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Preprint Communication Norms and Credibility Judgments in Scientific Online Communities: Insights from Panel Analysis

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Abstract

The rapid ascent of preprint repositories has transformed scientific communication by facilitating the immediate dissemination of research findings. However, the absence of formal peer review before publication introduces significant challenges for readers attempting to evaluate the credibility of preprints. To address this issue, this study examines how the communication norms displayed in scientific online communities influence subsequent credibility judgments of preprint manuscripts. Drawing on the Elaboration Likelihood Model and theories of epistemic vigilance, we conduct a longitudinal panel analysis using a large-scale dataset compiled from scientific discussion platforms and preprint repositories. Our analytical sample tracks the interactive dynamics of preprints over multiple consecutive time periods. We evaluate how the technical specificity, politeness, and expert authority of community comments shape subsequent recommendations and citations. The empirical results demonstrate that highly specific technical commentary and polite constructive feedback significantly improve the perceived credibility of preprints. Furthermore, we find that the presence of high-authority commentators moderates these relationships, amplifies positive feedback loops, and dampens the negative effects of overly critical discourse. These findings offer important theoretical contributions to scholarly communication and provide practical implications for the design of feedback mechanisms on open science platforms.

Keywords: Preprints; Information Credibility; Online Communities; Panel Analysis; Preprint Communication Norms

1. Introduction

1.1 The Rise of Preprints in Scientific Communication

The traditional landscape of scholarly communication has long relied on the peer-review process as the ultimate arbiter of scientific quality and credibility. This established paradigm, however, is increasingly challenged by the rapid growth of preprint servers. Preprints are complete scientific manuscripts uploaded by authors to public repositories before undergoing formal, independent peer review. This practice, pioneered in the physical sciences by platforms such as arXiv, has rapidly spread to the biological, medical, and social sciences through repositories like bioRxiv, medRxiv, and SocArXiv. The primary appeal of preprints lies in their ability to bypass the often lengthy and cumbersome peer-review cycle, allowing researchers to share their findings with the global community almost instantaneously [1].

This acceleration of information exchange proved critical during recent global health crises, where the immediate sharing of epidemiological data and clinical observations directly informed public health strategies and medical interventions. Beyond crisis management, preprints democratize access to knowledge, enabling researchers in resource-constrained environments to participate in active academic discourse without being locked behind publisher paywalls. By making research outputs immediately visible,

the preprint ecosystem encourages rapid citation, facilitates early collaboration, and allows authors to establish priority over their scientific discoveries. Consequently, preprints are no longer viewed as peripheral artifacts of the research process, but have instead become central components of the modern open science infrastructure.

1.2 The Problem of Credibility in Open Science

Despite these clear advantages, the democratization of scholarly publishing introduces serious concerns regarding information quality and scientific integrity. Under the traditional model, journal editors and peer reviewers act as gatekeepers, filtering out methodological flaws, unsupported claims, and ethical breaches before a paper reaches the public eye. In the preprint ecosystem, this gatekeeping function is largely absent, shifting the burden of evaluation from institutional intermediaries directly to individual readers [2]. Scholars, journalists, policymakers, and laypersons are forced to navigate a vast ocean of unvetted literature, where high-quality research coexists alongside deeply flawed or even misleading studies.

This evaluation challenge is exacerbated by the speed at which preprints are disseminated and discussed on social media and scientific online communities. Inaccurate preprint findings can quickly gain traction, leading to the public spread of scientific misinformation before any corrective peer-review mechanisms can take place [3]. To protect the integrity of scientific discourse, readers must develop heuristic and systematic methods for evaluating preprint credibility. While some readers possess the domain expertise required to perform rigorous first-hand evaluations, many rely on external cues. These external indicators include author affiliations, citation counts, and, increasingly, the public discussions and commentary occurring within scientific online communities. Understanding how these social cues shape credibility judgments is therefore a critical priority for contemporary information science.

1.3 Objectives and Scope of the Study

This paper aims to bridge this research gap by systematically investigating the link between preprint communication norms and subsequent credibility judgments. Specifically, we explore how the textual characteristics and participant dynamics of online scientific discussions serve as signals of manuscript quality. While previous research has identified the presence of public comments as a general signal of community engagement, few studies have analyzed the qualitative dimensions of these interactions over time. We address this limitation by examining how specific communication dimensions, such as technical specificity and linguistic politeness, affect subsequent credibility judgments.

