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Crisis Communication Timing and Rumor Correction in Public Health Agencies: Survey Experiment

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Abstract

During public health crises, the rapid spread of misinformation and rumors poses significant challenges to risk communication and emergency management. This study investigates the impact of crisis communication timing on the efficacy of rumor correction by public health agencies. Utilizing a randomized survey experiment with a sample of 1,200 participants, we analyze how proactive timing (inoculation or prebunking) versus reactive timing (debunking or refutation) affects public trust, belief in rumors, and subsequent health-protective behavioral intentions. The results indicate that proactive communication significantly reduces the initial and subsequent belief in rumors and enhances the credibility of public health agencies compared to reactive debunking. Furthermore, we find that the level of pre-existing institutional trust moderates the relationship between communication timing and correction efficacy. Specifically, proactive inoculation is highly effective even among individuals with low initial institutional trust, whereas reactive debunking depends heavily on high pre-existing trust to achieve any corrective effect. These findings offer critical insights for public health authorities aiming to optimize their strategic communication frameworks during epidemics, pandemics, and other health emergencies.

Keywords: Crisis Communication; Rumor Correction; Survey Experiment; Public Health Agencies; Multidisciplinary Research

1. Introduction

1.1 Background and Significance

The modern information ecosystem has fundamentally altered the dynamics of public health crises. While digital communication networks enable public health agencies to disseminate critical guidance to millions of citizens instantaneously, they also serve as highly efficient vectors for the propagation of misinformation, conspiracy theories, and unverified rumors [1]. During health emergencies, such as infectious disease outbreaks or vaccine rollouts, the public is often confronted with high levels of uncertainty, anxiety, and a perceived lack of control. Under these psychological conditions, individuals actively seek information to reduce cognitive ambiguity, creating a fertile environment for rumors to emerge and flourish. Unverified rumors can jeopardize public safety by promoting ineffective or hazardous treatments, discouraging compliance with essential health advisories, and ultimately undermining the collective response to the crisis [2].

Historically, public health communication has operated under a reactive paradigm. Public health agencies, prioritizing scientific accuracy and thorough evidence verification, often delay their official pronouncements until definitive empirical consensus is reached. Consequently, a temporal gap is created between the emergence of a health-related rumor and the agency's corrective response. During this temporal gap, rumors can diffuse widely, consolidate in public memory, and integrate into individuals cognitive mental models. Once a rumor has been accepted as truth, subsequent corrective efforts face severe cognitive and psychological barriers. This phenomenon necessitates a rigorous re-evaluation of communication timing in

the strategic portfolios of public health institutions. Specifically, there is an urgent need to examine whether proactive strategies, which anticipate and address potential rumors before they become deeply entrenched, are more effective than traditional, reactive refutations [3].

The significance of this research lies in its potential to bridge the gap between cognitive psychology and crisis communication practice. While cognitive psychologists have long explored the persistence of misinformation in controlled laboratory settings, crisis communication researchers have frequently focused on the rhetorical strategies of image restoration after a crisis has occurred. By linking the timing of communication directly to the cognitive processing of rumor corrections, this study provides a systematic framework for understanding how public health agencies can design timing-sensitive interventions. In an era where trust in governmental and scientific institutions is increasingly volatile, understanding the interaction between communication timing, pre-existing trust, and rumor correction efficacy is paramount for maintaining social stability and safeguarding public health [4].

1.2 Research Objectives and Questions

The primary objective of this study is to examine the causal relationship between the timing of crisis communication and the effectiveness of rumor correction within the context of public health emergencies. Rather than treating rumor correction as a static informational update, this research conceptualizes correction as a dynamic process that is highly dependent on when the corrective information is introduced relative to the rumor itself. To achieve this objective, we design and execute a randomized survey experiment that compares the psychological and behavioral outcomes of proactive communication, also known as prebunking or inoculation, with reactive communication, known as debunking or refutation.

