Rules, Reproducibility, and the Brief Frenzy of Animal Magnetism: Epistemological Foundations of Trust in French Enlightenment Medicine

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Enlightenment science and medicine achieved different levels of accuracy and precision as both sought rationality, empiricism, and the spread of human happiness. Animal magnetism was a unique medical phenomenon of late Enlightenment Paris that established trust with the public and had a significant cultural impact. Yet this method was not reproducible, involved limited rule-following, and lacked a coherent theoretical framework. Lessons from this phenomenon have included the first use of the placebo and the first design and implementation of careful, controlled experimentation in the medical context. Another lesson can be the power of demonstration and spectacle in communicating medical innovations. In fact, the underpinnings of science – the reproducibility of a certain scientific experiment and the rules, know-hows, and theories it assures – can be so conveyed to the public.

1.Introduction

The thinkers of the French Enlightenment promoted rational thought and empiricism in science in addition to notions of human happiness and freedom. The *philosophes* influenced this discourse to a significant extent, evoking major medical reforms and conversing with the leading scientists of the day. They were communicators too – between the technical world of science and the lay people who, above all, sought a sense of wonder.[1] While science itself was a rule-following enterprise that proposed somewhat accurate theories and reproducible experiments, medicine lacked many of the tools required for diagnosis and theory building. During the late Enlightenment, Franz Mesmer introduced animal magnetism to the general public. For six years it was a major sensation at all levels of Parisian society. This phenomenon established trust with the public without reproducibility and the constituents of science it assures: rules, know-how, and rule-based theory. How does scientific reproducibility assure such constituents? Why did animal magnetism establish a social and cultural rapport during the late Parisian Enlightenment? How can this inform modern medical communication? This article argues that controlled and replicable experimentation, which was first introduced in the medical context to disprove animal magnetism, must be effectively communicated – although this can be achieved through the very types of demonstration employed by Mesmer. The underpinnings of science – experimental reproducibility and the rules, know-hows, and theories it assures – can be so disseminated.

[1] A. Rupert Hall, "The Scientific Revolution, 1500-1800 the Formation of the Modern Scientific Attitude," 1954, iii.

2.Rule-following and Know-how

Know-how – the possession of a knowledge for performing an action – is one of the hallmarks of modern science and its reproducibility. Although ostensibly straightforward, its nexus with rule-following should be elucidated for a fuller epistemic theory of science and medicine.

In delineating know-how from propositional knowledge, the anti-intellectualist Gilbert Ryle claimed:

> Knowing a rule of inference is not possessing a bit of extra information but being able to perform an intelligent operation. Knowing a rule is knowing how. It is realized in performances which conform to the rule, not in theoretical citations of it.[2]

Here Ryle reaffirms his aversion to know-how as a form of propositional knowledge while asserting its close relationship with rules and rule-following. A somewhat parallel argument differentiating rules as socially constructed from rules as objective and internal to a practice has likewise had important implications for epistemic theories of scientific knowledge. Anti-intellectualist know-how and rules as internal to a practice find direct compatibility – they cannot be written down or reduced to prescriptions but are reliant on instinct, experience and context. Conversely, the conception of know-how as propositional knowledge is more amenable to rules as socially constructed owing to the communal nature of language (although one could certainly envision a connection between anti-intellectualist know-how and socially constructed rules or even between propositional knowledge and rules as internal to a practice).

A sufficiently general link between know-how and rule-following exists encompassing all such definitions. Know-how is expertise for performing an intentional operation that is reliant on – or even completely ensconced in – rules. Know-how is acquired once a rule for an

[2] Gilbert Ryle, "Knowing How and Knowing That: The Presidential Address," in *Proceedings of the Aristotelian Society* 46 (1945): 1–16.

intentional operation is known. Further rules can be discerned by extending the initial rule, noticing relevant similarities and differences between cases, and in turn developing additional or modified know-how. A salient difference is that rules are extendible and composed of many constituent rules whereas know-how is fixed to an existing set and comprised of fewer elementary components. For the math rule '2+2=4,' the constituent rules of '+' as well as '2' and '4' are assessed by comparison with other symbols and numbers and then extending to other cases: this is rule-following for an intentional action. Know-how would be the ability to perform an action specified as either '2+2=4' or '+.' Without rule-following one does not imply the other. As such, one could say that rule-following and rule extensionality are reliant on recognition of patterned repetition whereas this conception of know-how is reliant on repetition alone. Both rules as socially constructed and rules as internal to a practice imply pattern recognition.

These relations and distinctions do not contradict the aforementioned anti-intellectualist definition advanced by Ryle. Knowing a rule, according to Ryle, is being able to perform an intentional operation: it is equivalent with know-how. For Ryle this is also commensurate with ability and skill. Know-how is evinced as ability in colloquial expressions of intelligence such as one is "shrewd" or "prudent" since these impart the ability or inability to do certain things. Ryle further used skill and know-how interchangeably as a complex of dispositions.[3] While Ellen Fridland has argued that skills are minded and intelligent in both their nature and structure[4] and Carlotta Pavese and Bob Beddor put forward a comprehensive argument in favor of skillful action as guided by propositional knowledge,[5] Ryle's equating of knowing a rule, know-how, ability and skill is similar to such conceptions in that both leave room for the development of

[3] Gilbert Ryle, *The Concept of Mind*, Chicago: Chicago UP, 1949, 27-33.
[4] Ellen Fridland, "Longer, Smaller, Faster, Stronger: On Skills and Intelligence," *Philosophical Psychology* 32, no. 5 (2019): 759–783.
[5] Carlotta Pavese and Bob Beddor, "Skills as Knowledge," *Australasian Journal of Philosophy* (2022): 1–16.

know-how through repetition. Moreover, in both conceptions rules can be extended. While for Ryle knowing a rule is know-how, the rule itself is extendable and rule-following or actual performance may require or precede amending a rule and thus a coterminous change in know-how for a given set.

