Simplifying and Facilitating Comprehension: The “as if” Heuristic and Its Implications for Psychological Science

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Abstract
Simplicity is a fundamental tenet of cognition intended to cope with a complex and intricate world. Based on the writings of the German philosopher Hans Vaihinger, this article introduces a wide-ranging simplification scheme denoted the “as if” heuristic. Following this heuristic, much of our productive and constructive thoughts about the world, specifically in science, are based on idealized fictitious assumptions. Although descriptions of the world as portrayed by psychological models and theories may contain fictitious elements (antithetical or at least indifferent to the search for truth), they afford a simplification tool that facilitates our comprehension of a complex and obscured world. Numerous examples from the psychological literature in which the “as if” heuristic is apparent are presented. Specifically, we analyze the implications of exploiting the heuristic for the development of psychological constructs, theory building, and the foundations of psychological measurement. While highlighting the gains acquired from the use of the “as if” heuristic, we also discuss its possible pitfalls if not properly used.

Keywords
Cognition, fictions, heuristic, models, simplification, validity

Introduction
Human behavior is multifaceted, overly rich, and excessively complex to be understood without first simplifying it. How simplification is attained, at either the perceptual or cognitive levels, is a fundamental psychological question for which there is more than one answer. A common scheme of attaining simplification is by searching for and generating patterns. People tend to perceive patterns as units or wholes allowing them to simplify perception and cognition. This tendency can be traced back to Gestalt psychology and its laws of organization (e.g., Wagemans, Elder, et al., 2012; Wagemans, Feldman, et al., 2012). Broadly, the term Gestalt means form or pattern; an elementary tenet of the Gestalt school is the search for patterns with a robust preference for the simplest ones (Garner, 1970). For instance, the “law of Prägnanz” (law of simplicity) postulates that stimuli tend to be perceived in their most simple form. Gestalt principles, such as figure–ground, closure, proximity, or continuation, all promote in one way or another simplification while maintaining internal consistency (e.g., Rock, 1975).

More recently, psychologists have dubbed the so-called “simplicity principle” (e.g., Chater & Vitányi, 2003; Feldman, 2003) following which the search for simplicity drives a wide range of cognitive processes. The pursuit for simplicity and parsimony is further promoted in philosophy, for example, in Ockham’s razor1 according to which simpler theories are preferable (supposedly, more likely to be true). Researchers employ theories, models, and metaphors that explicitly or implicitly simplify reality so as to make it amenable to empirical investigations and formulate it in a comprehensive manner, given our limited cognitive capacity.

What are possible cognitive devices that may promote simplification? One common route is the use of heuristics, the original meaning (in Greek) referring to a method of discovery. In the past few decades, heuristics have been used and defined in several (yet highly similar) ways. For instance, in the context of problem solving, it has been described as a sort of interim reasoning supposed to

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facilitate the discovery of suitable solutions (Polya, 1945). Computer scientists and researchers of artificial intelligence (AI) consider it a shortcut method for solving problems (Newell & Simon, 1972) in a quick manner which implicitly assumes an optimal trade-off between accuracy and speed (often resulting in a good enough approximation rather than perfect solution). In psychology, the term has been advanced by the research program initiated by Kahneman and Tversky (1974) who proposed that under conditions of uncertainty, people tend to employ a “limited number of simplifying heuristics rather than more formal and extensive algorithmic processing” (Gilovich et al., 2002, p. xv).

In this article, we present yet another mean of simplification denoted the “as if” heuristic. Its central tenet is that human cognition employs simplified descriptions and theories which, strictly speaking, are often fictitious (and hence false). This heuristic enables us to capture the essentials in a suitable manner, thus offering optimal means for meaningful comprehension of the world. We implicitly pretend “as if” our portrayal of the world is precise and complete; although this is fictitious, it affords a useful and better understanding of the world around us. A common representative example of the “as if” heuristic is rationalization (e.g., Cushman, 2020). Specifically, the mind attempts to rationalize or reconstruct post hoc an event or an act “as if” it was a priori part of the person’s initial goals and beliefs. As we elaborate later, the “as if” heuristic, despite being a fiction, is nevertheless useful. Indeed, regarding rationalization, Cushman notes that “this is a useful fiction: Fiction, because it imputes reason to non-rational psychological processes; Useful, because it can improve subsequent reasoning.” As another example, the description of complex mental phenomena in a personified manner (e.g., “the brain decides . . . .,” or “emotions make us act . . . .”), while false in the sense that they do not describe what is actually occurring in terms of mental processes, acting “as if” they do may convey useful information for the purpose of understanding particular behavior. In addition to enabling us to capture the world in an abridged and eloquent (coherent) way, it also serves as a tool for facilitating communication.

The heuristic is derived from the writings of the German philosopher, Hans Vaihinger, whose work was originally published in 1911 and translated into English in 1924 (The philosophy of “as if”: A System of the Theoretical, Practical and Religious Fictions of Mankind). Recent work by Appiah (2017) elaborates and expands on Vaihinger’s original work. Although our conjecture of the “as if” heuristic is firmly based on Vaihinger’s and Appiah’s work, we differ from both authors in explicitly taking a psychological science perspective.

Vaihinger’s treatise is aimed at two related goals: On one hand, it offers insight into the cognitive processes underlying people’s simplification attempts, in particular scientists, for a better comprehension of our intricate world. In that respect, the manner by which he examines the “as if” construct may be seen as a pure cognitive-psychological investigation. On the other hand, the proposed conjecture regarding researchers’ cognitive processes is used to understand the nature and development of scientific models and empirical explorations and how these are understood and interpreted. As such, it can be viewed as a methodological, cognitive tool for further development of psychological science.

The remainder of this article is constructed as follows. We briefly introduce Vaihinger’s framework and examine its key constructs of fictions and the “as if” heuristic. The implications of this framework, in particular, for psychological science research, are then discussed and analyzed. It is proposed that encapsulated in Vaihinger’s analysis is a sort of validity assessment that is essential for understanding and elucidating research in psychological science. We elaborate on several representative examples to illustrate the significance of Vaihinger’s approach. The final discussion elaborates on the overall consequences of his perspective and examines its possible role in the development and explanation of empirical results and the interpretation of theories and models.

