BEYOND CAUSAL INFERENCE:
TAKING MECHANICAL, SYSTEMIC, AND RELATIONAL EXPLANATIONS SERIOUSLY

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Conceptions of causality often are divided into difference-making (e.g., probabilistic, counterfactual, and manipulation) and production (e.g., mechanism and process) accounts.[1] Contemporary social science, however, is dominated by a counterfactual interventionist conception that is commonly considered "a unified framework for the prosecution of causal questions;"[2] a "widely shared concept of what most social science causes are like."[3] "Nowadays, social scientists define and identify causality through the counterfactual effect of a treatment."[4]

I argue that an adequate social science should also, and no less centrally, take mechanisms, systems, and relations seriously as "things" that explain and should align theory and research with accounts of how, to the best of our knowledge, the world is organized and operates. The predominance of a causal effects conception of explanation, however, has largely blocked or sidetracked moves in this direction, even – in fact, especially – in the study of "causal mechanisms."

1. THE CAUSAL INFERENCE REVOLUTION

Although Judea Pearl goes too far in claiming that a "new science of cause and effect"[5] has emerged in recent decades, there has been a "causal revolution"[6] in the social sciences. We are in what Janet Lawler and David Waldner call "an age of causal inference,"[7] understanding "causal inference" as a

[1] See, for example, (Sober 1984), (Godfrey-Smith 2009, §3), (Aalen *et al.* 2012, 831-832), (Illari and Russo 2014, 52-53), (Woodward 2016, §3), (Glennan 2017, 153-154).

[2] (Morgan and Winship 2015, 3).

[3] (Seawright 2016, 32. See also 192).

[4] (Plümper, Troeger, and Neumayer 2019, 1).

[5] This is the subtitle of (Pearl and Mackenzie 2018).

[6] This too is Pearl's term (e.g., 2018, 14, 16, 137).

[7] (Lawler and Waldner 2023). A Google Scholar search in January 2024 for "causal inference" produced about 14,000 results for 1900-1999, 20,000 for 2000-2009, 82,000 for 2010-2019, and 78,000 for 2020-2023. (As a crude control for changes in the number of total sources, a search for "social science" in the same periods returned roughly 1.65 million, 2.2 million, 1.6 million, and 730,000 results.)

technical term "denot[ing] certain special ways to approach the causal aspects of statistical analysis;"[8] namely, "research that allows for … the unbiased estimation of a causal effect."[9]

Correlation, as every beginning statistics student learns, is not causation. Nevertheless, a "correlational shadow … will be cast by a causal process" and "the causal processes generating our observed data impose constraints on the patterns of correlation that such data display."[10] Therefore, careful modeling and research design may warrant a causal interpretation of (correlational) statistical analyses.

This has long been accepted for randomized controlled trials (RCTs), which apply a narrowly circumscribed "treatment" to one of two groups that are otherwise "the same." If the variation in outcomes between groups cannot plausibly be explained by chance then, it is generally agreed, we are warranted in considering the altered outcome a causal effect of the treatment.

The causal inference revolution has developed research design practices and statistical and mathematical techniques that may warrant causal inferences in observational and quasi-experimental research as well. This research has been methodologically varied, with important strands emphasizing

- regression modeling,[11] using sophisticated group assignment methods (e.g., propensity scores[12] and regression discontinuity designs[13]) and techniques for isolating the effect of the treatment (e.g., instrumental variables[14]).
- causal modeling, using techniques such as path analysis and structural equation models,[15] causal Bayesian networks,[16] and directed acyclic graphs (DAGs).[17] (The most ambitious example is Pearl's "structural causal model" approach.[18])
- experiments, especially "natural experiments," "in which social and political processes, or clever research-design innovations, create situations that approximate true [RCT] experiments."[19]

A single conception of causality, however, underlies nearly all this work. Despite the persisting intractability of philosophical disputes over the nature of causality,[20] self-consciously social-scientific empirical Economics, IR, Political Science, and Sociology – which, with considerable license, I call

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[8] (Aalen *et al.* 2012, 831).

[9] (Lawler and Waldner 2023, 224).

[10] (Shipley 2016, 20, 3). See also (Pearl and Mackenzie 2018, 163-164).

[11] (Gelman, Hill, and Vehtari 2021, ch. 18-21) and (Morgan and Winship 2015, ch. 6, 7) review contemporary regression-based methods of causal inference.

[12] (McBee 2021, ch. 4, 5), (Brumback 2022, ch. 10).

[13] (Dunning 2012, ch. 3), (Angrist and Pischke 2015, ch. 4), (McBee 2021, ch. 7).

[14] (Angrist and Pischke 2015, ch. 3), (Morgan and Winship 2015, ch. 9), (Huntington-Klein 2021, ch. 19), (Brumback 2022, ch. 9).

[15] (Bollen 1989), (Bollen and Pearl 2013), (Shipley 2016, ch. 3, 4, 6).

[16] (Pearl 2009b, §§1.2.2, 1.2.4, 1.3), (Pearl and Mackenzie 2018, ch. 3), (Scutari and Denis 2021).

[17] (Morgan and Winship 2015, ch. 3), (Pearl, Glymour, and Jewell 2016), (Huntington-Klein 2021, ch. 6ff.), (Brumback 2022, ch. 5ff.).

[18] (Pearl 2009b).

[19] (Dunning 2012, 2-3). For reviews of experimental methods, which have taken off in the social sciences in twenty-first century, see (Druckman 2022), (Druckman and Green 2021), (Mize and Manago 2022).

[20] See, for example, (Beebee, Hitchcock, and Menzies 2009), (Illari and Russo 2014).

here "the social sciences" – have largely adopted a potential outcomes,[21] counterfactual,[22] or intervention/manipulation[23] conception of causality. "Thinking about causation in the social sciences is currently dominated by a synthesis of counterfactual- and manipulation-based approaches."[24]

In this conception, "what distinguishes causal from merely correlational relations is that the former can be modified via localized interventions. Roughly, *C* is a cause of *E* when manipulating *C* in the right way can bring about a change in *E*."[25] Causal explanation is understood as identifying and estimating "causal effects," defined as the differences in the values of outcome/dependent variables, *E*, when a unit, A, is subjected to different values of treatment/independent variables, *C*, holding everything else constant (to isolate the effect of C).

Rarely, though, can we expose A to different values of *C*. Therefore, a study population is divided into similar groups that are given different treatments. The researcher observes, creates, imagines, or estimates "a 'surgical' change in [*C*] which is of such a character that if any change occurs in [*E*], it occurs only as a result of [*C*'s] causal connection, if any, to [*E*]."[26] The difference in average outcomes between groups[27] is then taken as the causal effect of the treatment.

This approach is broadly counterfactual; based on assessing what would have happened in a hypothetical situation. Causality is established through determining the effects of minimal manipulations that leave the rest of the causal structure unchanged. And, to increase tractability and reliability, the focus typically is on "effects of causes" (the results of minimal manipulations of treatment variables) rather than "causes of effects" (the range of determinants of an outcome).[28]

Counterfactual causal inference not only dominates practice – "most quantitative empirical analyses are motivated by the desire to estimate the causal effect of an independent variable on a dependent variable"[29] – but is regularly presented as privileged. Nobel-laureate economist James Heckman pointedly titles an article "The Scientific Model of Causality," by which he means counterfactual interventionist causality.[30] Pearl similarly speaks of "the scientific approach to causation,"[31] in the singular, and argues "all approaches to causation are variants or abstractions of the structural theory presented in this book."[32] Gary King, Robert Keohane, and Sidney Verba argue that "all good

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[21] (Rubin 1974, 2005), (Holland 1986), (Morgan and Winship 2015, ch. 2), (Imbens and Rubin 2015).

[22] (Illari and Russo 2014, ch. 9), (Morgan and Winship 2015), (Menzies and Beebee 2019).

[23] (Holland 1986), (Woodward 2003, 2009, 2023), (Illari and Russo 2014, ch. 10). (Shrapnel 2019, 4-8) provides an unusually clear brief statement of this approach.

[24] (Seawright 2018, 8).

[25] (Shrapnel 2019, 4).

[26] (Woodward 2016, 13).

[27] (Huntington-Klein 2021, ch. 10) surveys ways to define and measure "average" treatment effects.

[28] (Holland 1988) is a classic statement of this framing. Counterfactual approaches, however, can also address causes of effects (as well as other kinds of causality). See, for example, (Heckman 2005, 2-5), (Woodward 2004, 2002).

[29] (Winship and Morgan 1999, 659). "The goal of most empirical economic research is … to have something to say about the causal effect of a variable." (Angrist and Pischke 2009, 15).

[30] (Heckman 2005).

[31] (Pearl 2009a, 139).

[32] (Pearl 2009b, 353 n. 12).

research can be understood – indeed, is best understood – to derive from the same underlying logic of inference."[33] "Real explanation is always based on causal inferences."[34]

2. THE CAUSAL INFERENCE PARADIGM

The causal inference revolution has been associated with a vision of the world and of social science that I will call the causal inference paradigm.

