mentioning Freud's "epic of the ego, the id and the super-ego" in a later treatise.[31] He fails to examine these theoretical concepts[32] in any detail, however.

In summary, there exists without a doubt a danger of immunization of the theory of dreams as wish fulfilment, but this danger can be averted by accurately applying the psychoanalytic method. Could possible future results of brain research on the activity of

[28] Freud 1900, 166
[29] Ibid.
[30] Cf. Freud 1922, 310 and Freud 1933, 27
[31] Popper 2009, 56
[32] In: Freud 1923, 235-289

reward-related neuronal regions in relation to dreams bring further insights in this regard? The theory is falsifiable as stipulated by Popper in any case, but perhaps not as simply as Popper assumes.
Popper himself admits that human behavior contradicting Freudian metapsychology is imaginable (Popper 2002, 195f, English edition p. 169). Hence, we can clearly conclude that it possesses all characteristics required for facilitating a true gain in knowledge, and that using it as a point of departure for further scientific research is absolutely permissible. It is therefore time to further develop Freud's "mythological" approach into durable scientific propositions. On the one hand, Freud's models need to be described in greater detail (as he himself would undoubtedly have wanted); on the other hand, at least one simulation should allow to show, that metapsychological interrelations and propositions indeed result in coherent and sensible human behavior. Under specified environmental conditions (personality parameters, memories, initial conditions, etc.) and in a predefined world, a model simulation should result in predictable behavior – or not, thereby making the metapsychological model falsifiable at a fundamental level (see Chapter *Simulation and Evaluation*).

Part 2: Psychoanalysis and Engineering

1. How Can the Model of Psychoanalytic Metapsychology be Converted into a Technical Model?

In the year 1998, Dietmar Dietrich launched project SiMA (Simulation of Mental Apparatus and Applications; see also footnote 3). The purpose of the project (Dietrich 2000) was to expand the narrow technical boundaries of automation engineering and extend the field with typical characteristics of human intelligence using a bionic approach. The idea was to be able to handle situations which are too complex for conventional machines, but "somehow intuitively" manageable for humans ("Simulating the Mind", Dietrich 2009). While several similar attempts have been undertaken since that time in AGI (Artificial General Intelligence; "AGI": Goertzel 2007) research, the SiMA architecture[33] developed over the years by Dietrich and his team is the only one to combine the aspects discussed in the following.

(1) *Functional Model*
When confronted with the question of how a system specified for a certain task must be constructed, engineers generally differentiate between a behavioral model

[33] A current description of the SiMA model and its modeling can be found in Dietrich (2014)

and a functional model. The behavioral model is created from the list of requirements describing how the system is expected to behave in selected situations. As not all imaginable situations can generally be itemized, however, this behavioral model must necessarily remain incomplete. It is the engineers´ task to develop a functional model from this behavioral model, i.e. a description of the functional elements required for the system to achieve the desired behavior. For a physically described electronic system, the functional model is implicitly described in its entirety; in software systems like a database, however, the differentiation between behavioral and functional model is not necessarily trivial. The behavioral description may be represented by a table assigning output values to input values. This can be achieved exhaustively or not completely exhaustively. In the case of an exhaustive description, meaning that every possible state of the process (system) is defined via assignment (algorithm), the result is called a function and represents an electronic hardware. If one uses programming elements like if-then instructions, the system may not be fully specified in all its states and is therefore described as a behavioral model, not as a functional model. For a software algorithm to be understood as a functional model, it must therefore take into consideration every possible input signal while at the same time being a representation of a technical, scientific explanation of the behavior of the modelled system. It is this principle that the SiMA architecture follows for its description of the human psyche.

