Investigating journal peer review as *scientific* object of study

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Journal peer review performed in the natural sciences has been an object of study since at least 1830[1]. Researchers mostly implicitly frame it as a rational system with expectations of rational decision-making[2]. This in spite of research debunking rationality where journal peer review can yield low inter-rater reliability[3], be purportedly biased[4] and conservative[5], and cannot readily detect fraud or misconduct[4,6]. Furthermore, journal peer review is consistently presented as a process started in 1665 at the first journals and as holding a gatekeeper function for quality science[3,4,5,7]. In contrast, socio-historical research portrays journal peer review as emulating previous social processes[8] regulating what is to be considered as scientific knowledge (or not) (cf., inquisition, censorship) and early learned societies as engaged in peer review with a legal obligation under censorship[2]. However, to date few researchers have sought to investigate journal peer review beyond a pre-constructed process or self-evident object of study based on common experience[9]. Here I construct journal peer review as a scientific object of study[10] with key analytical dimensions based on its structural properties and I analyze the contemporary form of *pre*-publication journal peer review (*traditional* peer

review). I use the theoretical concept of social form to capture how individuals relate around a particular content[11]. For the social form of 'boundary judgement' (i.e., journal peer review), content refers to decisions from the judgement of scientific written texts held to account to an overarching knowledge system. Given its roots in censorship[2] with its function of bounding science, I frame journal peer review as following precursor boundary judgement forms of inquisition and censorship. Furthermore, analysis reveals that secrecy for editorial judgements and anonymity for referees in *traditional* peer review are counter to journal peer review's legal roots and can curtail rational decision-making. Constructing journal peer review as a scientific object of study contributes to improving it based on *scientific* understanding.

In the 17th century, Bacon referred to pre-constructed objects of study (objects) as 'prenotions' or 'vulgar notions' based on a failure to go beneath the surface[12] to construct an object scientifically. The use of pre-constructed objects in alchemy and astrology, for example, created a boundary for these activities from chemistry and astronomy that purposefully and painstakingly

constructed objects[12]. Moreover, Leibniz advanced that a mathematician could build an equation reflecting the curb of a series of points that make up the contour of a face, but that such a construction would not go beyond the perception of the object, and would only reify common perception instead of challenging it[10]. In contemporary science, pre-constructed objects or parts thereof persist.

Einstein lay bare such a pre-constructed notion, for example, when he overturned the absolute nature of simultaneity for time [13]. Since Kant, the self-evident understanding of time with absolute simultaneity had been assumed as an a priori condition of knowledge[13]. In doing away with time as a self-evident, Einstein paved the way for his theory of special relativity.

While trying to elucidate a cause for peptic ulcers, in another example, a long-standing biopsychosocial understanding proposing that stress was one of the main factors that caused these ulcers[14] was at least in part owing to peptic ulcers viewed as a pre-constructed object. As pre-constructed, it was generally self-evident that bacteria could not live in the highly acidic human stomach[15] and that bacteria therefore could not be the cause of peptic ulcers. Even if randomized controlled trials did not support the stress model[14] and if antibiotic treatments appeared to work[14,15], peptic ulcers as a pre-constructed object long prevailed. Marshall and Warren encountered resistance to their Nobel Prize winning work that challenged the pre-construction by proposing the *H. pylori* bacterium as a cause for peptic ulcers[15].

Furthermore, in the social sciences 'spontaneous sociology'[10] tends to investigate pre-constructed objects such as communication, leisure[10], 'natural' disasters, and climate change using common experience criteria where it fails to properly construct scientific objects. It is not sufficient to use a scientific approach to investigate an object in the social (or natural) sciences, the object itself must be meticulously constructed to gain scientific status[10]. To properly construct a *social* object such as journal peer review, therefore, is to go beyond its operational character and common experience definitions as process. In addition to tending to the scientific construction of the object itself, like natural scientists, social scientists must tend to how an object is shaped[10] (i.e., Big Bang theory in astronomy) in order not to perpetuate the apparent naturalness of a pre-constructed object.