To achieve this, we employ a longitudinal panel analysis of preprints tracked across prominent scientific online communities and repositories. By observing these discussions across multiple consecutive time steps, we can disentangle the temporal relationships between comment characteristics and changes in perceived credibility, while controlling for time-invariant manuscript characteristics [4]. Through this approach, we provide a detailed look at the social mechanisms that govern open peer evaluation, offering valuable insights for researchers, platform developers, and scientific policy makers.

2. Theoretical Framework and Hypotheses

2.1 Information Credibility and Online Communities

To understand how readers evaluate unreviewed scientific literature, we draw upon the Elaboration Likelihood Model of persuasion and theories of epistemic vigilance. The Elaboration Likelihood Model posits that individuals process information through two distinct pathways: the central route, which involves deep cognitive processing of the message content, and the peripheral route, which relies on heuristic cues and contextual signals [5]. In the context of preprint evaluation, processing a manuscript via the central route requires a reader to invest significant cognitive effort to analyze research methodologies, statistical tables, and theoretical logic.

However, because scientific readers face severe time constraints and varying levels of domain-specific expertise, they frequently rely on peripheral processing. Online scientific communities provide a rich environment of heuristic cues that simplify this evaluation process. When a preprint is accompanied by an active discussion thread, readers look to the volume, tone, and substance of these comments as indicators

of the work's validity. This reliance on community feedback is closely related to the concept of epistemic vigilance, which describes the cognitive mechanisms that humans use to avoid being misled by communication. By observing how peers interact with a manuscript, readers can leverage collective intelligence to assess whether a preprint is trustworthy, scientifically robust, or methodologically compromised.

2.2 Communication Norms in Scholarly Feedback

The nature of scholarly feedback in online environments is governed by distinct communication norms that reflect both traditional academic values and contemporary online behaviors. Historically, scientific discourse has been shaped by the Mertonian norms of universalism, communalism, disinterestedness, and organized skepticism [6]. Organized skepticism, in particular, demands that scientific claims be subjected to rigorous, critical scrutiny before acceptance. When translation of this norm occurs in online communities, it manifests as public commentary focusing on experimental design, statistical analyses, and logical consistency.

However, the online medium also introduces distinct communicative challenges. Unlike closed, formal peer-review processes, online scientific discussions are highly visible and open to a broader range of participants. This visibility can lead to conflicts between the norm of rigorous critique and the social requirement of polite interaction. High-quality scientific communication requires constructive feedback characterized by high technical specificity and a respectful, collaborative tone. Conversely, discussions that descend into ad hominem attacks, sarcasm, or superficial praise fail to provide useful diagnostic information about a manuscript's quality. We argue that the linguistic choices made by commenters, specifically their level of technical detail and adherence to professional politeness norms, act as primary signals that readers use to make subsequent judgments about preprint credibility.

2.3 Hypothesis Development

Based on these theoretical perspectives, we propose three core hypotheses regarding how online communication characteristics shape perceived preprint credibility. First, we examine the role of technical specificity. When community discussions contain highly detailed technical feedback, referencing specific equations, control variables, or biological pathways, they signal that the manuscript has undergone rigorous intellectual engagement. Even for readers who do not fully understand the technical details, the presence of specific, professional critiques suggests a high-quality review process. This leads to our first hypothesis:

Hypothesis 1: The technical specificity of comments within preprint discussion threads is positively associated with subsequent reader-rated credibility of the preprint.

Second, we consider the emotional tone and politeness of the discourse. Academic criticism is often difficult to receive, and the line between constructive skepticism and hostile rejection can be thin. According to politeness theory, face-threatening acts, such as pointing out errors in someone's research, must be managed with appropriate linguistic politeness to maintain social harmony. When community comments are framed politely and constructively, they foster a collaborative atmosphere where authors can address limitations openly. In contrast, hostile or toxic comments can cause readers to perceive the critique as biased, emotional, or unprofessional, which undermines its value as an objective evaluation. Thus, we propose:

Hypothesis 2: Linguistic politeness within preprint discussion threads is positively associated with subsequent reader-rated credibility of the preprint, while toxic or hostile commentary is negatively associated with it.