The Essentials of Vaihinger’s “as if” Philosophy

Vaihinger’s starting point fits well with current views of perception and cognition, namely, that human comprehension of the world does not entail an exact portrayal of reality. A cognitive representation that maps one-to-one with the outside world is an impossible task given the cognitive system’s limitations. To make the world more accessible and make sense of it, the internal representation needs to be simplified. The goal of cognition or thought is “to provide us with an instrument for finding our way more easily in this world” (p. 11). Simplification, following Vaihinger, can be achieved by an implicit idealization of the world which is realized by creating fictions. Specifically, our attempts to make sense of the world as reflected in descriptions, theories, and models of it are founded on some “as if” idealization which in principle is false (i.e., fictitious) in that it does not perfectly correspond with reality. This does not mean that fictions are a necessary characteristic of all kinds of simplification. For instance, the average or mean as a descriptor of a set of observations is in some way a simplification yet it carries useful information (and in addition it can be decomposed into its parts). However, in the case of the “as if” heuristic, essential information is omitted or assumptions are included that are not known to be true. As noted by Appiah (2017), Vaihinger’s main interest and contribution lies “in the role of untruth in thinking about reality” (p. 4).
Vaihinger’s major claim is that fictitious idealization—or the “as if” heuristic as we refer to it—is a necessary tool for facilitating our comprehension of a complex and multifaceted world. To understand and portray reality in a coherent and eloquent way, we need to simplify by idealization implying some deviation from a perfectly veridical perception of the world. Such idealization carries some untruth yet, following both Vaihinger and Appiah, this falsehood is constructive and functional for apprehending the world in a meaningful way.

Although “fictions” in Vaihinger’s thought play a major role, the concept in a scientific context carries a negative connotation being an antithesis of truth. Two observations are important in this regard. First, Vaihinger did not claim, neither do we, that all simplifications entail fictions. Second, Vaihinger’s notion of fictions is not so much antithetical to truth as indifferent to it. This is because truths and fictions serve different roles in the scientific process. In Vaihinger’s framework, fictions have an explicit constructive function, namely, generating mental structures that assist in forming a meaningful world around us. Fictions are mainly evaluated according to their usefulness in achieving particular scientific goals (e.g., understanding or predicting behavior), and much less according to their truth.

The cognitive facilitation underlying the “as if” notion is reminiscent of the supposition that “other things being equal” (ceteris paribus) that is often used in theory construction and modeling. Whether this simplification is a fiction depends on what information is left out. If the information omitted (or held equal) is not essential to what is being described, then it can be seen as a justified simplification. However, if one leaves out factors that are highly relevant to the phenomena under investigation, then the model (compared with reality) contains a fiction. Assuming that all factors and circumstances remain the same except for those that are explicitly varied, and ignoring all the potential interactions between variables, is an idealization (knowing that in reality it is unlikely to be true) yet necessary for making a theory or model workable.

Following Vaihinger, “as if” simplifications should not be evaluated by the ability to produce scientific truths but rather by the usefulness of creating a workable theory or model. It is important to realize that although fictions and truth (the ultimate goal of the scientific enterprise) may seem to be incongruent, the role of the fictitious “as if” is provisional. Specifically, it can be conceived as a “mental scaffold” used for temporary support supposed to be removed by the time that final comprehension is achieved. To illustrate, the imaginary numbers (containing \(i\), the square root of \(-1\)), are not “real” in the observed, three-dimensional (3D) space, yet they are in more dimensional worlds. Notwithstanding, imaginary numbers are regularly valuable in calculations involving the 3D world. The fictitious “as if” may be apprehended as a (cognitive) bridge between comprehension of reality and reality itself (i.e., between epistemology and ontology). Not undermining the heuristic’s efficacy, people may occasionally fail to remove the scaffold at the end of the process consequently leading to unwarranted conclusions and misunderstandings as illustrated in a later section.

Vaihinger’s framework and presuppositions are highly compatible with the study of selective attention, a major role of which is to handle the “. . . complexity of the information that is presented to the senses at any one time and the consequent risk of confusion and overload” (Kahneman & Triesman, 1984, p. 29). Furthermore, as already noted, Vaihinger’s approach also shares a fundamental feature with Gestalt psychology: Both relate to tools that enable the cognitive and the perceptual systems to make sense of a too complex and intricate world. Like the “as if” device which aims at simplified structures (albeit fictitious ones), the Gestalt movement assumes that wholes (Gestalten) are the simplified primary units the cognitive system is aiming at. Underlying the Gestalt laws is an attempt to explore possible simplifications in exchange for some lost precision. For instance, following the law of closure, people tend to perceive and structure objects in their entirety (as wholes) even when some (relatively negligible) parts are missing. They often perceive an object “as if” it was a whole even when it does not strictly match with reality. Thus, a circle drawn using broken lines is perceived in the present terminology “as if” it was a complete circle.

The “as if” heuristic and the reasoning/decision-making heuristics share a common objective of facilitation by simplification. Although strongly associated with computer programs, the term heuristic has originally been dubbed by Polya (1945) as a sort of reasoning “not regarded as final and strict but as provisional and plausible only, whose purpose is to discover the solution of the present problem” (p. 115). Indeed, being provisional, a heuristic approach is often incomplete implying that it may be error prone. It is this provisional state that grants the fictitious “as if” a status of a temporary mental scaffold that eventually has to be removed to get closer to truth. The “as if” and decision-making heuristics also share the conviction regarding the efficacy of heuristics. For instance, when introducing the heuristics used by people to assess probabilities, Tversky and Kahneman (1974) claim that “people rely on a limited number of heuristic principles which reduce the complex task of assessing probabilities” and further propose that “these heuristics are quite useful” (p. 1124) although sometimes they may lead to systematic errors.

Notwithstanding their facilitating function, fictions are to some extent untrue and, as discussed later, there is a trade-off between maximizing accuracy (antonymous to fiction) and construction of an effective and useful model or theory. An important distinction for assessing this trade-off is between what Vaihinger referred to as “true” and “semi”
fictions. A true (real) fiction is one that is both false and contradictory, an example of which is the square root of a negative number. This example highlights the fact that under some circumstances, even idealizations that contain contradictions may, for some purposes, be so valuable that they may overshadow other considerations such as faultless and perfect accuracy. In contrast to true fictions, semi-fictions, although not entirely compatible with reality, are not contradictory in themselves. Semi-fictions assume the unlikely or the “close” to real; true fictions contain the impossible (in a given world). Semi-fictions are abundant in both daily life and in the scientific discourse. For instance, a general case of semi-fictions are approximations: These are frequently used when considerations of cognitive clarity and ease of comprehension overrule minor inconsequential deviations from perfect precision. Simple linear regression is a semi-fiction because almost no behavioral phenomenon is strictly linear, yet it often captures an informative trend. Finally, many psychological constructs are not well-defined whereas researchers treat them (fictitiously) as if they were well-defined. Examples can be found in classifications that group observations into provisional categories such as the Big Five classification of personality (e.g., Hurtz & Donovan, 2000), Ekman’s (1992) seven basic emotions, or Fiske’s four relational models (e.g., Fiske, 2004). These classifications may have been useful in stimulating all kinds of psychological research yet they are semi-fictions in the sense that none is perfectly mapped with reality.