Since at least 1830[1] therefore, research on (natural) scientific and medical journal peer review that focuses on *process* and neglects shaping has failed to construct the object scientifically beyond its common sense pre-construction. As with the peptic ulcer object of study above, using rigorous scientific method (i.e., modelling[16] or randomised controlled trials[17]) on a poorly constructed object such as journal peer review as common experience *process*, with assumptions reflecting the apparent self-evidence and naturalness of *traditional* journal peer review, undoubtedly yields questionable scientific insights.

Moreover, researchers mostly implicitly frame journal peer review as a rational system with expectations of rational decision-making[2]. Such a normative framing further contributes to an ill-constructed object and might help explain why research on journal peer review reveals purported low inter-rater

reliability[3], bias[4], conservatism[5], and an inability to detect fraud or misconduct[4,6].

Ill-constructed journal peer review might also explain why researchers tend to attribute 'failings' of peer review to psychological, philosophical, and social causes such as bias, gender, age, epistemic conservatism, epistemic path dependence, and professional rank[4,18,19]. By attributing failings to causes external to peer review, researchers are engaging in 'asymmetrical accounting for error'[20] to account for discrepancies between expected rationality (cf., non-problematic decisions as rational) and empirically investigated non-rationality. A knowledge gap here is a need to produce understanding for journal peer review *itself* without resorting to external explanations and rationality.

One researcher who avoided journal peer review pre-constructed as process, Hirschauer, proposed that contemporary peer review can be understood as reciprocal accountability of judgements among peers[9]. Reciprocity means that authors and editorial readers are actively engaged in a process of mutual relations of accountability where the author is not unilaterally submitted to peer review[9]. Hirshchauer's conceptualization, though robust, was based on empirical research from the social sciences; it therefore appears to lack sensitivity to relations for journal peer review in the natural sciences. This knowledge gap on relations includes a pronounced relation of accountability to empiricism and relations of accountability to multiple actors with sometimes conflicting goals for authors, referees, and editors (i.e., to funders, journal publishers, and advertisers).

In addition, researchers take journal peer review as a self-evident object started at the first journals in 1665 without tending to its shaping[3,4,5,6,16,17]. This assumes journal peer review as a purely rational process borne of a need for rationality that is disembodied from the social conditions, the dynamics, the processes, and the contexts that contributed to its shaping. In contrast, historical research gives a glimpse into early journals that from their start held to account to sacred texts, the Church, and the State and maintained a legal obligation to perform censorship on scientific texts[2,8,21]. Gould brought attention to potential roots of peer review in the early 12th century at the start of inquisition and into censorship at the beginning of the printing press where scholarly inquisitors and censors performed 'peer' review[8]. Finally, Rip and Spier proposed historical footing for journal peer review in inquisition and its censorship function[22,23].

In spite of valuable insights, these researchers failed to construct a robust object owing in great part to a focus on apparent superficial self-evident commonalities instead of constructing deeper analogies[10] among inquisition, censorship, and journal peer review. Gould concentrated on 'peer review' from the 12th century onward[21] without due consideration for core characteristics that could distinguish these from self-evident objects, yet still allow generalisation[10] across inquisition, censorship, and journal peer review. Biagioli insisted on dissociating 'scientific peer review' from 'traditional religious censorship'[2] regardless that early learned societies were engaged in censorship practices and that conceptually these shared structural properties such as an overarching knowledge system bounding science that created contingency for new scientific knowledge entering into scientific

exchange. Rip and Spier for their part superficially focused historical analysis on specific cases of inquisition and censorship instead of identifying underlying analogies. This particular knowledge gap, therefore, relates to understanding analogies among inquisition, censorship, and journal peer review.

The above reveal a need to carefully construct journal peer review as a *social* object of study that breaks away from rational self-evidence by bringing attention to core relations. To construct journal peer review in this way, first I elaborate on how I harness the theoretical concept of social form. Second, I tend to shaping from precursor forms of inquisition and censorship since the 12th century. Finally, I propose a theoretical model for contemporary *traditional* peer review and briefly analyse its structural properties. The methods summary section presents the case study qualitative design and methods.

