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Theory Evaluation

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Few aphorisms have been repeated more often by social psychologists than Kurt Lewin's (1951) claim that there is nothing as practical as a good theory. Social psychologists strive to explain and predict social behavior not only to expand our understanding of human nature but also to identify leverage points for effective interventions that can remediate pressing social problems. As Lewin argued, the key to these endeavors is the formulation of good theories—but what constitutes a good theory? Psychological theories aim at identifying general principles that can be used to better understand why people behave the way they do (*explanation*) and to forecast how people will behave in particular situations (*prediction*). Hence, good theories should be consistent with empirical observations in that they can make sense of past observations of behavior and correctly predict future observations. These empirical criteria for deciding whether or not a particular idea constitutes a "good theory" seem intuitively straightforward, and social psychologists have been prolific in formulating an abundance of theories that are consistent with the empirical findings generated in a wide range of areas (Van Lange, Kruglanski, & Higgins, 2012).

To document the goodness of their theories, researchers typically seek to obtain confirmatory evidence in that they present evidence that is consistent with their preferred theoretical account. This confirmatory approach to theory evaluation has well-understood limitations (Greenwald, Pratkanis, Leippe, & Baumgardner, 1986), including the failure to consider potentially superior rival theoretical accounts for the same phenomenon. Consistency with empirical findings is a necessary but not a sufficient condition for establishing the goodness of a theory. Thus, a central question is how researchers can evaluate social-psychological theories over and above their mere consistency with empirical observations. Philosophers of science have identified several criteria that are suitable for the evaluation of scientific theories. The main goal of the current chapter is to review these criteria and to discuss their relevance for theorizing in social psychology.

Induction, Deduction, and the Logic of Falsification

The question of theory evaluation played an important role in historical debates on how to distinguish between scientific and nonscientific statements. In the philosophy of science, this question is known as the *demarcation problem* (Popper, 1934). Resonating with the philosophical notion of positivism, a common answer to this question is that scientific theories should be based on empirical observations. To the extent that a statement is not based on empirical observations, it should be regarded as speculative rather than scientific. From this perspective, the scientific status of a given theory increases as a function of the number of empirical observations it is based on: the more empirical observations have been gathered to support a given theory, the higher is its scientific status.

Although the positivist approach to theory evaluation resonates with lay conceptions of science as establishing irrevocable truths, it has been criticized for presupposing a logical principle of induction that could establish the truth of a general statement on the basis of individual observations—a principle that does not exist. As prominently outlined by Popper (1934), it is logically impossible to inductively verify the truth of a general statement on the basis of individual observations. For example, it is impossible to establish the truth of the general statement *all swans are white* on the basis of individual observations of white swans. After all, it is still possible that, despite painstaking counting of white swans, there is a black swan somewhere out there that was missed. Yet, classical logic does allow establishing the falsity of the general statement *all swans are white* through the observation of a single black swan.[1] In general terms, Popper's analysis suggests that, although it is impossible to inductively establish the truth of scientific theories (*verification*), it is possible to deductively establish their falsity (*falsification*).

In classical logic, the two kinds of inferences have been depicted in the form of valid and invalid syllogisms. The invalid syllogism underlying inductive inferences of truth can be depicted as

$T \rightarrow O$	*[If theory T is true, then observation O should occur.]*
O	*[Observation O occurs.]*
Therefore, T	*[Therefore, theory T is true.]*

As noted above, this syllogism is invalid because there is no logical principle that allows inductive inferences about the truth of a general statement on the basis of individual observations. Yet, it is possible to draw deductive inferences about the falsity of a general statement, as depicted in the valid syllogism of the *modus tollens*:

$T \rightarrow O$	*[If theory T is true, then observation O should occur.]*
$\neg O$	*[Observation O does not occur.]*
Therefore, $\neg T$	*[Therefore, theory T is not true.]*

These insights have important implications for the evaluation of scientific theories. In contrast to the positivist answer to the demarcation problem, Popper (1934) argued that scientific theories should be distinguished from nonscientific theories on the basis of their *falsifiability*. According to Popper, the falsifiability of a theory increases not as a function of the observations that are implied by the theory, but as a function of the observations that are *prohibited* by the theory. To the extent that a theory does not prohibit any observation, it is consistent with any potential finding, and thus unfalsifiable. For example, a theory of attitude change implying that attitudes may either change or remain unaffected in response to a persuasive message would be consistent with any empirical outcome, and thus unfalsifiable. Yet, a theory that implies specific predictions about the conditions under which attitudes do change versus do not change in response to a persuasive message would be inconsistent with certain empirical outcomes, and thus falsifiable. In fact, counter to the common goal of constructing theories that capture a wide range of possible observations, the informational value of a scientific theory increases with the number of events that should *not* happen according to the theory. To illustrate this idea, imagine that the weather channel tells us that tomorrow will be either rainy or sunny. In this case, we clearly have not learned much. However, if the weather channel tells us that tomorrow will bring sunshine, rain is ruled out as a possible event, thereby increasing the informational value of the forecast.