(2) *Top-Down Design*

The functional model of a system can be developed in two fundamentally different ways: bottom-up or top-down. In a bottom-up procedure, new partial functions are gradually added to the existing system – partial functions which the designer hopes will expand the system in a manner making its behavior ever more similar to the desired model. This procedure can be seen in most approaches in psychology where cognitive achievements of humans are isolated and described individually. The ultimate hope is to obtain a complete model of the human mind by combining these separate parts. A similar approach is followed in brain research, where the behavior of new brain regions is constantly being discovered and described in the hope that the sum of these individual findings will explain human behavior. The work by Marvin Minsky of the Society of Mind (Minsky 1988) also follows the bottom-up approach by integrating ever new functional elements into a society of mental performance units principally open to any extension. By contrast, the SiMA model follows the strict rules of information science in computer engineering, where the top-down approach is mandated in order to arrive at the optimal solution in every case. Based on the idea of ascribing the role of the central control unit in the regulative system of a human organism to the psyche, SiMA asks which partial

functions such a system must necessarily consist of and describes these partial functions step by step in iteratively increasing detail. In computer engineering, we differentiate between an abstracting top-down approach, where the highest level of abstraction exists in the topmost layer, and a functional top-down approach. The functional top-down approach is characterized by the fact that the topmost layer contains the functions describing the tasks of the overall process. These functions can be divided into sub-functions – which in contrast to the abstracting top-down approach can operate independently of one another. More detailed information can be found in Dietrich (2014).

(3) *Psychoanalytic Metapsychology as the Fundamental Model of the Human Psyche*
In a typically "technical" fashion, one could now begin to identify common elements of data-processing systems during the design of the sub-functions of this human control unit: database, master process, I/O interfaces, etc. Such elements do not represent components of the human psyche as we understand it today, however. In order to model all the required functionality, we need a description of precisely that target system which is reproduced in SiMA – a description following the functional approach in order to arrive at a functional description of the psyche. The cornerstones of such a functional description are laid down in the metapsychology of psychoanalysis. Unfortunately, psychoanalysts after Freud have hardly advanced these aspects since the psychoanalytic research intention was not fundamentally oriented towards establishing a comprehensive theory of psychic functionality – i.e. to further develop Freud's approach, and to axiomatize and systematize it.[34] At this moment in time we therefore have many good questions in this area, but only vague answers.

When attempting to implement Freud's metapsychology into a technical model, engineers inevitably come up with many questions directed at psychoanalysis which would never have occurred to analysts when working clinically in their practice. Answers to these questions require a detailing of the metapsychological theory which goes beyond the treatment necessities of individual clinical cases. Hitherto these questions were unthinkable in the development of psychoanalysis.

A brief discussion of the term "*psychic energy*" may serve as an example: in Freud's model of psychic economy, psychic contents are activated and become effective by being assigned a certain amount of *psychic energy*. Hence *psychic energy* is nothing more than a measurement of the relevance assigned to a particular content in the psyche. This is easy to

[34] There are also exceptions to this statement. See for example the works by Rapaport (1960), Holt (1985), and Jacobson (1953).

implement for a computer engineer: he simply associates the data representing psychic contents with a number, for psychic energy to him is nothing but a quantifying parameter for something. In SiMA, this parameter is known as *psychic intensity* according to the axiomatic nomenclature. But this raises various questions: what type of number should this ideally be, what values can it assume, how should the respective functions initialize the associated variables? The term *psychic energy* has its origins in bodily drive tension and determines the intensity with which the individual partial drives[35] occur. Since not every partial drive can be given the same amount of attention by the psychic apparatus at any given time, which means that the partial drives must be assigned differing intensities depending on the current situation, the following deliberation must be undertaken: is there a total amount of available psychic energy that is apportioned to the partial drives, or does each drive have its own "reservoir"? Freud did not choose the term *energy* arbitrarily for the phenomenon he described, and he almost certainly had an analogy of some kind to the forms of physical energy in mind. But this analogy leads to misunderstandings, for psychic energy clearly has no correlation with the actual physical energy available to the brain. No relationship between the two terms can be assumed.[36] For example, when a person is hungry the physical energy available to the brain will be reduced, but the psychic energy of the nourishment drive will increase. There remains the important question whether it is sensible to assume the existence of a form of energy conservation law – as postulated by psychoanalytic theory[37] – for psychic energy within the psychic processes. Freeing the discourse from a fixation on this image was a further reason for the SiMA project to replace the term *psychic energy* with *psychic intensity*. Intensities can be copied from one data set to another without the need to conserve a sum total.