- States of the world are caused primarily by discrete causal forces transmitting discrete effects.
- Social scientists study the world primarily by studying relations – especially statistical or mathematical relations – between analytically separable variables; "things" that can be counted or measured and take different values.
- Social scientists focus on relations between variables that they believe to be causally associated.
- Causality is established counterfactually or manipulatively.
- Social scientific explanations primarily identify and estimate causal relations between independent/causal and dependent/outcome variables, especially "causal effects."

This conception "works" – is "designed for" – when one or a few "causes" transmit discrete effects, more or less directly and deterministically. Much-taught exemplars include John Snow, who in 1854 linked cholera to water contaminated with sewage,[35] and Ignaz Semmelweis, who in the late 1840s pioneered antiseptic procedures in medicine, dramatically reducing puerperal fever in new mothers by having doctors wash their hands with chlorinated lime.[36] Randomized controlled trials perfectly fit this vision – and thus are not merely regularly, but ritualistically, referred to as "the gold standard" of causal inference.[37]

I will argue, however, that nothing close to an adequate social science is possible if we see the world as largely the result of causes transmitting effects that are identified through induced changes in the values of dependent variables. Large parts of the social world cannot be explained through independent-variable causes. And, I will argue, studying productive causality is essential to any epistemically or pragmatically adequate social science.

3. MECHANISMS, PROCESSES, AND SYSTEMS

Counterfactual causal inference is only one of many well-established styles of scientific explanation.

Natural law explanations show an outcome to be an instance of an invariant relationship. For example, according to Boyle's Law, pressure and volume are inversely proportional in a gas of a particular mass at a particular temperature. Neither pressure nor volume is the effect of the other

[33] (King, Keohane, and Verba 1994, 4).

[34] (King, Keohane, and Verba 1994, 75 n. 1).

[35] (Vinten-Johansen *et al.* 2003, ch. 7, 8), (Cameron and Jones 1983).

[36] (Carter and Carter 1994).

[37] A Google Scholar search in January 2024 for "randomized controlled trial" and "gold standard" produced over 280,000 results since 2000!

(or of anything else). If there is causality, it is a mysterious kind of productive causality – which has led some to argue that causality is at best superfluous to Physics.[38]

Network explanations[39] abstract from the entities involved and from the particulars of the activities, explaining outcomes by the "flow" through the "pipes" of the network. Familiar social science examples include the strength of weak ties,[40] first-mover and "network" effects,[41] and brokerage.[42]

Functional explanations are common in the life sciences.[43] They are powerful when it can be shown not merely that a trait "*is* functional but that that functionality explains its presence;" that "having the functional consequence in the past was responsible for the current presence of the item."[44]

Here I will focus on systemic explanations that show how a mechanism produces an outcome.

3.1. Mechanisms

"In many fields of science … a satisfactory explanation requires providing a description of a mechanism."[45] "Mechanistic explanations are ubiquitous across the empirical sciences,"[46] especially "in the causal interpretation of biological and neuroscientific experimental work."[47] Biologists explain "by describing the mechanism that produces that phenomenon."[48]

The ordinary-language sense of a mechanism as "a system of mutually adapted parts working together in a machine or in a manner analogous to that of a machine" or "an ordered sequence of events involved in a … process"[49] is also standard in the philosophy of biology. Peter Machamer, Lindley Darden, and Carl Craver, in their seminal article "Thinking About Mechanisms," define mechanisms as "entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions."[50]

Entities and activities are the interdependent elements of mechanisms.[51] Organization into productive processes makes these elements parts of mechanical wholes.[52] "Mechanisms are always

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[38] (Russell 1912) is the classic argument. More recently, (Norton 2003) has been relatively widely discussed. (Frisch 2022) discusses causation in Physics.

[39] (Victor, Montgomery, and Lubell 2017) and (Light and Moody 2021) provide extended overviews of political and social networks.

[40] (Granovetter 1973).

[41] (Kerin, Varadarajan, and Peterson 1992), (Weiss 2018), (Chalmers and Young 2020).

[42] (Burt 2005), (Goddard 2009), (Stovel and Shaw 2012), (Kwon *et al.* 2020).

[43] (Garson 2019).

[44] (Mitchell 2003, 97-98, 108). In evolutionary terms, the trait was not merely selected but selected *for*.

[45] (Machamer, Darden, and Craver 2000, 1).

[46] (Glennan, Illari, and Weber 2022, 148).

[47] (Leuridan and Lodewyckx 2021, 1).

[48] (Illari and Russo 2014, 121). See also (Machamer, Darden, and Craver 2000, 3, 7, 21, 22, 24).

[49] *Oxford English Dictionary*.

[50] (Machamer, Darden, and Craver 2000, 3). See also (Bunge 1997, 414), (Bechtel and Abrahamsen 2005, 423), (Craver and Darden 2013, 17, Table 2.1), (Illari and Williamson 2012, 123), (Illari and Russo 2014, 134), (Glennan 2017, 1, 17, 19-20).

[51] (Machamer 2004, 28-30, 32-34), (Illari and Williamson 2012, 125), (Glennan 2017, 20-22, 29-36), (Glennan, Illari, and Weber 2022, 145-146).

[52] (Machamer, Darden, and Craver 2000, 3), (Bechtel and Abrahamsen 2005, 430), (Illari and Williamson 2012, 127), (Glennan 2017, 23).

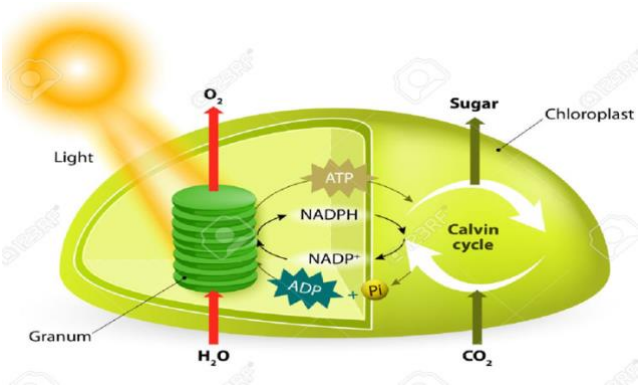
'for' something, and they are identified by what they are for."[53] And "doing" is central to mechanisms.[54]

Following Mario Bunge, I use the term "mechanismic"[55] to underscore that "one should not think of mechanisms as exclusively mechanical (push-pull) systems."[56] In the philosophy of biology, this is usually described as "the new mechanism"[57] – in contrast to the "old" "mechanical" mechanism of Hobbes, Descartes, Newton, La Mettrie, and Laplace.[58]

A mechanismic explanation "mak[es] intelligible the regularities being observed by specifying in detail how they were brought about."[59] It "is explanatory precisely in virtue of its capacity to enable us to understand how the parts of some system actually conspire to produce that happening."[60]

Figure 1 provides a mechanismic explanation of photosynthesis in plants; a model of how glucose is produced.[61] In organelles called chloroplasts, light initiates processes in the granum that, with the input of water, produce NADPH and ATP, which help to capture and reduce carbon dioxide in the Calvin cycle, producing glucose, which fuels life.

Figure 1: Photosynthesis



Source: https://www.123rf.com/photo_41854862.html

3.2. Processes

Process explanations are also important in the life sciences.[62] "Every biologist is engaged in the description of processes."[63] Laura Nuño de la Rosa even maintains that "following processes is a –

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[53] (Glennan 2016, 789). See also (Machamer, Darden, and Craver 2000, 5, 6), (Illari and Williamson 2012, 130), (Craver and Darden 2013, 23-24), (Garson 2019, ch. 10).

[54] (Machamer 2004), (Illari and Williamson 2013).

[55] (Bunge 1997, esp. 462).

[56] (Machamer, Darden, and Craver 2000, 2).

[57] (Glennan, Illari, and Weber 2022) try to present a consensus account of the new mechanism.

[58] (Glennan 2017, 5-11).

[59] (Hedström and Bearman 2009a, 5). See also (Machamer, Darden, and Craver 2000, 20).

[60] (Waskan 2011, 393). See also (Machamer, Darden, and Craver 2000, 22), (Illari and Williamson 2012, 123), (Craver and Darden 2013, 23).

[61] Diagrams often are central in mechanismic explanations in Biology. (Abrahamsen, Sheredos, and Bechtel 2017). See also §13.

[62] (Dupré and Nicholson 2018a) and (Dupré 2020) are excellent brief introductions.

[63] (Bapteste and Anderson 2018, 283). See also (Darden 2013).

if not the – characteristic activity of science."[64]

A process, in ordinary language, is "a continuous and regular action or succession of actions occurring or performed in a definite manner, and having a particular result or outcome."[65] As the philosopher Nicholas Rescher puts it, a process is "an integrated series of connected developments unfolding in programmatic coordination."[66]

"Mechanism" and "process" usually are used somewhat interchangeably, both in ordinary language and in professional jargon (including here). When distinguished, one usually is taken as the broader category (although there is no standard choice of which is which).

3.3. Systems

Mechanisms are systems, in the ordinary-language sense of "a group or set of related or associated things perceived or thought of as a unity or complex whole."[67] "A whole which functions as a whole by virtue of the interdependence of its parts is called a system."[68] More precisely, by "system" I mean a bounded set of components of particular types, arranged in definite ways, operating in a specific fashion to produce characteristic outcomes, some of which are emergent;[69] that is, are irreducible results of the organized operation of a structured whole.

