

1 Promises and Pitfalls of Theory

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Abstract

We present an overview of the role, benefits, and drawbacks of theory in scientific research, particularly in the social and behavioral sciences. We discuss what theory is and what it is not. We also focus on some key elements of theory, such as its ability to explain phenomena at multiple parallel levels of analysis. Evolutionary theory is offered as an example that illustrates the importance of conceptual integration across different disciplines. We further describe the key characteristics of good theories, such as parsimony, depth, breadth, and coherence (both internal and external), and we encourage the use of “coherence stress-tests” to help refine theory. We then discuss 4 advantages and 10 disadvantages of using theory in social and behavioral science research. Finally, we suggest conceptual tools and provide a list of recommendations for theory-driven research. We hope this chapter will help in the complex pursuit of improving research practices in the social and behavioral sciences.

Keywords: Top-down Approach, Theory Building, Conceptual Integration, Levels of Analysis, Parsimony, Interdisciplinarity, Evolutionary Theory

One of the strengths of scientific inquiry is that it can progress with any mixture of empiricism, intuition, and formal theory that suits the convenience of the investigator. Many sciences develop for a time as exercises in description and empirical generalization. Only later do they acquire reasoned connections within themselves and with other branches of knowledge.

(Williams, 1966, p. 20)

Introduction

The goal of science is to understand the world. This is much easier to do when we develop and rely on good theories (Goetz & Shackelford, 2006). Strong theoretical foundations help a researcher make predictions, ask the right questions, and interpret data in a meaningful way. Research lacking theory is, in a sense, exploratory, meaning that it is consigned to trial and error – an inefficient way of accumulating knowledge. Some scholars in the social and behavioral sciences have even contended that empirical findings generated atheoretically are less convincing and thus less likely to be used in practical applications (e.g., Burns, 2011). However, as we discuss later in the chapter, there are also ways in which theory can lead us astray.

To oversimplify, a scientific theory is a set of ideas that has the power to explain and predict real phenomena, albeit never fully or perfectly. For social and behavioral scientists, a strong grounding in theory is our best hope for understanding human cognition and behavior. In science, theory is generated, developed, amended, and replaced on evidentiary grounds. But how do we generate, develop, and amend theories? And how do we know which theories are fruitful and which may be leading us astray?

Many scholars have lamented the overuse, underuse, and misuse of theory in the social sciences (Borsboom et al., 2020; Fried, 2020; Gigerenzer, 2009, 2010; Meehl, 1978; Muthukrishna & Henrich, 2019; Symons, 1992; Tooby & Cosmides, 2015). This chapter describes some of the benefits and dangers of theorizing in the social sciences and offers recommendations for developing and evaluating theory. Theory can inspire and guide research, but what counts as theory, and what does not?

What Theory Is and What It Is Not

Much empirical research focuses not on *explaining* phenomena (making causal claims about how a phenomenon came to be), but simply on *describing* phenomena. For the purposes of this chapter, theory can be distinguished from descriptive research in that theory does not only describe facts, but theory also makes causal and explanatory claims about the world. By contrast, examples of descriptive research may include generalizations, regularities, typologies, and taxonomies. Such empirical research offers descriptions of the world, but does not offer causal explanations (indeed, empirical generalizations often *require* explanations). However, empirical generalizations that offer no explanations have sometimes been erroneously labeled “theory,” probably because they offer some predictive utility. Nettle (2021) illustrates this loose usage of the term “theory” with reference to “social identity theory.” However, social identity theory does not make causal claims; it only describes and predicts humans’ interest in their social identities. Theories should go beyond describing and predicting and afford a path to understanding. Empirical generalizations tell us about phenomena in the world, including their antecedents and consequents, but only theory can *explain* these effects, accounting for why they are the way they are or why we do not see different phenomena instead.

A common description of theory is a nomological network, namely, a representation of relationships between well-defined constructs (Cronbach & Meehl, 1955). Due to this definition, questions of theory underlie questions about validity because these also involve mapping the relationships between constructs. Causal links between constructs that describe real-world phenomena are key to questions about various forms of evidence for validity, including content and response processes (e.g., does our measure accurately capture all the aspects of a phenomenon?). To assess if a measure is accurate in detecting a phenomenon, we attempt to determine the measure’s criterion validity. To do so, we need to have a well-specified theory about when, why, how, and in what contexts the phenomenon in question will affect and be affected by other phenomena (Borsboom et al., 2004). A robust theoretical grounding, then, is key to validity (Gray, 2017).

Some scholars have likened constructing a theory to erecting a building using uneven bricks, whereby each brick is a study or a fact. Gray (2017) uses another metaphor for theory to remind us that it is not enough to focus on research methods alone: “The quest for reliable research methods – for making good bricks – is certainly noble, but the mere collection of reliable studies does not make for good science. We must remember that we scientists are not only brickmakers but also architects; we need to turn our attention back to building – to theory” (p. 732). The key point is that it is much easier to assemble a collection of uneven bricks into a robust and useful building when a good blueprint is available (Poincaré, 1905). Theories are like blueprints that help us understand how the empirical generalizations we discover fit with each other like pieces in a puzzle. Descriptions of some key concepts in theoretical and descriptive research can be found in Table 1.1. These concepts do not always have clear boundaries. For example, at what point does a theory become a paradigm? Nor do concepts have universally agreed definitions and usages. For example, “principle” is sometimes used to describe both theoretical tenets and empirical regularities. As a result, this table should be considered a rough