The technical model, which has been developed in the SIMA project – in a cooperation between engineers and psychoanalysts – has been discussed and explained in detail in Dietrich (2014). Scientific validation of the achieved model within the SiMA project seems to be well in keeping with Popper's requirements. In engineering, results are validated, i.e. it is confirmed that a technical product fulfils the requirements postulated in its blueprint. Furthermore, engineers use the term *proof of principle, which is* also known from biotechnology, pharmacy, medicine etc. This term refers to the proof that a certain

[35] A partial drive contains a partitioning of drive tension, in particular sexual drive tension, into different individual drives with their own source and satisfaction target.
[36] The metaphor "energy" from the realm of mechanics projects thought models into the field of information theory which are meaningless and/or incorrect there. One must understand that the information world must also be mathematically described in a different way than the physical world. One need only think of the model of the Mealy machine without which computers would not be possible.
[37] Cf. Rapaport 1960, 56

approach is fundamentally possible and achieves the desired result. The result being a falsification or a corroboration of a theory of natural science.

The following sections describe the validation process in project SiMA.[38] The first step is the explanation and establishment of the applied method known as case-driven agent-based simulation. This method is described in Section 2. The second step is using this method to test the developed model of the psyche as discussed in Section 3.

2. Case-Driven Agent-Based Simulation: The SiMA Model is Simulatable and Evaluable

The representation of psychic functionality and the interdisciplinary knowledge transfer between psychoanalysis and computer engineering pose special requirements regarding the methodology of interdisciplinary development and evaluation of the SiMA model. The questions raised are the following: What methodology is suitable for translating the insights of psychoanalysis into a deterministic, evaluable model of the human psyche? How can this methodology be used to evaluate the model as well as the underlying psychoanalytic theory? The so-called case-driven agent-based simulation[39] (Schaat 2014a) was developed for this purpose in project SiMA in order to guide interdisciplinary cooperation and be able to develop and evaluate the required functions and data for a simulation model of the human psyche. It has been found that the combination of a casuistic approach, requirement analysis and agent-based modelling are particularly suitable for following the SiMA principles and the challenges associated with it as well as with the psyche as the object of study. These challenges include in particular the limited accessibility of the human psyche, interdisciplinary knowledge translation, and the complexity of explaining the psyche and evaluating models of it.
The initial step in the methodology is the analysis of requirements for the development of a model of the human psyche. To achieve this, SiMA uses the expertise of psychoanalysts in a casuistic approach in which the behaviour triggered by psychic processes is described narratively in the form of exemplary cases, e.g. how a simulated hungry person (an agent)

[38] Another science, which extracts falsifiable propositions from psychoanalysis and validates them, is neuropsychoanalysis (cf. Solms 2002). The methodology is different to SiMA, therefore it is not considered in this paper.
[39] In SiMA, the simulated person is referred to as an agent. This term is widely used in engineering to describe an autonomous system consisting of sensors, a decision unit and actuators.

behaves in the presence of another agent and a food source. Additional assumptions were made regarding psychic processes and other influencing factors which lead to the respective behaviour. Our experience with interdisciplinary cooperation has shown, however, that the application of such an interdisciplinary exemplary case requires structuring and concretization in order to allow concrete and deterministic forms of psychoanalytic descriptions. The approach to such a case-driven simulation consists of the steps explained in the following (see Fig. 2 and 3).