An insightful example of a semi-fiction brought by Vaihinger (formally from economics but with unquestionable bearings to psychology) concerns Adam Smith’s seminal The Wealth of Nations, first published in 1776. It is one of the first treatises advocating the free market, and its most fundamental assumption is that people are selfish rational primates whose only goal is seeking to maximize their own interests. It was obvious to Vaihinger that Smith was well aware that this (“as if”) assumption is an oversimplification—as demonstrated, for instance, by Smith’s other well-known essay The Theory of Moral Sentiments, published in 1759—and hence false. Yet, he defended Smith by proposing that subsidiary causes and partially conditional factors, such as good will or habit, were knowingly ignored to achieve simplification that was necessary to obtain a comprehensible system. Smith’s assumption is thus semi-fictitious in that it is incompatible with reality but does not lead to internal contradiction.

It is more difficult to reconcile theories or models when true fictions are involved. This is a controversial and intricate issue on which scientists differ, and here we restrict the discussion to two important points. First, as Appiah correctly points out, the manner we deal with actual inconsistencies in our thought cannot be done by adopting a nonstandard logic. Rather, he suggests what he terms “functional isolation” following which “we have a large set of
fruitfully conceived as fictions, which is the basic tenet of the “as if” heuristic.

The essence of the “as if” philosophy boils down to the following: Although the essential goal of science is to unveil the ultimate truth, the world is so intricate and complex that it is next to impossible for humans to fully and absolutely achieve that goal. The “as if” approach embraces an inescapable compromise between two incompatible goals: the aim for comprehensive and complete accuracy which is unattainable, and the need for simplification that would enable a more sensible and reasonable comprehension. Unlike Vaihinger and Appiah, in this article, we employ a psychological rather than a philosophical terminology, yet in essence our analysis is compatible with their writings. Although Vaihinger’s work has recently regained some attention in the philosophy of science (cf. Suárez, 2009), few applications to psychological research have been proposed. A notable exception is the work by Smythe (2005, 2017) who argues, like we do here, that “as if” reasoning has a function in making “explanatory theories more accessible to our understanding, to elucidate the metaphorical basis of many psychological constructs” (Smythe, 2005, p. 300). In addition, relating to the work on psychological fictions by Adler, Smythe discusses the potential role of “as if” fictions in people’s narrative self-understanding. This article is devoted for scrutinizing the role of the “as if” heuristic in the broader field of (different domains in) experimental psychology.

In what follows, we explore the implications for psychology derived from the “as if” philosophy. We discuss the major question as to how far can we accept the “as if” heuristic (and the corresponding distortions implied by it) without completely falsifying our internal perception and understanding of the world. For illustration, we analyze in more detail a few key examples from the psychological literature highlighting the role of the “as if” framework. In the final discussion, we assess the pros and cons of this framework in relation to methodological and conceptual issues in psychological science.

**Implications for Psychology Entailed by the “as if” Heuristics**

We start by noticing that the notion of “as if” may be related to standard concepts of validity, in particular, ecological validity (Brewer & Crano, 2014), yet it is nevertheless fundamentally different. Specifically, ecological validity is aimed at assessing the extent to which the findings obtained from a specific setting or experiment(s) are generalizable to real-life settings. As such, the question of ecological validity examines the extent to which the correspondence (resemblance) between the (often artificial) experiment setting and the external world is justified. Does it offer a satisfactory imitation of reality and does it capture the major underlying variables of the phenomenon under investigation? In contrast, the construct of “as if” refers to the correspondence between the mind’s internal representation and the alleged reality. For instance, one may extend the notion of “as if” to the relation between a sample and the corresponding population. We often generalize from the sample to the population as if they were the same (indeed, as the sample gets larger, the “as if” notion gradually becomes less fictitious). It is of course legitimate to make inferences from sample results as long as one keeps in mind that the inference is probabilistic rather than deterministic. Researchers often ignore the probabilistic element of their results (especially at the interpretation and discussion stage) treating them “as if” they were population outcomes.

The notion of “as if” also differs from the concept of internal validity. The latter deals with precautions concerning causal inferences drawn from an experiment like ensuring the absence of confounding variables, safeguarding potential influences of external variables, and testing the extent to which alternative explanations can be ruled out. In contrast, the “as if” construct is impartial to tests regarding the internal logic of inferences; rather, it is assessed by its usefulness as a simplification tool facilitating the cognitive processes. Yet, it may carry potential threats to theory development and the interpretation of results if one fails to keep in mind the boundaries entailed by using this heuristic.

It is often claimed that cognitive heuristics are susceptible to different fallacies resulting in cognitive illusions (e.g., Pohl, 2004). Although cognitive illusions originated in perception, the term has been used as a metaphor in the context of reasoning and decision-making errors. Cognitive illusions are presumably resulting from underlying assumptions based on prior knowledge (regardless of its reliability) interacting with perceived reality. The term illusion is probably most suitable for the description of framing effects (e.g., Kahneman & Tversky, 1984) referring to different descriptions or frames of the same situation and the same object. For instance, the same ground beef can be described as 80% lean or 20% fat yet the two frames are not assimilated into the same cognitive structure. People evidently have a preference for 80% lean ground beef and even judge it to be tastier than 20% fat (Levin & Gaeth, 1988). Indeed, Kahneman and Tversky (1984) suggest that “in their stubborn appeal, framing effects resemble perceptual illusion” (p. 343). In the same vein, the “as if” heuristic can also be conceived as creating illusions (fictions) which, as with framing and other heuristics, people are not aware of.