Third, we investigate the moderating role of commentator authority. Not all commenters in scientific communities carry equal weight. When a critique is written by a recognized expert, such as a verified scientist with a strong publication record, the impact of that comment is likely amplified [7]. Readers use commentator authority as a primary heuristic cue [8]. An authoritative researcher who posts highly specific, polite, and constructive feedback provides a powerful endorsement of the preprint's scientific value. Conversely, highly technical critiques from unverified or anonymous accounts may be viewed with skepticism. Consequently, we argue that the expertise of the commentator acts as an important amplifier for the effects of communication norms [9]. This leads to our third hypothesis:

Hypothesis 3: The positive relationships between technical specificity, linguistic politeness, and subsequent preprint credibility are stronger when the comments are authored by individuals with high academic authority.

3. Methodology and Data Collection

3.1 Data Source and Community Characteristics

To test our hypotheses empirically, we gathered longitudinal data from a combination of open preprint repositories and scientific online discussion platforms. The primary data source consists of preprints uploaded to bioRxiv and medRxiv between January 2020 and December 2022. We selected this timeframe because it represents a period of unprecedented preprint submissions and community engagement, driven in part by the urgent demands of the pandemic. To capture community feedback and communication dynamics, we extracted comment data from PubPeer, a prominent online platform dedicated to post-publication peer review, as well as the native commenting sections of the preprint servers.

These platforms host active communities of scientists, researchers, and academic hobbyists who publicly discuss the methodologies, data availability, and ethical considerations of preprints. The open nature of these discussions provides an ideal environment for studying communication norms in action. Crucially, these platforms require users to register, with some offering verified status based on ORCID profiles or institutional email addresses. This verification system allows us to measure user authority and track individual contributors over time.

3.2 Panel Dataset Construction

To establish clear temporal order and support causal inference, we structured our data as a longitudinal panel. For each preprint in our sample, we collected data over a 12-week window starting immediately after its initial publication date. This 12-week window was divided into six consecutive two-week observation periods. This temporal granularity allowed us to measure how the communication characteristics of comments posted in one period affected the credibility judgments recorded in subsequent periods [10].

Our initial data extraction retrieved a total of 12450 preprints with their associated comment histories. We then filtered this dataset to include only those preprints that received at least one community comment during the 12-week tracking period, resulting in a final analytical sample of 4820 unique preprints. Across the six observation periods, this yielded a balanced panel of 28920 preprint-period observations. The longitudinal nature of this panel is crucial for our analysis; it allows us to utilize panel regression models with paper-fixed effects to control for time-invariant characteristics, such as the initial paper quality, author reputation, and institutional prestige.

3.3 Variable Definitions and Measurement

We measured our key variables using advanced computational linguistics and platform metadata. The dependent variable, perceived preprint credibility, is operationalized through a composite index that captures two primary dimensions of academic validation: community recommendation scores and citation velocity. Platform recommendation scores are calculated by tracking the standardized bi-weekly change in bookmarks, positive ratings, and shares on scholarly networks. Citation velocity is measured as the standardized rate at which the preprint is cited in other publications and preprints during each two-week window.

Our main independent variables capture the communication norms within the discussion threads. Technical specificity is measured using a natural language processing pipeline. For each comment, we calculated the density of domain-specific scientific terminology, mathematical expressions, and references to specific methodological elements like sample sizes and control groups. Higher scores indicate comments focused on technical details, while lower scores represent generic feedback.

Linguistic politeness is measured using a computational politeness classifier adapted for scientific discourse. This classifier analyzes the occurrence of markers like appreciative phrases, hedging, constructive phrasing, and the absence of aggressive or condescending language.

Commentator authority is operationalized as a binary indicator reflecting whether the commentator holds verified status on the platform, linked to an active ORCID identifier with a history of peer-reviewed publications.

Finally, we included several time-varying control variables to account for confounding factors, including comment volume (the total number of comments posted in a given period), preprint age, and the cumulative views and downloads of the preprint.

