Modeling the Social Apathy:
Stochastic Dynamics of Opinion Under Contradictory Stimulation

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This paper develops a stochastic dynamical model to investigate the psychological impact of exposure to contradictory information, a prevalent feature of modern media ecosystems. We formalize "contradictory stimulation" as stochastic noise in a model of emotional state dynamics. Our analysis reveals two key regimes: high-intensity contradiction drives individuals towards **stable apathy**, while specific parameter combinations produce **bimodal polarization**, where psychological states oscillate randomly between euphoria and lethargy. These results provide a mathematical basis for sociological phenomena like anomie and offer a novel mechanism for emergent polarization from a uniform information stream. The study establishes a theoretical framework for generating testable hypotheses about the effects of information chaos on political engagement and psychological well-being.

Keywords: Contradictory Stimulation, Mathematical Modeling, Political Psychology, Apathy, Polarization, Stochastic Dynamics.

I. INTRODUCTION

The contemporary information landscape is characterized by an unprecedented volume and velocity of content, often presenting individuals with conflicting narratives on significant social, political, and health-related issues [1]. This exposure to contradictory information—where competing claims are presented not as a debate between parties but as a fragmented and inconsistent stream from media ecosystems—poses a critical challenge to individual and collective decision-making.

From a psychological perspective, this phenomenon can be linked to the well-established theory of cognitive dissonance [2], where holding contradictory beliefs or being exposed to information that conflicts with existing cognitions creates a state of mental discomfort. While individuals typically seek to resolve this dissonance, a constant and overwhelming stream of contradictory stimuli may overwhelm cognitive resources, potentially leading to states of anxiety, decision paralysis, or disengagement [3]. Sociologically, this aligns with concepts of anomie [4], a state of normlessness or confusion arising when social guidelines are unclear or contradictory, which has been linked to feelings of alienation and apathy.

While the psychological effects of consistent negative or positive messaging have been studied [6], the systematic impact of stochastic and contradictory information streams remains less explored from a formal modeling perspective. Computational and mathematical models offer a valuable tool for theorizing about such complex, dynamic processes, allowing for the exploration of emergent outcomes from first principles [7].

In this paper, we propose a formal model to investigate the psychological impact of exposure to contradictory informational stimuli. We draw an analogy from a physiological phenomenon known as the Thermal Grille Illusion [8], where the simultaneous application of intermittent warm and cold thermal stimuli to the skin produces a paradoxical and often painful sensation of heat. We hypothesize that an analogous "informational grille illusion" may occur when individuals are exposed to alternating positive and negative emotional stimuli through media channels.

To model this, we develop a stochastic dynamical system framework where an individual's latent emotional state is represented by a continuous variable. The model incorporates key personality parameters, such as intrinsic emotional resilience and baseline affect, and subjects them to an external influence function that can be modulated to represent consistent or contradictory information environments.

The primary aims of this study are:

1. To formulate a mathematical model of emotional state dynamics under external influence.

2. To extend this model to simulate exposure to contradictory stimuli by introducing stochasticity to the influence function.

3. To derive testable hypotheses from the model regarding the emergence of psychological states such as bimodal polarization (e.g., euphoria vs. depression) and emotional apathy (a neutral, disengaged state).

4. To propose an empirical validation strategy, linking the model's predictions to existing literature and outlining a future experimental design for direct testing.

By providing a formal and quantifiable framework, this work aims to contribute to a deeper understanding of how modern information environments can influence public

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psychology, with potential implications for the study of political polarization, civic engagement, and mental well-being in the digital age.

To formally investigate these dynamics, we develop a stochastic dynamical model of emotional state. The following section (Section II) establishes the basic components and properties of this model in a general context, before we apply it to the specific case of contradictory stimulation in Section IV.

II.   A DYNAMICAL SYSTEMS MODEL OF EMOTIONAL STATE

To provide a formal basis for analyzing the effects of external influence on psychological state, we begin by proposing a core model.

Consider a variable x representing the emotional state of an individual at time t. $x > 0$ is a positive state that can be interpreted as a measure of psychological well being and, similarly, $x < 0$ represents a depressive psychological state. If we assume that any disturbance in the state of emotional equilibrium of a (psychologically balanced[43]) individual tends to decrease with time, the simplest model is

$$\frac{dx}{dt} = -mx + b = a(x) = -\frac{dV(x)}{dx}. \tag{1}$$

Equation (1) defines the *drift* and *potential* functions, $a(x)$ and $V(x)$, respectively. m is an "inertia" term which determines the time relaxation of the state x, and b characterizes a nonzero state of equilibrium. Any initial emotional state $x(0) = x_0$ different from the steady state $x(t \to \infty) = x^* = b/m$ relaxes to it exponentially. This equilibrium state x^* is given by the minimum of the potential $V(x) = -\int a(x)dx$. The parameter b is a measure of how good (or bad, if $b < 0$) is your emotional state of equilibrium and m is a measure of how fast the state of equilibrium is re-established if eventually disturbed. These two parameters (m and b) are associated with the intrinsic mentality of the individual. They are constants inherent to their personality, independent in principle, but not immune, to external influences. Our goal now is to add a term in Eq. (1) that characterizes the external influences *on* the individual. A *influence function* to model this external influences must have the following properties:

1. The intensity of the external influence on the individual should be approximately proportional to the emotional state x, when it is low. Individuals with emotional state close to neutrality are more stable psychologically and are hardly induced to euphoria or deep depression.