Another implication of Popper's (1934) analysis is that the idea of science as establishing irrevocable truths is an illusion. There is no logical principle that could inductively verify the truth of a scientific theory. Even after painstaking accumulation of confirmatory evidence for a particular theory, it is always possible that a new study provides evidence that disconfirms the theory. Popper proposed the term *fallibilism* to describe the insight that any well-established theory could be disconfirmed by new evidence. To be sure, Popper's rejection of inductivism as a basis for theory evaluation does not mean that scientists never engage in inductive thinking when they develop theories on the basis of previous observations. It simply means that individual observations can never guarantee the truth of a scientific theory. Whereas the former process refers to the context of *theory construction* as a creative activity (see Kruglanski & Higgins, 2004), the latter process refers to the context of *theory evaluation* as an epistemic activity that is constrained by the principles of classical logic.

Popper's falsifiability criterion further implies that scientific theories can be evaluated on the basis of their logical structure independent of any empirical evidence. Of course, logical analysis does not replace observation and experimentation as the empirical foundation of science. It simply means that scientific theories can be scrutinized for their logical structure without knowing whether they are consistent or inconsistent with the available evidence (Machado & Silva, 2007). For example, a minimum requirement for all scientific theories is that they should be logically coherent. If a theory is logically incoherent, it is essentially unfalsifiable because incoherent premises are consistent with any possible conclusion. For instance, if a given theory implies that self-relevance increases cognitive elaboration and, at the same time, that self-relevance decreases cognitive elaboration, it could be reconciled with any empirical outcome. Thus, to the extent that thorough conceptual analysis reveals that a given theory is logically incoherent, it does not matter that the theory is consistent with the available evidence because it would be consistent with *any* empirical observation. Although conceptual analyses for logical coherence are relatively rare in social psychology, there are a few examples in which well-established theories revealed logically incoherent assumptions, thereby challenging their status as scientific in terms of Popper's criteria for theory evaluation (see Trafimow, Chapter 12, this volume).

As a caveat, it is worth noting that logical incoherence can be rather difficult to detect, in particular for verbally formulated theories that rely only on the informal logic of natural syntax rather than mathematical formalizations (see Fiedler & Kutzner, Chapter 17, this volume; Klauer, Chapter 18, this volume; Smith & Beasley, Chapter 19, this volume). Johnson-Laird (2012) pointed out that a theory that includes n propositions can be inconsistent even if any $n - 1$ of them yields a consistent set. The implication for the identification of logical incoherence is illustrated by the fact that an exhaustive consistency assessment of a set of 100 propositions requires the consideration of 2^{100} possibilities. Even if each possibility could be examined in a millionth of a second, a comprehensive examination would take longer than the universe has existed. These issues suggest that theories are often more valuable if they include fewer rather than more assumptions. Theories involving a high number of propositions may give the superficial impression that they are precise and comprehensive. Yet, such theories would be useless according to Popper (1934) if they included unidentified inconsistencies.

Another important criterion in the logical analysis of scientific hypotheses is whether they are empirical or tautological. For example, the general statement *all bachelors are unmarried men* is tautological because the term *bachelor* is semantically equivalent to *unmarried man*. Hence, it serves little purpose to empirically investigate whether all bachelors are unmarried men. The statement is true by virtue of the semantic meaning of the two concepts. Some prominent social-psychological theories have been criticized for being pseudo-empirical, in that quasi-tautological claims make them resistant to any kind of counterevidence (e.g., Greve, 2001; Smedslund, 2000; Wallach & Wallach, 1994). For example, the hypothesis *difficult cognitive tasks require more cognitive resources than easy cognitive tasks* may be criticized as pseudo-empirical because the difficulty of a cognitive task is defined in terms of the cognitive resources it requires. If a cognitive task that was classified as difficult turned out to require fewer cognitive resources than a cognitive task that was classified as easy, we would not conclude that the proposed relation between task difficulty and cognitive resources is incorrect (i.e., cognitive tasks that are difficult actually require *fewer* cognitive resources than cognitive tasks that are easy). Instead, we would revise our beliefs about the relative difficulty of the two tasks, in that the task that was supposed to be difficult was in fact easy, and vice versa. Thus, in addition to identifying whether a theory is logically coherent, conceptual analysis is important to identify tautological claims that are true by definition instead of reflecting theoretical hypotheses that can be true or false.

The Pragmatics of Falsification and Holistic Theory Evaluation

Popper's (1934) deductive approach to theory evaluation is widely accepted in social psychology in that it serves as the conceptual basis for the practice of null-hypothesis testing. The basic idea is that tests for statistical significance do not verify a theoretically derived alternative hypothesis H_1, but instead falsify the null hypothesis H_0 (with an accepted alpha error probability of $p < .05$). Yet, the notion of falsification becomes much more complex when it is applied to the refutation of theories. Although the *modus tollens* provides a logical basis for deductive conclusions about the falsity of a general statement, the deduction and interpretation of observations are hardly ever based solely on a given theory. Rather, the deduction and interpretation of observations usually require the acceptance of numerous extra-theoretical background assumptions, including assumptions about the operationalization and measurement of the relevant theoretical constructs (McGrath, 1981; Proctor & Capaldi, 2001). Thus, it is not the theory alone that is subject to empirical test, but the theory in conjunction with all background assumptions that are required for the deduction and interpretation of a given observation (Duhem, 1908; Quine, 1953). Hence, if the prediction is disconfirmed, the empirical observation does not falsify the theory, but the conjunction of the theory and all background assumptions that are required to logically derive the predicted observation. In logical terms, this inference can be depicted in the following manner:

$$(T \wedge A1 \wedge A2 \wedge \ldots \wedge Ai) \rightarrow O$$

$$\neg O$$

$$\overline{\text{Therefore, } \neg(T \wedge A1 \wedge A2 \wedge \ldots \wedge Ai)}$$