These differences between rule-following and know-how were in fact made explicit in Ryle's definition. First, Ryle claimed that know-how (or knowing a rule) is being *able* to perform an operation. Rule-following is not simply being able to perform an operation, but actually performing an operation that may necessitate a rule change. Second, it is important to note that know-how is being able to perform an *intentional* operation. For example, one does not know how to digest. Rule-following need not involve intentional operations. While an individual digesting food or seeing a red tomato is following rules such as "an individual digests" or "a tomato is red," there is no know-how involved. This also directly implies that some instances of rule-following cannot be improved through repetition. Sensory perception or digesting are examples of this. Finally, rule-following is achieved through more varied means than know-how.

3.Definitions of Rules and their Extensionality

Rule-following requires rule extensionality (pattern recognition between cases) – the feasibility of which was contested in Kripke's *Wittgenstein on Rules and Private Language* where there is a demonstration of Wittgenstein's language game of the series 'n + 2' applied to numbers beyond those experienced by students. A similar case is whether or not the '+' remains addition or becomes something else, like quaddition, after computing a large enough summand. Wittgenstein wrote:

> This was our paradox: no course of action could be determined by a rule, because every course of action can be made out to accord with the rule. The answer was: if everything

> can be made out to accord with the rule, then it can also be made to conflict with it. And so there would be neither accord nor conflict here.[6]

Kripke's sceptic concludes that "the entire idea of meaning vanishes into thin air."[7]

This rule scepticism was of course rooted in a particular interpretation of Wittgenstein's *Philosophical Investigations*, which had been the first to invite rule-following onto the stage of serious philosophical inquiry and debate. Wittgenstein defined a rule as anything that can be followed insofar as its understanding connects to an action and it can agree or disagree with an action. A rule can be an intention, a request, an order, or a function or property used as a principle for doing things. It can range from a mathematical expression to an indication that a chess piece is the king. Rule-following is committing an action in accordance with a rule. Kripke's rule sceptic interpretation has been thought to underlie the sociology of scientific knowledge (SSK) which emerged in part from David Bloor's *Knowledge and Social Imagery*, whose strong programme advanced the primacy of scientific rules as socially constructed and the replacement of scientific theories, facts and proofs with beliefs. Antiscepticism conversely took Wittgenstein as arguing for the inseparability of rules from practical conduct. Harold Garfinkel and Harvey Sacks' ethnomethodology placed activity and formulation (indexical expression), irrespective of the formulation's truth or falsity, as pragmatic within a temporal order of action.[8]

Michael Lynch in "Extending Wittgenstein: The Pivotal Move from Epistemology to the Sociology of Science" compared these two divergent conceptions of rule-following for generating scientific knowledge. He presented the argument of G. P. Baker and P. M. S. Hacker wherein a "practical attunement" occurs via the order of activities in place when a rule is

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[6] Michael Lynch, "Extending Wittgenstein: The Pivotal Move from Epistemology to the Sociology of Science," in *Science as Practice and Culture*, edited by A. Pickering, 215-265. Chicago: Chicago UP, 1992, 222.
[7] Saul Kripke, *Wittgenstein on Rules and Private Language*, Cambridge, MA: Harvard UP, 1982, 22.
[8] Lynch, "Extending Wittgenstein: The Pivotal Move from Epistemology to the Sociology of Science," 217.

formulated. The relation between rule and application exists only as “a Praxis, a regular activity.”[9] Garfinkel and Sacks have focused on rules as “essentially contexted” in that formulations are not independent of activities and the formulations themselves are indexical. In both cases the order of an activity is already produced within the activity itself and the rule merely elaborates it. Lynch ultimately concluded in favor of these ethnomethodological accounts over Bloor’s SSK and propounded an ethnomethodological study of rule-following behavior as a useful extension of Wittgenstein’s body of work. This understanding of rule-following enforces extensionality through practice and can be tightly linked to the anti-intellectualist conception of know-how as knowing a rule (ability) and its subsequent performance as opposed to know-how as propositional knowledge. Rule-following in both senses can improve know-how and generate new know-hows.

By contrast, Kripke’s solution to his indeterminacy paradox for rule extensionality invoked social constructivism. A regularity in common behavior – a “form of life” established through example, guidance, expressions of agreement, and drill – provides meaning. This did not preclude small and closed professional disciplinary communities from influencing such regularities. How exactly is this solution to be interpreted? Martin Kusch claimed that Kripke put forward a sceptical understanding involving the social phenomenon of meaning attribution. Bloor claimed that Kripke advanced a simple form of communal reductive dispositionalism called ‘meaning-finitism.’ The answer ‘125’ to ‘57+68’ is correct because it is right collectively.[10] A strong criticism of these interpretations came from S. G. Shanker, who claimed, “The purpose of the *reductio* is certainly not to question the intelligibility of certainty of the

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[9] Martin Kusch, “Rule-Scepticism and the Sociology of Scientific Knowledge: The Bloor–Lynch Debate Revisited,” *Social Studies of Science* 34, no. 4 (2004): 571-591, 583.
[10] Ibid., 578.

practice of rule-following."[11] The question is one of grammar: it is not "is math objective?" but "in what sense can mathematical knowledge be said to be objective?" Shanker answered "in the sense" that there is an internal relation between the rule for counting by twos and actions done in its accordance. The actions of this ethnomethodological account are instances of rule-following and rule extensionality commensurate with the performance of a know-how. The constructivist approach relies significantly on normativity – how rules ought to be applied through guidance. Without an internal relation between rule and practice, Kusch's social phenomenon of meaning attribution, or Bloor's communal reductive dispositionalism, some fact would need to be found satisfying Kripke's skeptic that gives a rule meaning and permits rule-following. The meaning fact would need to meet conditions of extensionality (accounts for the conditions of correct rule application) and normativity,[12] although the accounts of meaning facts satisfying these conditions have posed significant challenges.[13]