"A whole can have properties (or powers) … that would not be possessed by its parts if they were not organised as a group into the form of this particular kind of whole."[70] Consciousness and life are classic examples of emergence. The wetness of water, musical chords, and traffic jams are more mundane but no less arresting examples.

"Mechanism," as we will see below, is regularly used in other senses in the social sciences. I will not argue that this systems sense – "mechanisms are collections of entities and activities organized … so that they do something that the components cannot do on their own;"[71] "'a mechanism for a behavior is a complex system that produces that behavior by the [structured] interaction of a number of parts"[72] – is "correct" or "best." I do, however, contend that structured productive processes are central to the social world but inaccessible to causal inference research.

More broadly, although I focus on mechanisms, I treat mechanismic, systemic, processual, and relational explanations as largely overlapping variants of an approach to social theory, research, and explanation[73] that today most often goes under the label "relationalism."[74] I thus am arguing, using

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[64] (Nuño de la Rosa 2018, 264).

[65] *Oxford English Dictionary*.

[66] (Rescher 2000, 22). See also (Glennan 2017, 26).

[67] *Oxford English Dictionary*. Although in some uses mechanisms need not be systems (e.g., Illari and Williamson 2012, 121), here I only address mechanisms that are systems.

[68] (Rapoport 1968, xviii).

[69] (Humphreys 2016) is a thorough philosophical study of emergence. See also (Holland 1998; 2014, ch. 6), (Jervis 1997, 12-17).

[70] (Elder-Vass 2007, 28). See also (Wimsatt 2007, 174, 274-277).

[71] (Craver and Darden 2013, 16). See also (Bechtel and Abrahamsen 2005, 423).

[72] (Glennan 2002, S334). See also (Glennan 1996, abstract).

[73] [potentially self-identifying note deleted]

[74] In IR see (Jackson and Nexon 1999, 2019), (Kurki 2022).

the example of mechanisms, that relational approaches, which are broadly systemic, should join causal inference approaches at the core of the social sciences.

3.4. Analytic vs. Systemic Explanations

Systems require (and provide) a distinctive type of explanation. Systemic explanations are usually contrasted to "analytic" explanations, in which "the whole is understood by knowing the attributes and the interactions of its parts," "disjoined and understood in their simplicity."[75] As Nicholas Onuf puts it, "analysis is the procedure whereby someone (the analyst) observes (or causes and then observes, or imagines) and describes the disaggregation of some (actual or hypothetical) unit."[76]

Disaggregating "things" into pieces, as a causal effects explanation does, often produces epistemically powerful and pragmatically valuable knowledge. If, however, the object of inquiry has properties arising from the organization or structured operation of its elements "then one cannot predict outcomes or understand them merely by knowing the characteristics, purposes, and interactions of the system's units."[77] One instead explains by showing the organized operation of a structured whole. (Balancing is the classic IR example.)

Systems and their components are *partially (in)separable*. Although much can be learned by studying the parts of a system separately, emergence is what makes systems epistemically and pragmatically significant. Conversely, elements of a system can only be incompletely understood independent of the system.

Analytic explanations exploit separability. Systemic explanations stress inseparability and emergence and show that certain results characteristically occur when *these* kinds of "things" are arranged *this* way and operate like *this*.

4. EXPLANATION AND CAUSATION

Comparing conceptions of explanation requires neutral terms of reference. No narrow notion is widely accepted today across disciplines. Therefore, I adopt a broad ordinary-language sense. An explanation "explains, makes clear, or accounts for something;" "make[s] plain or intelligible … describe[s] or give[s] an account of in order to bring about understanding."[78]

"Explanation is a matter of representing what depends upon what;"[79] showing that something we want to understand (the *explanandum*) depends on something else that does the explaining (the *explanans*). We have already seen, though, that there are different kinds of explanatory dependence.

Explanation is often specially associated with establishing causation,[80] in the broad sense of "production of an effect."[81] Causation, however, takes many forms.

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[75] (Waltz 1979, 18, 39).

[76] (Onuf 1995, 42).

[77] (Waltz 1979, 39).

[78] *Oxford English Dictionary*.

[79] (Glennan 2017, 212. See also 237).

[80] See §15 at nn. 197-200. (Lipton 2009) surveys the relations between causation and explanation.

[81] *Oxford English Dictionary*.

I use "causality" here as the broadest causal term, indicating generative effects of "things" governed by their properties.[82] I understand "to cause" broadly to mean "to effect, bring about, produce, induce, make."[83]

Outcomes, however, are caused (brought about) in varied ways. I will emphasize the differences between *relations of cause and effect* and *processes of causation*. Identifying "a cause" ("that which produces an effect"[84]) does not necessarily tell us anything about how that cause is "causative" ("productive of (an effect)"[85]).

5. CAUSAL INFERENCE VS. MECHANISMIC EXPLANATION

Even at this early point we can identify four interrelated differences between causal inferences and mechanismic explanations.

- *Analytic vs. systemic explanations.* Causal inference looks at the effects of analytically separate independent-variable causes. Mechanismic explanation is systemic. It explains through the organized operation of a structured whole.
- *Causes vs. causation.* Causal inference identifies causes and their effects; what is a cause (or an effect) of what. Mechanismic explanation identifies processes of causation; how an outcome is produced.
- *Causal relations vs. causal processes.* Causal inference identifies and estimates the effects of causal relations. Mechanismic explanation identifies and depicts productive causal processes.
- *Causal relevance vs. causal efficacy.*[86] Causal inference establishes causal relevance; shows that particular "things" are part of the story of causality. Mechanismic explanation establishes causal efficacy; shows how processes produce – actually *cause* – an outcome.

The following sections elaborate these differences.

6. WHAT, HOW, AND WHY: LINKING VARIABLES TO THE WORLD

Knowing what is an effect (or a cause) of what, without knowing how or why, may be of pragmatic value. Epistemically, though, it is far from optimal. It certainly is not the kind of knowledge that science should privilege or prioritize.

Accurate causal effects explanations often yield impaired understandings even in "easy" cases where one causal agent produces a singular outcome along a linear pathway. Thus both Snow and Semmelweis were unable to convince their colleagues, not only because their ideas contradicted established scientific theories but also because they could not identify a mechanism. (Pasteur's germ theory was developed in the 1860s.) And even after *Vibrio cholerae* was identified as cholera's cause, a

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[82] (Molnar 2003, 187).

[83] *Oxford English Dictionary.*

[84] *Oxford English Dictionary.*

[85] *Oxford English Dictionary.*

[86] (Machamer 2004, 36) uses this language. Glennan (2017, 150-151, 153-155) contrasts "causal relevance" to "causal production."

mechanist would note that the disease results not from the transmission of bacteria but from reactions provoked by toxins that the bacteria produce.[87]

Causal effect explanations are black boxes – which mechanismic explanations open up, "revealing the productive relation."[88] Mechanismic explanations "detail the cogs and wheels of the causal process through which the outcome to be explained was brought about."[89]

The shortcomings of causal effects explanations are even more severe when causality is more complicated or complex. In the social world, outcomes often are equifinal (multiply realizable); there are many paths to "the same" outcome. In addition, causes often are multifinal; they have different effects in different contexts. In both cases, because a causal effect is only an arbitrarily selected part of the story of causality, its import often is obscure (sometimes even misleading).

In addition, many variables studied in the social sciences (e.g., war, peace, respect for (and violations of) human rights, development, and social solidarity) reflect human interests more than how the world works. (They are more like "heart disease" than Huntington's disease.) When such variables are found to have or to be causal effects, as they regularly are, we still literally do not know what in the world is doing the causal work – let alone how.

The problem is not that causal effects explanations are incomplete. ("Explanations do not aim at being complete, but merely at answering the question that the researcher asks."[90]) Rather, I am arguing, causal effects explanations cannot comprehend huge swathes of the social world because they are analytic (not systemic); they consider only difference-making (what-causes-what) causality (not productive (how) causality); and they often address variables that have an obscure relation to how the world works.

7. HIERARCHICAL LEVELS OF ORGANIZATION

Systems have "multiple levels of organization … [arranged in] a rough hierarchy, with the components at each ascending level being some kind of composite made up of the entities present at the next level down."[91] In the life sciences, the standard framing is levels of *organization*, understood as "compositional levels – hierarchical divisions of stuff (paradigmatically but not necessarily material stuff) organized by part-whole relations, in which wholes at one level function as parts at the next (and at all higher) levels."[92] (For example, cells, tissues, organs, systems, organisms; alleles, individuals, populations, communities, ecosystems). As Bert Hölldobler and E. O. Wilson put it "life is a self-replicating hierarchy of levels. Biology is the study of the levels that compose the hierarchy."[93]

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[87] Machamer, Darden, and Craver (2000, 6) note that "it is not the penicillin that causes pneumonia to disappear, but what the penicillin does." Kenneth Rothman's (1976; 2012, 24-28ff.) "causal pie" model of "component causality" makes a similar point, emphasizing the multiplicity of operative causes in disease production.

[88] (Machamer, Darden, and Craver 2000, 21-22).

[89] (Hedström and Ylikoski 2010, 50).