2. In order to prevent the states of the individual from escaping to infinity, we want a function with a plateau at high influence levels;
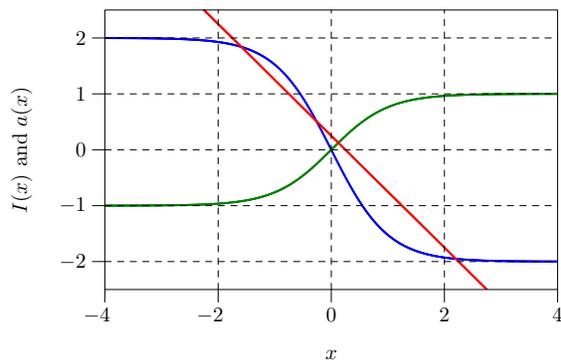

Figure 1. Plot of $-I(x) = -c\tanh x$ for $c = -1$ (green) and $c = 2$ (blue) and function $a(x)$ (red) with $m = 1$ and $b = 1/4$.
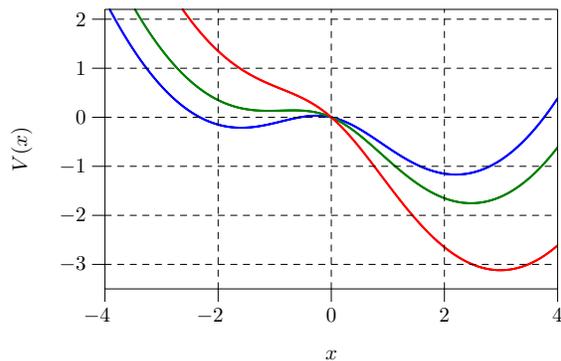

Figure 2. $V(x)$ for $m = 1$, $c = 2$ and $b = 1/4$ (blue), $b = 1/2$, (green) and $b = 1$ (red).

3. We want a influence function such that its signal strength (if positive or negative) can be varied by the signal change of a single parameter.

A influence function $I(x)$ that satisfies these properties is $I(x) = c\tanh x$, as shown in blue and green in Fig. 1.

With the influence function $I(x)$, our equation for the dynamics of the psychological state x of the individual in time t becomes

$$\frac{dx}{dt} = a(x) + I(x) = -mx + b + c\tanh x = -\frac{dV(x)}{dx}, \tag{2}$$

with $V(x) = -bx - c\log[\cosh(x)] + \frac{mx^2}{2}$. The equilibrium points are given by the solutions of $dx/dt \equiv \dot{x} = 0$, *i.e*, $-a(x) = I(x)$:

$$c\tanh(x) = mx - b \tag{3}$$

The psychological interpretation of these parameters aligns with established constructs in affective science. The resilience parameter m corresponds conceptually to the psychological construct of emotional homeostasis - the innate capacity to return to a baseline emotional state following perturbation [9, 10]. Individuals with high m demonstrate what clinical psychology would characterize as high emotional regulation capacity, recovering quickly

from stressful stimuli. Conversely, low m individuals exhibit emotional lability, remaining in altered states for prolonged periods.

The baseline parameter b operates as a dispositional affect marker, representing the individual's characteristic emotional setpoint. This aligns with research on affective temperaments, where individuals demonstrate stable predispositions toward positive or negative emotional baselines [11, 12]. The external influence function $I(x) = c \tanh(x)$ captures several psychologically relevant properties: its approximate linearity near neutrality reflects the greater susceptibility to influence when in emotionally ambiguous states, while its saturation at extremes models the psychological phenomenon of emotional ceiling effects, where strongly positive or negative individuals become resistant to further influence in the same direction [13, 14].

This mathematical formalization thus translates established psychological concepts into a dynamic systems framework, allowing for the exploration of their interactive effects over time.

Fig. 1 shows the plots of $a(x)$ and $-I(x)$ for some values of the parameters. Fig. 2 shows the potential $V(x)$ for different values of b. The most interesting case is when $c > 0$: the points of intersection of the red curve with the blue curve in Fig. 1 determine the possible equilibrium points. For the parameter values shown in the caption, the red curve intersects the blue curve in three equilibrium points, $x_1^* = -1.59$, $x_2^* = -0.26$ and $x_3^* = 2.20$. Stability analysis tells us that x_1^* and x_3^* are stable and x_2^* is unstable. This is easily seen in Fig. 2 where the *stable* equilibrium fixed points are represented by the potential wells of the blue line. We also see in this figure that if b increases, we lose the possibility of negative emotional equilibrium. This is represented in Fig. 2 by the progressive disappearance of the left potential wells as b increases. Individuals intrinsically happy (bigger b) are more difficultly induced to a depressive state. Pure common sense.

And what happens if an individual, when momentarily deprived of his state of balance, tends to come back to it very quickly? Mathematically, what happens if m is high? The answer is in Fig. 3. As we increase m, we lost the non-zero valleys of the potential and the only possible equilibrium becomes the complete neutrality ($x \approx 0$). What was an unstable fixed point (a potential peak) becomes a stable one. An individual of quick recovery after perturbed (big m) is a *phlegmatic* individual.

The next step is to ask what the effects of parameter c. The answer is simple: all the qualitative results remain. There are changes only in the values that the parameters b and m should assume to all the phenomenology described occurs.
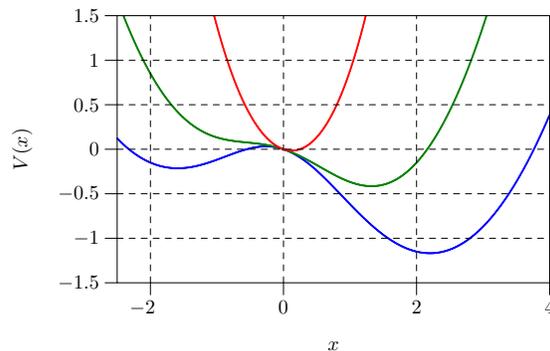

Figure 3. $V(x)$ for $b = 1/4$, $c = 2$ and $m = 1$ (blue), $m = 1.5$, (green) and $m = 4$ (red).