(1) *Narrative formulation of an interdisciplinary exemplary case containing theories to explain the described phenomena (e.g. the interaction behavior of two agents)*
Disciplines like medicine and law utilize typical cases from their practice to illustrate associated concepts. This vivid form of description is also used in the SiMA project to support the analysis and discussion of research questions. It also serves as an interdisciplinary platform by facilitating communication between researchers with often diverging ways of thinking and vocabulary. The use of a concrete case supports the bridging of the disciplines and improves the understanding between computer engineers and psychoanalysts. In particular, the use of concrete cases permits exemplification of our research questions regarding the development of a functional cognitive architecture with human-like capabilities.
In order to utilize exemplary cases as points of departure for the technical development of a causal model, however, several criteria must be taken into consideration. This applies first and foremost to the explication of implicit assumptions and requirements and the adherence to a consistent and deterministic form of description with a particular emphasis (e.g. decision making). Once an exemplary case has been clarified in regard to these aspects, it can be transformed into a more structured form – the simulation case.

(2) *Analysis and transformation of the* exemplary *case into a simulation case from which concrete requirements are extracted*
One focal point is the analysis of the data which determines the behavior and especially how changes to these data will presumably lead to changes in the behavior. We have found that four groups of determinants can be differentiated: experiences, personality factors (as a simplified abbreviation for memories and bodily functions), the state of the environment, and the initial internal state of the agent (drives and emotions).
The procedure of structuring and transforming the exemplary case follows a use-case-based requirement analysis as used in software engineering. Determinants represent the preconditions leading to the execution of the case; the description of the end state of the agent and the selected actions represent the postconditions. Due to the focus on allowing a deterministic description, every behavioral alternative described in the exemplary case

(Fig. 2) must be justified and derived causally via changes to the determinants. On the whole, this form of simulation case description permits the use of a deterministic and structured version of the exemplary case, a fine-grained requirement analysis, the development of a deterministic and causal functional model and the evaluation of that model.