Kripke argued convincingly against resolving his rule scepticism via individualistic reductive semantic dispositionalism – that meaning in '+' comes from oneself and facts about oneself. Dispositions are finite whereas a rule is infinite, someone might be systematically predisposed to error, and meaning is normative.[14] Jared Warren wrote that solving the finitude problem turns on solving the error problem. An individual is "stably disposed" to reply to '+' with addition in the vast majority of "normal situations," by which he meant respectively that the individual possesses normal cognitive functioning and that the ratio of answers to '+' other than the sum tends towards zero as cases increase.[15] This form of non-semantic reductive

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[11] Lynch, "Extending Wittgenstein: The Pivotal Move from Epistemology to the Sociology of Science," 226.
[12] Kripke, *Wittgenstein on Rules and Private Language*, 11.
[13] Alexander Miller and Olivia Sultanescu, "Rule-Following and Intentionality," *The Stanford Encyclopedia of Philosophy* (Summer 2022 Edition), edited by Edward N. Zalta.
[14] Kripke, *Wittgenstein on Rules and Private Language*, 37.
[15] Jared Warren, "Killing Kripkenstein's Monster," *Noûs* 54, no. 2 (2018): 268-271.

dispositionalism (rules come from oneself and facts about oneself without appealing to meaning) is intriguing even though it faces a problem. The major indictment is the question of how a non-semantic set of situations such as a “stable disposition” can exclude every member of an infinite set of semantically characterized states.[16] Some have argued for such situations being described by semantically reducible conditional statements. Another reductionist position was that of David Lewis in “New Work for a Theory of Universals,” who claimed that quadding is worse than addition by disjunction from previous cases.[17] Here semantic facts are determined by the best theory of the data.

These arguments appear to solve the three problems facing individualistic reductive semantic dispositionalism (finitude, error, normativity). A “stable disposition” is certainly finite, but it is entirely informed by increasing data – enough data will affect the ratio of answers to ‘+’ other than the sum towards zero. The normativity problem is overcome by the arguments being non-semantic and the naturalness in non-disjunction. According to Kripke, “The point is not that, if I meant addition by ‘+’ [to ‘57+68’], I will answer ‘125’, but that, if I intend to accord with my *past meaning* of ‘+’, I should answer ‘125.’”[18] Assuming no systematic predisposition to error, the Warren and Lewis arguments appear to satisfy Kripke for the purposes of normativity. And the error problem, which Warren directly attacked, is solved by a potentially very large number of cases and “normal cognition.” Crucially this non-semantic reductive dispositionalism predicated on data does not necessarily rely on the social constructivism of SSK; it relies on the internal relation between extendible rules and concordant actions or know-how performances.

4.Is Know-how a Species of Know-that?

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[16] Miller and Sultanescu, "Rule-Following and Intentionality."
[17] David Lewis, “New Work for a Theory of Universals,” *Australasian Journal of Philosophy* 61, no. 4 (1983): 343-377.
[18] Kripke, *Wittgenstein on Rules and Private Language*, 37.

Distinctions between ethnomethodological rule-following and Ryle's anti-intellectualist know-how lie not only in the extensionality inherent to rule-following but also in the separation of action and ability. Is Ryle well-founded in his direct likening of ability to know-how? Intellectualists arguing in favor of know-how as a form of propositional knowledge often rely on "practical modes of representation" – knowing a proposition (ability) does not imply knowing it practically. Knowing how to ski would involve knowing propositions about skiing not merely through demonstration or observation but represented under such a practical mode of representation. Anti-intellectualists have responded by claiming that an individual facing an amnesia attack being shown a video of skiing would still not be able to perform.[19] Fridland and Neil Levy, among others, have similarly argued that appealing to practical modes of representation might not be able to explain skilled motor behavior since these are non-conceptual.[20] Newer versions of intellectualism have introduced non-conceptual practical modes of representation. A convincing argument in favor of anti-intellectualism is that skilled motor behavior is vital for animals, many of whom are incapable of concept possession or any human psychological state while fully possessing know-how. Certainly, in these cases, knowing a rule or possessing an ability is equivalent with know-how.

More broadly, Ryle's anti-intellectualist argument has held up well over time as thought experiments, psychological studies and concrete examples have proliferated. Jason Stanley and Timothy Williamson initiated the modern intellectualist stance when they demonstrated an apparent inconsistency in Ryle's argument. Ryle wrote:

> I argue that the prevailing doctrine leads to vicious regresses, and these in two directions. (1) If the intelligence exhibited in any act, practical or theoretical, is to be credited to the

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[19] Carlotta Pavese, "Knowledge How", *The Stanford Encyclopedia of Philosophy* (Fall 2022 Edition), edited by Edward N. Zalta & Uri Nodelman.

[20] Ellen Fridland, "They've Lost Control: Reflections on Skill", *Synthese* 191, no. 12 (2014): 2729–2750; Neil Levy, "Embodied Savoir-Faire: Knowledge-How Requires Motor Representations," *Synthese* 194, no. 2 (2017): 511–530.