A. Unstable personalities without media influence

Let us understand the possible consequences of unstable personalities. We will do this including the possibility of the defining parameters of the personality, b and m, being random variables.

One possibility to address the intrinsic psychic fickleness of the individual is to consider b as a random variable. We will assume that b is a Gaussian variable so that $b \to b + \zeta(t)$, where $\zeta(t)$ is the white noise with statistical properties $\langle \zeta(t) \rangle = 0$, $\langle \zeta(t')\zeta(t'') \rangle = 2\sigma \delta(t'' - t')$, 2σ is the variance of $\zeta(t)$.

As a Gaussian random variable is not limited, there is the possibility of b be positive or negative, and this possibility will be greater or lesser depending on the *intensity of the noise* given by σ. Intense degrees of mental instability are represented mathematically by large values of σ.

The main principle that will guide us in the interpretation of the following results is:

Any method or technique that lowers a person's emotional state will make the person more susceptible to mind manipulation methods.

For example, malnutrition, sleep deprivation, torture, viruses, chemical toxins, radiation, lying and confusing others will all decrease a person's vitality to a degree.

This principle is partly based on common sense and backed in experiments which indicate that depressed emotional states disfavor making rational decisions [16].

1. Stochastic non-zero state of equilibrium

Making the change $b \to b + \zeta(t)$ in Eq. (2) with $c = 0$ and $m > 0$, we will have

$$\frac{dx}{dt} = -mx + b + \zeta(t) \qquad (4)$$

We can write the Langevin equation above as a *stochas-*

tic differential equation (SDE) [17–20] as follows,

$$dx_t = (-mx_t + b)dt + dW_t \quad (5)$$
$$\equiv f(x_t)dt + g(x_t)dW_t,$$

which defines the *drift* and *diffusion* functions, $f(x_t)$ and $g(x_t)$, respectively, where dW_t are the Wiener increments of x_t. For this particular case, $g = 1$ and we have additive noise. No ambiguity arises about which stochastic calculus (if Itô, Stratonovich, or other) we will use. This will not be the case in some of the subsequent sections, and so for this article, always consider the Stratonovich calculus.

Equation (4) describes the well-known Ornstein-Uhlenbeck process [18]. Analytical expressions for the probability density function of the Ornstein-Uhlenbeck process are well known and will not be displayed here. The steady state of the *probability density function* (PDF) of the emotional state of the individual follows Gaussian distribution. Using Eq. (23) of the appendix with $g_2(x) = 0$, the extreme x_m of the PDF is located at $x_m = b/m = x^*$.

Greater variability of b does not induce reductions in emotional states of the individual because x_m does not depend on σ.

2. Stochastic "inertia"

Following the same steps of the previous subsection but doing $m \to m + \zeta(t)$, we have

$$dx_t = (-mx_t + b)dt + xdW_t \quad (6)$$
$$\equiv f(x_t)dt + g(x_t)dW_t,$$

with $f(x_t) = -mx_t + b$ and $g(x_t) = x_t$. It is possible to find an exact expression for the PDF but it is too complicated to be useful to us. We prefer a more indirect approach, obtaining an expression of the extremes of the PDF using tools presented in appendix. Using Eq. (23) (see appendix) with $g_2(x) = 0$, the extrema x_m of the PDF is given by

$$x_m = \frac{b}{\sigma + m}.$$

Therefore we have a unimodal stationary distribution. We see that m and σ work together to compel the apex of the stationary probability density function to the origin. Phlegmatic personalities tend to be even more phlegmatic if unstable in their phlegmaticity.

B. Unstable personality with media influence

Before we investigate the effects of contradictory stimulation, let us first understand the possible consequences of media effects in unstable personalities. We will do this including the possibility of the defining parameters of the personality, b and m, being random variables.

1. Stochastic b with deterministic media influence

Making the change $b \to b + \zeta(t)$ in Eq. (2), we will have

$$\frac{dx}{dt} = -mx + b + c\tanh(x) + \zeta(t) \quad (7)$$

The corresponding SDE is

$$dx_t = [-mx_t + b + c\tanh(x_t)]dt + dW_t \quad (8)$$
$$\equiv f(x_t)dt + g(x_t)dW_t,$$

with $f(x_t) = -mx_t + b + c\tanh(x_t)$ and $g(x_t) = 1$. For these functions, the effective stochastic potential $\mathcal{V}(x)$ (see appendix) does not differ from the deterministic potential $V(x)$, i.e. $\mathcal{V}(x) = V(x)$. Then the *average* $\langle x \rangle$ is given by $\langle x \rangle = x^* = b/m$.

Conclusion: For certain values of the parameters, the potentials $\mathcal{V}(x)$ and $V(x)$ have two valleys, which corresponds to a stationary probability distribution $P_{st}(x)$ with two modal values. This means that the mental states oscillate between two values corresponding to the two potential minima.