Table 1.1 *Definitions and descriptions of common theoretical and descriptive entities used in research*

Theoretical terms	Definitions and descriptions
Paradigm	A cumulative integrative theoretical framework. A collection of general ways of viewing the world, typically comprised of interwoven theoretical claims and necessary auxiliary assumptions. A theory that is broad enough to guide an entire field of study is often referred to as a paradigm.
Theory	A set of ideas for explaining and predicting phenomena in the world. A proposition about the suspected relationship between variables. It is broader than a hypothesis and may be used to generate specific hypotheses. This typically explains a broad range of phenomena.
Causal hypothesis	A proposed explanatory link between two constructs. It is more specific than a theory and broader than a prediction.
Prediction	A testable proposition that is derived from, or generated on the basis of, a causal hypothesis. Hypotheses are tested via the specific predictions they yield.
Descriptive terms	Definitions and descriptions
Law, rule, or principle	Empirical generalizations that successfully describe an observed regularity. They are not explanations but are expected to be <i>explainable</i> (i.e., we can hope to use theory to explain why these generalizations hold). Note that depending on one’s philosophy of science, some fundamental laws of the universe may ultimately not be explainable.
Descriptive hypothesis	A proposed empirical generalization that describes (without explaining) a phenomenon or class of phenomena. If supported by evidence, then it may become a principle or rule or law. Although descriptive hypotheses can have predictive power insofar as their claims about <i>regularities</i> are well supported (and thus can be used to generate predictions), they are not predictions themselves.

guide rather than a presentation of universally agreed definitions. Still, scholars often find these concepts and distinctions useful for their heuristic and organizational value in discussions of theory (e.g., Gopnik & Wellman, 1994).

Key Elements of Theory

How Is Theory Linked to Reality?

Scientists and philosophers of science have grappled for decades with how theory and observations are linked (Godfrey Smith, 2003). All theories and hypotheses are necessarily linked to observations of the world, but there is disagreement about how theories relate to reality. There is also no formal theory specifying how theories ought to be evaluated or how theories can be securely arrived at from data.

Although operational definitions of concepts like *explanation* and *causation* that are at the heart of theory can be difficult to pin down, most scholars agree that theory comprises a key component of the scientific process, and it allows us to interpret, explain, and predict empirical phenomena. Furthermore, even though there is debate, there are some generally agreed principles for how to test and evaluate theories.

Some scientists and philosophers of science contend that Bayesian thinking may provide researchers with a formal theory of confirmation and evidence (see Earman, 1992 and Chapter 23 of this volume). In Bayesian thinking, two key ideas inform us of the probability that a hypothesis is true (Godfrey Smith, 2003). First, evidence (e) supports a hypothesis (h) only if e increases the probability of h . Second, probabilities are *updated* in accordance with Bayes's theorem – $P(h|e) = P(e|h)P(h)/[P(e|h)P(h) + P(e|\text{not-}h)P(\text{not-}h)]$. To illustrate, imagine you are unsure whether reading this chapter will help you to become a better researcher. The hypothesis that the chapter will be helpful is h . Now imagine that you discover evidence e that informs you that the chapter is highly cited. Suppose now that before learning about the number of times the chapter has been cited, you estimated that the probability that this chapter would help you is 0.50. In other words, your initial estimate of the probability that this chapter would be helpful was 50%. Suppose that the probability of it being highly cited *given* that it is indeed helpful is 0.70 (in other words, imagine that 0.7 is the probability of finding e if h is true). Suppose also that the probability of the chapter being heavily cited if it is *not* helpful is only 0.20. Assuming that these prior probabilities are true, we can calculate the probability that the chapter will be helpful (i.e., the probability of h) given evidence that it is heavily cited. Using Bayes's theorem, we get $P(h|e) = (0.70)(0.50)/[(0.70)(0.50) + (0.20)(0.50)] = 0.77$. In other words, if we come across evidence that the chapter is highly cited, the probability of h goes up from 0.50 (our initial estimate) to 0.77. That is, Bayesian techniques can help us more accurately estimate the probability that a hypothesis is true as new evidence becomes available. Of course, this assumes we can accurately estimate the requisite prior probabilities for Bayes's theorem. That will sometimes be difficult, especially in the complex world of the social and behavioral sciences.

In null-hypothesis significance testing, we are always testing $P(e/h)$ (technically, the probability of obtaining the *evidence* given *not-h* – the *null* hypothesis). This is in a sense backwards since what we *really* want to know is $P(h/e)$. What we really want to know is: given the evidence we have obtained, what is the probability that our hypothesis is true? Bayes's theorem enables us to flip the question so that we are asking the question that we actually want answered. Although there is no universally accepted method for building theory, Bayes's theorem can render theories more tethered to reality by steering us towards the right questions and allowing us to more directly assess the probability that our hypotheses are correct.

How and When Should We Test Theory?

Most theoretically guided research in the social and behavioral sciences involves four steps: (a) generating causal hypotheses, (b) deriving predictions from those hypotheses, (c) empirically testing those predictions, and (d) interpreting the study results (Lewis et al., 2017). One way of conceptualizing this process is provided by Popper's (1959) hypothetico-deductive model. This consists of proposing a causal hypothesis and then testing predictions derived from the hypothesis with the goal of falsifying incorrect hypotheses (Popper, 1959). This "negative" rather than "positive" way of arriving at knowledge is considered a useful model for science, although some disagree about its utility and how accurately it describes the research activities of scientists (Borsboom et al., 2020; Godfrey Smith, 2003; Ketelaar & Ellis, 2000).