> occurrence of some ulterior act of intelligently considering regulative propositions, no intelligent act, practical or otherwise, could ever begin.... (2) If a deed, to be intelligent, has to be guided by the consideration of a regulative proposition, the gap between that consideration and the practical application of the regulation has to be bridged by some go-between process which cannot by the presupposed definition itself be an exercise of intelligence and cannot, by definition, be the resultant deed.[21]

If the contemplation of a proposition is itself an action, this would lead to the need to appeal to increasingly complex propositions whereby no action could ever be taken. Clearly this only holds for intentional action. According to Stanley and Williamson, the second premise that propositional knowledge must be accompanied by actions of contemplation is false unless it refers to a non-intentional action (or unless 'action' is deflated). Ryle's infinite regress cannot get off the ground if the actions of both premises do not match. Stanley and Williamson additionally claimed that know-how and ability are not correlated and went on to argue in favor of know-how as propositional knowledge on the basis of linguistic theory comparing the two.[22]

In spite of this attempt at subsuming know-how to propositional knowledge, at least three strong arguments exist against it: the aforementioned full possession of know-how by animals, the lack of truth or falsity for know-how, and certain well-established tenets of cognitive science. Concerning the truth or falsity unique to propositional knowledge, Pavese has recently claimed that both propositional knowledge and know-how can be graded quantitatively as well as qualitatively. For example, one might know in part, or better than someone else, who arrived at a party.[23] In response, one may argue that a proposition or its constituent propositions are still true or false statements whereas know-how must be assessed on a continuum. And the cognitive science argument separates the procedural system encoding motor know-how from the declarative system encoding propositional knowledge, guaranteeing that at least some know-how

[21] Ryle, *The Concept of Mind*, 2.
[22] Jason Stanley and Timothy Williamson, "Knowing How," *The Journal of Philosophy* 98 (2001): 411–444.
[23] Pavese, "Knowledge How."

does not require propositional knowledge. [24] The anti-intellectualist conception of know-how is thus well-founded. It is also readily relatable to the ethnomethodological conception of scientific rule-following, with the relevant differences being: generalizability (rule-following can be achieved in different ways), the need for intentionality (know-how is for an intentional action), actual performance (rule-following), improvability (know-how can be improved), and extensionality via pattern recognition.

5.Scientific Reproducibility: Rules in Science and Proliferation of Experimental Know-how

It is this very pattern recognition characteristic of rule-following that bridges the gap between ability and action in such a way that the seed of technical proficiency can germinate. Although specific abilities improve through repetition, their novelty or modification must be generated from actions channeled by extensible rules that are developed and discerned as cases are compared. This proliferation of know-hows is simply a natural tendency – limited only by physical form and technological extensions thereof. As human know-hows proliferate and leave behind technological artifacts, diverging through time and geographical space, they and their artifacts can interact, recombine, be displaced or secured, be forgotten or reintroduced, and ultimately serve peculiar societal functions. One such peculiar societal function can be the proliferation of know-hows and associated artifacts for and by itself. Science in the modern sense forms from the conjunction of rule-based theoretical frameworks and this phenomenon, with scientific reproducibility often considered its linchpin.

Although there has been some academic debate on the matter,[25] this interplay is characteristic of science while reproducibility assures the validity of rule-based theories, the

[24] Ibid.
[25] Felipe Romero, "Who Should Do Replication Labor?" *Advances in Methods and Practices in Psychological Science* 1, no. 4: 516-537.

reliability of a know-how and associated artifacts, and the effective communication of both to experts and laymen alike. Stefan Schmidt claimed, “To confirm results or hypotheses by a repetition procedure is at the basis of any scientific conception.”[26] Stephen Braude further remarked that reproducibility is a “demarcation criterion between science and nonscience.”[27] With reproducibility assured, ideally anyone can know or possess a relevant rule or know-how, follow the extensible rule to understand its limits, and modify or generate further know-how. Brian Nosek, Jeffrey Spies and Matt Motyl plainly stated, “The entire body of scientific knowledge can be reproduced by anyone.”[28]

The relation between the epistemic components of science and their assurance by reproducibility is brought to light in part through replication typologies. Direct reproduction closely follows the initial study while conceptual reproduction deliberately modifies the initial study to generalize findings or hypothesis tests.[29] Omar S. Gómez, Natalia Juristo and Sira Vegas identified five types of experimental modifications: the experimental site, the experimenters themselves, the apparatus (design, materials, instruments, general objects and procedures), operationalisations (measurements of variables), and population. No change in these five categories indicates a direct reproduction with the purpose of controlling for sampling error, establishing experimental reliability, and confirming conclusion and theoretical validity. A change of site, experimenter or apparatus confirms internal validity of an experiment by controlling for intervening variables and assuring the hypothesis is actually being tested. A change of operationalisation assesses the extent to which the effect generalizes over measures of

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[26] Stefan Schmidt, “Shall We Really Do It Again? The Powerful Concept of Replication Is Neglected in the Social Sciences,” *Review of General Psychology* 13, no. 2 (2009): 90–100, 90.
[27] Stephen E. Braude, *ESP and Psychokinesis. A Philosophical Examination*, Philadelphia: Temple UP, 1979, 2.
[28] Brian A. Nosek, Jeffrey R. Spies, and Matt Motyl, “Scientific Utopia: II. Restructuring Incentives and Practices to Promote Truth Over Publishability,” *Perspectives on Psychological Science* 7, no. 6 (2012): 615–631, 618.
[29] Fiona Fidler and John Wilcox, "Reproducibility of Scientific Results," *The Stanford Encyclopedia of Philosophy* (Summer 2021 Edition), edited by Edward N. Zalta.

manipulated or dependent variables. A change of population strengthens external validity (results are generalizable to different populations). These last two modifications test hypotheses and establish theoretical validity.[30] Hans Radder referred to a change of apparatus as "replicability" and certain types of operationalization modifications as "material realization with differing theoretical descriptions" and "reproducibility given a fixed theoretical description."[31] Edouard Machery's Resampling Account did away with conceptual reproduction entirely. It proposed reproduction as an experiment that resamples the random components of an initial experiment (experimental units, treatments, measurements, and settings) whose function is to assess the latter's reliability.[32] These are contrasted with extensions, which sample from a different population (for random factors) or change the level of a fixed factor for the purpose of testing experimental validity and the invariance range of phenomena.