[90] (McKeown 1999, 177). Contemporary mechanists acknowledge, and even emphasize, that mechanismic explanations are incomplete. See below at n. 226.

[91] (McClamrock 1991, 185).

[92] (Wimsatt 1994, 222).

[93] (Hölldobler and Wilson 2009, 7).

Levels of organization are (understood as) "in the world." "Levels of organization are a deep, non-arbitrary, and extremely important feature of the ontological architecture of our natural world."[94] The world "is" a layered system of systems of systems in which parts at one level are wholes on "their own" lower level.[95]

Consider The Standard Model of particle physics.[96] The lowest level of organization is populated by quarks and leptons (and gauge bosons, which carry elementary forces). Quarks combine into hadrons, which are either mesons (composed of a quark and an antiquark) or baryons (composed (usually) of three quarks). Protons and neutrons, the lightest and most stable baryons, combine with one type of lepton, electrons, to make atoms,[97] which naturally occur on Earth in 92 forms (elements) – which are variously combined to make the stuff of the world.

Higher-level "things" are, of course, made up (and obey all the laws) of lower-level "things." A systemic "thing," however, cannot be explained fully in terms of its components. Quite the contrary, its distinctive character only emerges in the higher-level whole that is constituted by the organized operation of its parts.

"Higher-level entities and activities are … essential to the intelligibility of those at lower levels, just as much as those at lower levels are essential for understanding those at higher levels."[98] "The combination of 'top-down' effects … and 'bottom-up' effects … is a pervasive feature of complex systems."[99] In mechanisms in particular, "it is the integration of different levels into productive relations that renders the phenomenon intelligible and thereby explains it."[100]

Causal effects explanations either reductively explain the large by the small or are organizationally flat – and therefore cannot grasp the emergence of the many and varied higher-level entities, activities, properties, and forces that are central features of the physical, living, and social worlds.

8. MODULARITY AND SELF-ORGANIZATION: COMPLEX ADAPTIVE SYSTEMS

In addition to this "vertical" nesting, most mechanisms are "horizontally" nested; modular.[101] Sets of elements are interlinked with respect to a function or process but relatively autonomous from other modules. (Figure 1 depicts the principal modules of photosynthesis.)

Mechanisms are (only) partially decomposable. Much can be learned by disaggregating them into modules (and modules into their parts). But disassembled, mechanisms do not work.

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[94] (Wimsatt 1994, 225).

[95] For reasons of space, I merely assert this – and note that it is compatible with most broad philosophical and scientific orientations other than empiricism.

[96] (Lincoln 2012, ch. 3) provides a popular account.

[97] (Economou 2016, ch. 2, 8-10) discusses these processes without too much math.

[98] (Machamer, Darden, and Craver 2000, 23).

[99] (Holland 2014, 5).

[100] (Machamer, Darden, and Craver 2000, 23). "Successively lower level mechanisms account for different phenomena. Scientists construct a cascade of explanations, each appropriate to its level and not replaced by those below." (Bechtel and Abrahamsen 2005, 426).

[101] Although not all definitions include modularity (e.g., Illari and Williamson 2012, 122), I treat all mechanisms as modular.

In living systems, and in many social systems, both modularity and hierarchical levels of organization are closely connected with the system being self-organized.[102] "'Order' at a higher level [is generated] from the interaction of components at a lower level without requiring the resulting structure to be coded for in genetic blueprints or be solely a result of centralized control structures."[103]

The system "has many distributed, interacting parts, with little or nothing in the way of a central control."[104] And it "reproduces itself through time, given appropriate energy inputs."[105] Consider living organisms, beehives, human societies, and ecosystems. These are "complex adaptive systems;" systems with variable elements that "change and reorganize their component parts to adapt themselves to the problems posed by their surroundings."[106] In IR, consider states (or polities more broadly) and alliances.

Modularity greatly facilitates adaptation, which is *much* easier if only certain modules must be reconfigured, rearranged, or replaced. And in living systems, modularity is necessary to "permit[] change while the organismic machine is running."[107] Modularity also usually is central to creating complicated things and complex systems.[108]

Modularity, self-organization, and adaptation, however, cannot be comprehended by causal effects explanations (which consider only the sequential operation of causes).

9. TRANSFORMATIVE PRODUCTIVE PROCESSES

Hierarchical organization and modularity are also essential to the transformative productive processes that are central to most mechanisms – but inaccessible to causal inference research.

Consider baking a cake. Cake is not a dependent variable. It is the output of a productive process. Flour, leavening, sugar, fat, and flavorings are not independent variables. They are inputs into a productive process. Mixing and heating are not intervening or mediating variables. They are transformative operations. And this structured process produces an emergent outcome.

At the level of the mechanism, causal effects rarely are central to answering questions of causality. "What one wants to do in establishing and displaying mechanism is to show *how* one stage produces the next, and so on. … *The causality lies in the production*."[109]

A "complete" account will, of course, include cause-effect relations, both within modules and at lower levels of organization. But the outcomes of productive processes and the effects of causes are different kinds of "things" that are caused/produced differently – and therefore require (and provide) different kinds of explanations. Mechanismic knowledge *of* a mechanism differs fundamentally from cause and effect knowledge about what happens within a mechanism.

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[102] (Kauffman 1995) is the best place to begin reading on self-organization.

[103] (Mitchell 2003, 38).

[104] (Holland 1992, 21).

[105] (Padgett and Powell 2012, 8).

[106] (Holland 1992, 18). "Complex physical systems" have parts that are physically the same in every token of a type (e.g., every water molecule has two atoms of hydrogen and one atom of oxygen).

[107] (West-Eberhard 2003, 164).

[108] (Simon 1962) is the classic statement.

[109] (Machamer 2004, 35 [emphasis added]).

10. REGULATIVE AND CONSTITUTIVE RELATIONS

Causal inference explanations also are unable to comprehend the regulative and constitutive causality of structured social relations and practices.

Social systems regulate behavior, in the strong ordinary-language sense of governing, controlling, or directing. Causal inference research can address the impact of this (rather than that) rule or these (rather than those) expectations. It cannot, however, address the structured systems of relations within which rules and expectations operate.

Furthermore, causal inference research cannot comprehend the creation and operation of dispositions to act (or not act) in particular ways. And this is crucial because people rarely consult and follow rules. Usually they "are" – have been socially constructed to be – "pre-disposed" to act in particular ways, more or less unthinkingly.

Constitutive rules, institutions, and practices also are fundamental to social life.[110] But social identities, positions, and meanings are not caused by independent variables. They do not transmit causal effects. And they rarely can be fruitfully studied through surgical manipulations.

Who I am and what I value, as well as what I characteristically do (and how I do it), change with my changing social positions. (I am a different person as a father, teacher, voter, homeowner, driver, shopper, patient, and tennis player.) The individuals and groups with whom I interact also are socially constituted and regulated – across multiple domains and along multiple dimensions. And our interactions not only take place within but also help to both reproduce and transform structured systems of relations.

Understanding the constitutive and regulative effects of systems of structured social relations requires systemic or relational theories and research.

For example, in field theories, changes in an element are explained not by changes in other elements ("causes") but by the conjunction of certain features of the elements with certain qualities of the "space" of interaction. The field is neither a cause nor a force but a potential that is realized only in the presence of entities with specific features.

Social field theories explain "regularities in individual action by recourse to position vis-à-vis others."[111] For example, in Pierre Bourdieu's well-known schema,[112] actors with particular dispositions (*habitus*) and resources (capital) respond creatively to the opportunities and constraints of a particular social field (that values many dispositions and resources differently than other fields). And the resulting streams of practice not only reproduce but also transform the fields, dispositions, and resources that shaped those activities and outcomes.

Causal effects explanations consign structured social relations and practices to an "everything else" that is held constant – and thus excluded from research. I am arguing that social practices and structures should be central subjects of investigation and important *explanatia*.

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[110] (Wendt 1999, 77-89) and (Ylikoski 2013) compare "causal" and "constitutive" relations, explanations, and causality. See also (Leuridan and Lodewyckx 2021).

[111] (Martin 2003, abstract). (Kluttz and Fligstein 2016) reviews field theories in Sociology, the social science discipline where they are most frequently employed.

[112] (Bourdieu 1990 [1980], ch. 3-9), (Bourdieu 1996 [1989]).

A similar problem arises with causal structures. The causal inference revolution has stressed causal modeling that "summarize[s] our existing scientific knowledge"[113] and aspires to capture the full web of causal relations within which an outcome variable is enmeshed. But causal inference research investigates not interconnected causal forces but sets of discrete ties between separate variables. (For example, in causal structural models "each equation represents a stable autonomous mechanism"[114] that remains invariant when another is subjected to external intervention.[115]) And the structure of causal relations is relegated to a background condition. This is especially unfortunate because counterfactual reasoning depends largely on the character of the specified causal structure – which is not (cannot be) an object of investigation in causal inference research.

In both cases, the effects of structures, which often are crucial to causality, are excluded from analysis. Causal effects explanations address only the effects of isolated changes within a structure.