Thus, what researchers learn from a disconfirmed prediction is that the conjunction as a whole is incorrect, but the disconfirmed prediction is insufficient to specify which particular component of the conjunction is incorrect. It might be the theory, but it could also be one of the background assumptions. In social psychology, researchers typically try to resolve this ambiguity by conducting additional tests of their background assumptions (e.g., manipulation checks to test the effectiveness of experimental manipulations; independent tests to establish the accuracy of measurement theories). On the basis of this practice, one might be tempted to conclude that a theory is falsified if all relevant background assumptions have been confirmed. Yet, what should be clear from Popper's (1934) rejection of inductivism is that it is impossible to establish conclusively the truth of the background assumptions. In other words, although the *modus tollens* provides a logical basis for deductive inferences about the falsity of *sets of theoretical assumptions*, the impossibility of inductively verifying the truth of general statements makes it impossible to conclusively ascertain the falsity of a *particular theory*. Without verification, there is no conclusive falsification. In the philosophy of science, this insight is known as the *Duhem–Quine thesis*, with reference to its originators Pierre Duhem (1908) and Willard Van Orman Quine (1953).

The impossibility of conclusively verifying or falsifying scientific theories led some philosophers to claim that science is an "anarchical" business that is guided by the principle of "anything goes" (e.g., Feyerabend, 1975). Yet, counter to such pessimistic views, others conceptualized the evaluation of scientific theories as consistency tests of broader sets of theoretical and empirical assumptions (e.g., Hempel, 1965; Quine & Ullian, 1978). Using the extended depiction of the *modus tollens* in its application to actual theory testing, one could argue that disconfirmed predictions signal the inconsistency of a broader set of assumptions that includes the theory, the relevant background assumptions, and the empirical observation. It is not possible to accept all of these propositions at the same time, because their inconsistency indicates that at least one of them must be wrong. To identify which proposition should be rejected, each of them can be scrutinized by testing the consistency of other sets that include one (or more) of the original propositions. To the extent that a given proposition is part of multiple sets that turn out to be consistent, it will likely be treated as "correct." If, however, a proposition is part of multiple sets that turn out to be inconsistent, it will likely be rejected as "false." Such consistency checks may involve earlier studies, for example when a theory previously led to predictions that were empirically confirmed or disconfirmed. Alternatively, consistency checks may involve the derivation of novel predictions, for example, when a post-hoc explanation for a disconfirmed prediction leads to the derivation of a new prediction (Lakatos, 1970). These consistency checks resemble Popper's (1934) tests of logical coherence in that both are concerned with the logical consistency of a given set of propositions. Yet, they are broader in that holistic network tests involve not only the consistency of the theory itself, but the entire network of theoretical and empirical assumptions (Quine, 1953). According to Popper (1934), a logically incoherent theory should be rejected even if it is consistent with the available evidence. Moreover, the notion of holistic theory evaluation implies that a logically coherent theory may be rejected if it is inconsistent with the broader network of theoretical and empirical assumptions.

The Evaluation of Scientific Research Programs

Holistic network checks for logical consistency provide an answer to the questions that arise when Popper's (1934) deductive approach is applied to the pragmatics of theory testing in psychological science. However, a holistic reinterpretation of deductive theory testing also has important implications that are not evident from Popper's original analysis. Because holistic network checks depend on the current network of accepted propositions, and because there is no possibility of conclusively verifying or falsifying any of these propositions, the outcome of any consistency check is contingent upon potential changes of the current network. For example, even if the current network suggests the rejection of a particular theory, new evidence may suggest a rejection of an involved measurement theory or an operationalization assumption. In other words, it is always possible that a theory that is accepted today will be rejected tomorrow and conversely that a theory that is rejected today will be resurrected tomorrow (see Aronson, 1992, and Kluger & Tikochinsky, 2001, for discussions of examples).

Such developments of holistic networks over time are a central theme in Lakatos's (1970) analysis of scientific research programs. Lakatos distinguishes between what he calls the *hard core* and the *protective belt* of a scientific research program. The hard core includes the central assumptions of a given theory; the protective belt includes a large set of background assumptions that are needed to derive testable predictions from the theory (e.g., measurement theories; operationalizations). According to Lakatos, researchers typically protect the theoretical core in the face of disconfirmed predictions by making adjustments in the protective belt. Thus, instead of interpreting the disconfirmed prediction as evidence against their theory, scientists tend to "neutralize" the negative evidence by searching for potential problems with the background assumptions of the protective belt. Whereas the protection of the theoretical core is described as a *negative heuristic* in response to disconfirming evidence, the revision of background assumptions in the protective belt is described as a *positive heuristic*.