This brings scientific reproducibility back full circle to the very notion of an epistemic rule. A Wittgensteinian rule as a function or property used as a principle for doing things can form the foundation of an epistemic theory of scientific knowledge. The statement that a neutral hydrogen atom is composed of a proton, a neutron and an electron is such a rule since it serves as a property for guiding action. Know-how as an ability for intentional action is a subset of such Wittgensteinian rules. One may for example possess the know-how to identify a particle based on its charge-to-mass ratio. The tendency for rule-following extends rules such as these and generates further know-hows and artifacts, under the right circumstances doing so within a rule-based theoretical framework subjected to constant change. According to the aforementioned

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[30] Omar S. Gómez, Natalia Juristo, and Sira Vegas, "Replications Types in Experimental Disciplines," in *Proceedings of the 2010 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement*, Bolzano-Bozen, Italy: ACM Press (2010): 1-10.

[31] Hans Radder, *The World Observed/The World Conceived,* Pittsburgh, PA: University of Pittsburgh Press, 2006, 113-114.

[32] Edouard Machery, "What is a replication?," *Philosophy of Science* 87, no. 4 (2020): 545-567, 547.

understandings of scientific reproducibility, direct reproduction establishes the reliability of the initial experiment. Is the know-how worth knowing? The assessment of validity in the sense of the experiment testing its hypothesis – however this is understood – spurs rule-based theoretical development. The ideal of scientific reproducibility thus guarantees the efficiency of the entire system, providing data for further rule development with less inaccuracy and miscommunication.

Above all, though, reproducibility embodies a particular form of efficiency: trust – that between scientists and themselves and more broadly that between those who have and have not already developed a full theoretical understanding. Felipe Romero emphasized trust as a requirement for efficiency in science and how any lack of confidence in reproducibility would compromise trust in peer-reviewed publications and more generally. A lack of confidence in reproducibility would additionally damage the trust of lay people in a science that professes the ideal of self-correction – that in the long run the scientific method will refute false theories and find closer approximations to true theories.[33] Fostering trust in science in every sense thus requires the image and reality of scientific reproducibility and their effective communication.

Medicine is unique in that it applies scientific knowledge and methods directly to individuals, facilitating trust between its practitioners and patients and between the scientific establishment and people at large. Medical doctors can explain to patients presenting an array of symptoms why these are manifesting through the accurate, empathetic and shared process of diagnosis. They can do much the same for prognosis and treatment. This channel of communication opens the door for patients to understand science through their very bodies. Ideals of scientific reproducibility, scientific theory and technical know-hows are tacit yet omnipresent. A language composed entirely of rules builds up between the two – the guise of

[33] Felipe Romero, "Philosophy of science and the replicability crisis," *Philosophy Compass* 14, no. 11 (2019): e12633.

reason and compassion serving as a steadying presence. Although modern medical research has been beset with pressing claims of a reproducibility crisis, these claims have not penetrated deeply into the collective psyche. Doctors remain vital, trusted scientific communicators. But was this always the case? When and to what extent did trust become enmeshed with medicine and how can it be maintained?

6.Enlightenment Science and Medicine

Laboring exhaustively over his chemical balance, reactants and products sealed tightly within glass vessels, day by day Lavoisier would chart his own path in the new field of quantitative chemistry – eliminating measurement inconsistency much in the same way a vacuum pump evacuates its contents. Lavoisier was not only meticulous; in 1789 he induced from such measurements the general and enormously useful law of conservation of mass. "Nothing is lost, nothing is created, everything is transformed," he pronounced in his *Traité Élémentaire de Chimie* that would also introduce oxygen in favor of phlogiston theory and the notions of a chemical element and compound.[34] In furtherance to these theories and methods Lavoisier would labor to prove the composition of water by passing it through a red-hot gun barrel, allowing oxygen to form an oxide with iron as hydrogen exited the other side. He also developed an apparatus for such ends that employed a well calibrated pneumatic trough, set of balances, thermometer, and barometer.

While of supreme importance, natural science was typified by such experiments during the Enlightenment. Its benefits were not widely perceived. Rousseau critiqued it for distancing man from nature and not producing happiness.[35] Its methods were more thoroughly applied in facsimile to the study of social and political thought. For much of the Enlightenment its direct

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[34] Antoine-Laurent de Lavoisier, *Traité élémentaire de chimie*, Maxtor France, 2019.
[35] James MacGregor Burns, *Transforming leadership: A new pursuit of happiness*, Grove Press, 2004.

discoveries remained mostly shrouded from and misunderstood by the public. Yet during this period natural science was reconfiguring, hurriedly self-correcting as it sought accuracy and precision. Above all, unhindered reason and sense-based empiricism were valued by experts over testimony. Those lay people who did glimpse its innovations were more awed than curious and understanding – their trust implicit but reliant on constant demonstration and spectacle. Balloon flights drew far more attention than Lavoisier's reports to the Academy of Sciences.[36]

Another notable characteristic of Lavoisier's experiment analyzing the constitution of water was that it was not reproducible, signifying an oft-unrealized ideal of Enlightenment science that was vital for trust within the scientific community itself. The experiment could not be replicated as it lacked sufficient details regarding measurement precision as well as a full accounting of all phases and quantities of matter.[37] Others in the scientific community spent some time replicating pivotal experiments – with careful measure ensuring their precision and the accuracy of accompanying theories. Such a task was important during this nascent period of modern science.

While Lavoisier's overall work on combustion and conservation of mass was in fact highly meticulous and largely reproducible, lay people did not view such reproducibility as a necessary aspect of science. Their trust in testimony was implicit as Diderot chronicled to the literate much of science in his *Encyclopédie* of 1751 and Voltaire publicly reified the gravitational theory of Newton. Increasing wealth and nutrition led to increasing literacy and resources for education, while coffeehouses and lecture halls served as the perfect venues for dissemination of texts, discoveries, and demonstrations. The reaction of the interested public to

[36] Robert Darnton, *Mesmerism and the End of the Enlightenment in France*, Harvard UP, 1968, 22.
[37] Frederic Lawrence Holmes, *Lavoisier and the chemistry of life: An exploration of scientific creativity*. No. 4. U of Wisconsin Press, 1985, 237.

science was one of awe rather than understanding, with the view shared between intellectuals and lay people alike that it represented advancement and civilization.