First, this work focuses mainly on the proposed social form of 'boundary judgement' where individuals aggregate around a common content – decisions as to what can be deemed scientific (or not) – based on the judgement of scientific written texts against an overarching knowledge system. The main social form, boundary judgement, interacts with a second social form, scientific exchange[11] (cf., the communication of scientific knowledge). For example, a scientist who presents a paper at a conference or submits a paper for publication in a journal is an actor in the form of scientific exchange.

What is more, to investigate social forms is to "…identify and classify the different forms of social interaction; […] to study the conditions under which they

emerge, develop, flourish, and dissolve; and to investigate their structural properties"[11]. Structural properties refer to elements that shape relations in a social form (i.e., types of relations (cf., economic, power, political, accountability), and structural dynamics such as anonymity, temporality of review, secrecy of review, and actors). An example of a structural property is closed access to editorial judgements in *traditional* peer review that shields these from outside actors while they are being constructed through negotiations among authors, referees, and editors and regulates closed access following a decision for a manuscript.

Second, I tend to shaping. A first social form of boundary judgement, inquisition, emerged in the 12th century as the investigation of heresy (cf., espousing beliefs that went counter to those of the Church or heterodoxy)[8,24]. Scholarly members of the Church engaged in inquisition for manuscript books and shorter written texts[8,24]. Although heresy had been common before the Middle Ages, the Church intervened by constructing the legal process of inquisition during the Middle Ages in order to deal with a growing number of heretics and increasing violent actions of the population dealing with heretics as they saw fit[24].

The emergence of the legally-binding social form had a goal of giving heretics an opportunity to repent and "return to the faith"[24], that for scholars translated into espousing dominant Latin Christian-sanctioned scientific knowledge. Heretics were problematic for the Latin Christian Church that tried to prevent the spread of 'error' and preserve orthodox religious beliefs[25,26]. Change in relations here included religious actors now holding explicit dominating relations of

power over texts and scholars accused of heresy. By doing so, the social form of inquisition helped reproduce boundaries for scientific knowledge – scholars who returned to the faith would thus abandon 'heretic' knowledge deemed as 'non-scientific' in that context. Decisions therefore determined what could be deemed scientific (or not) – based on the judgement of scientific written texts against religion as a knowledge system. Finally, concordance with Roman legal procedures meant upholding non-anonymity for inquisitors who made judgements and who could be held to account for judgements, shielding the proceedings themselves, and making judgements public[26].

Core structural properties stand out for inquisition. First, temporally, judgement and decisions on texts occurred *after* scientific knowledge had circulated therefore there was no contingency placed on the form of scientific exchange. In addition, already printed texts that were 'corrected' produced 'open' judgements. Second, it held texts, authors, and inquisitors in a main relation of accountability to orthodox doctrine. Third, scholars acted as authors and frequently as inquisitors judging written work. Fourth, inquisitors were non-anonymous in keeping with Roman legal procedures. Fifth, structural secrecy shielded outside actors from the inquisitor procedures (closed to outside actors) but final verdicts and sentencing details were public (open). Corroborating transparency, documents from the Spanish Inquisition are available to this day[26].

With the advent of printing came the new role of censor, new institutional actors including learned societies, and new structural properties within the emerging social form of censorship.

Scholar actors engaged in the role of specialized scientific censors. In England, it was around 1530 that the licensing system started under the control of legal mechanisms to prevent printers from publishing without prior approval by State-sanctioned authorities[21]. Moreover, new and varied economic and political relations entered the social form. These involved the Crown, the State, universities, printers, and booksellers.

Structurally, a shift from *post-* to *pre-*publication boundary judgement in censorship meant that the Church constructed a series of new legal relations. Scientific texts could now be held to relations of accountability to State/Crown prerogatives and sacred texts before and/or after publication. In the Spanish Inquisition in the 17th century, for example, criticism of censorship was founded on "…the belief that the censorship functions of the Inquisition were an attack, not exclusively upon doctrinal error, but on the expression of ideals itself"[26]. Contemporary accounts of suppression of new ideas in *traditional* peer review[5,8], therefore, mirror 17th century criticisms where a change in boundary judgement social form went from *post-* to *pre*-publication in censorship. The change created contingency for scientific exchange where scholars could no longer engage in exchange without *first* having their text enter into boundary judgement.