Specifically, this study addresses three central research questions. First, how does the timing of communication by public health agencies affect the public's belief in health-related rumors? This question seeks to determine if proactive inoculation provides superior cognitive protection against subsequent exposure to misinformation compared to reactive refutation. Second, how does communication timing influence the perceived credibility of and trust in the public health agency itself? This question explores whether being proactive enhances the perceived competence and benevolence of the agency, or if reactive, post-hoc corrections are sufficient to maintain institutional trust. Third, to what extent does pre-existing trust in public health institutions moderate the relationship between communication timing and rumor correction efficacy? By addressing these questions, this study aims to build a comprehensive empirical model that details the boundaries and mechanisms of timing-sensitive risk communication.

2. Literature Review and Theoretical Framework

2.1 Crisis Communication and Rumor Dynamics

Within the field of crisis communication, rumors are defined as unverified and instrumentally relevant information statements that circulate in contexts of risk, danger, or potential social disruption [5]. Rumor dynamics are characterized by their rapid transmission, resilience to simple factual corrections, and ability to adapt to changing information landscapes. The classic formula of rumor propagation posits that rumor strength is a function of the importance of the topic to the individual multiplied by the ambiguity of the evidence surrounding it. Public health crises represent the archetype of this formula. The personal importance of health outcomes is exceptionally high, and the scientific uncertainty surrounding novel pathogens or medical interventions generates profound ambiguity. Under these conditions, rumors function as collective problem-solving devices, helping communities make sense of confusing and threatening events [6].

The challenge of correcting health rumors is compounded by the architecture of digital platforms, which often prioritize sensational and emotionally valenced content. Health rumors typically appeal to primary human emotions such as fear, anger, or hope, making them highly shareable. Furthermore, once an individual is exposed to a rumor, the cognitive processing of that information is subject to confirmation bias and motivated reasoning. If the rumor aligns with pre-existing political, cultural, or ideological beliefs, it is accepted with minimal scrutiny. Even when individuals are presented with high-quality, scientifically sound corrections from official agencies, they may reject the correction to maintain cognitive consistency.

Therefore, understanding rumor dynamics requires public health agencies to look beyond the content of the correction and focus intensely on the structural and temporal variables of the communication process [7].

2.2 Inoculation Theory vs. Reactive Refutation

The theoretical foundation for proactive crisis communication is rooted in inoculation theory, originally developed by William McGuire in the early 1960s. Drawing a direct analogy to medical vaccination, inoculation theory posits that individuals can be cognitively immunized against persuasion and misinformation by exposing them to a weakened version of the counter-argument along with pre-emptive refutations. A standard inoculation message consists of two core components: a threat component and a refutational preemption component. The threat component explicitly warns individuals that they are likely to encounter persuasive attempts or misinformation, thereby motivating them to defend their existing beliefs. The refutational preemption provides them with the cognitive tools and arguments necessary to dismantle and reject the misinformation when it is subsequently encountered [8].

In contrast, reactive refutation, commonly referred to as debunking, is an ex-post intervention that occurs after the individual has already been exposed to and potentially assimilated the rumor. While debunking is the most common response strategy employed by public health agencies due to resource constraints and the unpredictable nature of rumors, it suffers from several cognitive limitations. The most prominent of these is the continued influence effect of misinformation, which describes the phenomenon where corrected information continues to influence an individual's reasoning and decision-making even after they have acknowledged and understood the correction. This occurs because the initial rumor is integrated into a coherent mental model of the event. When a public health agency debunks the rumor, it leaves a gap in the individual's mental model unless a plausible alternative explanation is provided. Without a proactive framework, reactive corrections often fail to fully overwrite the cognitive traces left by the rumor [9].

Furthermore, reactive debunking can sometimes trigger a backfire effect, where the correction inadvertently reinforces belief in the rumor. This can happen through the familiarity backfire effect, where repeating the rumor during the correction process makes the rumor more familiar and therefore more likely to be accepted as true later, or the overkill backfire effect, where providing too many complex counter-arguments leads individuals to reject the correction in favor of the simpler, albeit false, rumor. Proactive inoculation bypasses many of these cognitive traps by establishing a healthy skepticism and cognitive defense before the rumor is ever encountered, thereby preventing the rumor from being integrated into the individual's mental model in the first place [10].