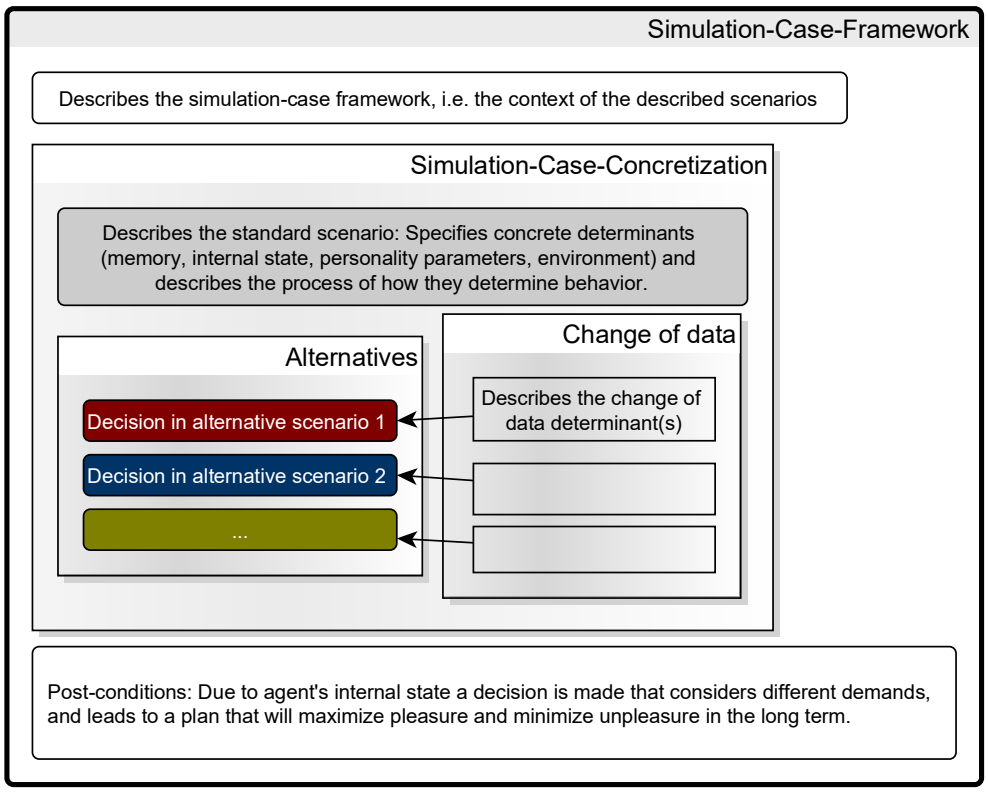

Fig. 2: Correlation between simulation case as described by the expert, the axiomatic specification of the simulation case, and its different scenarios

(3) *Development of algorithms and knowledge representations fulfilling the requirements of the simulation case*
In this step, functions creating the behavior of the case are implemented and data determining the behaviour are represented.

(4) *Evaluation of the resulting model by observing whether the parametrized simulation shows the expected functionality and behavior*

The simulation case is used as a test bed to check whether processing of the determinants described in the simulation case leads to the expected behavior and whether defined changes to the parameters result in the described changes in behavior. By following a visualization of the processing steps, it is also possible to track if the functions are working as described which helps to prevent receiving correct output despite internal errors in the system. If the simulation case does not generate the expected results, an analysis is conducted to determine which step needs to be adapted in a further iteration (see feedback cycles in Fig. 3), thereby continuing the development of the simulation model. An overview of the functionality can be found in Fig. 3.