To further contextualize, for the Church one goal was to brand texts by 'separating bad from good books' and to protect by 'saving the reader from moral injury'[27]. Protection implied that the reader was not capable of judgement in the relation with the text and needed to be shielded from harm. By analogy, the

social form of censorship corroborates decisions based on the judgement of scientific written texts against a dominating knowledge system – here still religion.

Of interest is that the new learned societies in London and Paris obtained the privilege of controlling academic censorship[2]. With these new functions and within a context of frequent stealing of scientific works[21] emerged the social form of early journal peer review with an editor. The shorter journal format was better suited to publish quickly and prevent theft of written works[21].

Early examples of censorship include the Royal Society's *Philosophical Transaction* delaying the publication of a paper owing to a relation of accountability to the King and the temporary closure of the *Journal des Sçavans* in France with accountability to the Jesuits and sacred texts[2,21]. In addition, at the Royal Society practices to establish priority included secretive rights of 'perusal and consideration' by the editor and potentially other members[21] that enacted secrecy and boundary-making between those engaged in science at the Royal Society and those who were not. Boundary judgement decisions were shared with authors, and archives could be consulted by members[21] but were structurally closed to access instead of public as for inquisition and censorship.

Moreover, members that did not take part in scientific exchange practices contingent on journal peer review were pressured to do so. This was the case for astronomer John Flamsteed in the 17th century, for example[21]. Flamsteed contemplated resigning his residency as royal astronomer given "ye impertinences of a croud of visitants" who sought "immature papers and

wrietings forced forth of my hands & detained as if I had no interest in them"[21]. The quote highlights a tension between more private work where Flamsteed could be "Master of my selfe"[21] and the Royal Society that promoted the scientific exchange of short written papers through relations of power over peer review and text ownership[21].

The Royal Society was thus shaping early journal peer review as a dominant social form to construct value for scientific knowledge while also creating a relation for rights over knowledge for the Royal Society. In parallel, a new relation of accountability to experimentalism arose which eventually became to empiricism[21]. In the late 18th and early 19th century, science eventually became self-regulated as the dominance of the Church receded. The social forms of inquisition and (most) censorship eventually dissolved[26] and from that point forward the only overarching knowledge system was science itself. Once more, by analogy, the archetypical form of journal peer review corroborates decisions based on the judgement of scientific written texts against a dominant knowledge system – now science. Finally, it is difficult to pinpoint when referee anonymity became a widespread practice in journal editorial peer review. Anonymity might have become more prevalent from 1832 onward[28], and given self-regulation, science had abandoned its legal roots with premises of accountability and transparency.

In this final part, empirical research helps construct a model for a particular contemporary paradigmatic social form at natural science and medical journals: *traditional* peer review (Fig. 1). It is a 'traditional' form used at journals framed as dominant (i.e., *Nature*,