Although Lakatos's analysis of how scientists deal with disconfirming evidence may sound like a textbook example of motivated reasoning (Kunda, 1990), it fully embraces the idea of rational theory evaluation. What matters according to Lakatos is whether revisions in the protective belt lead to novel predictions that survive empirical testing. To the extent that a disconfirmed prediction enforces revisions in the protective belt that lead to a novel prediction that can be empirically confirmed, the research program is characterized by what Lakatos calls a *progressive problem-shift*. If, however, the enforced revisions lead to novel predictions that are disconfirmed, the research program is characterized by a *degenerative problem-shift*. Similarly, degenerative problem-shifts are said to occur when revisions in the protective belt do not lead to any new predictions at all. Drawing on Popper's (1934) analysis, such cases could even be described as nonscientific because they tend to involve ad-hoc claims that do not allow further empirical testing.

Lakatos's (1970) analysis has three important implications. First, his framework shifts the focus from individual theories (Popper, 1934) and current networks of theoretical and empirical assumptions (Quine, 1953) to changes in theorizing over the course of a research program. Second, the focus on changes in theorizing over the course of a research program implies that even well-established theories may eventually be rejected if they involve long-lasting degenerative problem-shifts that fail to inspire novel predictions that can be empirically confirmed. Third, the nature of problem-shifts itself may change over time in that a degenerative research program may change into a progressive one, or vice versa. To illustrate such changes in the nature of problem-shifts, Lakatos (1970) described the example of a disconfirmed prediction about the course of a particular planet. To reconcile the conflicting observation with the theory, the researcher may postulate the existence of another planet that distorted the predicted course in line with the assumptions of the theory. If the researcher failed to detect any such planet, she might go on to postulate the existence of a third planet that concealed the view of the hypothesized second planet. Eventually, the researcher may be able to detect both hypothesized planets. Thus, what started as a degenerative research program eventually turned into a progressive one involving the discovery of two new planets that had been unknown before. Drawing on Lakatos's (1970) conceptual framework, Ketelaar and Ellis (2000) reviewed some interesting examples of progressive and degenerative research programs in the field of evolutionary psychology (see also Ketelaar, Chapter 11, this volume). Addressing the common criticism that evolutionary theories tend to be unfalsifiable, Ketelaar and Ellis showed that some research programs in evolutionary psychology involved degenerative problem-shifts that ultimately led to their rejection, whereas others were characterized by progressive problem-shifts involving the generation of novel predictions that have led to interesting discoveries about the workings of the human mind.

Metatheoretical Criteria for Theory Evaluation

Another important aspect of holistic conceptualizations of science is the empirical underdetermination of scientific theories (Quine, 1960). According to holistic conceptualizations, scientific theories are connected to empirical "facts" by the statements they imply about particular observations. Yet, in order to be non-tautological, these observation statements have to be implied by the theory without the theory being implied by the observation statements. If there were a bi-conditional relation between the theory and the observation statement ($T \rightarrow O$ and $O \rightarrow T$), the two would be conceptually equivalent, making any claim about their relation tautological, and thus pseudo-empirical (cf. Popper, 1934). Importantly, the requirement that observation statements have to be implied by a theory without the theory being implied by the observation statements allows for the possibility that two (or more) theories imply the same set of observation statements, even when the theories themselves do not imply each other (Quine, 1981). In other words, two theories can be empirically equivalent (i.e., implying the same observation statements) without being just semantically different formulations of the same theoretical assumptions. In such cases, it is impossible to empirically decide which of two (or more) competing theories should be preferred, because there will never be any evidence that could distinguish between them (e.g., Greenwald, 1975).

Although the underdetermination of scientific theories can make it difficult (and sometimes impossible) to empirically decide between competing theories, philosophers of science have proposed a number of metatheoretical criteria for the evaluation of scientific theories that are particularly useful when empirical data are unable to distinguish between competing theories (e.g., Harman, 1965; Quine & Ullian, 1978; Thagard, 1978). In addition, these criteria can provide a framework for the revision of theoretical networks in cases of disconfirming evidence. The underlying goal of these criteria is to maximize the ability to explain and predict events, which gives them the status of pragmatic heuristics (Quine & Ullian, 1978).

Conservatism

When scientists are confronted with observations that conflict with the predictions of a given theory, the resulting inconsistency requires revisions in the network of currently accepted propositions. As outlined by Lakatos (1970), these revisions typically involve questioning one or more assumptions in the protective belt, rather than challenging the central theoretical assumptions of the hard core. Examples include the reinterpretation of previous findings and the introduction of new assumptions that are able to resolve the inconsistency. According to the criterion of conservatism, scientists should aim for theoretical revisions that minimize changes in the network of currently accepted propositions. The rationale underlying the quest for conservatism is to ensure the ability to explain and predict events, which would be undermined if researchers prematurely rejected well-established theories in the event of a disconfirmed prediction.