Many scholars have urged researchers not to feel pressured to generate and test causal hypotheses before they are ready (Barrett, 2020; Meehl, 1978; Rozin, 2001; Scheel et al., 2020). Some scientists caution us to first focus on (a) (re)conceptualizing the phenomena that we are interested in, (b) validating the constructs used to measure these phenomena, and (c) observing, cataloguing, and describing these phenomena before theorizing about them. In evolutionary biology, for example, decades of empirical research in taxonomy took place before formal phylogenetic theories were introduced (Nettle, 2021). Focusing on first improving measurements and amassing descriptions of phenomena and empirical generalities can lay the foundation for better theory and ensure we are not devising theories to explain inaccurate observations.

Theories Provide Explanations

One of the central roles of theory is to provide explanations. There is no universally agreed theory about the elements of a good explanation (Godfrey Smith, 2003). Explanations can be expected to take many forms because there is no single way to gauge explanatory goodness that works equally well in all scientific disciplines. Furthermore, a single phenomenon can often be explained in a number of different ways. Theory, however, can help us turn the sea of possible explanations into a smaller pool of more plausible ones. In addition to relevant information (i.e., signal), data contain information that is irrelevant to the phenomena of interest (i.e., noise). Theory helps us differentiate noise from signal and explain the phenomena of interest.

As the complexity of the phenomena we seek to explain increases, the pool of theories that can coherently explain the phenomena becomes progressively smaller (Dawkins, 1986). A complex phenomenon is one that involves many variables and causal connections, and it may require theory that is commensurately complex. The more causal propositions a theory posits and the more breadth we attempt to cover with our theory, the more we can explain (and the more that might go wrong). As the number of propositions increases, fewer other propositions can be added while maintaining internal coherence. As the theory's breadth increases, so do the possible ways in which evidence can counter the theory. Furthermore, as the complexity of the phenomena under study increases, so does the risk of overfitting (i.e., interpreting irrelevant noise as relevant signals and falling into the trap of "explaining" noise; see Gigerenzer, 2020). That is one reason why it is important to ensure that our theories can predict new findings (i.e., afford foresight) and not just explain data in hindsight.

Theories Incorporate Parallel Explanations and Multiple Levels of Analysis

Complex phenomena can often be explained or analyzed at multiple levels of analysis (Mayr, 1961; Tinbergen, 1963). For example, in the domain of biology and behavior, all phenomena can be analyzed and explained at four levels – also known as Tinbergen's four questions. They are: (1) survival value (i.e., adaptive function – how the trait contributes to survival and reproduction), (2) mechanism (i.e., causation – how a trait works mechanistically, including what triggers and regulates it), (3) development (i.e., ontogeny – how a trait develops over the lifespan), and (4) evolution (i.e., phylogeny – the evolutionary processes that gave rise to a trait).

The answers to Tinbergen's four questions offer four non-competing explanations of a trait, two of which are proximate and two of which are ultimate (see Nesse, 2013, p. 681, for a table that further organizes Tinbergen's four questions). From a theoretical perspective, this is important. First, recognizing that there are four *parallel* answers can correct misconceptions about competition between these different kinds of explanations. Second, recognizing complementary levels of analysis not only protects the researcher from contrived conflict, it can reveal gaps in theory (e.g., unexplored levels of analysis) and can lead to more complete explanations (Al-Shawaf, 2020). Third, the four questions are interrelated in ways that are useful and revealing when evaluating or proposing hypotheses or theories. For example, functional hypotheses yield specific predictions about proximate and mechanistic phenomena. An understanding of the latter can rule out certain functional hypotheses and point researchers toward others (Lewis et al., 2017).

The key point is that complex phenomena are often explicable at multiple levels of analysis. For a complete explanation of a mental phenomenon, we must address all four of Tinbergen's questions: how it evolved, why it evolved, how it works mechanistically, and how it developed across the organism's lifespan. These levels are typically non-competing. In other words, they are mutually compatible. When we ignore some levels, we fail to provide a comprehensive explanation of the phenomenon in question.

Characteristics of Good Theories

What makes a good theory? Theories vary on a number of characteristics, including simplicity, depth, breadth, and coherence. The best theories are often high in all four characteristics.

Simplicity or Parsimony

The principle of parsimony states that a theory should only posit entities that are *necessary* to do the explanatory work. One rule of thumb for building theories is to keep them as simple as possible. This does not mean that simple theories are more likely to be true than complex theories. A more complex theory is preferable to a simpler one if the simpler one is unable to explain the phenomena at hand; simplicity is most useful as a tiebreaker between theories that have the same explanatory and predictive power (Coelho et al., 2019). Simple theories are sometimes described as “elegant” and are said to benefit from “explanatory economy” (Tooby & Cosmides, 2015, p. 37).

Breadth

All else equal, a theory that can explain many different phenomena is preferable to a theory that can explain fewer phenomena. For example, a theory that can explain diverse behaviors across 1,000 species is more powerful than a theory that can do so across only 10 species. The more ground a theory covers, the greater the breadth of the theory.

A distinct kind of breadth involves the diversity of the *kinds* of evidence that support the theory (e.g., behavioral evidence, physiological evidence, cross-cultural evidence, evidence from other species, etc.; Schmitt & Pilcher, 2004). For example, mating-related theories in humans were originally inspired by evidence from other species (Trivers, 1972). Subsequently, they were supported by evidence from humans across various cultures using psychological, physiological, and behavioral data (e.g., Buss, 1989). Convergent evidence from multiple sources enhances the likelihood that the theory is correct and raises our confidence in the veracity of the theory.