Medicine is a field that, perhaps more than any other, embodies a synthesis of science and its communication, of advancement and happiness. In spite of its logical coherence and Galenic principles, by the early eighteenth-century medicine had become somewhat derided. Physical examination of the time (when considered necessary) was less comprehensive than its more modern counterpart, consisting of feeling the pulse, examining the tongue, and conducting a uroscopy.[38] Differential diagnosis of the sort that distinguished a particular disease from others presenting with similar clinical features could not be performed without the appropriate tools or theories for understanding the body. Voltaire wrote of treatment, “There is more vitriol in a bottle of [the healing spa] Forges water than in a bottle of ink, and frankly I don't believe that ink is very good for the health.”[39] These techniques were administered to most of the population in their rural environs by various practitioners, clergy, local wise-women, and bonesetters, with the wealthier inhabitants of major towns and cities being serviced by the official network of physicians, surgeons, and apothecaries in that hierarchical order.

By the mid-eighteenth century this state of affairs began to change as Cartesian mechanism finally made its appearance.[40] Thinkers such as Locke and Condillac stringently believed knowledge had to be grounded experimentally, with this type of thought affecting the fast-rising profession of surgery first and foremost. One of the fathers of modern surgery John Hunter, who was renowned across Europe for his encyclopedic knowledge of medicine and awareness of post-surgical complications, constantly sought to replicate surgical successes from

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[38] Edward Shorter, “Lecture 6,” *The Social History of Medicine in the 19th and 20th Centuries*, 2022.
[39] Roy Porter ed., *Medicine in the Enlightenment*, Rodopi, 1995, 83.
[40] Ibid, 83.

elsewhere of his own accord. Whereas the *Encyclopédie* entry on medicine by Jaucourt was disparaging, the surgical contribution was assembled with more deference by the Paris surgeon Antoine Louis.[41] New hospital-based medical schools gained valuable data by examining the cadavers of patients who had given them over to science in exchange for a free stay. A description of almost 700 post-mortem examinations formed the basis of Giovanni Battista Morgagni's massive 1761 work *De Sedibus et Causis Morborum*. These changes occurred most rapidly in France. Vicq d'Azyr, Pierre-Jean-Georges Cabanis, Samuel Tissot, and Philippe Pinel, all of whom had close links with leading Enlightenment figures such as Condorcet and Destutt de Tracy, greatly reformed medical teaching while expanding its reach and uniformity. All courses would become hospital-based and medical students had to interact with patients before practising.[42]

Lavoisier too was applying his empiricist approach and advances in chemistry to medical research. He extended his theory of oxygen in its preliminary form to respiration. His first memoirs on the topic were read to the Academy of Sciences in 1777 and eventually culminated with the publication of "On Heat." Lavoisier and Laplace designed an ice calorimeter apparatus for measuring heat given off during respiration, discovering its equivalence with combustion.[43] Such experiments would continue in 1789-1790 alongside Armand Seguin. They were used to quantify the amount of air consumed per hour by an average man for the purposes of understanding and alleviating the effects of uncleanliness in hospitals and prisons.[44]

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[41] Ibid., 84.
[42] Ibid., 80-85.
[43] Andrea C. Buchholz and Dale A. Schoeller, "Is a calorie a calorie?," *The American journal of clinical nutrition* 79, no. 5 (2004): 899S-906S.
[44] Arthur Donovan, "Lavoisier and the Origins of Modern Chemistry," Osiris 4 (1988): 214-231.

Enlightenment science heralded many such multidisciplinary advances and preliminary developments in medical theory.

All the intellectual criticisms and innovations inveighed against and promoted for the medical establishment were ultimately informed by the values of the day. The ideal of an open and meritocratic society was to be promoted within the medical community, with Vicq d'Azyr stressing personal talent and competition as requisites for membership in the Société Royale de Medicine during the period 1776-89.[45] The ideal of happiness in the temporal world over the afterlife encouraged good health for all regions and strata of society. Diderot insisted in a 1748 letter to the Paris surgeon Saveur-Franois Morand that a man could not be truly happy suffering from ill health.[46] The ideal of scientific advancement influenced the merger of medicine and surgery for better data collection and a fuller understanding of the body.

Enlightenment medicine nevertheless remained more distinct from its present-day counterpart compared with contemporaneous scientific disciplines. A great deal of debate over fundamentals permeated the field. The iatrochemical school invoked alchemy and chemistry haphazardly for understanding human health and disease. Vitalism contended that life was dependent on a principle distinct from purely chemical or physical forces. Doctors such as Thomas Sydenham chose to focus more on bedside manner and practice rather than theorizing. Through all this, diagnosis and treatment could be effective but were mostly not experimentally reproducible in the modern evidence-based sense.

It was in this milieu of idealized civilization, scientific display, and somewhat stagnant medicine that a peculiar phenomenon emerged in spectacular fashion as their shared icon. For six years a sensation arose in late Enlightenment Paris that was palpable at all levels of society and

[45] Porter, 81.
[46] Ibid., 82.

throughout all forms of communication. Franz Mesmer and his followers, patronized by members of Parisian high society, continuously practised animal magnetism and promulgated its concept. Satirized and celebrated, scrutinized and lauded, it made a claim of scientific authority while exemplifying the day's showmanship and sense of wonder. Mesmer claimed, "All bodies were, like the magnet, capable of communicating [the] magnetic principle" which like a universal aether "penetrated everything and could be stored up and concentrated."[47] The magnetist could give and receive this magnetic fluid and restore the circulation that had become blocked in the sick. Power lay not in metal but in the man. "I have been able," Mesmer said, "to magnetize paper, bread, wool, silk, leather, stone, glass, water, various metals, wood, men, dogs, everything I touch. And these magnetized objects have produced the same effects on patients as have magnets themselves."[48]

This medical frenzy represented a bifurcation of trust; the mainstream medical community of practitioners, professional societies, and political bodies rejected and continuously thwarted Mesmer as he concurrently marshalled popular support through the hope he offered and charisma he channelled. The treatments gave off the public appearance of reproducible healing largely through the power of testimony.