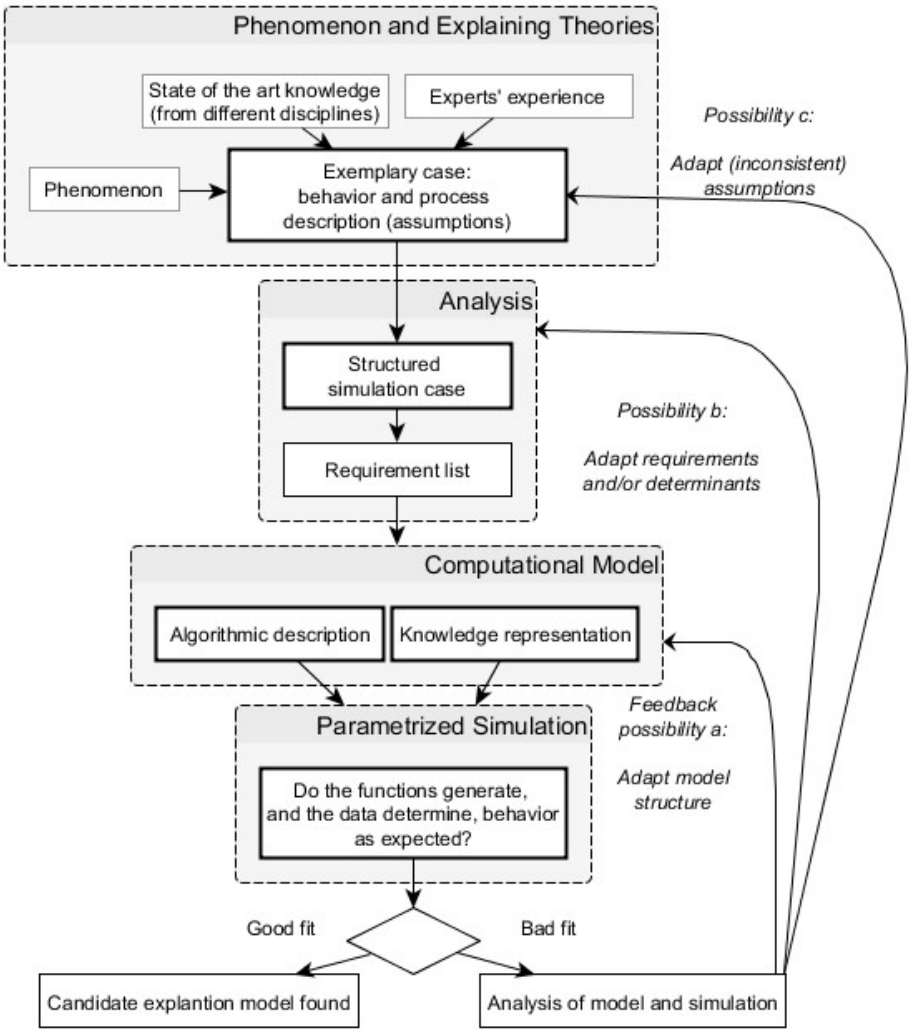

Fig. 3: Methodology of case-driven agent-based simulation (Schaat 2014a)

3. Simulation and Evaluation

The methodology and the model thus developed are evaluated using simulations parameterized in accordance with the simulation case to be examined. The simulation allows checking whether the assumptions (including the psychoanalytic assumptions) of the simulation case create the expected behavior and the integrated hypotheses can be accepted as correct. Specific assumptions (e.g. psychoanalytic concepts) as well as combinations of assumptions are tested; it must be taken into consideration that a combination of valid assumptions cannot implicitly be viewed as valid but instead constitutes a new assumption to be tested separately. A hypothesis in this sense is an arrangement of assumptions. One hypothesis is that the interaction of the developed functions results in the expected behavior. A further assumption is that the interaction of the specified determinants representing the different demands of drives, emotions, social rules, and the environment lead to the predicted behavior.

The use of this methodology does not represent a self-fulfilling prophecy; this applies to functional approaches in general since knowledge of their constituent parts does not establish the ability to predict the behavior of the overall system. The reason for this is the fact that we are dealing with complex processes which cannot be exhaustively described mathematically. One can observe, however, that as opposed to a behavioral model the behavior created with a functional model cannot be predetermined by the engineer as a matter of principle, and that it must therefore be simulated. Furthermore, the agent's behavior is determined by the interaction of a number of factors; as the complexity of the process and therefore the number of factors and the mutual interference of determinants increases, the behavior of the overall system becomes ever more difficult to comprehend. If the simulated behavior of the agent or the observation of the model sequence via visualization shows an aberration from the specified simulation case – and thereby a possible falsification of the assumptions respectively their combination – a further iteration must occur following analysis and adaptation of the respective step (cf. feedback possibilities in Fig. 3). The possibilities (a) and (b) in Fig. 3 are required if the knowledge from other disciplines than computer engineering (in particular that of psychoanalysis) has been incorrectly interpreted or translated, or if implicit requirements become apparent during the simulation (the implementation of a model implies its specification and the determination of its implications). Possibility (c) is caused by inconsistencies in the underlying psychoanalytic theory or between different theories (e.g. between psychoanalytic drive theory and Damasio's (1999) theory of emotions). Such feedback helps to concretize the psychoanalytic theories and formulate them more precisely, thus leading to further development of these theories by eliminating contradictions found in them. If this is not possible, e.g. because fundamental contradictions cannot be eliminated, then the respective theory must be assumed to be falsified. A pre-stage to this situation is