Depth

Depth here refers to explanatory depth. A theory is deeper if it provides *chains* of explanations rather than just a single explanation. Consider the following example: Why are men, on average, more violent than women? The answer is partly that, ancestrally, there was greater reproductive variance among men relative to women. In other words, men were more likely to be shut out of reproduction completely than women (a lower floor for reproductive success) but are also more capable of having a large number of offspring (a higher ceiling). As a consequence of this greater variance in reproductive success, aggression yielded greater reproductive payoffs for men than women. But why was there greater reproductive variance among men than among women in the first place? This is because of sex differences in the minimum

parental investment in offspring. But why were there sex differences in the minimum parental investment in our species? This is partly due to sex differences in assurance of genetic parentage (maternity certainty and paternity uncertainty; Trivers, 1972). The point is that in this explanatory chain, we did not have to stop after explaining the initial phenomenon of interest; we were able to go deeper and *explain the explanation*. Explanatory depth can be increased by identifying the proximate causes of our initial phenomena of interest as well as the causes of those causes.

Coherence

People have used the term “coherence” to describe two characteristics of theory: (a) internal logical consistency and (b) accuracy – the latter of which refers to “coherence” with the external world. Empirical generalizations cannot be judged on internal coherence because they simply describe facts about the world. Theory, on the other hand, is evaluated on its internal coherence because it contains multiple propositions used to *explain* facts, and these propositions must be internally consistent. Internal coherence is thus achieved when an analysis demonstrates that the assumptions, propositions, and conclusions of a theory are logically consistent with one another. External coherence is achieved when an analysis demonstrates that the theory is consistent with other known principles or facts that are closely related to the theory in question. For example, the “crime and punishment model” (a theory positing that punishing crime is important for deterring crime; Becker, 1968) may be *internally* coherent, but it is not high in *external* coherence because it appears to be incompatible with the empirical findings criminologists have documented (De Courson & Nettle, 2021).

Coherence Stress-Tests

To increase the coherence of a theory that deals with complex phenomena, researchers can design “coherence stress-tests” to deliberately identify logical inconsistencies or incompatibilities within the theory, or between the theory and data. This can be done in a number of ways, including attempts to disconfirm the theory and attempts to confirm, or be maximally charitable to, rival theories. This is an arduous process that some scholars find psychologically aversive because the process may involve a loss of prestige, among other costs, if one’s theories are disproven. Our human tendency to be more skeptical of viewpoints that contradict our beliefs can hinder the scientific enterprise (Greenwald et al., 1986). We need to counteract these tendencies by seeking and bolstering arguments that constructively criticize a theory, especially if it is one that we believe is true. It also helps to acknowledge facts that are apparently inconsistent with a favored theory. A perceived inconsistency between theory and data may sometimes lead us to abandon the theory, or it may propel us to find ways to reconcile the two in a manner that improves or expands the theory. Darwin famously did this when he realized that his theory of natural selection could not explain the peacock’s lavish tail. Instead, it was his theory of sexual selection that eventually offered the explanation (Darwin, 1871).

Example of a Good Theory

The breadth, depth, and coherence of Darwin's theory of selection (natural and sexual), combined with the many sources of empirical evidence supporting it, make it the guiding paradigm of the life sciences. This theory explains known findings, predicts new ones, and integrates findings from a large variety of scientific fields (Al-Shawaf et al., 2018). The theory is also elegant and simple, as its main claim about evolution follows as a necessary conclusion given only three premises (genetic variation, inheritance, and differential reproduction). This is the closest thing that the social and behavioral sciences have to a universal scientific *law* (i.e., a regularity in nature that is universal; Dawkins, 1983).

Advantages of Theories

Good theories offer researchers several advantages. The more a theory exhibits the advantages discussed here, the more confidence we can have in its accuracy.

1. Explaining Findings That Are Otherwise Puzzling

One benefit of a good theory is that it can explain otherwise puzzling findings (Al-Shawaf, 2021). Atheoretical empirical work can *describe* puzzling phenomena but typically leaves these unexplained. To *explain* phenomena, especially in a psychologically satisfying way, we need theory (Gopnik & Wellman, 1994; Tooby & Cosmides, 1992). Good theories explain a phenomenon thoroughly, often across multiple levels of analysis.

2. Bridging Different Disciplines

Consilience, also known as conceptual or vertical integration, is the idea that findings across disciplines must not clash with one another. A consilient theory is consistent with the findings and theories of other disciplines. Contrary to what some believe, consilience does not entail reductionism. For example, the theory of natural selection is not reducible to theories in chemistry, and good theories in chemistry are not reducible to theories in physics, but they are all compatible with one another. Similarly, the social and behavioral sciences should be mutually compatible as well as compatible with the natural sciences and other disciplines related to the social sciences, including genetics, animal behavior, behavioral ecology, anthropology, and cognitive science (Tooby & Cosmides, 1992, 2015). This does not necessarily mean sociology is reducible to chemistry, but it does mean that the various sciences must not propose principles, hypotheses, and theories that *violate* those that are strongly supported in the other sciences.