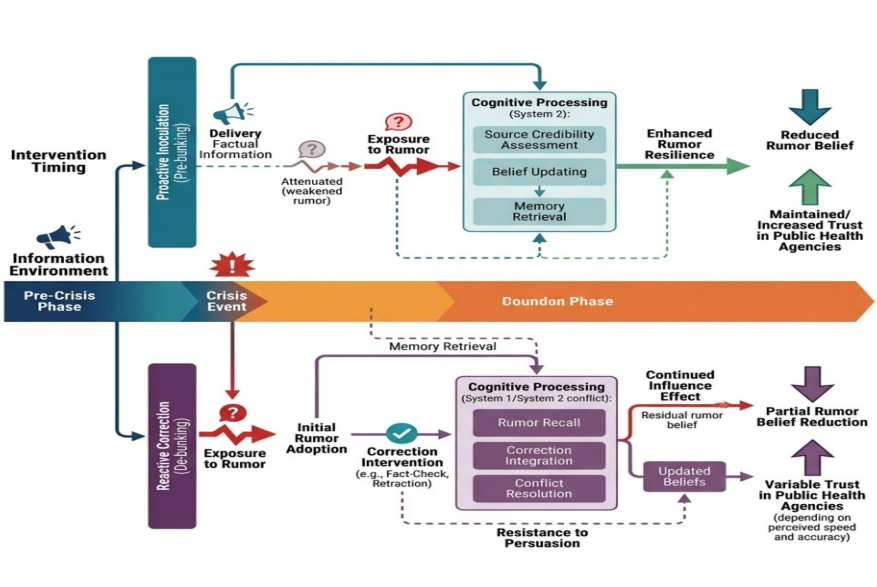

Figure 1: Comprehensive Schematic of Crisis Communication Timing and Rumor Correction Mechanisms

2.3 The Moderating Role of Institutional Trust

While the timing of communication is a critical structural variable, its efficacy does not occur in a vacuum. Rather, the impact of timing is highly dependent on the baseline level of trust that individuals place in the communicating institution. Institutional trust in the context of public health refers to the public's expectation that health agencies will act competently, benevolently, and with integrity to protect the health of the population. When institutional trust is high, citizens are more receptive to risk communication, more willing to comply with behavioral recommendations, and more likely to accept official corrections of rumors. Under these conditions, the specific timing of the message may be less critical, as the high credibility of the source can overcome cognitive barriers associated with reactive debunking.

However, in environments characterized by low institutional trust, the dynamics of rumor correction become significantly more complex. When individuals distrust a public health agency, they are likely to view reactive corrections with skepticism, often interpreting them as defensive damage control or political propaganda. In such cases, reactive debunking may fail entirely or even exacerbate distrust. Proactive communication, on the other hand, may operate differently in low-trust contexts. By proactively addressing potential rumors and acknowledging uncertainty before a full-blown crisis occurs, a public health agency may signal transparency, honesty, and competence. This proactive posture has the potential to mitigate the negative effects of low pre-existing trust, making inoculation a particularly valuable tool for agencies operating in highly polarized or low-trust public environments. Thus, institutional trust is conceptualized as a critical moderator that dictates the boundary conditions of timing-sensitive crisis communication.

3. Methodology and Experimental Design

3.1 Sample and Data Collection

To empirically test the theoretical propositions outlined above, a randomized survey experiment was conducted. The sample was recruited via a professional online survey panel provider in China, utilizing stratified random sampling to ensure a broad representation of the adult population in terms of gender, age, and educational attainment. A total of 1,200 participants completed the experiment. To ensure data quality, several screening mechanisms were implemented, including attention-check questions, minimum completion time thresholds, and IP address verification to prevent duplicate submissions.

The demographic profile of the final sample of 1,200 participants is presented in Table 1. The sample exhibits a balanced gender distribution, with 51.00 percent identifying as female and 49.00 percent as male. The age of participants ranged from 18 to over 60, with the largest cohort falling within the 30 to 49 age bracket (42.67 percent), reflecting the active online population. In terms of education, the majority of the sample held an undergraduate university degree (65.33 percent), while 17.92 percent had a high school education or less, and 16.75 percent possessed a postgraduate degree. This diverse demographic spread ensures that the experimental findings have strong external validity and can be generalized across key segments of the public.