Figure 1: Model of the boundary judgement social form of *traditional* peer review at natural science and medical journals
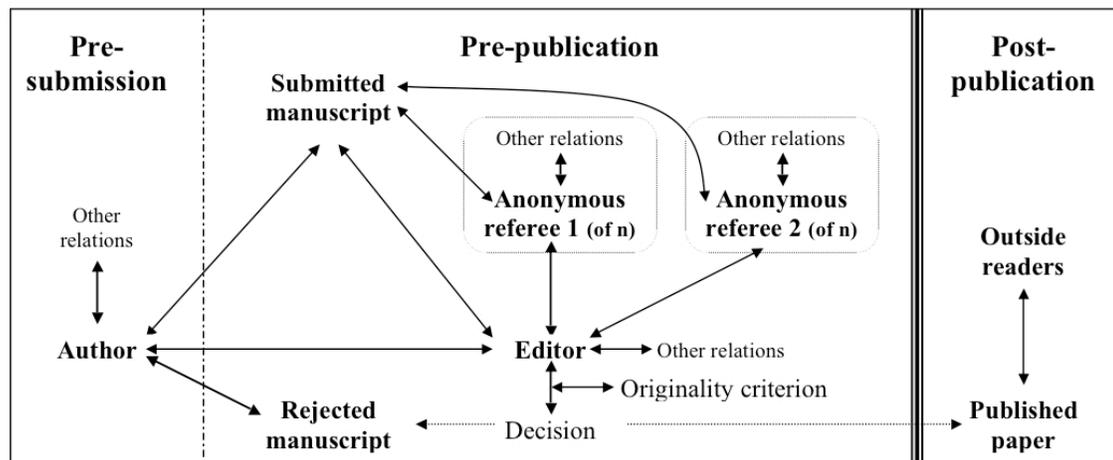
Structural properties start with 3 temporal periods from left to right: pre-submission, pre-, and post-publication. Main actor roles depicted are author, submitted manuscript, editor, anonymous referees (1 and 2 of n), and in the post-publication period, outside readers. Each actor role holds relations as depicted with arrows and additional respective social relations and relations of accountability as 'Other relations'. The editor role uses a criterion of originality to construct a decision. The boundary judgement decision relates with the editor and either a rejected manuscript or a published paper. Scientific exchange contingent on review is designated with bold vertical lines between *pre-* and *post*-publication that also depicts *pre*-publication as structurally closed to outside actors.

Science, *The Lancet*) and by innumerable other journals worldwide. It attained greater capacity to restrict scientific exchange when in the mid-1960s, the Ingelfinger rule was put in place that prevented authors from submitting a manuscript to several journals or publication venues. By paradigmatic, I mean that *traditional* peer review acts as the prototype for journal peer review against which all other contemporary social forms of journal peer review are typically compared (cf., other forms such as that at *PLoS ONE* without a criterion for originality and at journals with social forms sporting structural properties of open access to editorial judgements and non-anonymity for referees).

In contrast with research that focuses on process, the model (Fig. 1) brings attention to structural properties. These can otherwise remain invisible including: economic and political relations, relations of accountability,

structural closure in *pre*-publication, a confluence of relations to the role of editor that contributes to potentially increased power in the role, and strictly guarded duplication of published papers.

To start, the role of author holds additional relations of accountability to editorial guidelines, readers, sponsors/funders, and empiricism. In addition, interviewees corroborated that when submitted manuscripts remain invisible this can lead the author role to hold lower accountability to a manuscript and submit less optimal writing with a goal to gather feedback for subsequent submissions. This can then potentially burden already-strained referee resources.

For the role of editor, additional political and economic social relations and relations of accountability include those with board members, advertisers, the journal publishers/owners, empiricism, guidelines, the boundary judgement decision, and readers. The

relation of accountability to readers is linked with a criterion for originality through which the role of editor purportedly constructs value for the reader by increasing selectivity in manuscript selection. This criterion harks back to censorship where protection implied that the reader was not capable of judgement in the relation with the text and needed to be shielded from harm – in this case one harm being research with 'less' value. Viewing the relation of accountability to readers as 'protection' also assumes that the reader be shielded from decision-making for manuscripts and must engage in blind trust that boundary judgement leads to protection from 'bad' research.

For anonymous referees in contrast, relations of accountability are limited whereby anonymous judgements hold less potential for impact on an 'unknown' referee. At worst, editors can stop asking a referee to peer review or can refuse to consider a judgement from a referee. Nonetheless, potential accountability relations for referees include those to editorial guidelines, empiricism, funders/sponsors, and their judgement that contributed to the boundary judgement decision. The 'competing interests' forms that authors and referees are frequently required to complete prior to engagement in journal peer review substantiate the importance of these potentially conflicting relations. Moreover, interviewees and self-accounts in case studies support that for authors, anonymity in the role of referee contributes to lack of trust in the role and in referee judgements.

Lastly, outside readers hold a relation of accountability to empiricism that can contribute to post-publication corrections and retractions.

Finally, I analyse how two elements in the model can contribute to decreased potential for rational decision-making: anonymity for referees and structurally closed access to referee judgements and boundary judgement decisions. I draw from interviews and contemporary legal scholarship[29] as legal studies have confronted what appear as similar dynamics to those of structural secrecy and anonymity in traditional peer review when dealing with 'faceless courts'[30] (where the judge remains anonymous).