2. Stochastic "inertia" with deterministic media influence

Following the same steps of the previous subsection but doing $m \to m + \zeta(t)$, we have

$$dx_t = [-mx_t + b + c\tanh(x_t)]dt + xdW_t \quad (9)$$
$$\equiv f(x_t)dt + g(x_t)dW_t,$$

with $f(x_t) = -mx_t + b + c\tanh(x_t)$ and $g(x_t) = x_t$. I was not able to find a solution to the integral in Eq. (20). By simulating the stochastic differential equation (9)[44] I got the results shown in Figs. 4 and 5. We show probability distributions at different times for two different values of σ. The higher the variability of m, we get closer to origin and more symmetrical is the probability distribution of emotional states. Large variabilities in the degree of phlegmaticity destroy an intrinsic "spiritual haughtiness" when influenced deterministically by the media. The blue distributions in the two figures corresponds to the stationary distributions.

For certain values of the parameters there are two peaks in the stationary probability distribution $P_{st}(x)$ and mental states oscillate again between the wells of the potential. A slightly more careful analysis is done in the following subsection, which includes the last two subsections as particular cases.

3. Full stochastic

What happens if both b and m are treated as random variables? If $b \to b + \zeta(t)$ and $m \to m + \eta(t)$ are placed in Eq. (2), we get the following SDE:

$$dx_t = [-mx_t + b + c\tanh(x_t)]dt + x_t dW_t^1 + dW_t^2$$
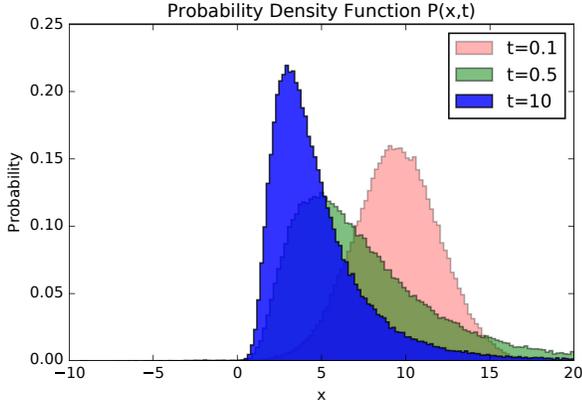$$\equiv f(x_t)dt + g_1(x_t)dW_t^1 + g_2(x_t)dW_t^2, \quad (10)$$

Figure 4. $P(x,t)$ for $b = 1$, $c = 4$, $m = -1$ and $\sigma = 0.4$, for $t = 0.1$ (red), $t = 0.5$ (green) and $t = 10$ (blue). $x(0) = 10$.
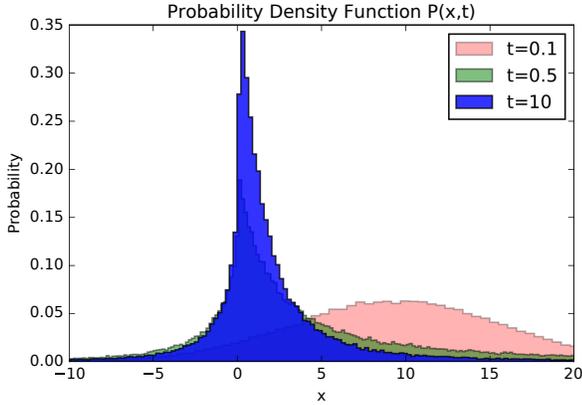

Figure 5. $P(x,t)$ for $b = 1$, $c = 4$, $m = -1$ and $\sigma = 1$, for $t = 0.1$ (red), $t = 0.5$ (green) and $t = 10$ (blue). $x(0) = 10$.

where $f(x_t) = -mx_t + b + c\tanh(x_t)$, $g_1(x_t) = x_t$, $g_2(x_t) = 1$ and $\eta(t)$ and $\zeta(t)$ are white noises with the following properties

$$\langle \zeta(t) \rangle = \langle \eta(t) \rangle = 0, \tag{11}$$

$$\langle \zeta(t)\zeta(t') \rangle = 2\sigma\delta(t - t'), \tag{12}$$

$$\langle \eta(t)\eta(t') \rangle = 2\Gamma\delta(t - t'), \tag{13}$$

$$\langle \zeta(t)\eta(t') \rangle = \langle \eta(t)\zeta(t') \rangle = 2\lambda\sqrt{\sigma\Gamma}\delta(t - t'), \tag{14}$$

where σ and Γ are the noise intensity of $\zeta(t)$ and $\eta(t)$ respectively, and λ is the correlation between noises. Fig. 6 shows the results of the simulation for the probability density function $P(x,t)$. For the parameter values shown in the caption, we see that a bimodal distribution emerges.

A simple way to analyze the situation is solving Eq. (23) (see appendix). There is no analytical solution for x_m but
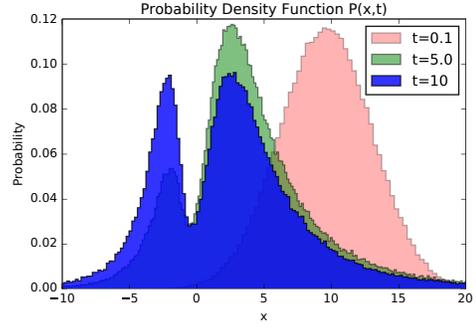

Figure 6. $P(x,t)$ for $b = 1$, $c = 5$, $m = -1$ and $\sigma = 0.25$, $\Gamma = 0.33$, $\lambda = 0.6$ for $t = 0.1$ (red), $t = 5$ (green) and $t = 10$ (blue), $x(0) = 10$.

it is easy to analyze the results graphically, as done in section II. The solution results in

$$c\tanh(x) = m'x + b', \tag{15}$$

with $m' \equiv m + \sigma$, $b' \equiv \lambda\sqrt{\Gamma}\sigma - b$. Since Eq. (15) is identical to Eq. (3) exchanging $b \to b'$ and $m \to m'$, the graphical analysis performed is the same just reinterpreting the stable fixed points as peaks of the stationary probability distribution $P_{st}(x)$. Some possible interpretations:

- For $|b'|$ not too big, $P_{st}(x)$ is bimodal. People sufficiently well enough emotionally or sufficiently depressed are not subject to mood swings.