In sum, the main process underlying idealization and the corresponding “as if” heuristic concerns the need for simplification caused mutually by the boundless world complexity on one hand, and human’s limited cognitive resources on the other hand. Notwithstanding the usefulness of the “as if” heuristics (in Vaihinger’s terminology—the usefulness of fictions or “untruth”), the question remains as to how far can
we accept this heuristic (and the corresponding distortions implied by it) without completely falsifying our internal perception and understanding of the world.

In what follows, we examine several examples from psychology aimed at demonstrating both the likely advantages of employing the heuristic as well as the potential dangers involved in overusing it. We discuss a representative sample of prevalent usages of the “as if” heuristic epitomizing a large range of domains in psychology. In particular, we examine the manner by which the “as if” construct is reflected in (a) the use of psychological concepts, (b) the employment of metaphors and development of theories and models, and (c) in research methodology, specifically in measurement and data analysis.

**The “as if” Heuristic as Reflected in Psychological Constructs**

Psychological constructs are often elusive in that they are either imprecise or not well-defined. Utility, well-being, attitudes, processing capacity, psychological distance (to mention just a few) are all complex thorny constructs that researchers pretend to comprehend “as if” they are well-defined. On second more profound thoughts, however, their exact meaning is vague which should not be surprising, given that many psychological constructs originate from folk-psychological models (Danziger, 1997). Notwithstanding the fictitious “as if” nature of many psychological constructs, employing such constructs may nevertheless be seen as useful in Vaihinger’s framework. Below, we examine some representative examples of constructs pointing out their fictitious nature and at the same time indicating the benefits obtained from their use.

**Dichotomization** is a par excellence example of using the “as if” heuristics reflecting the tendency to simplify and minimize cognitive effort. Formally, a dichotomy consists of a partition into two parts or subsets that are jointly exhaustive and mutually exclusive. In reality, however, these two requisites are rarely satisfied conjointly. Most dichotomies are fictitious (thus false) being either not jointly exhaustive and/or not mutually exclusive. In the most recurrent case, the two ends of the dichotomy are presented “as if” they are exhaustive while in fact there are other possibilities in between as for instance in far-close, expensive-cheap, or abstract-concrete. Furthermore, dichotomies are often constructed as if the two categories of the dichotomy are rigorously well-defined which is often a fiction.

Bedford (1997) demonstrated the problem describing a physician from the mid-18th century who claimed to discover the organ system that removes toxins from the blood, which he labeled the “liver.” He further claimed to discover a second organ, whichcirculates the blood, absorbs nutrients, expels waste products from the body, and attacks foreign invaders. For when the liver is removed, the body is still able to do all these things and more, until such time as the toxin buildup is fatal. (p. 231)

The physician suggested calling this second organ “not-the-liver.” Clearly, he had not discovered a second organ but has merely shown that the liver is not the only organ present in the body. The fallacy lies in the erroneous assumption “as if” what remains after damage is a coherent category. Because “not-the-attribute” may not be a unitary concept, such a practice makes the attribute under discussion vague and, as noted by Bedford, may lead to self-perpetuating false claims and misguided research. In a later paper, Bedford (2003) illustrates how the fallacy occurs in different domains of psychology (e.g., the explicit vs. implicit memory distinction) and in neuropsychological research.

The use of false dichotomies in psychology “as if” they were true is wide spread—both in methodology and data analysis as well as conceptually in theory building. Regarding the former, null hypothesis significance testing (NHST), has been practiced by many researchers (deliberately or not) “as if” NHST determines truth whenever the empirical results yield an $\alpha < .05$, otherwise it is false. NHST is clearly a fiction because $\alpha < .05$ is an arbitrary criterion (e.g., Wagenmakers, 2007). Does $p = .0499999999$ entail that the null hypothesis is false but $p = .050000001$ not? Although NHST comprises a fiction (with undeniable deficiencies), it is a simplification that under certain conditions may be considered a useful fiction. As noted by J. Cohen (1990), NHST procedures are attractive because they offer “a deterministic scheme, mechanical and objective” (p. 1309) resulting in an unequivocal yes/no decision. It is obviously beyond the scope of this article to discuss the replication problem, except for noting that when one removes the fictitious nature of hypothesis testing (i.e., eliminating the “as if” mental scaffold) then the predication of the so-called replication crisis may be questionable. As another example, simple linear regression is often used to study whether the phenomenon under discussion is linear or not (a real dichotomy). In reality, psychological phenomena are rarely perfectly linear. However, the fiction in this case is valuable because we are interested in the trend, and linearity offers a simplified (albeit false) valuable knowledge.

Fictitious dichotomies are also pervasive in theorizing and the formulation of conceptual constructs of psychological phenomena. Formulations such as global versus local perceptual primacy (e.g., Kimchi, 1992; Navon, 1977), automatic versus controlled processing (e.g., Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977), and low- versus high-level construals (e.g., Trope & Liberman, 2010) to mention just a few examples, are all fictitious dichotomies. Nevertheless, they often constitute useful simplifications that enable theory development and facilitate the construction of accessible and meaningful concepts.
Intelligence is another hallmark psychological construct that is measured by different indices mainly IQ tests. Irrespective of whether intelligence is conceived as being a single general ability or comprehended as consisting of multiple intelligences (Gardner, 1983), the concept itself is an abstract term that cannot be directly observed. Rather, it is a latent construct inferred from, for example, factor analysis of scores on many different cognitive tests. The most common interpretation of intelligence assumes that it is the cause of observed scores (i.e., a reflective model). Following this interpretation, correlations among different types of cognitive tasks emerge because of the effect of difference in intelligence implying observed differences between people in their educational attainment, job performance, or life success. Such a causal interpretation implicitly suggests that intelligence is an existent real causal factor ingrained in people beyond the realm of statistical abstraction (e.g., Borsboom, 2005).