Waddams argued that 'justice', 'rule of law', and 'impartiality of the tribunal' are idealized forms that in Western society have yet been attained[29]. With respect to impartiality of the tribunal, he further argued that "[n]o judge can free herself from her background and surroundings. In a sense no judge who is not an automaton can be completely impartial"[29]. Congruent with Hirschauer, Waddams advanced that the idea of eliminating legal argument in order to allow individual judges to simply make sensible decisions is a form of 'palm tree justice'[29]. For Hirschauer, this equated with the impossibility of a 'wise prejudice free' individual dispensing peer review judgements[9]. The *traditional* peer review social form model (Fig. 1) illustrates how the editor role could be placed in such a position of power with ultimate control over decisions and a confluence of relations that structurally keeps other roles from relating with one another (cf., author and referee roles). A solution, according to Waddams, is to ensure transparency where "[t]here is no better guarantee of impartiality and rationality in decision-making that the requirement of reasons open to the scrutiny of the public"[29]. Transparency includes naming those who engage in judgement in order to

ensure accountability and credit for the role[4,17,30] as was the case in precursor forms.

The structurally closed social form of *traditional* peer review, therefore, with anonymous referees, increased power in the role of editor, and no transparency for editorial judgements and boundary judgement decisions, is thus perhaps less likely to contribute to rational decision-making, much like 'faceless courts' and the problems they face with corruption[30]. In Columbia, for example, "[w]ith almost no public accountability, the faceless courts seemed to be designated as a cover for corruption"[30]. Like Knoester who argued that Columbian faceless courts might be exploited by American business interests[30], here I argue that *traditional* peer review appears more susceptible to abuse by publishers, authors, and editorial readers. Structural secrecy for editorial judgements and anonymous referees 'hide' how manuscript decisions are made and render a meaning of scientific knowledge as 'absolute' and 'truth-like'. Moreover, hiding the messiness of valuation of scientific knowledge in *traditional* peer review can be an important tool to uphold journal business models that tend to give scientific knowledge a meaning of *news*.

To conclude, investigating journal peer review constructed as a scientific object leads to insights that can help manage and potentially reduce the plethora of peer review social forms in use at natural science and medical journals. Following are at least four interrelated selection criteria that could contribute to the task: potentially higher or lower (1) rational decision-making; (2) trust, accountability to judgements, and credit for the role of referee; (3) contingency on scientific exchange; and (4) accountability to submitted manuscripts for the role of author. Structural properties of *traditional* peer review, as analyzed in this paper, tend to: minimize the potential for rational decision-making, lead to lower trust, accountability to judgements, and credit for the role of referee, create maximal contingency on scientific exchange, and minimize the accountability relation of authors to their manuscripts.

If the main goal is *quality* in scientific publication, selection of a particular boundary judgement social form should be based on a *scientific* understanding of peer review as object. Selection should not simply reflect the apparent dominance of a specific social form – in this case *traditional* peer review – because its dominance is so entrenched that its naturalness is not questioned.

METHODS SUMMARY
I used a case study qualitative research design. For the shaping of journal peer review, I performed document analysis mostly on (socio-)historical secondary documents and some primary documents. For the model of *traditional* peer review, I performed document analysis on primary and secondary documents including editorial judgements, published papers, and journal editorial guidelines. I also performed inductive analysis with 25 case studies and 11 semi-structured interviews with authors and editors. Cases rendered *traditional* peer review dynamics visible through purported resistance to new scientific ideas in manuscripts. They include 19 Nobel Prize® laureate cases with 22 laureates (some cases had multiple authors), 3 individual authors who were not laureates but who's new ideas nonetheless purportedly encountered

resistance, 2 area of study cases where one had a dearth of new ideas and another purportedly encountered resistance to a new idea, and one journal that converted from editorial-only review to journal peer review following the publication of a controversial paper. In all, the cases featured 31 journals that engaged in variations of *traditional* peer review.

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