- The lower the slope m', the greater the distance between the peaks of $P_{st}(x)$, if there are two. People with slow recovery of personality, when in the "two peaks" regime, can suffer major mood swings.

- For unimodal $P_{st}(x)$, one possibility is a big Γ (noise intensity in m) and/or a big σ (noise intensity in b), and in this case, the peak occurs at negative values of x. Elevations in σ marginally increase the chances of unimodal $P_{st}(x)$ in the negative x.

- Large variability in the slowness with which the emotional state returns to the equilibrium if disturbed (inertia m with high Γ) induces negative emotional states.

One possibility to produce large intrinsic variability of personality and induce people to a negative level of emotional state relatively easily is to act in children's education. This suggests that early-life experiences that increase personality variability may have long-term psychological consequences.

III. THEORETICAL FOUNDATION: FROM COGNITIVE DISSONANCE TO CONTRADICTORY STIMULATION

This section synthesizes the psychological and sociological foundations that inform our model, establishing

"contradictory stimulation" not as a novel conspiracy but as an emergent phenomenon in complex information environments, rooted in established science.

A. The Psychological Basis: Cognitive Dissonance and Overload

The core psychological mechanism we aim to model is the state induced by inconsistent information. Leon Festinger's theory of cognitive dissonance [2] posits that individuals experience psychological discomfort when holding two or more contradictory beliefs, ideas, or values, and are motivated to reduce this discomfort.

Our model extends this concept to environments of high-frequency, exogenous information. We hypothesize that when contradictory stimuli are presented not as a single, resolvable inconsistency but as a continuous, external stream, the cognitive load required for resolution may become unsustainable [22, 23]. This can lead to a state of cognitive or decisional paralysis, a dynamic captured by the model's convergence to a stable, apathetic state near $x = 0$ or to a fragmented psyche where conflicting states are adopted alternately (represented by the model's bimodal probability distribution).

B. A Physiological Analog: The Thermal Grille Illusion

A powerful analog for our proposed mechanism exists in sensory physiology. The Thermal Grille Illusion (TGI) occurs when an individual places a hand on a grill of alternating warm and cool bars, which paradoxically produces a sensation of intense, often painful heat [8, 24].

Neuroimaging studies show that this illusory pain is associated with intense activity in the anterior cingulate cortex (ACC), a brain region involved in conflict monitoring and processing of incongruent stimuli [25]. We posit that exposure to contradictory informational stimuli—warm praise and cool condemnation on the same topic—may trigger an analogous "informational conflict" signal in the same neural substrates, leading to psychological distress or avoidance (anomie/apathy). This analogy provides a biological plausibility for the non-linear, emergent effects of contradictory inputs.

C. The Sociological Dimension: Anomie and Social Control

At the sociological level, the outcome of sustained contradictory stimulation resonates with Émile Durkheim's concept of anomie [4]—a state of normlessness, deregulation, and social instability where societal guidelines become unclear or contradictory. Durkheim linked anomie to outcomes like alienation and disengagement.

This connects directly to Social Control Theory [26], which suggests that weakened social bonds can lead to deviance and disengagement. A constant stream of contradictory norms and values can effectively weaken an individual's cognitive "bond" to a coherent reality, potentially inducing a state of apathy or suggestibility, as the individual's capacity to form stable, rational objections is eroded. This provides a sociological interpretation for the model's prediction that high noise intensity (σ) compels the emotional state toward apathy.

1. A Philosophical and Mass-Psychological Perspective: Dialectics as Technique

Beyond a mere chaotic byproduct of the information environment, contradictory stimulation also resonates with a philosophical framework that views it not as an accident, but as a method. The Hegelian dialectic—in which an initial state (thesis) is confronted by its negation (antithesis) to generate a new synthesis [27]—provides the logical structure for a *deliberate application* of this technique. In this reading, flooding the public with radically opposing narratives (thesis and antithesis) is not aimed at fostering reasoned debate. Instead, its purpose is to exhaust the cognitive capacity for resolution, inducing a state of confusion and apathy that serves as the intended "solution" or synthesis: a disengaged and psychologically pliable populace.

This mechanism echoes the pioneering intuitions of Gustave Le Bon on the psychology of crowds, where confusion and contradiction are powerful tools to dissolve individual critical thought and facilitate collective manipulation [28]. Le Bon observed that crowds are not influenced by logic but by images, feelings, and contradictory impulses presented with affirmation and repetition—a description that presciently fits the modern media environment.

Our model, by mathematically demonstrating how contradictory noise (σ) inevitably drives the system towards apathy ($x \approx 0$), provides the formalization and proof-of-concept for this long-standing philosophical and sociological hypothesis. It shows that the final, "synthesized" state of a mind subjected to unresolved dialectical tension is not a higher truth, but a collapse into neutral disengagement. This offers a parsimonious explanation for how the "problem-reaction-solution" paradigm, a vulgarization of dialectical process often discussed in critical social theory, can be operationalized at a mass psychological level through information patterns.

D. Synthesizing the Framework for the Model

These perspectives—psychological, physiological, and sociological—converge on a common principle: the presentation of irreconcilable, high-frequency contradictions can induce aversive psychological states that lead to disengagement, paralysis, or erratic judgment.