However, besides being conceived as a general mental capability, the exact definition of intelligence remains vague and controversial. At the neurological level, many brain areas have been found to be involved during cognitive tasks and dozens to hundreds of different genetic loci have been associated with intelligence scores (Barbey et al., 2012; Savage et al., 2018). In addition, alternative models have been proposed that explain the observed correlations equally well without the need for the existence of a factor of general intelligence (Van der Maas et al., 2006, 2014). This would imply that intelligence may as well be a statistical index, emerging from the data, that has no causal function at all (i.e., a formative construct). Furthermore, intelligence, most explicitly in its popular operationalization as an intelligence quotient, is by definition an individual differences measure. It describes differences in performance (or derived capacity) between people. It has been seriously questioned whether such inter-individual constructs can be generalized to intra-individual constructs (Molenar, 2004; Molenar & Campbell, 2009). Although most researchers treat intelligence “as if” it is a well-defined individual attribute, it remains to be extremely useful for explaining differences between individuals in a wide range of settings, including recruitment, and selection. Examining the veracity of the concept by strict scientific criteria would lead to the conclusion that it is a fiction and hence all its applications could be judged to be invalid. Such a radical conclusion could be averted, however, by applying the “as if” heuristic thus conceiving intelligence as a useful fiction. Specifically, we could proceed with our research “as if” intelligence is a causal mechanism in human performance. At the same time, though, we might heed Vaihinger’s warning that any evidence congruent with a fiction should not be seen as evidence for the fiction’s truth. As such, extrapolations from findings on intelligence measures to the capacities of individuals or groups of individuals, which have stirred-up a lot of controversy (e.g., Fancher, 1985; Sternberg et al., 2005), are not warranted. Yet, studies using different models of intelligence would be warranted, even if these models might be internally contradictory (e.g., interpreting inter-individual data at an intra-individual level) or contradictory with one another (e.g., intelligence as a real cause or as a constructed statistical index).

As a final example, we examine the concept of randomness. Whether randomness is inherent in nature (e.g., the moment at which a radioactive element decays; genetics in modern biology) or whether it indicates the limits of our knowledge remains an open question. Regardless of the answer, the construct remains intricate and elusive (Ayton et al., 1989; Lopes, 1982; Nickerson, 2002) for two main reasons. First, it lacks a rigorous precise definition: It can be defined either in terms of the process underlying randomness or in terms of the characteristics of the outcome of the process. Second, and related, there are no unqualified tests to determine its existence (e.g., Bar-Hillel & Wagenaar, 1991; Falk & Konold, 1997).

Despite its indefinable nature, randomness plays a pervasive role in psychological research in two different domains: in the perception of randomness and in research methodology in which it is constructed as part of the investigation process (e.g., random selection of subjects, random choice of stimuli, or random order of presentation). In both domains, although researchers pretend “as if” they command randomness, the concept remains to be elusive. Adopting strict criteria, the concept is a fiction because it can never be rigorously verified, yet as noted by Nickerson (2002), “the usefulness of the concept, despite its shaky conceptual foundations, is remarkable” (p. 335). This usefulness stems from two sources: First, there are several main characteristics that delineate the meaning of the concept such as complete unpredictability (Neuringer, 1986) or the lack of a pattern or a principle of organization. Although these criteria cannot replace a rigorous definition, they nevertheless provide a good approximation. Second, there are evidently several qualified tests (e.g., Chaitin, 1975; Strube, 1983) that supposedly assess randomness, albeit probabilistically.

Not undermining its usefulness, the fictitious nature of randomness should not be overlooked. For instance, several studies investigated people’s biases to perceive randomness by testing whether they are able to distinguish between sequences produced by random or by non-random processes (for a review, see Bar-Hillel & Wagenaar, 1991). Nickerson (2002) correctly noted that in studies on the perception of randomness, researchers do not provide their subjects with sufficient information and do not specify underlying assumptions (in the present terminology, “as if” subjects possess all the necessary information and are familiar with the underlying assumptions). He therefore stated “that conclusion drawn from performance data
regarding the ability of people to produce or perceive random sequences must be considered tenuous” (p. 351). Given the sizable number of studies pertaining to people's deceptive and biased perception of randomness, researchers are reminded that studies employing concepts which Vaihinger referred to as fictitious, may be useful but should be interpreted with care.

The “as if” Heuristic as Reflected in Metaphors and Theoretical Models

A common simplifying strategy in behavioral sciences is adopting a particular setting or a specific metaphor serving as a model for a much broader class of human situations. For instance, the image of a hungry rat learning to negotiate a maze served for many years as the prime model of how people adopt to their circumstances.

Metaphors are pervasive in both daily life as well as in scientific discourse, specifically psychology (Hoffman et al., 1990). Metaphors in psychological research are abundant—the mind as the software of the brain, memory store, and memory scan; attention as a spotlight, a resource, and processing capacity; emotions as energy, defense mechanisms, calibration of probabilities, and open-minded thinking—all comprise only a small sample of metaphors used in the psychological terminology. Metaphors are not just a characteristic of language but supposedly reflect a feature of our thought process (Lakoff & Johnson, 1980). Whereas Lakoff and Johnson (1980) claim that metaphors may constrain our thinking (of the object or phenomenon under hand), Hoffman et al. (1990) convincingly demonstrate the usefulness of metaphors in the scientific inquiry. For the present context, metaphors and models are treated in the same section. The simplification and facilitation obtained through the use of metaphors and models is encapsulated in the fact that they supposedly highlight the more important characteristic of the phenomenon under investigation.

Metaphors like models attempt to portray or simulate reality while, by definition, not being identical with it and hence can be considered as another class of instances of the “as if” heuristic. The main difference is that for metaphor users, it is clear that the simplification of reality is false; the usefulness of acting “as if” is explained by the potential production of new insights. This is less clear in the case of models because models that leave out irrelevant information may constitute a justified simplification and thus not necessarily count as a fiction. Put differently, metaphors refer to concepts people already possess such as “love is like a flower” in which the fictitious nature is self-evident. Models are more abstract schemes, construed for identifying the core variables of a phenomenon leaving minor factors aside and demonstrating a particular mechanism or relation between constructs. The potential fictitious facet of a model is not contained in the disregarded variables; rather it is the likelihood that by the end of the model construction process, researchers will draw unwarranted conclusions under the fictitious assumption that the model is complete, overlooking the neglected variables that are not included. Below, we examine a few examples that highlight the potential pros and cons embedded in the “as if” heuristic underlying models and metaphors.

One of the more frequently discussed metaphors in psychological science concerns the depiction of the mind “as if” it is a computer. Accordingly, the cognitive system has been (since the cognitive revolution of the 20th century) commonly referred to as an information processing system leading to the claim that neural computations can explain cognition (Piccinini & Bahar, 2013). Refraining from a detailed presentation of the controversial mind–computer issues (see Gigerenzer & Goldstein, 1996, for a review of the mind–computer metaphor), it may nevertheless be important in the present context to mention Searle’s (1980) widely cited paper titled “Minds, Brains and Programs.” In this paper, he distinguishes between what he referred to as “weak” and “strong” AI. Following the weak version, the computer is a powerful tool in assisting the study of the mind, yet it nevertheless contains the “as if” characteristics and resembles the mind only on some but not all dimensions. For instance, a computer or a computer program does not possess intentionality. In contrast, following strong AI, the computer is not just a research tool but “rather, the appropriately programmed computer really is a mind in the sense that computers given the right programs can be literally said to understand and have other cognitive states” (p. 418). Following strong AI, the computer program is not an “as if” fictitious mind. Rather, “programs are not mere tools that enable us to test psychological explanations; rather, the programs are themselves the explanations” (p. 418).