It was during this period immediately at the dawn and seedbed of modern medicine that the mainstream medical community would spring into action to examine the actual reproducibility of the technique and provide official recommendations. Lavoisier was a major participant in these investigations as a member of the 1784 Royal Commission. This body devised the first single-blind experiments to examine whether the purported effects were

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[47] Tim Fulford, "Conducting the vital fluid: the politics and poetics of mesmerism in the 1790s," *Studies in Romanticism* 43, no. 1 (2004): 57-78, 64.
[48] Ibid., 62.

produced by magnetisation or imagination. The medical placebo that had first been quietly conceived by William Cullen in 1772 was put to good use. It may have been the idea of Lavoisier, who wrote in designing the experiments that, "These reflections have suggested the following plan to me."[49] The Royal Commissions ultimately concluded that, "It appears by the experiments we have related that imagination alone produces the crisis."[50] It was in this way that the Enlightenment empiricism and aspiration for reproducibility emblematized by the work of Lavoisier made yet another mark on science and medicine. Scientific replication – a signature of Lavoisier's work and always at the forefront of its author's mind – in this instance played a critical role in establishing the ineffectiveness of a medical treatment.

7.Animal Magnetism: Popular Trust in Authority and Curiosity in Spectacle

Scientific reproducibility is an ideal that often remains unrealized. Friedrich Steinle claimed that the value of replication is "much more complex than easy textbook accounts make us believe."[51] Contemporary accepted theory, practical constraints on pursuing replication, and perceived credibility of researchers all determine the necessity for reproducibility. Many discoveries require substantial technical know-how. For example, in the 1650s German scientist Otto von Guericke designed the first successfully demonstrated vacuum pump, yet it could not be replicated due to expense and lack of a sufficient description. Steinle claimed that "no doubts were raised about his results" likely due to the "public performances that could be witnessed by a large number of participants."[52]

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[49] I. M. L. Donaldson, "Antoine de Lavoisier's role in designing a single-blind trial to assess whether 'Animal Magnetism' exists," *Journal of the Royal Society of Medicine* 110, no. 4 (2017): 163-167.
[50] Lars Ole Andersen, "Before the placebo effect Discussions on the power of the imagination in 19th century medicine-with perspectives to present discussions on the mind's influence upon the body," *Tidsskrift for Forskning i Sygdom og Samfund* 12, no. 23 (2015), 38.
[51] Friedrich Steinle, "Stability and replication of experimental results: A historical perspective," *Reproducibility: Principles, problems, practices, and prospects* (2016): 39-63, 60.
[52] Ibid., 55.

While reproducibility would become paramount for trust within the growing and complexifying Enlightenment scientific community, demonstrations such as those performed by Mesmer remained sufficient for the public. Mesmer arrived in Paris in 1778 and quickly established his practice after having faced professional rejection in Vienna. Pre-revolutionary Paris society was more open than Vienna in part due to the more prevalent coffeehouse scene as well as other cultural factors. Parisians were periodically "carried away by sensational reports of novelties, inventions, and scientific and medical marvels . . .[making] Paris a fertile ground for dissemination of the magnetic doctrine."[53] The highly charismatic Mesmer was able to garner support from all levels of society in such a climate, acquiring clients from the upper classes and patrons such as Queen Consort Marie Antoinette, Charles-Phillip, Count d'Artois and Marquis de Lafayette. The fact that Mesmer never received testimonials from professional medical bodies was of no hindrance; he was inundated with patients to the extent that he designed methods of mass treatment using devices such as a baquet – a large wooden vat of magnetized water equipped with protruding metal rods.[54]

Around the baquet, patients bound by ropes would sit or stand while pressing their bodies against the metal rods and linking fingers to complete a kind of circuit. Music, incense, symbols and reduced lighting enhanced the performance given by Mesmer, who would enter wearing a gaudy robe and slippers and send patients into trances while provoking screams, laughter and convulsions. It was a choreographed theatre where the reactions of patients were both contagious and viewed as curative. These types of performance enthralled the public. Benjamin Franklin remarked that the baquet as well as the hot air balloon created a craze, stating, "Struck with the

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[53] Douglas J. Lanska and Joseph T. Lanska, "Franz Anton Mesmer and the rise and fall of animal magnetism: dramatic cures, controversy, and ultimately a triumph for the scientific method," *Brain, mind and medicine: Essays in eighteenth-century neuroscience* (2007): 301-320, 305.
[54] Ibid., 305.

clearness and accuracy of [Mesmer's] reasonings, the magnificence of his pretensions, and the extraordinary and unquestionable cures he performed, some of the greatest physicians and most enlightened philosophers of France became his converts."[55] The public of Enlightenment Paris was in search of dramatic demonstration even more than the supposed scientific advancement and civilization that often could only be conveyed through drab apparatuses or theoretical advancements.