Our mathematical model, introduced in Section II, operationalizes this principle. The drift function $-mx + b$ represents the individual's intrinsic psychological homeostasis. The external influence term $c\tanh(x)$ represents coherent media messaging. Finally, introducing stochasticity to parameter c - transforming it into $c + \zeta(t)$—directly models the phenomenon of **contradictory stimulation** as a random alternation between positive and negative influence. The model allows us to derive specific, testable hypotheses about the conditions under which the outcomes predicted by dissonance theory and anomie (bimodality, apathy) will emerge.

IV. RELATED WORK: POSITIONING IN SOCIAL SIMULATION AND OPINION DYNAMICS

Our work builds upon and dialogues with several established traditions in mathematical sociology and opinion dynamics. The core structure of our model, given by Equation 2, shares similarities with foundational models in the field. Specifically, the drift term $-mx + b$ resonates with classical attitude dynamics models [29, 30], where attitudes decay towards an innate baseline. The introduction of an external influence function $I(x)$ aligns with models investigating media effects on public opinion [31, 32].

However, our approach diverges significantly in its treatment of the influence parameter c. Traditional models often treat media as a constant or slowly varying field, promoting consensus or stable polarization [33–35]. In contrast, we introduce stochasticity directly into c, a novel operationalization of the chaotic modern media environment. This places our model at the intersection of stochastic dynamics and social simulation.

Unlike agent-based models (ABMs) of opinion dynamics that generate macro–level phenomena from micro–level interaction rules [36–38], our population-level model focuses on the emergent psychological states of a 'representative individual'. This provides a complementary perspective to ABMs, offering analytical tractability and clear insights into the *conditions* under which phenomena like apathy or bimodality emerge from first principles. Furthermore, while some models generate polarization through homophily and echo chambers [39, 40], our mechanism is distinct: polarization here is not a result of social segregation but a *psychological* reaction to a uniformly applied, yet contradictory, information field. This offers a parsimonious explanation for how volatile polarization can occur even in the absence of tightly knit social networks.

V. MODELING CONTRADICTORY STIMULATION

In the previous sections, the parameter c represented the strength of a deterministic media influence. We now repurpose this parameter to model the baseline intensity of a media influence that is itself stochastic, representing an environment that is, on average, more positive ($c > 0$) or negative ($c < 0$), but subject to high-frequency contradictions.

Having established the theoretical foundations of contradictory stimulation in Section III, we now operationalize this phenomenon within our mathematical framework. We propose that exposure to contradictory information can be modeled by introducing stochasticity to the parameter c, which governs the media influence function $I(x)$. This represents a media environment that randomly alternates between encouraging positive emotional states ($c > 0$) and negative ones ($c < 0$), with σ quantifying the intensity of this contradiction. The modified Langevin equation becomes:

$$\frac{dx}{dt} = -mx + b + c\tanh(x) + \tanh(x)\zeta(t) \qquad (16)$$

where $\zeta(t)$ is the white noise associated to σ as in the previous sections. Aggressiveness, in politics, in exposing citizens to the effects the contradictory stimulation is represented by large values of σ.

We can write the Langevin equation above in the following form

$$\begin{aligned} dx_t &= [-mx_t + b + c\tanh(x_t)]dt + \tanh(x_t)dW_t \\ &\equiv f(x_t)dt + g(x_t)dW_t, \end{aligned} \qquad (17)$$

which defines the *drift* and *diffusion* functions, $f(x_t)$ and $g(x_t)$, respectively.

The expression for $\mathcal{V}(x)$ can be easily obtained from Eq. (20) in appendix but it is complex and not very useful for our purposes, and therefore it will be omitted.

Fig. 7 shows the effective potential for some values of σ. We see that as we increase the intensity of contradictory stimulation, σ, quickly the emotional state of the individual collapses to *apathy*, operationally defined as a stable emotional state near $x = 0$. These results suggest that high-intensity contradictory stimulation (σ) may effectively induce a state of collective *torpidity* or *disengagement*.

The transition to apathy under high σ represents a fundamental shift in the system's attractor landscape. At low contradiction levels ($\sigma < 1$ in Figure 7), the potential maintains distinct wells corresponding to coherent emotional states. As σ increases, these wells merge into a single, deep well at neutrality, indicating that the most probable state becomes emotional disengagement.

This mathematical transition has a psychological interpretation: low-level contradictions can be resolved through cognitive effort, maintaining coherent (though potentially oscillating) emotional positions. However, beyond a critical threshold of inconsistency, the cognitive cost of maintaining coherent positions becomes prohibitive. The psyche 'defaults' to a state of minimal engagement - apathy - as a protective mechanism against the metabolic expense of continuous cognitive reconciliation.
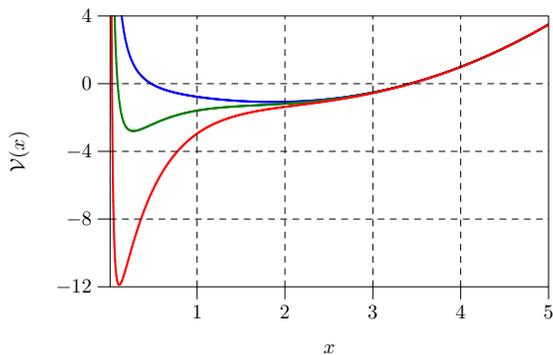
Figure 7. $\mathcal{V}(x)$ for $b = 1$, $c = 1$, $m = -1$ and $\sigma = 0.5$, (blue), $\sigma = 1$, (green) and $\sigma = 1.5$ (red).
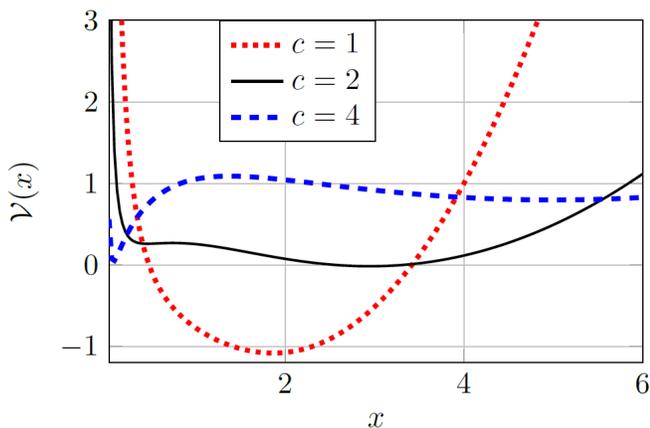