The controversy whether AI should be classified as weak or strong initiated a long and intense debate (e.g., Harnad, 1989). We only note that although computers did not yet exist at Vaihinger’s time, his approach should most probably be classified under the weak AI approach. In Vaihinger’s framework, the computer may be a useful fiction in studying the cognitive system (or the mind as he would refer to it) but it remains a fiction. Hence it should only be used provisionally as a mental scaffold and be removed at a later stage. In contrast, strong AI supporters assume that the computer and the mind are identical. Hence, following the strong version, AI should not be considered as a temporary cognitive stage but rather the end goal itself.

Another prevalent metaphor that witnessed an upsurge during the past decades suggests that the mind consists of two (supposedly) entirely different “systems” that govern reasoning (e.g., Evans & Stanovich, 2013; Kahneman, 2011; Sloman, 1996). One system is presumably fast and intuitive usually referred to as System 1, the other slow and deliberative referred to as System 2. Despite their
popularity, there have been growing criticisms on different aspects of two-system frameworks (e.g., Keren, 2013; Newstead, 2000). One major problem is that two-system researchers pretend “as if” a mental system is a well-defined construct which is highly questionable. Moreover, it should be noticed that two-system theories often confuse between system and process which they use interchangeably. The two concepts constitute different units of analysis (e.g., Keren & Schul, 2009; Schacter & Tulving, 1994). To use the computer analogy discussed above (even we use this “as if” fictional metaphor, but are careful to use it in a constructive way only for the purpose of elucidation), processes are comparable with software whereas systems might be seen as the computer involving both software and hardware. A recent paper by Melnikoff and Bargh (2018) offers an extensive examination of the different criticisms and concludes that cognitive science would do better without the dual system typology.

The point to be emphasized here is that readers often fail to notice the “as if” nature of two-system frameworks interpreting the two systems as if they were real two separate computer programs, or worse, as two different homunculi. Among the few who explicitly caution readers are Kahneman and Frederick (2002) who note that they use the term systems as a label for two (supposedly) distinguished sets of processes, and Kahneman (2011, pp. 28–29) who explicitly notes that the two systems are actually fictions (albeit useful ones that simplify the story, making it more comprehensible). Yet, even with these cautious remarks, the term system is so widely spread (in an era where almost all technologies are associated in one way or the other with systems) that it is difficult to accept that it is necessary to confuse between system and process which they use interchangeably. Even in such straightforward cases, one has to take care that the similarity is not taken beyond justifiable limits.

A final illustration is taken from the field of judgment and decision making. It adopted as an analogy for a decision maker the metaphor of a bounded (Simon, 1982, 1991) rational gambler (i.e., who employs limited reasoning) engaged in selecting the most advantageous bet from a small currently available set. For instance, initial empirical attempts to measure utility (e.g., Coombs & Komorita, 1958; Mosteller & Nogee, 1951) used choice between monetary gambles as their main empirical tool. Eventually, choice between gambles was firmly established as the paradigmatic riddle of decision making. Pretending “as if” gambling offers an adequate analogy for decisions in general, certainly a highly questionable assumption, contains two essential virtues: First, it captures two of the main variables underlying the large majority of decisions, namely, the consequences reflected in worth or utility (leaving the assumption aside as if it is measurable) and uncertainty. Second, it lends itself easily to modeling in theories such as utility or prospect theory (Kahneman & Tversky, 1979).

One of the merits of Vahinger’s “as if” framework is an attempt to bolster the essential role of theory and model building in the process of the scientific inquiry. This is convincingly illustrated in the development of game theory by von Neumann and Morgenstern (1953), one of the most fruitful theories in the social sciences. These authors were aware of the conceptual and practical difficulties associated with utility which is a necessary construct in the development of their theory. Yet, for the purpose of their theory, they take what they call an opportunistic stand and use monetary terms (which can exactly be measured) “as if” they were utilities. Being aware of the fictitious assumptions they made, they added that “this preliminary stage is necessarily heuristic [italics in original], i.e. the phase of transition from unmathematical plausibility considerations to the formal procedure of mathematics” (p. 7).

The gambling paradigm and the metaphor of the decision maker as a gambler offer a useful simplification that facilitates modeling and the testing of hypotheses. However, the decision maker as a gambler remains a fiction. In particular, the gambling model neglects and suppresses some
essential features of the decision process like internal conflicts and their associated emotions, and it remains silent with regard to intangible outcomes. Except perhaps for gamblers in a casino, most daily decisions, important as less important ones, are essentially different except for the uncertainty underlying almost any decision. To illustrate, a patient who has to decide whether to undertake an operation does not resemble in any way a gambler and even her probability assessments are supposedly guided and (occasionally) biased by different considerations. The message to be taken from Vaihinger is not that the gambling paradigm is fundamentally invalid—it may still provide a useful benchmark for assessing the quality of decision making. Rather, it is to remind researchers that by the end of the day, the gambler’s metaphor is fictitious and thus one should be cautious in the interpretation of empirical results.

Quantitative Measurement and Analysis of Subjective Experiences

Another case where the “as if” heuristic is evident concerns the quantitative measurement of subjective experiences. Scales that require participants to indicate their experiences (e.g., feelings, emotions, attitudes, sensations, evaluations) on a number of verbal or numeric categories are commonplace in psychological inquiry. Subsequent analysis of the obtained data is performed by means of parametric analyses (e.g., t tests, ANOVA) which assume measurement at an interval or a ratio scale. However, the assumption that subjective ratings of this kind actually produce quantitative data is contentious and is usually not supported by tests. Put differently, the data are treated “as if” measured on an interval or ratio scale which is simply a fiction. In developing the law of comparative judgment, Thurstone (1994) acknowledged that it was unclear whether the psychological continuum that is supposed to underlie the modeled judgments actually existed, which in the present terminology boils down to a fiction. Specifically, he noted that “the psychological scale is at best an artificial construct. If it has any physical reality we certainly have not the remotest idea what it may be like” (p. 266).