As an example, imagine a case in which scientists respond to a disconfirmed prediction of an established theory by rejecting the theoretical assumptions underlying a commonly used measure. Such a rejection may resolve the inconsistency between the theoretically derived prediction and the empirically observed result, thereby protecting the theory from the disconfirming evidence. Yet, the rejection of the measurement theory would require reinterpretations of all empirical findings that were based on the relevant measure, which may produce even more inconsistencies that need to be resolved. Thus, to the extent that the employed experimental manipulation is relatively novel and less established than the measurement procedure, the principle of conservatism may lead scientists to attribute the disconfirmed prediction to inadequate assumptions about the experimental manipulation rather than inadequate assumptions about the employed measure.

The principle of conservatism illustrates not only why well-established theories are often retained despite disconfirming evidence (cf. Lakatos, 1970); it also illustrates the importance of well-founded assumptions about methods (e.g., measurement, operationalization) that impose strong network constraints in the case of disconfirmed predictions. To the extent that method-related assumptions are weak, they will be an easy target in the resolution of inconsistency, thereby allowing for the retention of pretty much any theory (LeBel & Peters, 2011). According to Kuhn (1962), the set of method-related assumptions that is accepted by the scientific community constitutes a *paradigm*, which he considered a fundamental precondition for scientific progress. If there was no consensus about the methods that are suitable to study a particular phenomenon, researchers would have to justify every background assumption they rely on when deriving predictions about empirical observations, which undermines stringent tests of their theories. The principle of conservatism contributes to scientific progress by preventing premature rejections of paradigmatic assumptions about methods, thereby imposing stronger constraints on the hypotheses of the theoretical core.

Parsimony

Although conservatism is important to ensure the ability to explain and predict events, it implies the risk that a theory is continuously protected from its disconfirmed predictions through a never-ending accumulation of ad-hoc assumptions. Such assumptions can undermine the ability to explain and predict events if they increase the complexity of the theoretical network to a point where it becomes unclear what empirical outcome one should expect under particular conditions. The criterion of parsimony counteracts such increases in complexity by favoring theories that require fewer assumptions to explain a particular empirical finding.[2] If scientists would be willing to accept theories that make unnecessary assumptions to explain a given finding (i.e., when there are theories available that explain the same finding with less assumptions), the network of theoretical propositions might acquire a level of complexity that could ultimately undermine the possibility of relating its theories to empirical observations. At the macro level, potential conflicts between conservatism and parsimony are reflected in what Kuhn (1962) described as *scientific revolutions*, which are characterized by substantial revisions of theoretical core assumptions in favor of parsimonious theories. Because rejections of theoretical core assumptions often require revisions of related assumptions about methods, scientific revolutions are further characterized by *paradigm shifts* in that method-related assumptions that have been accepted in the past are replaced by a new set of paradigmatic assumptions.

An often-overlooked aspect of parsimony is that it refers to the total number of theoretical propositions that are required to explain a given finding rather than the number of propositions of what might be considered the core of the relevant theory. As we outlined earlier in this chapter, statements about observations are never derived from a theory alone, but from the theory in conjunction with multiple background assumptions. The criterion of parsimony refers to the conjunction of a theory and the background assumptions that are needed to explain an empirical finding, not to the theory alone. An illustrative example is the ongoing debate between the proponents of single-process theories (e.g., Kruglanski, Erb, Pierro, Mannetti, & Chun, 2006) and dual-process theories (e.g., Deutsch & Strack, 2006) in social psychology (see also Deutsch, Chapter 7, this volume). Single-process theorists often appeal to the quest for parsimony, arguing that dual-process theories are less parsimonious than single-process theories because they postulate two qualitatively distinct processes rather than a single one. However, to explain a particular finding, single-process theories have to rely on a host of additional assumptions over and above the hypothesis that information processing is guided by a single process. For example, Kruglanski's unimodel proposes that judgments are the outcome of a single process of rule-based inference that is modulated by five processing parameters (Kruglanski et al., 2006). Importantly, two of these processing parameters (i.e., accessibility, relevance) have a striking conceptual resemblance to what some dual-process theorists describe as associative and propositional processes (e.g., Gawronski & Bodenhausen, 2006, 2011; Strack & Deutsch, 2004). Thus, when evaluating theories on the basis of their parsimony, it does not suffice to count the number of propositions that may be regarded as the core of a given theory (e.g., single-process vs. dual-process), but the entire set of propositions that is required to capture a given finding.

Generality

According to the criterion of generality, preference should be given to theories with higher rather than lower explanatory breadth. The larger the number of phenomena a theory is able to explain, the higher is its degree of generality. For example, a theory that offers explanations for the results of several operationalizations to study a particular phenomenon may be preferred to a theory that explains only the results of a particular operationalization. Similarly, scientists usually prefer theories that make predictions across a wide range of topics, rather than theories with a limited range of applicability.