This phenomenon penetrated the Parisian social fabric far more deeply than such a medical remedy normally would. It was "an epidemic that had overcome all of France."[56] Vivid demonstrations were at the heart of Enlightenment European society. Fellows of the Royal Society had long relied on spectacle and performance – such theatre could be seen in parallel to the magnetizer's control over his patient or even the sovereignty of a ruler over his subject.[57] Moreover, Enlightenment France was particularly welcoming to any research on magnetism due to its long Cartesian mechanical tradition. Such research was greatly encouraged by the centralized state.[58] And Parisian society had already been enthralled by Newton's gravity, Franklin's electricity, and the gases of the Charlieres and Montgolfieres that lifted man off the ground.[59] If man could not *see* such phenomena when they were real, who is to say a universal magnetic fluid was fiction? The line between science and imagination was hard to draw. For all these reasons, animal magnetism garnered significant cultural attention; satirists used it to lampoon medicine generally while the many pamphleteers who wrote on the subject evoked

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[55] Blackwood's Edinburgh Magazine, Sept. 1817, 564.
[56] Darnton, 40.
[57] Patricia Fara, "An Atttractive Therapy: Animal Magnetism in Eighteenth-Century England," *History of science* 33, no. 2 (1995): 127-177, 129.
[58] Ibid., 133.
[59] Darnton, 11.

erotic tropes amongst others. Defenders of Enlightenment reason decried it as an example of the public's gullibility.[60]

It was the Royal Commissions beginning in 1784 and their production of widely and rapidly distributed reports that eroded Mesmer's support base and compelled the Parisian Faculty of Medicine to suppress the professional practice of animal magnetism. Although mesmerism was transmitted by Mesmer's disciples to other parts of the world, it faced varying and relatively muted levels of popularity while the scientific community universally condemned it. What these psychotherapeutic techniques lacked in theoretical foundation, though, was made up for by the patients' enthusiasm for treatments. They were genuinely believed to be beneficial through the power of suggestion and imaginations working in congruence.[61] But this lack of developed theory, as well the absence of reproducible experiments and most extendible rules, significantly differentiated animal magnetism from science in the modern sense. It was a mere know-how or collection of know-hows, though perhaps this was sufficient for the minds of highly impressionable patients during the Enlightenment. Regardless, without reproducibility, such know-hows were simply not worth knowing and no valid theory could be developed beyond the initial propositions.

More generally the Enlightenment medical community within and without professed the ideals of attaining good health and self-correction – that eventually all diseases could be eradicated. This view was not shared by the majority of the European lower classes. Sickness remained mysterious, the consequence of fate or divine punishment. Treatments could be sought from all forms of healer, although complete resignation was common. "The peasants," wrote a

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[60] Fara, 149.
[61] Fred Kaplan, "" The Mesmeric Mania": The Early Victorians and Animal Magnetism," *Journal of the History of Ideas* 35, no. 4 (1974): 691-702, 702.

French physician in 1785, "do not appeal to anyone. They believe there is nothing to be done. Moreover the priests tell them that their hour is decided and that it is useless to spend money for remedies that will not help."[62] These views were aggressively combatted by the Enlightenment medical establishment; society had to be "medicalized," with the medical elite playing a more prominent social and political role that could reach the masses as health matters became increasingly centralized.[63]

Medicine in France would change in the nineteenth century as the Revolution accelerated movements that had begun in the previous century. Led by Laennec, the Parisian School of Medicine initiated a number of innovations that permitted accurate and precise diagnosis. Trust in medicine would become reliant on the diagnostic power of the professional doctor and his tools. It is no surprise, however, that animal magnetism could proliferate under the circumstances of Enlightenment France. Burgeoning Enlightenment science relied on rules, know-how and reproducibility for its own self-assurance while its fruits were conveyed largely through demonstration. The Enlightenment medical community was less self-assured but equally able to put on a good show; the lay people less trusting of relatively ineffective medicine but willing – perhaps even clamorous – for a dramatic spectacle.

8.Conclusion: Lessons for Modern Medicine

Animal magnetism was introduced on the basis of poorly supported and developed theory and disseminated through lay channels with the aid of supportive testimony. To discredit it, the Royal Commissions for the first time relied on carefully designed experiments over experience and authority.[64] Lay channels of communication and enthusiastic testimony will always exist in

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[62] Gunther Risse, "Medicine in the age of Enlightenment," in *Medicine in Society: Historical Essays*, ed. A. Wear, 149-196, Cambridge: Cambridge UP, 1992, 153.
[63] Ibid., 174.
[64] Lanska, 317.

tension with science as authority. Certain elements of animal magnetism's popularity such as demonstration can be used in conjunction with carefully communicated experiments to broadcast effective medical innovation. Science and medicine can be conveyed through demonstration and as a rules-based progression without appeals to authority.

Communication of medicine without appeals to authority can be tied into interpretations of the modern scientific reproducibility crisis. Simine Vazire invoked norms of science – communality, universalism, disinterestedness, and organised skepticism – as well as concomitant counternorms in setting the goals for open science.[65] Vazire held that counternorms such as self-interestedness and organized dogmatism dominate science and have given rise to the reproducibility crisis. Lasting trust in science and medicine is predicated on transparency for lay people and experts alike; the science must be manifestly reproducible.

Medicine in particular has the advantage of direct access to lay people for the purposes of communication. The image of modern medical know-how is established through the power of physical tests, but this has harmed the doctor-patient relationship as doctors are less sympathetic and patients lack procedural comprehension. Doctors then should focus on communicating the science behind their diagnoses and techniques and direct patients to visual demonstrations and verbal descriptions.

During the Enlightenment in France, however, trust was limited within the medical community and even more so without. Animal magnetism proliferated rapidly under such conditions and in a society in search of both spectacle and civilization. Present day science builds trust through reproducibility. Rule-following extends rules, generates know-hows and artifacts, and can do so within a rule-based theoretical framework. These rules must be validated, and

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[65] Simine Vazire, "Implications of the credibility revolution for productivity, creativity, and progress," *Perspectives on Psychological Science* 13, no. 4 (2018): 411-417.

these know-hows must be found reliable. As these norms entered medicine after the Enlightenment – increasing diagnosis and treatment efficacy – there are nonetheless lessons to be learned from the brief frenzy of animal magnetism: lessons about scientific knowledge, its communication, and the value of a good show.

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