Table 1: Demographic Profile of Experimental Participants

Demographic Variable	Category	Frequency	Percentage
Gender	Female	612	51.00
Gender	Male	588	49.00
Age	18 to 29	345	28.75
Age	30 to 49	512	42.67
Age	50 and above	343	28.58
Education	High School or Less	215	17.92
Education	Undergraduate Degree	784	65.33
Education	Postgraduate Degree	201	16.75

3.2 Experimental Stimuli and Procedures

The experimental design utilized a three-arm randomized controlled setup to compare different communication timing strategies. The context of the experiment was a hypothetical public health scenario involving the outbreak of a fictitious respiratory pathogen named the XH-9 virus. A hypothetical scenario was chosen to eliminate any pre-existing political, emotional, or factual biases that participants might hold

regarding real-world pathogens such as COVID-19 or influenza, thereby isolating the causal effect of the experimental manipulations.

Upon entering the survey, all participants were first administered a pre-test questionnaire designed to capture their demographic characteristics and their baseline level of pre-existing trust in public health agencies. Following the pre-test, participants were randomly assigned to one of three experimental groups: the Proactive Inoculation group, the Reactive Refutation group, or the Control group. The specific flow and stimuli received by each group are detailed in Table 2.

Table 2: Matrix of Experimental Treatment Conditions

Treatment Group	Phase 1 Communication	Phase 2 Event	Phase 3 Measurement
Proactive Inoculation	Agency warning with prebunking	Exposure to rumor narrative	Evaluation of rumor belief and trust
Reactive Refutation	Neutral agency health notice	Exposure to rumor narrative	Evaluation after agency debunking
Control Group	No initial agency message	Exposure to rumor narrative	Evaluation of rumor belief and trust

In Phase 1, the Proactive Inoculation group received a mock official news release from a public health agency. This release warned of the XH-9 outbreak and explicitly preempted a potential rumor, specifically the false claim that a common over-the-counter herbal tea could cure the virus. The release explained the scientific inaccuracy of this claim. The Reactive Refutation group received a standard, neutral news release from the agency warning of the outbreak but containing no mention of any herbal remedies. The Control group received no communication from the agency in this phase.

In Phase 2, all three groups were exposed to a simulated social media post written by a popular blogger. This post propagated the rumor that the herbal tea was a highly effective cure for the XH-9 virus and urged the public to stockpile it immediately.

In Phase 3, the Reactive Refutation group received an official debunking release from the public health agency, which explicitly refuted the herbal tea rumor with scientific facts. This occurred immediately after their exposure to the rumor. The Proactive Inoculation and Control groups received no further agency messages at this stage. Finally, all participants completed a post-test questionnaire to measure the primary dependent variables.

3.3 Measurement of Variables

The experiment measured three primary dependent variables: belief in the rumor, perceived credibility of the public health agency, and health-protective behavioral intentions. All variables were measured using multi-item scales adapted from validated instruments in the communication and psychological literature, with responses recorded on seven-point Likert scales ranging from strongly disagree to strongly agree [11].

Belief in the rumor was measured using a four-item scale that assessed the extent to which participants believed the herbal tea was effective against the XH-9 virus. Example items included: I believe the herbal tea is an effective treatment for the XH-9 virus, and The claim that the herbal tea can cure the XH-9 virus is highly credible. The reliability of this scale was exceptionally high, with a Cronbach's alpha of 0.89 [12].

Perceived credibility of the public health agency was evaluated using a six-item scale measuring three dimensions of credibility: competence, benevolence, and integrity. Example items included: The public health agency is competent in managing this outbreak, and The public health agency acts in the best interest of the public. This scale achieved a Cronbach's alpha of 0.92 [13].