The social and behavioral sciences often focus their studies on humans. Because humans are also biological creatures, the social and behavioral sciences can be

thought of as nested within the larger umbrella of biology and the life sciences. As a result, we can borrow from successful biological theories such as the modern evolutionary synthesis – a paradigm that has proven extremely fruitful for the life sciences (Williams, 1966). As the geneticist Dobzhansky (1964, p. 449) famously remarked: “Nothing in biology makes sense except in the light of evolution”. Although it may sound surprising to some social and behavioral scientists, proposing theories of human behavior or psychology that are incompatible with evolutionary biology is akin to proposing a chemical reaction that contradicts the laws of physics. Accordingly, social and behavioral scientists who want to ensure consilience and avoid obvious errors should make an effort not to run afoul of the principles and theories of evolutionary biology (Tooby & Cosmides, 1992, 2015).

Unfortunately, theoretical work in the social and behavioral sciences is often underdeveloped and may lack the breadth required to do the work of bridging different disciplines. Anthropologist Pascal Boyer once commented that “[t]he study of human behavior is encumbered by the ghosts of dead theories and paradigms” (Boyer, 2018, p. 28). These dead theories and paradigms do not have to encumber us, however, as they can narrow the search space by helping us rule out theories that failed to be supported by evidence or that failed to be consistent with established knowledge in other disciplines. The search for consilience is helpful in a similar way – it can narrow the search space by ruling out possibilities that are implausible given other disciplines’ established findings and theories.

The social and behavioral sciences are replete with theories that have not been checked for compatibility with other areas within and beyond these fields, although there have been attempts to integrate related paradigms and theories (e.g., evolutionary and health psychology; Tybur et al., 2012). For example, researchers often limit themselves to the theories and empirical generalizations accepted in their specific departments, conferences, and journals (Gigerenzer, 2010). It is as if there were 10 separate investigations about one murder, but each investigative team was unconcerned with the hypotheses and findings of the other teams’ investigations. If only they could consult each other and consolidate their theoretical analyses and findings, they would be more likely to uncover the answer. Fields that deal with a broad range of phenomena (i.e., human nature and culture) and are founded on theories and findings spanning several disciplines (e.g., cognitive science, anthropology, evolutionary biology, psychology) exhibit greater consilience compared to fields that deal with a narrower range of phenomena or that engage with fewer theories from different disciplines. A shift toward greater interdisciplinarity can thus motivate the development of more accurate theory that explains a broader range of phenomena.

3. Predicting New Findings

Good theories lead to hypotheses that can make new predictions and lead us to new discoveries (Lewis et al., 2017; Muthukrishna & Henrich, 2019). In some cases, empirical generalizations can also help to accurately predict phenomena, and it is sometimes possible to use statistical relationships to predict phenomena without having a theory to explain them. Still, prediction is enhanced by good theory, and

predicting findings in advance is a key means of assessing a theory's utility. Often, good theories and hypotheses will lead to predictions both related to what we expect to see in a given context or experiment as well as what we expect *not* to see. Finally, only theory (and not merely descriptive research) holds the promise of predicting new *kinds* of phenomena, as discussed next.

4. Pointing to Fruitful Questions

Good theory offers heuristic value – it can guide us in new and fruitful directions by hinting at the existence of previously unconsidered phenomena, even before looking at the data (Barrett, 2020; van Rooij & Baggio, 2021). It can also suggest new questions that we had not previously thought to ask. This advantage of theory – heuristic value – is not just about proposing a priori predictions. Instead, it is about asking new kinds of questions and starting new research areas that may have otherwise remained unexplored.

Ten Ways Theory Can Lead Us Astray

There is no question that the social and behavioral sciences should be grounded in good theory. However, it is also possible for theory to lead researchers astray, and we need to be aware of these pitfalls. In addition to the dangers posed by theory, we must also take our cognitive biases into account.

1. Seeking to Confirm Theory

Many psychological features of humans – such as confirmation bias or myside bias – hinder our search for truth and can affect how we conduct science. We selectively seek, remember, and attend to evidence that supports our beliefs (Lilienfeld, 2010; Loehle, 1987). We erroneously avoid theories that may contradict our ideological worldviews (e.g., von Hippel & Buss, 2017). We sometimes amend theory after the fact so that unexpected findings or counter-evidence can fall within its explanatory purview. Without knowing it, we may choose to observe or pay more attention to phenomena that confirm our hypothesis even when such findings are not especially helpful in testing our hypothesis (see, for example, the Wason selection task; Cosmides, 1989). Findings that are in line with predictions derived from our hypotheses support our hypotheses only *tentatively*. As a result, we need to be mindful of our tendency to seek confirmation of our hypothesis as well as our tendency to interpret data in ways that fit with our prior beliefs. The coherence stress-tests mentioned above can help to combat these tendencies.

2. Theory Influences How We Interpret Data

A theory's ability to guide us in interpreting data is one of the features that make theory useful. But if a theory is wrong, it can thwart our understanding of the data.

Because we may be motivated to interpret data in ways that confirm our theory, the risk of misinterpreting data may be considered a manifestation of the problem of seeking to confirm theory, discussed above. Even descriptive findings, similar to empirical generalities, are subject to our confirmation bias–infused interpretations. However, having a specific theory in mind before one begins increases this risk. As fictional detective Sherlock Holmes put it, “[i]t is a capital mistake to theorize before you have all the evidence. It biases the judgment” (Doyle, 1887/1995, p. 23).

3. Theory Influences How We Measure and What We Observe

When theory influences how we make observations, or what we choose to observe, these observations are said to be theory-laden. This means that our findings may be biased by our previously held theoretical beliefs or folk intuitions (Lilienfeld, 2010). Whenever feasible, it is important to be transparent about how theory may have influenced our measures, constructs, and interpretations of our findings, although this may sometimes be unconscious (Barrett, 2020). Theory can also influence observation in the sense that our theories tell us where to look and what is worth observing in the first place (e.g., Barrett, 2020). To the extent that we are burdened with an invalid theory, we may be wasting time by observing or measuring the wrong things.