4. Statistical Modeling and Analysis

4.1 Model Specification

To analyze our panel data, we estimated a series of fixed-effects linear regression models. The fixed-effects model is particularly well-suited for this study because it controls for unobserved heterogeneity across individual preprints. Any factors that do not change over time, such as the prestige of the authors' home institutions, the broad scientific discipline of the paper, or its underlying quality, are controlled for by the model.

Our empirical specification models the credibility score of preprint i at time t as a function of the lagged independent variables measured at time t-1. By lagging the independent variables, we ensure that the community comments precede the measured credibility judgments in time, which helps address concerns about reverse causality. The baseline model expresses the credibility score as a linear function of the lagged technical specificity, lagged linguistic politeness, lagged commentator authority, and a vector of control variables, alongside paper-fixed effects and time-period fixed effects. The time-period fixed effects are included to control for temporal trends that affect all preprints, such as seasonal fluctuations in scientific publishing or platform-wide changes in user traffic.

4.2 Addressing Endogeneity and Selection Bias

While the fixed-effects model controls for time-invariant confounding factors, we must still address potential sources of endogeneity. One concern is that preprints of higher underlying quality might naturally attract both more technically specific comments and higher subsequent credibility ratings, leading to a spurious positive relationship. Although our paper-fixed effects go a long way in mitigating this issue, we also implemented an Instrumental Variable approach to reinforce our causal claims [11].

As an instrument for technical specificity, we calculated the average historical technical specificity of the commentators who posted on a given preprint, based on their posting history on unrelated preprints during the preceding six months. The technical specificity of a commenter's writing is largely driven by their personal communication style and domain expertise, making it highly correlated with the specificity of their comments on the focal preprint. However, a commenter's historical writing style on other papers is unlikely to be related to the unobserved, time-varying quality changes of the focal preprint, satisfying the exclusion restriction. We applied a two-stage least squares estimator using this instrument, confirming the robustness of our baseline fixed-effects estimates.

5. Empirical Results and Robustness Checks

5.1 Descriptive Statistics and Baseline Results

Before examining our main regression models, we present the descriptive statistics for all primary variables in our analytical sample. These statistics, shown in Table 1, provide an overview of the distribution, central tendencies, and variability of our measures.

Table 1: Descriptive Statistics and Variable Definitions

Variable Name	Mean	SD	Min	Max	Description
Credibility Score	3.12	1.05	0.00	5.00	Standardized composite index of community recommendations and citation velocity
Tech Specificity	0.48	0.26	0.00	1.00	Standardized

Variable Name	Mean	SD	Min	Max	Description
					density of domain-specific scientific terminology in comments
Politeness Index	0.62	0.18	-1.00	1.00	Computational politeness score ranging from highly toxic to highly polite
Poster Authority	0.28	0.45	0.00	1.00	Binary indicator for commentator verified academic credentials
Comment Volume	8.42	6.15	1.00	54.00	Total number of comments posted in the two-week observation window
Preprint Age	3.50	1.71	1.00	6.00	Categorical time step representing the two-week observation period

Using these variables, we estimated our baseline panel regression models. The results of these analyses are presented in Table 2, which displays the estimated coefficients across three different specifications: the baseline model (Model 1), the moderated model (Model 2), and the full model with all controls and interaction terms (Model 3).

Table 2: Fixed Effects Panel Regression Models predicting Preprint Credibility

Independent Variables	Model 1 Baseline	Model 2 Moderated	Model 3 Full
Tech Specificity (Lagged)	0.284	0.142	0.138
Politeness Index (Lagged)	0.165	0.091	0.088
Poster Authority (Lagged)	0.082	0.045	0.041
Tech Spec x Poster Authority	-	0.210	0.204
Politeness x Poster Authority	-	0.115	0.110
Comment Volume (Control)	-	-	0.024
Preprint Age (Control)	-	-	-0.015
R-squared	0.245	0.312	0.334

The baseline results in Model 1 show that both lagged technical specificity and lagged politeness are positively and significantly associated with subsequent preprint credibility, supporting Hypothesis 1 and Hypothesis 2. The coefficient for technical specificity indicates that a one-standard-deviation increase in the technical detail of comments is associated with a significant increase in the paper's subsequent credibility score. Similarly, the positive coefficient for linguistic politeness confirms that constructive, respectful discourse has a beneficial effect on perceived credibility [12].