Behavioral intentions were measured using a three-item scale assessing the participants' likelihood of engaging in recommended protective behaviors, such as wearing masks, avoiding crowds, and consulting medical professionals rather than relying on unverified home remedies. Example items included: I intend to follow the official guidelines issued by the public health agency. The scale demonstrated robust reliability with a Cronbach's alpha of 0.85 [14].

Additionally, pre-existing institutional trust was measured in the pre-test phase using a five-item scale adapted from established public management research, assessing general trust in government institutions

and public health agencies prior to the experimental manipulation. This scale served as the primary moderating variable in subsequent analyses.

4. Empirical Analysis and Results

4.1 Manipulation Checks and Descriptive Statistics

Before conducting the primary hypothesis tests, manipulation checks were performed to confirm that participants successfully perceived the timing and content of the experimental stimuli. Participants were asked to identify whether the public health agency had warned them about the herbal tea rumor before they read the social media post, after they read the post, or not at all. A chi-square test revealed that 92.5 percent of participants in the Proactive Inoculation group correctly identified the sequence of events, and 89.8 percent of those in the Reactive Refutation group correctly identified the sequence. This indicates that the temporal manipulations were highly successful and perceived as intended.

Descriptive statistics across the three experimental groups were examined. The mean rumor belief score for the Control group was 4.82 on a seven-point scale, indicating a relatively high level of susceptibility to the rumor in the absence of timely agency intervention. For the Reactive Refutation group, the mean rumor belief score was 3.45, suggesting that post-hoc debunking did have a corrective effect. Most notably, the Proactive Inoculation group exhibited the lowest mean rumor belief score of 2.15, indicating that proactive communication was highly effective in limiting the cognitive acceptance of the rumor. Furthermore, the perceived credibility of the agency was highest in the Proactive Inoculation group, with a mean of 5.62, followed by the Reactive Refutation group at 4.95, and the Control group at 4.12.

4.2 Effects of Timing on Rumor Belief and Agency Trust

To test the statistical significance of these differences and control for potential demographic covariates, ordinary least squares regression analyses were conducted. Model 1 regressed rumor belief on the treatment conditions (using dummy codes, with the Control group as the reference category) and demographic controls. Model 2 regressed perceived agency trust/credibility on the same set of predictors [15].

Table 3: Ordinary Least Squares Regression Models

Independent Variable	Model 1 Rumor Belief Coefficient	Model 1 Standard Error	Model 2 Agency Trust Coefficient	Model 2 Standard Error
Proactive Inoculation	-0.68	0.05	0.45	0.04
Reactive Refutation	-0.24	0.05	0.18	0.04
Pre-existing Trust	-0.32	0.04	0.58	0.03
Constant	4.12	0.08	3.24	0.06

The regression results presented in Table 3 demonstrate that both communication strategies significantly reduced rumor belief relative to the control. However, the coefficient for Proactive Inoculation is substantially larger than that for Reactive Refutation, confirming that proactive timing is significantly more effective at suppressing rumor belief than reactive refutation. Specifically, proactive inoculation reduced rumor belief by 0.68 scale points, whereas reactive refutation reduced it by only 0.24 scale points. This difference is statistically significant.

Similarly, in Model 2, both strategies significantly increased the perceived trust and credibility of the agency compared to the control condition. Once again, Proactive Inoculation yielded a larger positive coefficient than Reactive Refutation, demonstrating that being proactive in communication timing serves to build and maintain higher levels of institutional trust during a crisis [16].

Furthermore, as expected, pre-existing trust had a significant direct effect on both dependent variables, being negatively associated with rumor belief and positively associated with agency credibility in the post-test phase [17].

4.3 Moderating Effects and Interaction Analysis

To address the third research question regarding the moderating role of pre-existing institutional trust, interaction terms between the treatment conditions and pre-existing trust were entered into the regression

models. A moderation analysis was performed using standard statistical software to estimate the conditional effects of the treatments at different levels of pre-existing trust.

The interaction analysis revealed a significant interaction between the Proactive Inoculation treatment and pre-existing trust in predicting rumor belief. For individuals with high levels of pre-existing institutional trust, both proactive inoculation and reactive refutation were highly effective in reducing rumor belief, and the difference between the two timing strategies was relatively small. This suggests that when the public already trusts the health authority, they are receptive to official information regardless of when it is delivered.