11. "CAUSAL MECHANISMS"

"Causal mechanisms" have received considerable attention from causal inference theorists and researchers. For example, Alexander George and Andrew Bennett argue that "causal mechanisms and causal effects are equally important to causal explanation."[116] Gary Goertz claims that "demonstrating a causal effect is only half the job; the second half involves specifying the causal mechanism and empirically examining it."[117] Goertz even "argues for taking a causal mechanism view of research."[118] Bennett calls for "orient[ing] International Relations theorizing around the idea of explanation via … causal mechanisms."[119]

In most such work, though, anything that lies between (or beneath) a cause and its effects is considered a "causal mechanism." Furthermore, causal force is understood to be concentrated in (or even restricted to) independent variables. Productive processes – mechanisms – thus are stripped out of "causal mechanisms."

11.1. Intervening Variables and Causal Pathways

"The most widely used definition of causal mechanism sees them as a series of intervening variables through which an explanatory variable exerts a causal effect on an outcome variable;"[120] "an intervening variable or set of intervening variables that explain why a correlation exists between an independent and dependent variable."[121] $X \rightarrow Y$ is a cause-effect relation. $X \rightarrow M \rightarrow Y$ is a mediated cause-effect relation. M – whatever comes between X and Y – is a "causal mechanism."[122]

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[113] (Pearl and Mackenzie 2018, 14). See also (Morgan and Winship 2015, 12-13, 34, 70, 79, 326, 441, 448-450).

[114] (Pearl 2009b, 69).

[115] (Pearl 2009b, 63).

[116] (George and Bennett 2005, 12).

[117] (Goertz 2017, 1).

[118] (Goertz 2017, 167. See also 2, 8).

[119] (Bennett 2013a, 459). See below at nn. 159-163.

[120] (Beach and Pedersen 2013, 36), citing half a dozen examples.

[121] (Mahoney 2001, 578), citing half a dozen examples. See also (George and Bennett 2005, 147), (Checkel 2015, 92), (Morgan and Winship 2015, 329-331), (Weller and Barnes 2016, 5-6).

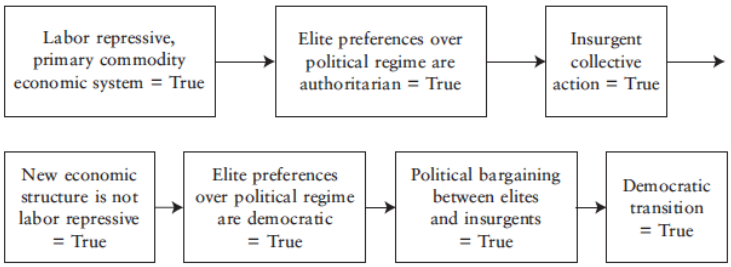
[122] $X \rightarrow M \rightarrow Y$ is, according to Goertz (2017, 32), "by far the most popular way … to conceptualize in an abstract sense a causal mechanism."

An intervening variable, however, is simply an independent variable that has not been "treated" in a particular research design. Adding additional causal variables just creates more complicated causal effects explanations. (The only thing that "causal mechanisms" change is the number of causal links.[123]) No attempt is made to indicate what the "causal mechanism" does (or how).

Causal "pathways"[124] or "chains"[125] may seem a more promising framing but in practice prove to be simply strings of intervening variables. They identify "the causal steps that stand between the treatment and the outcome"[126]– ignoring the organized activities and operations that *produce* the outcome.[127]

Consider Goertz's model of El Salvador's democratic transition.

Figure 2: The Causal Mechanisms of El Salvador's Democratic Transition



Source: (Goertz 2017, 32).

Causal *variables* are strung together with no account of causation. Each box represents the value of a variable; an instance of what Goertz calls the "causal mechanism X = 1."[128] The boxes are *black boxes* – as are the arrows. No attention is paid to, and the explanation does not rely on knowing or depicting, what goes on within (or between) the elements.

Such "causal mechanisms" are simply relabeled causal *variables*. They identify when or where, not how, causes operate.[129]

In mechanismic research, by contrast, "the focus is not the unfolding of a causal sequence over time, but the exact interdependencies between different factors and processes, jointly producing a specific

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123 (Guzzini 2011, 332).

124 (Gerring 2008, 163, 178), (Weller and Barnes 2014), (Checkel 2015, 76, 77), (Morgan and Winship 2015, 325), (Seawright 2016, 55-67, 94- 99, 101-03, 121, 122), (Druckman 2022, 45).

125 (Mayntz 2004, 241-242, 243-246), (Waldner 2012, 70), (Weller and Barnes 2014, 12, 13, 14, 15, 17, passim), (Bennett and Checkel 2015a, 6).

126 (Seawright 2016, 159).

127 John Gerring (2008, 178) argues that "the core meaning of mechanism" is "the pathway or process by which an effect is produced or a purpose is accomplished." I am emphasizing the difference between pathways and processes – and suggesting that "causal mechanisms" usually are treated as pathways, with little attention to the nature of the productive process. (Ross 2021 [2018]) contrasts "pathways" and "mechanisms" in Biology.

128 (Goertz 2017, 21).

129 Those who employ "causal mechanisms" usually do claim to explain how. See, for example, (Beach and Pedersen 2019, 1, 2, 4, 5, 6, 7, 8, passim), (Checkel 2015, 74, 76, 82, 89, 96), (Goertz 2017, 12, 18, 25, 29-30, 31, passim), (Kay and Baker 2015, 2, 3, 11), (Morgan and Winship 2015, 339), (Trampusch and Palier 2016, 442, 448).

outcome."[130] And the mechanisms addressed are "continuous chains of productive activities and interactions"[131] (not strings of causes and effects).

11.2. Process Tracing

Causal mechanisms also appear prominently in "process tracing," a research method that "attempts to identify that intervening causal process – the causal chain and causal mechanism – between an independent variable (or variables) and the outcome of the dependent variable."[132] But tracing "the *sequence of events* that intervenes between the starting point and outcome of the case"[133] usually does not involve "the detailed empirical tracing of the *operation of mechanisms*."[134] Process tracing instead aims to "establish whether there is a causal chain of steps connecting X to Y."[135]

Both the individual mechanisms and the aggregated process usually are understood to provide only case-specific[136] "mechanistic evidence"[137] that supports an explanatory causal inference. Bennett and Jeffrey Checkel speak of "diagnostic evidence" that "indicates the kind of process taking place, but does not transmit any independent effects to the dependent variable."[138] Derek Beach and Rasmus Pedersen repeatedly insist that "mechanisms are not causes but are causal processes that are triggered[139] by causes and that link them with outcomes."[140]

Causes explain. "Causal mechanisms" merely provide evidence of causal effects. "Causes" exercise their effects through "causal mechanisms." The causal (and thus explanatory) force, however, lies in the independent variables. And mechanisms, in the sense of *organized, productive, repeatable, explanatory processes*, are not examined.

11.3. Transmitters of Causal Effects

A causal mechanism that "convey[s] an initial causal impulse of some sort forward to an outcome,"[141] as in cascading dominoes, is indeed a mechanism in a strong sense of the term. But a mechanism that "transmits causal force, without adding to it, subtracting from it, or altering it"[142] is of limited interest. And most social mechanisms are transformative or productive.

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[130] (Mayntz 2016, 485).

[131] (Glennan 2016, 812). See also (Machamer, Darden, and Craver 2000, 3).

[132] (George and Bennett 2005, 206. See also 147, 177, 183). See also (Beach and Pedersen 2019, 1, 2), (Clarke 2023, 306, 307-309), (Trampusch and Palier 2016).

[133] (Bennett 2013a, 211 [emphasis added]).

[134] (Beach and Pedersen 2019, 6 [emphasis addded]). See also n. 127.

[135] (Bennett 2010, 209).

[136] In the social sciences, mechanisms tend to be associated with (singular) within-case explanations and causal effects with (generalizable) between-case explanations. But both causes and mechanisms come in both token (singular, individual-level, case-based) and type (general, population-level, variance-based) forms. And in the life sciences, mechanismic explanations usually are general/type explanations.

[137] (Beach and Pedersen 2019, 1, 4, 6, 10, 35, passim).

[138] (Bennett and Checkel 2015a, 7). See also (Bennett 2010).

[139] But if independent-variable causes merely trigger processes, focusing on "the causes" is fundamentally misguided.

[140] (Beach and Pedersen 2019, 1, 3, 30, 69). See also below at nn. **Error! Bookmark not defined.**-209.

[141] (Seawright 2016, 57. See also 86, 89, 97). See also (Kay and Baker 2015, 5), (Beach and Pedersen 2019, 4, 38, 39, 64, 69, 254).

[142] (Bennett and Checkel 2015a, 6-7). See also (Beach and Pedersen 2019, 4, 38, 64, 69, 254).

Even an explanation of cascading dominoes that sees only a transmitted force misses the point – and the mechanism. It does not even address the phenomenon that the mechanism produces, namely, the flow of falling dominoes (which is an emergent system effect). The causality of the organized operation of the parts of a whole is treated as an unexamined background condition.

Thus Bennett and Checkel ask "If one had a row of fifty dominoes lying on the table after they had previously been standing, how could one make inferences about whether the first domino caused the last to fall through a domino process, or whether wind, a bump of the table, or some other force caused the dominoes to fall?"[143] They rightly identify the "domino process" as the cascade triggered by tapping the starting domino. But as causal inference scientists they cannot study it. They can only investigate different treatments that might leave lines of fallen dominoes on the table. And if a bump or a breeze triggers the fall, they cannot conclude that the mechanism has malfunctioned (or that the setup conditions have been appropriated for a different process/mechanism).