The issue of how, if at all, can mental phenomena be quantified and measured has long been debated, yet the outcomes of these debates have gone largely unnoticed in the psychological literature (Cliff, 1992). Several approaches have been proposed to tackle the issue, the most important being additive conjoint measurement (Kranz et al., 1971) and related approaches (e.g., Rasch, 1960). Irrespective of the extent to which these approaches can be considered successful, they are rarely used in contemporary studies. The quantitative measurement by such scales appears to be simply assumed without much further reflection or evidence that this assumption is warranted (Tafreshi et al., 2016). In other words, researchers act as if their scales measure subjective experiences at interval or ratio level.

The way researchers use quantification of experiences is compatible with Vaihinger’s proposal of how true fictions are used in the process of research yet are themselves omitted from the final result. Likewise, quantification is used in the process of coding and analyzing scale responses but is often omitted in the stage of interpretation. Most psychological studies do not use precise quantified hypotheses; mostly they are phrased in a directional or ordinal way (e.g., x will be higher in group A than in group B; y has an effect on z, even after controlling for q). Furthermore, the majority does not contain quantified conclusions of the data; they are also commonly phrased in nominal or ordinal fashion. For example, results are interpreted as significant or not. Effect sizes, which are quantitative, are also often interpreted at the last stage in J. Cohen’s (1988) categorical terms of “small,” “medium,” and “large.

In sum, although quantitative measurement of subjective experiences, especially by scales, may be seen as a fiction, it may nevertheless be useful in that results obtained with such measures may enhance theory building and in a practical sense improve predictions. Notwithstanding, it should be noted that creating results that are theoretically or practically useful does not constitute any proof for their measures truly being quantitative. As such, researchers should be cautious in the quantitative analysis and interpretation of their data or, ideally, provide evidence that quantification is warranted and not a fiction at all in their data.

Summary and Conclusion

A central feature encapsulated in the cognitive system is the search for simplicity, which can be attained by different means. A common simplification strategy is the use of a heuristic which serves as an aid for learning, discovery, and comprehension. This article introduced an overarching heuristic of cognition labeled “as if,” pertaining to the tendency to portray the world in a simplified idealized manner. While often fictitious, it assists in enhancing comprehension and making sense of the world around us. In addition, and closely related, a prominent aspect of the usefulness of the “as if” heuristic is the facilitation it offers in terms of communication.

Like other types of simplification, it involves the omission of some information to reduce reality’s complexity. Yet, unlike regular simplifications, in which omitting information that is not essential to the phenomenon can be acceptable, “as if” simplifications may involve fictions known to be false and hence cannot be justified from a rigorous perspective of a truthful representation of reality.

Fictions may be of two sorts: first, the omission of information known to be relevant to our understanding of reality (Vaihinger’s “semi-fictions”), as is the case with Adam Smith’s economic model on which we elaborated earlier. Kahneman (2003) explained that such assumptions, while
questionable, are made because they serve the purpose of allowing economists to analyze and predict economic behavior. Thus, “whether or not psychologists find them odd and overly simple, the standard assumptions about the economic agent are in economic theory for a reason: they allow for tractable analysis” (p. 166). Indeed, as we noted, Smith’s book The Theory of Moral Sentiments suggests that he was probably aware of the fictitious assumption he made when developing his economic model and made this assumption deliberately to be able to develop an amenable model.

The second sort concerns fictions known to be false or at least can currently not be justified to be true (Vaihinger’s “true fictions”). For instance, Friedman’s (1953) economic agent model employs a metaphor of an excellent billiard player whose shots can be perfectly predicted if one assumes that the player made his shots “as if” he perfectly knew the complicated mathematical formulas that determine the ball’s trajectory. Following Friedman, the confidence in such an assumption is not based on our beliefs about the billiard player’s abilities (and correspondingly, the economic agent whose capacities are assumed to be selfish, rational, with unchanging preferences). Rather, following Friedman, neither the billiard player nor the economic agent would have been capable to reach the outcomes unless they possessed the assumed capabilities. Besides being a logically circular argument, it is important to note that Friedman’s sole interest is in building a theory that would be capable of making the best predictions. Friedman’s use of the “as if” heuristic and correspondingly employing “true fictions,” is primarily justified for improving predictions. In contrast, Vaihinger’s “as if” methodology is aimed at explaining and understanding the world around us thus creating cumulative knowledge.

As noted earlier, psychological concepts are frequently vague and poorly defined. Danziger (1997) provides a compelling analysis of constructs such as cognition, emotions, attitudes, intelligence, and so forth doubting their universal validity and claiming that “psychological theory operates on the basis of some pre-understanding of that which it is a theory of” (p. 6). In the present terminology, Danziger asserts that psychologists use the “as if” heuristic without actually acknowledging it. Given the fuzziness of psychological constructs and the ensuing need for defining them, one may adopt one of two potential approaches, a pragmatic and an ontological one. Specifically, the “as if” heuristic can be seen as a bridge between more pragmatic views of psychological science (i.e., finding out what works) and more ontological ones (i.e., attempting to capture reality and finding out the true nature of psychological constructs and processes). This bridge is in particular important in the field of psychology, which in its relatively short but productive history has seen several shifts in the way that mental processes have been conceived and studied (e.g., introspection, behaviorism, cognitivism, psychoanalysis).

The difference between the pragmatic and ontological perspective can be illustrated by analyzing the intelligence construct. Following a pragmatic, operationalist approach, intelligence is conceived and measured in terms of IQ tests. Indeed, such an approach—posing “as if” we know what intelligence is—may yield useful and practical knowledge for predicting performance on different cognitive tasks. Alternatively, one may prefer a more ontological approach aiming for a better understanding of the construct of intelligence by developing alternative models of what intelligence consists of and how it operates (e.g., a latent model, a network model). Under such an approach, hypotheses can be derived and tested by an “if-then” method, namely, if the hypothesis is correct then we should expect a certain pattern of results.

Note that the pragmatic approach directly relates to the “as if” heuristic—its test is not in terms of truth but rather in terms of usefulness. The ontological approach is more geared toward an if-then test which is assessed by tests of truth. The heuristic’s efficacy is also apparent in the process of evaluating a model and the assessment of its value. A model is an abstraction of the world, a process which requires some loss of details and hence never strictly captures reality perfectly. However, models serve as assertions of a working hypothesis (Hogarth, 1986), and useful models should supposedly encapsulate the main variables that affect the phenomena. Yet, even successful models (in terms of their efficacy of predictions) account only for a relatively small part of the variance. They remain in some respect incomplete to the extent that researchers draw broad conclusions while overlooking the size of the unexplained component.