Figure 8. Effective stochastic potential $\mathcal{V}(x)$ for some values of c.

Something interesting also occurs when we vary c. Fig. 8 shows that as c increases from a certain value, the potential has two wells, indicating that there is a *bimodal* distribution of stationary probabilities.

With intense influence functions (high c), an individual can be in two different emotional states, one of them apathetic or *lethargic*, in which the individual is literally at the rock bottom, and the other positive, away from the origin. The psychic condition of the individual oscillates randomly between these two possible states, but once it is in the lethargic state, it will be hard to leave him if c is large enough. And once in the positive state beyond the origin, the unstable mental aspect of the individual is manifested in the almost flat appearance of the potential.

Interestingly, the deeper the potential well, higher the corresponding state of euphoria (x far from origin). The individual may manifests itself totally apathetic and lethargic, but euphoric outbursts can sometimes occur.

A.   Two noises

In line with what was done for the case without contradictory stimulation, we will consider the possibility
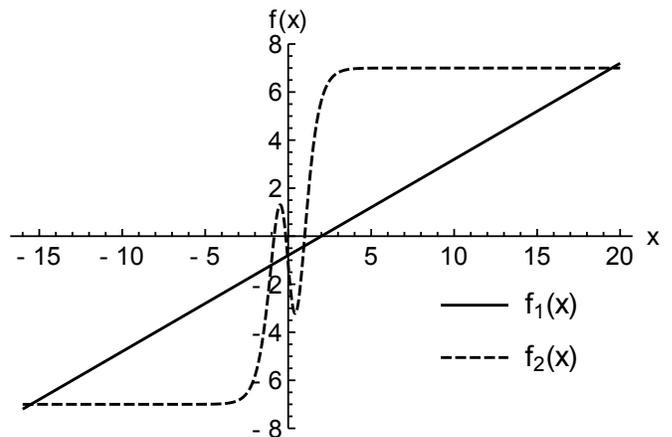

Figure 9. Graphical solutions of (18) for $b = 0.8$, $c = 7$, $m = 0.4$ and $\sigma = 15$, $\Gamma = 1$, and $\lambda = 0.3$ with $f_1(x) = mx - b$ and $f_2(x) = c \tanh(x) - \mathrm{sech}^2(x) \left(\lambda \sqrt{\Gamma \sigma} + \sigma \tanh(x) \right)$
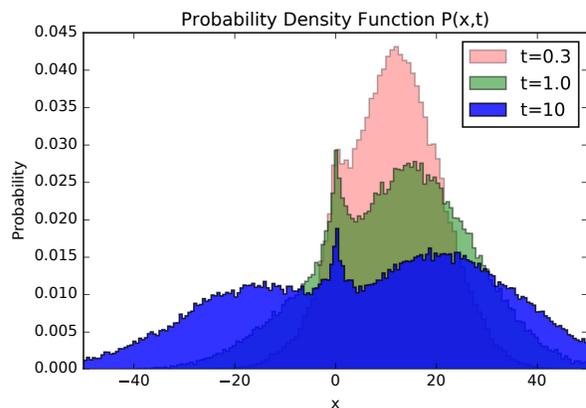

Figure 10. $P(x, t)$ for $b = 0.8$, $c = 7$, $m = 0.4$ and $\sigma = 15$, $\Gamma = 1$, $\lambda = 0.3$, for $t = 0.3$ (red), $t = 1.0$ (green) and $t = 10$ (blue). $x(0) = 10$.

that more than one parameter varies stochastically. The first situation that we analyze is that of both b and c are random. Along the same lines than was previously presented, let $b \to b + \zeta(t)$ and $c \to c + \eta(t)$, $\zeta(t)$ and $\eta(t)$ following (11-14).

Using Eq. (23) with $g_1(x) = c \tanh(x)$, $g_2(x) = 1$, we have

$$mx - b = c \tanh(x) - \mathrm{sech}^2(x) \left(\lambda \sqrt{\Gamma \sigma} + \sigma \tanh(x) \right) \quad (18)$$

Exact analytical solution for Eq. (18) does not exist. Again we appeal to a graphical solution, shown in Fig. 9.

This figure predicts the occurrence of an unexpected event: the emergence of a stationary multimodal distribution, with three peaks, which is confirmed by Fig. 10 where we present $P(x, t)$ simulated for three values of t. In addition to being induced to negative psychic states if $x(0) > 0$, persons subject to contradictory stimulation tend to show erratic behavior, alternating states of

euphoria to depression, through apathy states. Similar qualitative conclusions are obtained when we consider as stochastic the parameters m and c.