4. Poorly Defined Theoretical Constructs

It is necessary to define our theoretical concepts with as much precision as possible (Gerring, 1999). What are the necessary and sufficient attributes of the phenomena under study, if any? How differentiated are the constructs that capture these attributes from similar concepts? For example, theories that claim to differentiate grit from conscientiousness may need to be revised given meta-analytic evidence that these two concepts are highly interrelated (Credé et al., 2017). If the concepts and variables included in our theoretical work are not well specified or operationally defined, we will be unable to gauge whether our measures are behaving as expected. The concept “social group,” for instance, is ubiquitous and yet difficult to operationalize (Pietraszewski, 2021). This is problematic because it can give us more leeway when interpreting findings and may leave us more vulnerable to the problem of accommodating unanticipated findings in our theory.

5. Theorizing Too Soon

Are we proposing causal hypotheses and theories too soon? Journals that encourage theory are no doubt useful for the social and behavioral sciences. At the same time, the review process for some journals in these fields may be pushing us to theorize too soon (and possibly unduly criticize manuscripts that do not offer much in the way of theory; Biswas-Diener & Kashdan, 2021). It may be helpful to keep in mind the risk that our eagerness to theorize about

phenomena sometimes exceeds our ability to realistically do so in a rigorous way (Barrett, 2020).

In some cases, we may be theorizing too early in the sense that we are attempting to explain phenomena that are not yet properly described. In such situations, accurate descriptive empirical work can be a crucial foundation before theoretical explanations are attempted (Barrett, 2020; Rozin, 2001; van Rooij & Baggio, 2021). We note that there are many books, articles, and courses that teach us how to conduct empirical research in the social and behavioral sciences, but the same is much less true for theoretical research and theory construction (Gray, 2017; despite some exceptions, Fried, 2020). A useful exception is Borsboom et al.'s (2020) course about building theory with practical suggestions for developing an interdisciplinary understanding of the phenomena of interest.

6. Theorizing Too Late

Hypothesizing after the results are known (HARKing) is the process of revising a hypothesis after we have looked at the data so that the hypothesis can better account for the data – especially data that do not fit well with the original hypothesis (Kerr, 1998). To be charitable, HARKing may be an indication of non-fraudulent scenarios, including: (1) the unpredicted findings *could* have been predicted via the original hypothesis but the researcher simply forgot to derive the prediction that would have forecasted the unanticipated data, or (2) the hypothesis really does need to be amended to incorporate the unanticipated findings because these could be explained by an amended causal hypothesis (but this must be done transparently). However, HARKing can also be an indication that (3) our hypothesis can too easily accommodate all kinds of data because it is underspecified or unfalsifiable or (4) we are engaging in the epistemologically and ethically suspect behavior of pretending we predicted something in advance when we did not. In the social and behavioral sciences, theories are often formulated in such an unspecified and loose way that it is nearly impossible for any finding to disconfirm them (Meehl, 1978). Unspecified theories are more amenable to HARKing-type revisions that sometimes take the form of positing the existence of moderator variables that would make the hypothesis more compatible with the data.

7. Not Even Theory

One way to avoid being led astray by theory is to learn about the common but loose surrogates that masquerade as theory in the social and behavioral sciences. As discussed by Gigerenzer in his short essay on the subject, these surrogates include labels (e.g., “cultural”, “learned”, “evolved”), false dichotomies (e.g., learned versus evolved), and underdeveloped theoretical concepts and connections (Gigerenzer, 2009). A complement to HARKing is CITEing (calling it theory for effect), which is when we call something a theory even though we are referring to empirical generalities (Nettle, 2021). It is often better to delay or avoid proposing a theory than it is to propose one that is vague and underspecified. For instance, a theory needs to specify

the domains to which it applies, as well as those to which it does not (Gigerenzer, 2020).

8. Vagueness, Imprecision, and the Utility of Formal Mathematical Models

“Formalized” theory is a theory that is quantified and uses mathematics to increase precision (Guest & Martin, 2021). Mathematical models have some advantages over verbal models: (1) they are often explicit about the assumptions that they make, (2) they are precise about the constructs that they use, and (3) they may make it easier to derive predictions from the hypothesis (Guest & Martin, 2021; Smaldino, 2020). As a result, theories that are formalized with mathematical models are sometimes more transparent about the assumptions and relationships included in the model.

There are many benefits to becoming familiar with mathematical models. Putting on a “modeler’s hat” can improve our ability to think clearly (Tiokhin, 2021). Epstein (2008) lists numerous reasons to build mathematical models, including developing causal explanations, suggesting analogies, demonstrating trade-offs, and revealing the apparently simple to be complex (and vice versa). In the absence of mathematical modeling, using verbal qualifiers (i.e., phrases expressing the degree of confidence one has in an assumption or verbally delineating the boundary conditions of the phenomenon) can also serve to promote better theory specification and transparency.