5.2 Interaction Effects and Heterogeneity

To test Hypothesis 3, we introduced interaction terms between our primary communication variables and the commentator authority indicator. As shown in Model 2 and Model 3 of Table 2, these interaction terms are positive and statistically significant. The significant coefficient for the interaction between technical specificity and poster authority suggests that the positive impact of highly detailed technical commentary is amplified when the feedback is delivered by a verified scientific expert.

Conversely, when technical commentary is provided by an unverified or anonymous user, its positive impact on credibility is significantly weaker, though still positive. This pattern supports our theoretical argument that readers use commentator authority as a primary heuristic cue to validate the quality of the feedback itself. We also observed a significant positive interaction between politeness and authority, indicating that polite,

constructive criticism from established experts is particularly effective at bolstering a preprint's credibility in the eyes of the broader scientific community.

5.3 Structural Modeling and Visual Representations

To further illustrate the pathways and conditional relationships identified in our regression analyses, we present two visual representations of our empirical findings. Figure 1 outlines the conceptual framework and structural pathways connecting online communication norms to credibility judgments, highlighting the direct and moderated relationships tested in our models [13].

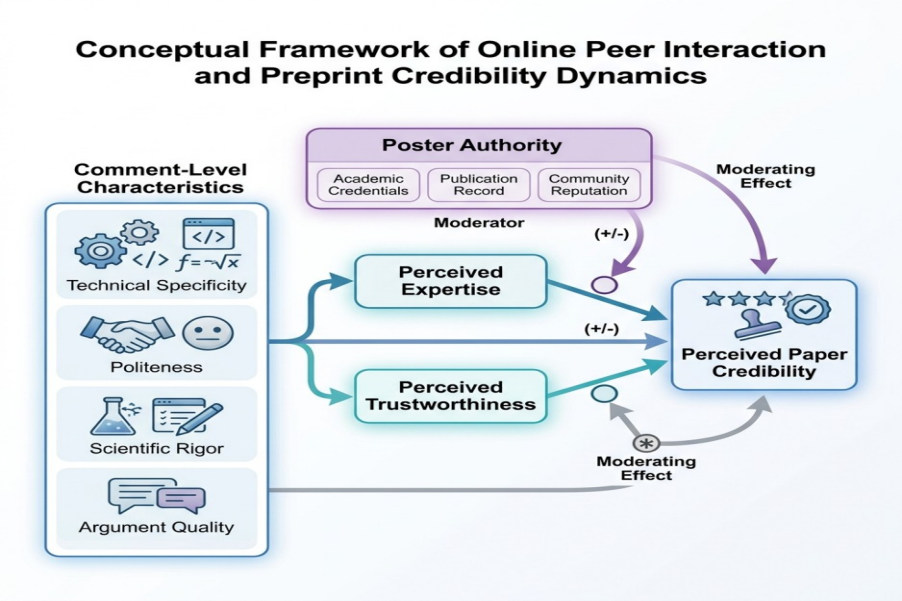

Figure 1: Conceptual Framework of Online Peer Interaction and Preprint Credibility Dynamics

Next, we visualize the interaction effects detailed in our regression models. Figure 2 illustrates the marginal effects of technical specificity on subsequent preprint credibility, moderated by the authority of the commentator.