Mechanismic research studies not the transmission of causal effects (through mechanisms) but the structured production of outcomes – which rarely is simply a matter of transmitting causal forces. For example, even in the relatively simple and "mechanical" mechanism of a grandfather clock, the purpose is (the emergent systems effect of) telling the time. And we can only understand what transpires in the light of that purpose/function.

11.4. Rationalist Models

Rational-actor models are another commonly employed type of "causal mechanism." ("Game-theoretic models constitute causal mechanisms."[144] "'Prisoners' dilemma,' 'Chicken,' and the other formal type games of game theory a[re] prototypes of rationalistic mechanisms."[145]) Although rationalists rarely employ causal inferences, I digress briefly to show that another important strand of contemporary social science also refuses to address structured productive processes.

Rationalist "causal mechanisms" typically are understood to provide "a *micro-level causal link* between macro-level variable A and macro-level variable B."[146] They give a "micro-level (microfoundational) explanation for a causal phenomenon."[147]

But treating the micro level as foundational produces *reductive* explanations (that employ "causal mechanisms" on that lower level). The micro level is considered not merely a lower level of organization but more revealing, more profound, or more (or more truly) explanatory. Peter Hedström and Richard Swedberg even argue "there exist no macro-level mechanisms."[148]

Mechanismic/systemic explanations of macro-level phenomena, however, also, centrally and essentially, involve macro-level entities and activities. As noted above, "it is the integration of different levels into productive relations that renders the phenomenon intelligible and thereby

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[143] (Bennett and Checkel 2015a, 6).

[144] (Goertz 2017, 165. See also 10, 26, 55, 174, 177).

[145] (Bengtsson and Hertting 2014, 716). See also (Zagare 2011, 25), (Lorentzen, Fravel, and Paine 2017, 468, 474).

[146] (Bengtsson and Hertting 2014, 710). See also (Mayntz 2004, 247-252), (Checkel 2006, 363), (Hedström and Bearman 2009a, 4, 8-9).

[147] (Gerring 2010, 1500). Causal inference research also tends to prioritize lower-level explanations, as (Morgan and Winship 2015, 346-352) strikingly illustrates.

[148] (Hedström and Swedberg 1996, 299).

explains it."[149] (If there are micro-foundations there also are macro-foundations – and neither is "more foundational.")

Furthermore, although rationalists sometimes claim that a process of rational decision-making did in fact produce an outcome, actors usually are treated only *as if* they were rational. The resulting (analogical, predictive, or how-possibly) explanations are neither causal nor mechanical – making it perverse to call them "causal mechanisms."

11.5. Typological Theories of Causal Mechanisms

Bennett also advocates focusing on theories about causal mechanisms. Such theories, though, prove to be simply sets of independent variables.

Bennett defines causal mechanisms as

> physical, social, or psychological processes through which agents with causal capacities operate, but only in specific contexts or conditions, to transfer energy, information, or matter to other entities.[150] In so doing, the causal agent changes the affected entity's characteristics, capacities, or propensities in ways that persist until subsequent causal mechanisms act upon it. If we are able to measure changes in the entity being acted upon after the intervention of the causal mechanism and in temporal or spatial isolation from other mechanisms, then the causal mechanism may be said to have generated the observed change in this entity.[151]

This, though, depicts an independent-variable treatment that has a causal effect. ("Cause" and "causal mechanism" are largely indistinguishable.) And "causal mechanisms" tell us what changes what – not how.

Bennett's examples of causal mechanisms include relative deprivation, structural opportunities, principal-agent relations, lootable resources, bargaining indivisibilities, welfare capitalism,[152] intersubjective meanings, discursive communication, and norms of appropriateness.[153] These are all "things" that have causal effects; explanatory variables; "causes" (not mechanisms).[154]

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[149] (Machamer, Darden, and Craver 2000, 23).

[150] This account is rooted in a very particular account of causality that is highly contentious even when applied to the classical physical world and clearly not applicable to the biological and social worlds. ((Illari and Russo 2014, ch. 11) provides a good critical introduction to this "Salmon-Dowe" approach to causality.) Here I emphasize that mechanisms/processes such as photosynthesis and baking a cake, and nearly all the mechanisms in the social world, are *not* centrally a matter of preserving or transmitting a conserved quantity, mark, or causal force. And in fact when Bennett addresses particular causal mechanisms there is not even a pretense of studying the transfer of energy, matter, or information.

[151] (George and Bennett 2005, 137), quoted at (Bennett 2013a, 210; 2013b, 466; Bennett and Checkel 2015a, 12; Bennett and Mishkin 2023, 156).

[152] (Bennett and Mishkin 2023, 157).

[153] (Bennett 2013b, 468).

[154] Bennett also identifies some mechanisms in the sense of processes with a characteristic outcome (e.g., alliance burden sharing and national unification (Bennett and Mishkin 2023, 157)). But this is irrelevant to them being "causal mechanisms." And they are treated as explanatory variables (not mechanisms).

Furthermore, although Bennett advocates "explanation *via reference to* causal mechanisms"[155] – causal mechanisms are "the basis of theoretical explanations"[156]and "the locus of explanatory theories"[157] – "causal mechanisms," in his account, do not explain. Explanation is by *theories about* causal mechanisms,[158] understood as explanatory variables.

Bennett argues for reorienting IR around a two-dimensional "taxonomy of theories about causal mechanisms."[159] The first dimension distinguishes "theories about mechanisms of power, institutions, and legitimacy"[160] – which are not mechanisms but classes of explanatory variables. The second dimension "captures the four possible kinds of mechanisms through which agents and structures interact: agent to agent, structure to agent, agent to structure, and structure to structure"[161] – which are types of causal pathways. To the resulting twelve types, Bennett and Benjamin Mishkin have recently added "seven categories of theories about within-agent mechanisms"[162] – at least six of which are variables not mechanisms.[163]

Bennett also advocates developing typological theories about causal mechanisms.[164] These, though, are "generalizations on how and under what conditions [*independent variables*] behave in specified conjunctions or configurations to produce *effects on specified dependent variables*."[165] "The analyst defines the dependent variable of interest and uses prior theories … to identify the relevant independent variables. The analyst then creates a typological space … that consists of all the possible combinations of the variables."[166] One studies "how combinations of variables behave"[167] (not how mechanisms are organized, operate, and explain).

Consider Bennett's illustrative typological theory on cross-border havens of rebel groups. The dependent variable is "the nature of the triangular relations and bargaining among the home government, the host government, and the rebels."[168] The three independent variables are whether the rebels control territory in their home state, whether the potential host is a weak or a strong state, and whether a potential host government or a minority in that state (or neither) supports the rebels.[169] A predicted outcome is then identified for each of the twelve types (two variables have two possible values and one has three). For example, when rebels control territory in their home state, have the support of a minority group in the host state, and that state is weak (e.g., the Ugandan

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155 (Bennett 2013a, 205, 206, 207, 210, 229; 2013b, 465, 475; 2023, abstract), emphasis added.

156 (Bennett 2013b, 461-462).

157 (Bennett 2013b, 461. See also 465).

158 (Bennett 2013b, 459, 461, 462, 465, 471, 472, 474, 476; 2013a, 211, 216, 225; Bennett and Mishkin 2023, 154, 155, 157, 169, 170).

159 (Bennett 2013b, 459, 462, 472ff.; Bennett 2013a, 214-216ff.; Bennett and Mishkin 2023, 168-170).

160 (Bennett 2013b, 459. See also 472).

161 (Bennett 2013b, 472-473).

162 (Bennett and Mishkin 2023, 158).

163 "Cognitive heuristics and biases; information processing/cognitive styles; aging/life cycle effects; personality types; the role of emotions; and substantive beliefs." (Bennett and Mishkin 2023, abstract. See also 158-168). The seventh, rational choice, may be a mechanism.

164 (Bennett 2013a, 216, 221-228; 2013b, 462, 472, 474-476; Bennett and Mishkin 2023, 157, 169, 170).

165 (Bennett 2013a, 216 [emphasis added]), quoting (George and Bennett 2005, 235).

166 (Bennett 2013a, 221).

167 (Bennett 2013b, 474).

168 (Bennett 2013a, 224).

169 (Bennett 2013a, 223).

Lord's Resistance Army in the Democratic Republic of the Congo from 2002 to 2005) the rebels should have considerable leverage.

This typology is insightful. The strategy of typological theorizing has many attractions. (Most notably, it requires considering the full range of combinations of causal variables.) But it has nothing to do with explaining by or studying mechanisms. Cause-effect relations have simply been relabeled "causal mechanisms."

12. CAUSES AND THEORIES

In addition to explaining with causes, empirical social scientists, as Bennett illustrates, explain with theories. In fact, theoretical knowledge is often seen as the ultimate goal. For example, Seawright and Collier define a theory as "the conceptual and explanatory understandings that are an essential point of departure in conducting research, and that in turn are revised in light of research."[170] King, Keohane, and Verba argue that ideally "every piece of information that we gather should contribute to specifying observable implications of our theory"[171] that, when tested, feed back into improving the theory.