9. Theory Can Send Us Down the Wrong Paths and Waste Our Time

Our eagerness to theorize, combined with the way theories guide our thinking, may lead us to ask the wrong questions and waste time pursuing unfruitful research. This problem is exacerbated when we are overly confident in our theory. In some situations, a bottom-up, observation-driven approach may be preferable to a top-down approach in which an invalid theory dictates where we should look and which research questions we should ask. Additionally, the hypothetico-deductive model’s popularity may lead us to focus too much on (dis)confirming causal hypotheses at the expense of other key components of the scientific process that often need to precede or complement the testing of causal hypotheses (Borsboom et al., 2020). As discussed earlier, amassing descriptions of phenomena and identifying empirical generalities can be a useful starting point and stepping stone for theoretical work.

10. Missing Out on Phenomena

Top-down research begins with theory, whereas bottom-up research begins with observation. A top-down account of a phenomenon has the strength of generating a priori predictions. The bottom-up approach can sometimes be prone to post hoc explanations if not executed properly. Still, bottom-up approaches are an important source of knowledge about the world, and the risk of post hoc explanation can be avoided if we derive (and test) new predictions from the hypothesis we just put forth to explain our bottom-up observations (Al-Shawaf, 2020; Al-Shawaf et al, 2018). Briefly put, the risks

of bottom-up research can be mitigated, and theory-driven top-down research has its costs, too. That is, if our research is derived top-down from theory, and our theory doesn't point toward a particular phenomenon, we may miss certain phenomena.

Ways to Develop Theory

Integrating What We Already Know

Integrating Theoretical and Empirical Work

Connecting theories is one way to increase our ability to explain otherwise puzzling findings. A theory integration program can take the form of two simple steps that build on each other (Gigerenzer, 2017). The first step involves the integration of empirical findings that are each explained by their own theories. The second step involves the integration of these otherwise disconnected theories. Gigerenzer (2008) has suggested that integration can take the form of collating two existing theories, and he cites as an example the productive merger between the ACT-R cognitive architecture program and the Adaptive Toolbox program – a merger that led to a counterintuitive “less-is-more” discovery that simpler heuristics can yield better results than more computationally intensive procedures (Schooler & Hertwig, 2005).

Integrating Theory with Methodology

Integrating theory with the methods that we use can help us to develop and improve theory. Reliable methods and good theories are synergistic in the sense that (1) theories can suggest new methods, and (2) new methods allow access to previously unreachable findings that can inspire new theories or refine existing ones (Gray, 2017). Reliable methods and rigorous theory can inspire improvements to one another.

Thinking About Psychology and Behavior Across Three Computational Stages

To illustrate top-down theorizing (i.e., generating a priori causal hypotheses), consider evolutionary psychology, which draws from both evolutionary theory and the computational sciences (Tooby & Cosmides, 2015). For example, one can approach psychology and behavior with a three-step model borrowed from the cognitive sciences. These three steps are the “inputs” stage, the “processes” stage, and the “outputs” stage. The “inputs” stage is when we specify the stimuli that a psychological mechanism is predicted to be sensitive to (i.e., the inputs that the mental mechanism is expected to process). In this first step, it is also useful to specify the inputs that the trait is predicted *not* to be sensitive to (i.e., the inputs predicted to be irrelevant; see Lewis et al., 2017 for a discussion of such “negative” predictions). The “processes” stage involves identifying the algorithms and decision rules by which the psychological mechanism

processes the relevant inputs. The “outputs” stage – the stage perhaps most familiar to social and behavioral scientists – involves specifying the behavioral, cognitive, and physiological characteristics that the mental trait produces as outcomes. This last stage can be thought of as the outcome of the first two stages.

This model can help us to avoid gaps in our understanding of psychological and behavioral phenomena. These gaps often reside in the “processes” stage that was often ignored by the behaviorists (Norris & Cutler, 2021), who focused solely on the stimulus stage (roughly, the inputs) and the response stage (roughly, the outputs). In sum, this model can be a useful reminder not to elide processing stage between inputs and outputs.

Other Conceptual Tools

There are other conceptual tools for theory building at our disposal. A tool called “condition seeking” describes the act of identifying the necessary and sufficient conditions of a phenomenon. It involves asking questions such as “is the phenomenon domain-general or domain-specific?” and “have we exhausted the conditions under which this phenomenon emerges?” (Greenwald et al., 1986). Another tool at our disposal involves “reverse-engineering”, which is useful for generating hypotheses about why certain psychological capacities exist or why they work the way that they do (Tooby & Cosmides, 1992). Consider, for example, friendship jealousy. A third key conceptual tool is called “evolutionary task analysis,” which (a) begins with an “adaptive problem” humans have recurrently faced during their evolution, (b) asks what kind of psychological mechanism could possibly solve such a problem, and then (c) posits hypotheses about how this psychological mechanism might work (e.g., see Al-Shawaf et al., 2016; Lewis et al., 2017). For a longer discussion of useful conceptual tools, see Kenrick’s (2020) table listing six heuristics for generating hypotheses along with examples and applications for each heuristic.

One Last Red Flag: Too Much Explaining and Too Little Predicting

Lakatos (1976) argued that a research area can be said to be progressing when its theoretical growth *anticipates* its empirical growth. That is, as long as it demonstrates predictive power by helping us to generate novel empirical findings. By contrast, it is “degenerative” or stagnant if its theoretical growth lags behind its empirical growth. As a result, too much explaining and too little predicting is the kind of lag that scientists may regard as a red flag. To check the discrepancy between a theory’s explanatory and predictive power, we need to first examine a research field with an eye to the number of novel findings predicted by the theory. To do this properly, we may need to control for factors such as the number of researchers who use the theory, the resources they have at their disposal, and how long the theory or research field has been active (Miller, 2000). The key point is that we need to be aware of how much post hoc explaining is occurring relative to a priori theorizing.