An illustrative example is the development of dual-process theorizing in social psychology over the last decades (for a review, see Gawronski & Creighton, 2013; see also Deutsch, Chapter 7, this volume). In the 1980s and 1990s, social psychologists proposed numerous dual-process theories for a wide range of phenomena, including persuasion (e.g., Chaiken, Liberman, & Eagly, 1989; Petty & Cacioppo, 1986), attitude–behavior relations (e.g., Fazio, 1990), prejudice and stereotyping (e.g., Devine, 1989), impression formation (e.g., Brewer, 1988; Fiske & Neuberg, 1990), and dispositional attribution (e.g., Trope, 1986; Gilbert, 1989). Although these phenomenon-specific theories were supported by a substantial body of evidence, the following decade was characterized by a remarkable shift toward domain-independent dual-process theories (e.g., Smith & DeCoster, 2000; Strack & Deutsch, 2004). The latter kinds of theories are more general in the sense that they offer explanations for phenomena in a wide range of research areas. Importantly, domain-independent dual-process theories do not imply any predictions that would conflict with the predictions of the earlier phenomenon-specific theories. Yet, they do differ in terms of the hypothesized explanatory constructs, allowing them to provide explanations for a broader range of phenomena.

Refutability

The quest for generality poses the risk of creating theories that explain everything, yet predict nothing. The criterion of refutability imposes constraints on such developments by emphasizing the predictive power of theories. Although refutability has a close resemblance to Popper's (1934) notion of falsifiability, the refutability criterion is broader in that it considers theories in conjunction with the network of currently accepted propositions. According to Popper, a theory is unfalsifiable—and thus nonscientific—if it is consistent with any empirical observation. As we outlined earlier in this chapter, this would be the case for theories that are either logically incoherent or tautological. In addition to the rejection of unfalsifiable theories, Popper argued that scientists should prefer theories with a higher degree of falsifiability, which corresponds to the number of observations that are prohibited by a theory. As implied by the Duhem–Quine thesis, however, empirical observations are not implied by a theory alone, but by the conjunction of the theory and multiple background assumptions. This insight is captured in the criterion of refutability, which can be interpreted as a holistic reinterpretation of Popper's (1934) quest to prefer theories with a higher degree of falsifiability. From a holistic point of view, refutability depends on the network of currently accepted propositions in that the number of observations that are prohibited by the theory is contingent on the background assumptions that are available to derive testable predictions (Quine & Ullian, 1978). Thus, different from the quest for logically coherent and non-tautological theories, the degree of refutability cannot be determined a priori on the basis of the logical structure of a given theory. Instead, refutability depends on the current state of scientific research. Hence, the refutability of a given theory could even change over time, in that the theory may seem irrefutable at an early stage of inquiry because of the absence of suitable background assumptions that would allow the derivation of testable predictions. Yet, the same theory may acquire a high degree of refutability when new research developments provide background assumptions that, in conjunction with the theory, prohibit specific observations.

An illustrative example for such changes is the revival of psychoanalytic assumptions about unconscious motivational processes, which have been criticized as nonscientific on the basis of Popper's falsifiability criterion (e.g., Grünbaum, 1986). From a holistic point of view, the low degree of refutability was rooted in the difficulty of either assessing or manipulating these processes. However, recent methodological developments offer some valuable tools that might capture at least some of the processes proposed by psychoanalytic theory. Thus, in conjunction with the network of currently accepted propositions, many assumptions about unconscious motivational processes may be refutable today, although they were irrefutable in the early days of psychoanalytic theory. For example, although not too long ago many psychologists would have rejected the idea of unconscious motivation as unfalsifiable, it has become a central concept in research on unconscious goal pursuit (Förster, Liberman, & Friedman, 2007; but see Newell & Shanks, 2014, for a critical discussion). Similar changes can be observed for many other constructs that are even closer to the original formulations of psychoanalytic theory (e.g., Erdelyi, 1985; Westen, 1998; Wilson & Dunn, 2004).

Precision

An important means to achieve a high level of refutability is precision: The more precise the formulation of a given theory, the less ambiguous it will be which observations are prohibited by the theory in conjunction with available background assumptions. Thus, whereas the quests for parsimony and generality emphasize the *explanatory* power of scientific theories, refutability and precision are important criteria to ensure their *predictive* power.

A useful example to illustrate the criterion of precision is provided by theoretical claims about the contribution of automatic versus controlled processes to social-psychological phenomena. In a strict sense, theoretical claims that a phenomenon is due to an automatic or a controlled process may be regarded as insufficient because such claims do not say what exactly the process is and in which particular sense the process is supposed to be automatic. For example, racial bias in weapon identification is often claimed to involve both automatic and controlled processes (for a review, see Payne, 2006), but such claims remain ambiguous about the exact nature of these processes (e.g., does the controlled process involve the identification of the target object or the inhibition of racially biased response tendencies?) and the particular sense in which these processes operate in an automatic versus controlled fashion (e.g., is the process claimed to require awareness, intention, or cognitive resources?). Precise formulations of these assumptions increase not only the informational value of the relevant theories; they also clarify which empirical observations are prohibited according these theories, thereby increasing their refutability.

Logical Fallacies

So far, our chapter has focused on various criteria for the evaluation of scientific theories. Some of these criteria involve logical analyses of deductive relations, such as the quest for logically coherent and nontautological theories and the metatheoretical quests for parsimony and refutability. In the final section, we discuss a number of logical fallacies that can distort the outcome of such analyses. These fallacies are important not only for the evaluation of scientific theories, but also for the theoretical interpretation of empirical findings.