King, Keohane, and Verba's definition of a theory as "a reasoned and precise speculation about the answer to a research question, including a statement about why the proposed answer is correct"[172] corresponds to the ordinary-language sense of "an explanation of a phenomenon arrived at through examination and contemplation of the relevant facts."[173] Empirical social scientists typically understand theories as more or less abstract epistemic structures that answer why questions[174] by showing an observation or association to be an instance of a more or less generalizable type of relation, process, or pattern – especially a set of causal relations.

But King, Keohane, and Verba's examples of theories – "modern democracies do not fight wars with one another due to their constitutional systems" and "revolutions only occur under conditions of severe economic depression"[175] – look like statements of causal effects. Beach and Pedersen call $X \rightarrow Y$, which depicts a simple cause-effect relation, a "causal theory."[176] Bennett and Checkel repeatedly write of "a theory or explanation."[177]

How – other than that theories are generalizable but explanations need not be – do theories and explanations differ? And how are theories related to causal inferences?

Empirical social scientists typically treat theories as explanatory sets of cause-effect relations that are supported or suggested by prior research. And good (causal) research is understood to cumulate into theories that in principle are reducible to series of causal effects but that in practice, because of our limited knowledge, have additional heuristic or explanatory power.

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[170] (Seawright and Collier 2010, 354).

[171] {King, 1994 #8332@51}.

[172] (King, Keohane, and Verba 1994, 19).

[173] *Oxford English Dictionary*.

[174] "To explain an event is to give an account of why it happened." (Elster 1989, 3). An explanation is "a statement about why an outcome has occurred." (Seawright and Collier 2010, 329. See also 325). See also (Bennett and George 2005, 134), (Waltz 1979, 5, 7, 8).

[175] (King, Keohane, and Verba 1994, 21).

[176] (Beach and Pedersen 2013, 56. See also 72, 90, 95).

[177] (Bennett and Checkel 2015a, 7, 13, 16).

But most generalizable explanatory "things" are not "theories" in the sense of sets of causal variables that answer why questions. (We have looked at causes, mechanisms, and systems as well as, more briefly, natural laws, rationalist models, functions, and fields.) Different kinds of *explanatia* provide different types of why answers. (Mechanisms, for example, explain why by showing how.[178]) And, I am arguing, it is foolhardy at best to refuse to explore the distinctive ways in which mechanisms (and systems, fields, …) explain.

13. MECHANISMS AND MODELS

As noted above,[179] causes usually are not central to explanations *at the level of the mechanism*. Neither are theories. Mechanismic explanations instead rely on processual models of a mechanism (as in Figure 1 or a cake recipe). An outcome is explained by showing it to be an instance of the modeled mechanism.

Glennan contrasts this "mechanisms and models" strategy of explanation, which is common in Biology, with the "law and theories" strategy that dominates Physics[180] – and which, I am arguing, also dominates the empirical social sciences in a "causes and theories" variant. Very roughly, models of mechanisms play the role of causes and theories in causal inference social science and of laws and theories in Physics. They are types that explain a phenomenon as an instance of that type.

In the literature on biological mechanisms, a simplified (abstracted) representation of a mechanism that leaves out only "unimportant" "details" often is called a "schema."[181] (Figure 1 is a (highly abstracted) schema.) A "sketch" of a mechanism, by contrast, has "missing pieces, black boxes, which we do not yet know how to fill in."[182] Craver and Darden further distinguish black box sketches (in which the mechanisms are largely unknown or highly speculative) and grey box sketches (which contain incomplete or contested knowledge of the mechanism).[183]

But even mechanism sketches, which usually are the best that we can hope for in the social sciences,[184] explain by the operation of the mechanism (not causes and their effects). And mechanismic research seeks to accurately depict the organization and operation of productive processes (not link causes and their effects).

14. MECHANISM TYPES AND PROCESS PATTERNS

In the social world, mechanisms – structured productive processes that produce a particular outcome or perform a particular function[185] – often vary considerably in how that function or

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[178] This is my gloss on William Bechtel and Adele Abrahamsen's (2005, 422) pithy observation that "biologists explain why by explaining how." See also n. 48.

[179] See §9.

[180] (Glennan 2017, 7, 8).

[181] (Machamer, Darden, and Craver 2000, 17).

[182] (Machamer, Darden, and Craver 2000, 18).

[183] (Craver and Darden 2013, 31).

[184] (Wimsatt 1994) argues that in the social sciences it is typical to have what he calls "perspectives" and "causal thickets" – which implies that even a mechanism sketch represents a significant epistemic achievement.

[185] On the centrality of function or purpose to mechanisms, see n. 53.

outcome is realized; that is, they have sub-types. Hedström and Peter Bearman use the awkward but descriptive label "semigeneral mechanisms."[186] I suggest "mechanism types."

Jörg Friedrichs similarly talks of "process patterns," understood as "recurrent sequences of interaction observed across any number of domains."[187] And he argues that "insofar as process patterns are about causality in motion, it is possible to repackage them as causal mechanisms whenever they follow specific trigger events, occur in specific contexts, and lead to specific outcomes."[188]

The point that I am trying to make is that, in the social sciences, explanatory models of mechanisms will tend to be not only fairly incomplete sketches but also pretty highly abstracted, with more than one way to produce an outcome (e.g., political legitimation through elections, charisma, ideology, religion, or ethnicity) or more than one kind of context in which a patterned process occurs (consider the wide range of contexts in which a prisoners' dilemma arises). But – and this is the crucial point – even such abstract sketches provide a distinctive kind of explanatory leverage, rooted in understanding how outcomes are produced (not what causes what).

Mechanism types and process patterns fit awkwardly with, and thus rarely are employed in, causal effects explanations. They often, though, are used in rationalist research.[189] And what I would call "relational types" are a regular feature of relational social science. For example, in IR Daniel Nexon studies international change in early modern Europe with network-based models of relational types, especially patron-client networks aggregated into dynastic empires modeled as "weak states."[190]

Pressed for space, I conclude by comparing mechanism-type and causal-effects accounts of great power balancing.

When one power, facing a challenge from another, increases its defense spending or strengthens its ties to allies, a mechanist explains those behaviors as instances of balancing, a well-known (but I suspect still not adequately studied) mechanism. In sharp contrast, Kenneth Waltz's classic argument that in anarchy we can "expect states to behave in ways that result in balances forming"[191] effectively treats balances as a causal effect of the independent variable anarchy.[192] There is no attention to *how* balancing works. *Balancing* is treated as a black box or intervening variable that somehow links the cause of anarchy to the effect of balances.

Anarchy is indeed associated with balances. But anarchy *does* nothing. And identifying balances as a causal effect of anarchy tells us nothing about how the world works. In fact, to the extent that anarchy is, as Waltz argues, a permissive or underlying, not an efficient, cause,[193] anarchy also does not tell us why balances form.

Furthermore, this "balances tend to form" account diverts attention from the fact that different forms of balancing may have different consequences, both in general (e.g., internal balancing (by

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[186] (Hedström and Bearman 2009a, 6-7).

[187] (Friedrichs 2016, 81).

[188] (Friedrichj 2106, 83).

[189] (Hedström and Udehn 2009) is a good introductory overview. The approach is usually seen as rooted in Robert Merton's (1968, ch. 2) notion of "theories of the middle range." See also (Tilly 2010).

[190] (Nexon 2009). Chapter 2 outlines the approach and lays out a set of models.

[191] (Waltz 1979, 125).

[192] [potentially self-identifying note deleted]

[193] (Waltz 1959, 232ff.)

building up one's arsenals) versus external balancing (through alliances)) and in particular contexts (e.g., depending on the offense-defense balance[194]). In addition, there are characteristic "pathologies" of balancing, such as "under-balancing,"[195] conflict spirals arising from the security dilemma,[196] and arms races that ought to be studied but cannot even by identified by causal inference methods.

I am not arguing that mechanism-type or process-pattern knowledge is "better" or "more useful" than causal-effects knowledge. I am, though, insisting that it is at least equally deserving of attention.

15. HOW DO MECHANISMS DISAPPEAR FROM "CAUSAL MECHANISMS"?

As an advocate of taking mechanisms seriously, it would seem incumbent on me to show how mechanisms end up getting stripped out of "causal mechanisms." The heart of the explanation, I argue, is the paradigmatic view that (only) "causes" explain.

Raymond Boudon speaks for most empirical social scientists when he claims "'explaining' means 'finding the causes'"[197] – which in the causal inference paradigm means identifying and estimating causal effects. With explanation reduced to causality and causality reduced to the effects of independent-variable causes, no space exists for systemic, mechanismic, or relational explanations. (Causal mechanisms thus are "naturally" treated as intervening variables.)

Causal effects explanations are treated as the ideal, if not the only, type of social scientific explanation. King, Keohane, and Verba insist that all real explanations are based on causal inferences and that causal mechanisms are reducible to strings of causal effects.[198] Hedström argues that "mechanisms should be seen as theoretical propositions about causal tendencies, not as statements about actualities."[199] James Mahoney even claims that causal mechanisms are "posited relations or processes that the researcher imagines to exist; they do not refer to any particular set of empirical conditions."[200] And even empirical social scientists who acknowledge the reality of mechanisms and the possibility of explanatory pluralism usually privilege or prioritize causal effects explanations.