At present, theories in the social and behavioral sciences often do too much explaining and too little predicting (Yarkoni & Westfall, 2017). Theory is often

amended to explain findings and empirical generalities that were not predicted a priori. Finding counter-evidence to a theory sometimes leads researchers to (a) reinterpret the counter-evidence as consistent with the theory (also referred to as conceptual stretching; Scheel et al., 2020), or (b) treat the counter-evidence as irrelevant noise (Lakatos, 1976). Such a posteriori revising of theory to accommodate findings risks making our theories less coherent. Furthermore, a theory that can explain everything may not be explaining anything. As a result, post hoc explanations must be regarded with caution (Ellis & Ketelaar, 2000), and new predictions must be derived (and then tested) from the recently posited post hoc explanations as a key “check” or safeguard (Al-Shawaf et al., 2018).

Despite these dangers, a posteriori revising can sometime be important in building good theories. As discussed earlier, it is sometimes better to revise a theory after finding counter-evidence rather than getting rid of the theory altogether – the latter may be going too far (see the subsection above on coherence). This is one of the central tensions of science – it is important to revise one’s theory in accordance with counter-evidence, but it is also important not to have a theory that is infinitely malleable and stretchy, capable of accommodating anything (and therefore explaining nothing). These tensions and balances are often a key part of science.

Conclusions and Summary of Theory-Related Recommendations

To conclude, good theory helps generate hypotheses as well as narrow them down, and it has great utility in helping us more efficiently interpret, explain, and predict phenomena in the world (Muthukrishna & Henrich, 2019). Theory is thus extremely useful and can spark progress in the currently disunited and often atheoretical social and behavioral sciences. At the same time, theorizing contains risks because theory can bias what we see, where we choose to look, and how we interpret our results. Of course, if our theory is reliably explanatory and predictive, then this effect will be positive – it will help us to *more correctly* interpret what we see, suggest useful new directions for research, and lead to plausible new predictions. Seen in this way, using theory is a high-risk, high-reward game for scientists who are trying to improve their empirical research and their understanding of the world.

To improve research in the complex realm of the social and behavioral sciences, it may be useful for us to remember the following theory-related recommendations:

- Delay theoretical work until we have better concepts, methods, and empirical descriptions (see “How and When Should We Test Theory?”).
- Ensure that our theories predict new findings, not just explain known ones (see “Predicting New Findings and Pointing to Fruitful Questions”).
- Specify what our theory predicts will (and will *not*) occur and consider computational three-stage models of psychology and behavior for more complete theories

(see “Thinking About Psychology and Behavior Across Three Computational Stages”).

- Consider complementary levels of analysis for more complete theories (see “Theories Incorporate Parallel Explanations and Multiple Levels of Analysis”).
- Remember that parsimony and simplicity are important, but more complex theories may be needed if simpler theories are unable to explain the phenomena of interest (see “Simplicity or Parsimony”).
- Strive to improve theories’ breadth, depth, and coherence (see “Breadth,” “Depth,” and “Coherence”).
- Diversify sources of evidence (see “Breadth”).
- Integrate theoretical work across disciplines to ensure consilience (see “Bridging Different Disciplines”).
- Formalize theoretical structures with mathematical modeling or verbal qualifiers for more precision and transparency (see “Vagueness, Imprecision, and the Utility of Formal Mathematical Models”).

Engaging with predictively and explanatorily powerful theories will put the social and behavioral sciences on firmer footing, but it is not a magic bullet. Consider the possibility of needing to scrutinize two detectives’ stories to determine whose “theory” should be prioritized in a murder investigation on a tight budget. It may not be enough to only scrutinize the detectives’ methods and tools. Scrutinizing the plausibility of their theories or hypotheses on the basis of the criteria discussed in this chapter may also be helpful, though perhaps not enough. We may additionally need to consider a number of miscellaneous factors such as the detectives’ (a) confidence levels in their claims, (b) personality traits that lead them to be overconfident or underconfident in their judgments, (c) past efficiency in solving similar problems, (d) intellectual honesty, and (e) degree of rigor, clarity, and nuance when making claims. These kinds of factors are studied by philosophers of science and sociologists of science to better understand how our procedures, psychologies, incentive structures, and values may be helping or hindering the scientific enterprise (e.g., Merton, 1973).

Science is one of humankind’s most powerful inventions (Borsboom et al., 2020), and theory is a key part of science. Theory can not only drive empirical work, but it also has the unique ability to help researchers interpret and explain phenomena, predict the existence of novel phenomena, and link bodies of knowledge. Theory offers heuristic value. It can steer us in directions that we otherwise would not have traveled. However, theory can also steer us away from the truth, given its ability to affect how we measure and what we observe, bias our interpretations, and cause us to waste time and resources by leading us down incorrect paths. Additional dangers stem from “surrogate theories,” seeking to confirm theory, and theories that are so loosely specified that they can accommodate unanticipated findings. Despite these potential pitfalls, strong theories hold immense promise for the social and behavioral sciences. To build and assemble robust theories and bodies of knowledge in the social and behavioral sciences, cross-pollination of different theoretical and empirical research programs is key. This kind of scientific progress holds great potential

for achieving two grand goals: increasing our understanding of the world and reducing the suffering of humans and other sentient beings (Kenrick, 2020; Gainsburg et al., 2021).

Acknowledgments

We thank the editors for inviting us to write this chapter on theory and for their constructive comments on an earlier version of this chapter.

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