However, a different pattern emerged for individuals with low pre-existing institutional trust. For this segment of the population, reactive refutation was largely ineffective, showing no statistically significant reduction in rumor belief compared to the control group. Conversely, proactive inoculation remained highly effective, producing a significant and substantial reduction in rumor belief even among those who highly distrusted the agency. This finding is of immense practical importance. It suggests that proactive communication timing has the unique ability to break through the defensive cognitive barriers of low-trust individuals, offering public health agencies a strategic tool to manage crises in skeptical or polarized societies.

5. Discussion and Policy Implications

5.1 Theoretical and Practical Contributions

The findings of this study make several significant contributions to both the theoretical literature on crisis communication and the practical administration of public health campaigns. Theoretically, this research extends inoculation theory to the domain of digital public health crises, providing empirical evidence of its superior efficacy over traditional reactive debunking. While previous psychological studies have demonstrated the cognitive benefits of prebunking in controlled, laboratory settings, this study contextualizes these mechanisms within a realistic public health emergency framework. By integrating institutional trust as a critical moderating variable, we highlight the boundary conditions of these theories, showing that the cognitive benefits of proactive inoculation are particularly salient for individuals who possess low trust in government and scientific institutions [18].

From a cognitive processing perspective, the success of proactive inoculation lies in its ability to prevent the integration of rumors into individuals' mental models. When a public health agency proactively warns the public about a potential rumor, it creates a cognitive framework or mental schema that acts as a filter. When individuals subsequently encounter the rumor, they do not process it as novel or trustworthy information; instead, they recognize it as the very misinformation they were warned about and reject it immediately. This process avoids the continued influence effect that so often plagues reactive debunking, where corrected information persists in memory because the correction occurred too late to modify the established mental model.

Practically, these results suggest a profound paradigm shift for public health agencies. For decades, the standard operating procedure has been to monitor social media, identify rumors, and then issue reactive corrections. This study demonstrates that this reactive posture is fundamentally disadvantaged. Public health agencies must transition from a reactive model to a proactive, preemptive communication model. This involves active infodemic surveillance, predictive modeling of potential rumor trends, and the systematic implementation of prebunking campaigns. By proactively warning the public about common scientific misconceptions, vaccine myths, or emerging rumors, agencies can build widespread cognitive resistance, thereby reducing the vulnerability of the population to misinformation before a crisis escalates.

5.2 Limitations and Future Research Directions

Despite the significant findings and contributions of this study, several limitations must be acknowledged, which in turn point to valuable directions for future research. First, this study utilized a hypothetical scenario (the XH-9 virus) to maximize internal validity and control for pre-existing biases. While this experimental control is essential for establishing causal relationships, it may limit the ecological validity of the findings. In a real-world pandemic, individuals are exposed to a highly complex, emotionally charged, and politically polarized information environment where rumors are discussed, debated, and reinforced within social

networks over extended periods. Future research should attempt to replicate these findings using field experiments or observational designs during actual public health events.

Second, the experiment evaluated the immediate and short-term effects of communication timing on rumor belief and trust. In real crises, the long-term durability of inoculation effects is a critical concern. Psychological research suggests that cognitive resistance built through inoculation may decay over time, requiring periodic booster messages to maintain protection. Future longitudinal designs should investigate the decay rate of proactive inoculation in public health contexts and determine the optimal timing and frequency of booster communications.

Third, this study focused primarily on one-way communication from a public health agency to the public. However, the contemporary digital landscape is characterized by interactive, peer-to-peer communication on social media. The way individuals discuss, share, and validate rumors within their social networks can significantly alter the efficacy of both proactive and reactive communication. Future studies should explore how interpersonal communication and social network structures interact with agency communication timing to influence the diffusion and correction of health rumors [19]. Notwithstanding these limitations, this study provides a robust empirical foundation for the strategic integration of timing-sensitive protocols into the public health communication architecture.

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