Affirming the Consequent

One of the most common inferential fallacies in psychology is the fallacy of affirming the consequent, also known as reverse inference. In abstract terms, the fallacy can be described as the conclusion of *X* on the basis of the observation *Y* and the conditional "if *X*, then *Y*[3]" A useful example to illustrate this fallacy is the interpretation of the spreading-of-alternatives effect, which describes the phenomenon that choosing between two equally attractive alternatives leads to more favorable evaluations of chosen as compared to rejected alternatives (Brehm, 1956). The spreading-of-alternatives effect was discovered on the basis of a prediction by dissonance theory (Festinger, 1957), suggesting that people experience an aversive feeling of postdecisional dissonance when they recognize either (1) that the rejected alternative has positive features that the chosen alternative does not have, or (2) that the chosen alternative has negative features that are not present in the rejected alternative. To reduce this aversive feeling, people are assumed to emphasize or search for positive characteristics of the chosen alternative and negative characteristics of the rejected alternative, which in turn leads to more favorable evaluations of the chosen compared with the rejected alternative. Drawing on evidence for the contribution of postdecisional dissonance to the spreading-of-alternatives effect, some researchers have conversely interpreted the emergence of the spreading-of-alternatives effect (*Y*) as evidence for the presence of cognitive dissonance (*X*) on the basis of the theoretical conditional *if dissonance, then spreading-of-alternatives* ("if *X*, then *Y*"). For example, it has been argued that the mere emergence of a spreading-of-alternatives effect demonstrates postdecisional dissonance in children and monkeys (Egan, Santos, & Bloom, 2007) and in amnesic patients who cannot remember their choice (Lieberman, Ochsner, Gilbert, & Schacter, 2001). This inference is logically flawed because the conditional "if *X*, then *Y*" entails only that *Y* can be inferred from *X*, not that *X* can be inferred from *Y*. After all, *Y* may be implied by other premises that are not *X* (e.g., if *Z*, then *Y*). For example, spreading-of-alternatives effects have been shown to emerge in the absence of postdecisional dissonance as a result of mere ownership (Gawronski, Bodenhausen, & Becker, 2007) or simple methodological factors (Chen & Risen, 2010). In addition to the widespread equation of a behavioral outcome with a particular psychological mechanism (e.g., equation of the spreading-of-alternatives effect with the presence of postdecisional dissonance), reverse inferences are very common in the field of social neuroscience, where the activation of a particular brain area during the operation of a particular process is often used to draw the reverse inference that the process must be operating when there is evidence for activation in this brain area (see Beer, Chapter 9, this volume).

Appealing to Ignorance

Another common inferential error in psychology is the fallacy of appealing to ignorance. Depending on whether the fallacy refers to positive or negative evidence, this fallacy can be reflected in two kinds of inferences: (1) there is insufficient evidence that *X* is true; therefore, *X* is false; and (2) there is insufficient evidence that *X* is false; therefore, *X* is true. An illustrative example is research and theorizing on unconscious processes, in which proponents of conflicting views often use weak evidence for the other theoretical view as support for their own view. For example, research on the contribution of unconscious processes to decision making has been criticized for offering weak evidence that the hypothesized processes indeed operate outside of conscious awareness (e.g., Gawronski & Bodenhausen, 2012; Newell & Shanks, 2014). Yet, the weakness of the available evidence for unconscious influences does not imply that the obtained influences operate under conscious awareness. After all, absence of evidence for unconsciousness is not the same as evidence for consciousness.

Nominal Fallacy

The nominal fallacy describes a variant of circular argumentation in which a given phenomenon is labeled as an instance of a particular category without providing an explanation of why the observed phenomenon occurred (also known under the phrase *naming is not explaining*). An illustrative example is Gigerenzer's (1996) critique of Kahneman and Tversky's research program on heuristics and biases (for an overview, see Kahneman, Slovic, & Tversky, 1982). To "explain" a variety of empirical phenomena that involve deviations from normative rules of inference, Kahneman and Tversky proposed three judgmental heuristics that were claimed to bias judgments in a systematic manner: (1) the anchoring-adjustment heuristic, which involves use of a numerical value as an anchor with insufficient adjustment (Tversky & Kahneman, 1974); (2) the availability heuristic, which involves probability or likelihood judgments on the basis of the ease by which relevant instances come to mind (Tversky & Kahneman, 1973); and (3) the representativeness heuristic, which involves the use of information on the basis of whether it seems representative rather than on the basis of its reliability or prior probability (Kahneman & Tversky, 1973). The three heuristics have been criticized for providing re-descriptions of the observed judgmental biases without explaining *why* these biases occur. According to Gigerenzer (1996), a theoretically convincing explanation would require a specification of the psychological computations that are responsible for the observed judgmental biases. Although such explanations were missing in the early stages of inquiry, several researchers worked toward overcoming the nominal fallacy by developing and testing theories about the mental operations underlying the observed judgmental biases. For example, Schwarz et al. (1991) argued that judgmental biases that have been attributed to the availability heuristic stem from the use of recollective experiences in retrieving relevant information from memory (instead of the content of the retrieved information) to solve the judgmental task (e.g., *if it is difficult to recall, it cannot be typical*). Such assumptions go beyond the criticized re-descriptions by providing clear specifications of the mental operations underlying the observed judgmental biases.