the demonstration of an implausibility of the model. This would be the case if – after several iterations of the methodology – all alternative behaviors are simulated as expected (and a stable version of the model has thus been achieved), but an unspecified change in determinants were to lead to incomprehensible behavior (it must however be taken into consideration that a certain action can be caused by different sets of determinants). This additional plausibility check occurs on the basis of the experience of psychoanalysts and (in future) via comparison with empirical data.
Using simulation within the SiMA project, it was possible to show (e.g. Schaat 2014b) that the SiMA methodology as a combination of casuistics, agent-based simulation and requirement analysis is a suitable methodology for interdisciplinary cooperation to concretize testable assumptions from psychoanalysis. In order to achieve even better evaluation, the behavior of the SiMA model needs to be tested against empirical data. However, due to limited accessibility of the study object – the psyche – this is only possible on the level of behavior. Such an evaluation would therefore only provide further evidence for the plausibility of the model. Hence the result could only be corroboration of the model's plausibility, but not the verification of the functional mechanisms and inner parameters of the human psyche. This implies that our model is a plausible representation of the functionality of the human psyche. To deduce from this plausibility of the model, however, the claim that it represents the only valid explanation of the human psyche is not possible using the means currently available to science and would constitute an unrealistic claim to absolute truth. The results are nevertheless adequate in regard to the motivation of the SiMA project and the three main areas in which the SiMA model is used, namely corroboration of psychoanalytic metapsychology, technical realization of a model of the human psyche for technical applications and as a means for predicting human behavior. It also becomes apparent that insights into the human psyche are requirements for our work on the one hand, and results of our applied methodology on the other.

Conclusion

As illustrated, Popper put the scientific basis of psychoanalysis as a whole into question – and devalued it calling it a pseudoscience – with his rationalistic criticism of one single sentence from Freud's dream interpretation. Popper obviously did not understand the context of Freud's statement and quoted him in a drastically oversimplified manner. Lastly Popper's critique ignored Freud's later improvement of his theory. Popper's critique therefore represents a scientifically untenable generalization onto all of psychoanalytic theory. This has on the one hand damaged psychoanalysis as a holistic theory relating to the human psyche, on the other hand caused the natural sciences to condemn the Freudian

models overhastily and to refuse utilizing them for their purposes. Hence Popper's judgment of psychoanalysis is not only overdrawn, it is also incorrect since it is based on a reduced understanding of its subject matter; according to Perner (1997), 224 it may also be doubted whether other natural sciences in their broadest sense would be able to fulfil Popper's criteria.

By contrast, the SiMA project intends to face the challenges and replicate psychic functionality in a computer engineering simulation. The requirements to achieve this goal are increased precision of psychoanalytic theories in an axiomatic and information-engineering sense as well as interdisciplinary cooperation with psychoanalysts familiar with psychoanalysis in theory and practice.

Besides their practical technical application in automation engineering the models developed in the SiMA project also allow a corroboration of the underlying theory in a case-driven simulation. By applying this methodology, we have already demonstrated how assumptions from psychoanalysis can be concretized and their plausibility evaluated in simulations. The results show that the hitherto examined psychoanalytic assumptions are consistent and conclusive. The plausibility of the model does not result in a claim of verification, however.

With a view to this development, even Popper's criticism of psychoanalysis can be seen in a new light. For the only true accusation levied by Popper against psychoanalysis was that it produces no testable hypotheses – and this has been refuted by SiMA.

In his postscript to The Logic of Scientific Discovery, Popper takes a slightly different stance regarding non-falsifiable theories (Popper 2001, 229f, English edition p. 199). He recognizes such theories particularly in what he calls research programs, i.e. the attempts to reduce the complexity of reality to comparatively few simple explanatory fundamental principles. He argues for taking seriously their pretension of being tentatively taken for truth so long as they can be "criticized rationally". From the appreciation he shows for Freud's psychoanalysis in other places[40], we can assume that he may have considered psychoanalysis to be such a program for the explanation of the human mind. The essential aspect of such programs, Popper states, is their "fertility", meaning their ability "to gather all true aspects of the world […] into a unifying picture which may enlighten […] and which one day may become part of a still more comprehensive picture, a better picture, truer picture" (Popper 2001, 242, English edition p. 211). Hence such pictures must also stimulate attempts to be replaced by better ones. Fertile research programs can result in concrete and eventually falsifiable theories. This is the point at which we see Freud's metapsychology today.

[40] Popper 2002, 189, English edition p. 164; Popper 2002, 199, English edition p. 172; Popper 2009, 56, English edition p. 38.

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