I have already shown, though, that causal effects explanations cannot comprehend systems effects, modularity, adaptation, transformative and productive processes, social and causal structures, and regulative and constitutive relations and practices. Here, space limits me to offering a few illustrations of the inability of causal inference social scientists to even imagine other kinds of explanations.

Causal mechanisms are usually employed in multi*method* research that adopts a causal inference conception of explanation. In Henry Brady and David Collier's *Rethinking Social Inquiry: Diverse Tools, Shared Standards*, the "shared standards" are counterfactual causal inference.[201] In Goertz's

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194 (Glaser and Kaufmann 1998).

195 (Schweller 2006).

196 (Jervis 1978).

197 (Boudon 1998, 172). See also (George and Bennett 2005, 134).

198 (King, Keohane, and Verba 1994, 4, 75 n.1, 85-87). See also (Morgan and Winship 2015, 350, 448, 450).

199 (Hedström 2005, 108). See also (Morgan and Winship 2015, 340, 345-346).

200 (Mahoney 2001, 581).

201 "The central concern here is with causal inference." (Collier, Brady, and Seawright 2010, 3).

Multimethod Research, "multimethod … means complementary causal inference methodologies."[202] Goertz and Mahoney argue that qualitative and quantitative research are united by "the employment of scientific methods for the generation of valid causal inferences."[203] Jason Seawright's *Multimethod Social Science* uses "causal inference" forty times in the seventeen pages of Chapter 1.[204] *Explanatory* pluralism seems inconceivable.

Even attempts to take mechanisms seriously typically are short-circuited by a causal inference framing. For example, Beach and Pedersen distinguish mechanisms from intervening variables,[205] stress that "the effects of a mechanism are more than the sum of their parts,"[206] and present the goal of mechanismic analysis as "enabl[ing] us to answer the question *How does it work?*"[207] The "it," however, is a cause-effect relation (not a productive process). Beach and Pedersen focus on *productive relationships between causes and effects*[208] rather than *productive processes operating in and through mechanisms*. They even title a section "Mechanisms Are the Link between Causes and Outcomes – And Nothing More;"[209] that is, intervening variables.

The myopia of the causal inference vision is strikingly illustrated by appropriations of Machamer, Darden, and Craver's seminal "Thinking About Mechanisms" [hereinafter MDC].[210]

Beach and Pedersen cite MDC to support their argument that a full-fledged account of a mechanism unpacks "its constituent parts in enough detail to explain the workings of the process between the causes and the outcomes."[211] But MDC' do not even mention causes in their definition of mechanisms.[212] And when they do address causes, MDC argue that "activities are needed to specify the term 'cause'" and that "an entity acts as a cause when it engages in a productive activity."[213] A causal inference framing, however, removes activities and thus relegates "causal mechanisms" to black boxes between treatment and outcome variables. The result is what Stuart Glennan nicely calls "bare causal explanations."[214]

Or consider Stephen Morgan and Christopher Winship's use of MDC's observation that different fields recognize different "bottom-out entities."[215] MDC stress that this largely reflects conventional methodological choices.[216] (A physicist's bottom-out entities are different from those of a chemist

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[202] (Goertz 2017, 5).

[203] (Goertz and Mahoney 2012, 4).

[204] (Seawright 2016).

[205] (Beach and Pedersen 2019, 33-34, 55). See also (Waldner 2012, 67, 75).

[206] (Beach and Pedersen 2019, 3. See also 69-73).

[207] (Beach and Pedersen 2019, 69).

[208] (Beach and Pedersen 2019, 1, 3). See also §11.2.

[209] (Beach and Pedersen 2019, 50).

[210] (Machamer, Darden, and Craver 2000).

[211] (Beach and Pedersen 2019, 54. See also 30, 70).

[212] See above at n. 50. Similarly, Mahoney (2001, 578) cites (Glennan 1996) as holding that mechanisms are intervening variables that explain correlations between independent and dependent variables. But Glennan never mentions independent, dependent, or intervening variables. ((Beach and Pedersen (2013, 29) similarly misattribute to (Glennan 1996) the claim that "a causal mechanism … transmits causal forces from X to Y.")

[213] (Machamer, Darden, and Craver 2000, 8, 6). See also (Machamer 2004), (Illari and Williamson 2013).

[214] (Glennan 2017, 223).

[215] (Morgan and Winship 2015, 346-347).

[216] (Machamer, Darden, and Craver 2000, 13).

and an astrophysicist's are different from a particle physicist's.) Morgan and Winship, however, argue that "one can conceive of causal analysis in the social sciences as the pursuit of explanations that bottom out."[217] This is pretty much the opposite of MDC's argument, quoted above, that "higher-level entities and activities are … essential to the intelligibility of those at lower levels, just as much as those at lower levels are essential for understanding those at higher levels. *It is the integration of different levels into productive relations that renders the phenomenon intelligible and thereby explains it.*"[218] Explanation through bottom-out entities is a reductionist causal-inference alternative to systemic/mechanismic explanation.

Mechanisms, to repeat, explain why by showing how. Attention to causal mechanisms by causal inference researchers reflects awareness of the importance of knowledge of how. The causal inference paradigm, however, neither recognizes how as why nor acknowledges productive causality as causal.

Rationalist models do provide how-possibly or how-plausibly explanations, which may be of considerable value. But the real epistemic prize, I would argue, is generalizable how-actually knowledge – which rationalists rarely even try to produce and which causal inference social science produces only accidentally, when an outcome happens to be the product of a simple string of causes and their effects.

16. EXPLANATORY (NOT MERELY METHODOLOGICAL) PLURALISM

Causation "is not a single kind of relation or connection between things in the world."[219] It is "irreducibly plural or diverse."[220] And so is explanation. There is no single "best" or "scientific" kind of explanation because neither the world nor science speaks in a single voice. Sandra Mitchell's argument for the life sciences holds equally for the social sciences: varied explanatory practices "are driven by both the ontology of the biological world and the special interests of the scientific community."[221]

We need, as Nancy Cartwright puts it, "a view of nature as a realm of diverse powers, potencies and dispositions, creatively building up emergent systems of order."[222] Such a world, as Mitchell argues, demands explanatory pluralism. "Nature is complex and so, too, should be our representations of it. … The multilevel, multicomponent, complex systems that populate the domain of biology [and the social sciences] are ill suited to a simple, unified picture of scientific theorizing. Pluralism in this domain is … the mark of a science of complexity."[223]

I have thus argued that mechanismic, systemic, and relational explanations demand no less a central place in the social sciences than causal inference explanations. In fact, a strong case can be made

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[217] (Morgan and Winship 2015, 347. See also 325-326, 350, 445).

[218] (Machamer, Darden, and Craver 2000, 23 [emphasis added]). As Craver and Darden put it in a later work (2013, 25), "it is not part of our view that all explanations must bottom out in some privileged set of fundamental entities and activities."

[219] (Godfrey-Smith 2009, 326).

[220] (Godfrey-Smith 2009, 327).

[221] (Mitchell 2003, 112).

[222] (Cartwright 2016, 234).

[223] (Mitchell 2003, 115).

that "the claim 'C causes E' is impoverished compared to the claim that 'this mechanism produces this phenomenon.'"[224]

Seawright, it seems to me, gets things almost completely backwards when he argues, from deep within the causal inference paradigm, that "process tracing and other subunit analyses are useful for finding plausible hypotheses about causal mechanisms which can, in turn, promote descriptive generalizations and prepare the way for causal inference."[225] Accurately estimating a causal effect in fact is, as Snow and Semmelweis show, only a first (not the final) step on the way to understanding.

Causal effects explanations can add depth to systemic, mechanismic, network, field, and other relational explanations. They can be of immense heuristic value – which should not be denigrated when dealing with complex or complicated phenomena. Furthermore, bare causal explanation often is the best that we can achieve.

But causal effects explanations capture only difference-making, not productive, causality. They cannot even identify, let alone explain, the substantial and important parts of the social world that depend on the organized operation of structured systems and relations. And, I would argue, a bare causal explanation should not be taken very seriously unless supported by sketches of the mechanisms and processes by which the effect likely was produced.

Nevertheless, mechanismic, systemic, and relational explanations alone provide incomplete understanding. And mechanists embrace explanatory pluralism. As Glennan, Phyllis Illari, and Erik Weber put it, simply because "mechanistic explanations are ubiquitous in all scientific disciplines does not entail that all scientific explanations are mechanistic."[226]

I thus titled this essay beyond – not against – causal inference. I have criticized only the perverse prioritization of causal inference in contemporary empirical social science. And I have argued for the *necessary additional* contributions of mechanismic, systemic, and relational approaches to causality and explanation.

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[224] (Darden 2013, 20).

[225] (Seawright 2016, 228). Mahoney (2001, 581) similarly contends that "useful causal mechanisms are those that help analysts … integrate existing correlational knowledge into a coherent framework … [or] suggest new correlations not previously discovered."

[226] (Glennan, Illari, and Weber 2022, 151).

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