Denying the Antecedent

A fourth inferential error is the fallacy of denying the antecedent, which involves rejection of the consequent of a conditional on the basis of rejecting the antecedent. In abstract terms, this fallacy can be described as the rejection of Y on the basis of the conditional "if X, then Y" and the rejection of X. However, the rejection of X in the conditional "if X, then Y" does not guarantee that there is no alternative Z that also implies Y. A typical example in psychology is the denial of a behavioral phenomenon that is implied by a theory that has been rejected as a viable explanation of human behavior. From a logical point of view, any such rejection presupposes that there is no alternative mechanism that could also produce the relevant phenomenon. For instance, the rejection of behaviorist reinforcement theories does not mean that the phenomena of stimulus-response learning predicted by these theories do not exist. After all, phenomena of stimulus–response learning could be mediated by cognitive learning mechanisms that are not part of the original behaviorist theories that led to the discovery of these phenomena.

Disjunctive Fallacy

The disjunctive fallacy involves the inference that a given proposition must be incorrect, if there is evidence that supports an alternative proposition. In abstract terms, this fallacy can be described by the disjunction "either *X* or *Y*", which may lead to the rejection of *Y* if there is evidence for *X*. An illustrative example is the theoretical debate about whether certain kinds of individual differences are the product of genetic or environmental influences (see Johnson & Penke, Chapter 10, this volume). For a long time, research in this area was framed as a question of either–or, and each piece of evidence supporting one theoretical view was interpreted as invalidating the opposing view. Yet, more recent accounts explicitly acknowledge the contribution of both genes and environment (as well as their interactions) as important sources of individual differences (Johnson, 2007). In fact, it seems as if contemporary social psychology has become much less prone to the disjunctive fallacy, given the increasingly widespread acknowledgment that many social-psychological phenomena are multiply determined.

Moralistic Fallacy

The moralistic fallacy involves the assumption that the validity of a theoretical proposition is a function of its moral desirability. In abstract terms, the moralistic fallacy can be depicted by an inferential structure that resembles the *modus tollens*. Yet, its underlying inference is invalid in that it is based on a judgment of moral desirability rather than empirical observation. Specifically, the moralistic fallacy can be depicted by the inference: "if *X*, then *Y*"; *Y* is morally undesirable; therefore *X* is false.[4] For example, claims relating to race and sex differences are often evaluated by reference to their moral palatability, even though such considerations obviously cannot count as scientific evidence (Pinker, 2003). Another interesting case to illustrate the moralistic fallacy is the response to a meta-analysis by Rind, Tromovitch, and Bauserman (1998) suggesting that the relation between child sexual abuse and psychopathology in adulthood is relatively weak and fully explained by the relation between family environment and psychopathology. The finding caused a major controversy in psychology, the public media, and government legislation, involving an unprecedented condemnation of Rind et al.'s meta-analysis by the U.S. Congress (Lilienfeld, 2002). Drawing on the moralistic fallacy, one could argue that this controversy was at least partially driven by the conviction that child sexual abuse is morally wrong. Therefore, any research suggesting that the negative psychological consequences of child sexual abuse are minor must be flawed. Although less explicit, similar arguments have been raised against evolutionary explanations of intergroup prejudice, which have been accused of justifying morally despicable behavior (see Ketelaar, Chapter 11, this volume).

Conclusion

The main goal of the current chapter was to review criteria for the evaluation of scientific theories and to illustrate their relevance for theory evaluation in social psychology. We started by outlining the problems associated with logical incoherence and tautological assumptions for the falsifiability of social-psychological theories. Acknowledging pragmatic limits in the actual falsification of theories, we further explained the implications of the Duhem–Quine thesis for holistic consistency checks in theoretical networks and the evaluation of progressive and degenerative problem-shifts in scientific research programs. Finally, we illustrated the usefulness of various metatheoretical criteria for the evaluation of theories (i.e., conservatism, parsimony, generality, refutability, precision) and the inferential errors resulting from logical fallacies in the conceptual analysis of theories and the interpretation of empirical data. We hope that our review of these criteria provides a useful framework for both the evaluation of existing theories and the construction of new theories, thereby advancing research and theorizing in social psychology.

NOTES

1. Note that in a strict sense, general statements are falsified by statements about observations rather than observations in the sense of perceptual experiences (Popper, 1934).
2. The criterion of parsimony has also been described as simplicity (Thagard, 1978) or modesty (Quine & Ullian, 1978). In the philosophy of science, it is widely known as Occam's razor.
3. Note that the inferential structure of the fallacy is equivalent to Popper's (1934) rejection of inductive inferences as a basis for the evaluation of scientific theories.
4. A related inferential error is the naturalistic fallacy, which is essentially the reverse of the moralistic fallacy. Whereas the moralistic fallacy involves inferences about validity on the basis of moral desirability, the naturalistic fallacy involves inferences about moral desirability on the basis of what is the case.

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