The idea that fictions may be useful in the process of scientific inquiry may sound as anomalous. How could the explicit embrace of untruths lead to finding out truths? One has to keep in mind that the fictional stage is supposed to fulfill a temporary aid and is not the final goal. In other words, the fiction is assumed to disappear as scientific inquiry may sound as anomalous. How could the explicit embrace of untruths lead to finding out truths? One has to keep in mind that the fictional stage is supposed to fulfill a temporary aid and is not the final goal. In other words, the fiction is assumed to disappear as scientific understanding progresses. Three potential pitfalls underlie the use of the “as if” heuristic. First is ignorance or disregard for the fictitious nature of the “as if” heuristic. A main purpose of this article is to remind researchers to keep the heuristic’s use in mind. Second, the usefulness of fictions should not be taken as a proof for their veracity (it works, therefore it is true). Third, the temporary advantage of fictions should not be neglected by failing to remove them (whenever possible) by the end of the process.

The implicit assumption of the heuristic namely that our research is based on provisional assumptions is concomitant with three options: First, in the case of Vaihinger’s true fictions, it may turn out that the assumptions can be omitted from future theorizing without loss of accuracy. For instance, the construct of ether in physics was assumed for a long time to be the medium for the propagation of light.
As insight in electromagnetism advanced, the concept was simply dropped. Similarly, psychologists may conclude in the future that the “two system” notion is superfluous for understanding cognition and reasoning processes. Second, concerning Vaihinger’s semi-fictions, existing assumptions may in the future be replaced by more accurate and proper assumptions. Finally, our understanding may reach a point at which specific assumptions may be converted into precise and testable hypotheses. For example, advanced tools for the measurement of feelings may enable data gathering that surpasses the axiomatic tests of quantification laid out by additive conjoint measurement allowing for enhanced quantification of feelings.

It was proposed that the “as if” construct may be conceived as resembling the notion of ecological validity. A major difference between the two concepts is that while ecological validity evaluates the correspondence between a simulated experiment and the real world, the construct of “as if” refers to the correspondence between the mind’s internal representation and reality. The notion of ecological validity can also be conceived as yet another demonstration of the “as if” heuristic. Specifically, researchers are inclined to interpret the results of artificially designed experiments as if they genuinely and indisputably represent the real world, consequently abolishing any considerations of ecological validity.

One central question is whether the “as if” heuristic operates deliberately or mainly as an automatic process. The answer to this question depends on the perspective one takes. As illustrated throughout this article, several researchers deliberately used a fiction in the development of their model or theory because they found it useful for furthering our understanding of human behavior. However, under many other circumstances, the usage of the “as if” heuristic is likely to be an unconscious process. In that respect, it resembles the heuristics that have been prevalent in both the psychology of reasoning (Evans, 2006; Newell & Simon, 1972) and the psychology of decision making (e.g., Fredrick, 2002; Gigerenzer et al., 1999; Kahneman et al., 1982; Keren & Teigen, 2004). These heuristics concern mental shortcuts based on simple and efficient algorithms or rules that frequently work well yet can also lead to systematic deviations (biases), and are presumably employed automatically.

The importance of acknowledging the “as if” heuristic is to remind researchers of the boundaries that the heuristic’s use imposes, and accordingly be cautious in their inferences and conclusions. For instance, we noted that sometimes the “as if” facet is masked as in the “two system” theoretical framework where it is essential that the researcher should explicitly state the use of the heuristic to avoid misinterpretation and miscommunication. In other circumstances, such as comparing self-control operations with that of a muscle (Muraven & Baumeister, 2000), the employment of the “as if” heuristic is self-evident.

Another illustration in which the heuristic is overlooked is associated with the seminal work of Kahneman and Tversky on heuristics and biases. While their work was original and offered insights into the cognitive pitfalls of reasoning under uncertainty, it has often been interpreted as if it demonstrated failures of rationality. Such an elucidation is problematic because it is conceived “as if” the construct of rationality has only one interpretation and that it is presumably well-defined. It is beyond the scope of this article to analyze the rationality debate except of noting that almost all researchers who contribute to this debate ignored the “as if” characteristic underlying the rationality construct. L. J. Cohen (1981) correctly claimed that “the actual interpretation of experimental data is bound to be affected by the resolution of certain fundamental issues about the normative criteria for rationality” (p. 361).

The use of heuristics, “as if” not excluded, has its pros and cons. Newell and Simon (1972), who pioneered the use of heuristics for problem solving, proposed that complex problems are solved by the use of heuristics that are fairly efficient. Yet they explicitly note that the use of such heuristic does not guarantee perfect solutions. The originators of the heuristics research program in reasoning and decision making (e.g., Kahneman & Tversky, 1974) have accentuated the undesirable consequences of heuristics, in particular, the biases and potential errors associated with their use. Others (e.g., Gigerenzer, 2008; Gigerenzer et al., 1999) have noted the constructive and adaptive facets resulting from the use of heuristics. Simplification, given human limited processing capacity and restricted memory, is often a compelling necessity. The use of heuristics is an efficient way of achieving simplification yet it carries a price. The purpose of this article was not just to introduce the “as if” heuristic, but mainly to make researchers aware of its use being attentive to both its benefits as well as its potential pitfalls.

The “as if” heuristic is indeed a broad concept encompassing simplifications of different kinds. One may wonder whether such a construct is needed for examining such a wide-ranging set of phenomena. We propose that the “as if” construct serves as a unifying function to remind researchers to explicitly state their assumptions and boundary conditions. Overlooking the “as if” heuristic may lead researchers to unwarranted conclusions that go beyond the real given evidence. The usefulness of the heuristic lies in affording a lucid and an eloquent comprehension of the world that can be easily articulated in communication with others.

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Notes
1. Note that while the law of Prägnanz is descriptive in nature, Okham’s principle is basically normative.
2. In Vaihinger’s framework, their logical (mathematical) consistency and their fit with all instances of empirical observation.
3. As in geometrical systems where axioms (like the “as if” construct) are not subject to tests of truth—Only the conjectures or hypotheses that are based on these axioms require a proof.

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