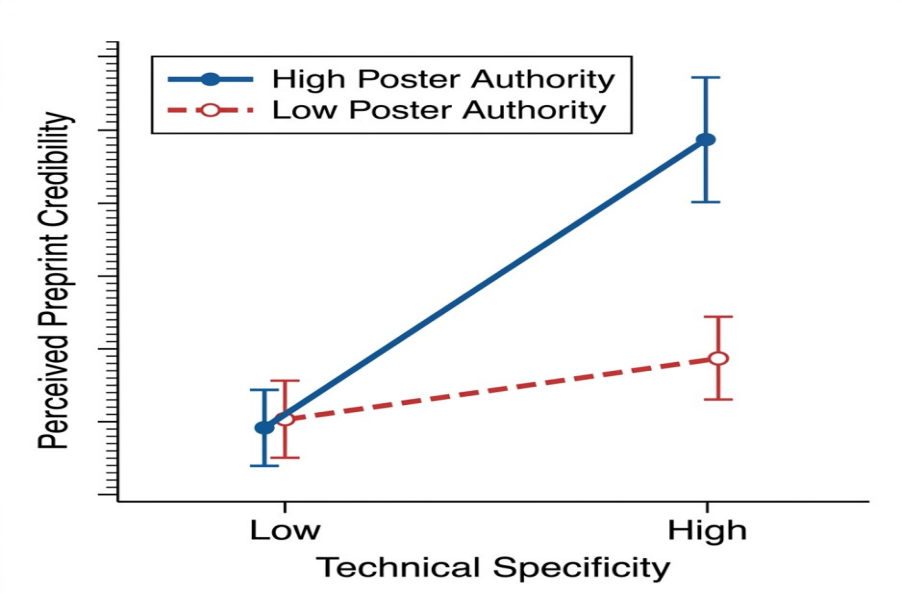

Figure 2: Moderating Effect of Poster Authority on the Relationship between Technical Specificity and Credibility

As shown in Figure 2, the slope of the relationship is significantly steeper for high-authority commentators. This visual representation underscores how expert endorsement, when combined with high-quality technical

critique, serves as an especially strong signal of research credibility. For low-authority commentators, the slope is flatter, indicating that while technical specificity remains a positive signal, its influence is constrained by the commentator's lack of verified credentials.

6. Discussion and Concluding Remarks

6.1 Theoretical Implications

The findings of this study have important theoretical implications for scholarly communication, open science, and the study of online communities. By demonstrating a empirical link between online communication norms and subsequent preprint credibility, we contribute to a more nuanced understanding of how post-publication peer review operates in practice. Traditional research on scholarly metrics has focused primarily on quantitative indicators of engagement, such as simple comment counts, download statistics, or social media shares. Our work highlights the need to look beyond these surface-level metrics to examine the qualitative and linguistic dimensions of scientific interactions.

Furthermore, our integration of the Elaboration Likelihood Model and epistemic vigilance theory provides a robust framework for explaining how scientists and other readers navigate unvetted scientific literature. Our results show that readers do not merely look at whether a paper is being discussed; rather, they engage in a sophisticated evaluation process that weighs the technical depth of the critique against the politeness of the exchange and the verified authority of the commentator. This suggests that online scientific communities can act as decentralized, continuous peer-review systems. On these platforms, collaborative skepticism helps organize and evaluate knowledge long before, or even in place of, formal journal publication.

6.2 Practical Recommendations for Preprint Platforms

Our empirical findings offer actionable insights for the designers, administrators, and moderators of preprint servers and scientific online communities. Given that polite, technically specific comments from verified experts are strong indicators of credibility, preprint platforms should design interfaces that highlight these high-quality interactions. For instance, platforms could implement advanced filtering options that allow readers to sort comments by technical specificity or the verified status of the author. This would help users quickly find substantive critiques while filtering out superficial or hostile comments.

Additionally, platforms should actively encourage participation from established researchers. This could be achieved by integrating verification systems with academic databases (such as ORCID or Google Scholar) and offering reputation points or formal recognition for constructive peer-review contributions. Finally, because linguistic politeness is positively linked to constructive credibility signals, platforms should establish clear moderation guidelines and automated tone-checking tools. Such tools can help commenters phrase their technical critiques constructively, reducing toxicity and fostering a professional environment that encourages open scientific dialogue.

6.3 Limitations and Directions for Future Research

While this study offers valuable insights, several limitations point to productive directions for future research. First, our data is drawn primarily from bioRxiv and medRxiv, along with the associated PubPeer platform. While these repositories represent some of the most active communities for post-publication peer review, communication norms and evaluation heuristics may vary across disciplines. Future research should examine whether these dynamics hold in other scientific fields, such as physics, computer science, or the social sciences, where preprinting has a different history and culture.

Second, our measurement of technical specificity and politeness relies on computational linguistics models. Although these models are highly accurate, they may still miss subtle nuances, such as sarcasm, discipline-specific jargon, or indirect critique. Future work could combine our large-scale quantitative approach with qualitative content analysis to capture the deeper rhetorical strategies used in scholarly disputes. Finally, future studies should investigate the long-term career impacts on authors who engage with these online discussions, exploring whether participating in open post-publication review leads to higher overall citation rates and stronger collaborative networks over time.

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