B. Implications for Policy and Public Discourse

The insights from our model carry significant implications for policymakers, educators, and media practitioners concerned with the health of public discourse. The primary finding—that high-intensity contradictory stimulation (σ) induces apathy—suggests that the very architecture of the information ecosystem may be a root cause of political disengagement. This moves the focus beyond the content of individual messages to the structural pattern of information flow.

The model's findings shift the focus from regulating information content to strengthening the psychological and cultural foundations of a healthy public sphere. The optimal defense against the disorienting effects of contradictory stimulation (high σ) is not the suppression of specific ideas, which would itself be a form of manipulation, but the cultivation of *informed intellectual and cultural resilience.*

This suggests a return to principles that have historically fortified societies against ideological chaos:

1. **Cultivating Cultural and Epistemic Anchors:** A robust defense against informational chaos may be found in a strong cultural core. This suggests that educational and cultural efforts could prioritize the transmission of a shared canon of knowledge, logical reasoning, and the enduring wisdom found in classical philosophy, literature, and historical study. These traditions provide individuals with stable reference points—a "cultural immune system"—and the intellectual tools to navigate contradictory narratives without succumbing to cognitive overload or apathy. They foster the ability to discern signal from noise, rather than having a predefined signal mandated by an authority.

2. **Championing Uninhibited Discourse as an Antidote:** The model demonstrates that it is the pattern of chaotic, unresolved contradiction—not the content of any particular idea—that is pathogenic. The remedy, therefore, lies in the opposite of suppression: the promotion of a truly open and reasoned discourse where all ideas can be confronted and tested. In such an environment, contradictions are not left to fester as a psychological weapon but are brought into the light of public reason for examination, debate, and synthesis. This represents the classical liberal ideal of the "marketplace of ideas" as a therapeutic process against manipulative stimulation.

3. **Fostering Communities of Meaning and Deliberation:** Apathy is a symptom of disconnection.

The voluntary formation of local, professional, and intellectual communities bound by shared inquiry and civil dialogue creates essential "low-σ" environments. These communities are not echo chambers but arenas of trust where complex ideas can be deliberated with coherence and depth, allowing individuals to rebuild the cognitive and social bonds fractured by the chaotic mainstream discourse.

In conclusion, the model warns that a public sphere dominated by contradictory stimulation is inherently self-corrosive. The sustainable path forward is not through greater centralized control of information, which risks repeating the problem under a different guise, but through a societal recommitment to the foundational pillars of liberal civilization: the valorization of inherited wisdom, the sovereignty of the individual reason, and the open, courageous confrontation of ideas in pursuit of truth.

VI. DISCUSSION

This study developed a stochastic dynamical model to explore the psychological impact of exposure to contradictory information. Our analysis yields several key insights that formalize and extend theoretical concepts from psychology and sociology into a quantifiable framework.

A. Interpretation of Key Findings

Our primary finding is that a highly contradictory information environment (high σ) acts as a powerful mechanism driving the emotional state x toward a stable equilibrium of apathy ($x \approx 0$), as evidenced by the single, deep well in the effective potential $\mathcal{V}(x)$ (Figure 7). This provides a formal mathematical basis for the sociological concept of anomie [4] and observations of political disengagement, modeling how inconsistent signals can erode motivation and lead to psychological withdrawal.

Furthermore, under conditions of strong but stochastic media influence (high c, high σ), the model predicts a **bimodal distribution** of emotional states (Figure 8). This result is particularly significant as it offers a novel mechanism for the emergence of polarization. Unlike models where polarization arises from echo chambers or homophily, here it emerges from the same contradictory information stream, with individuals randomly oscillating between states of euphoria and lethargy. This captures the volatile and erratic political engagement observed in modern democracies.

The scenario with multiple stochastic parameters revealed the potential for even more complex dynamics, including **multimodal distributions** (Figure 10). This suggests that individuals subjected to contradictory stimulation across multiple psychological dimensions (e.g., both in their baseline outlook b and media influence c) may exhibit highly unpredictable and fragmented emo-

tional responses, alternating between euphoria, apathy, and depression.

A limitation of the model lies in the model's assumption of a static personality. In reality, parameters like resilience (m) may adapt over time due to repeated exposure to stressful information environments. Future work could explore a meta-dynamic where m itself evolves, potentially decreasing with sustained high σ, leading to a vicious cycle of increasing susceptibility.

Another promising avenue is the integration of network effects. While our model treats individuals in isolation, embedding it within a social network would allow us to investigate how apathy and polarization propagate. Would local social reinforcement protect individuals from contradictory stimulation, or would it amplify its effects? Developing a multi-agent version of our model, where each agent follows the internal dynamics described here but is also influenced by neighbors, is a logical and critical next step.

These dynamics find resonance in several observed sociopolitical phenomena. The prediction of apathy under high contradiction aligns with declining voter turnout and political engagement in populations exposed to highly polarized media environments. The bimodal oscillation mechanism offers an explanation for the rapid, seemingly random shifts in public opinion observed on contentious issues, where the same population demonstrates wild swings between enthusiasm and despair without intermediate positions.

Furthermore, the model provides a novel explanation for the failure of traditional fact-checking and correction campaigns. If the primary pathogenic effect of contradictory information is not misinformation per se, but the induction of apathy or erratic oscillation through a high-σ environment, then corrections that simply add another layer of competing claims may inadvertently exacerbate the problem. They contribute to the very noise they seek to combat, deepening the sense of cognitive overload. This insight shifts the paradigm for resilience: the solution cannot be a centralized arbiter of truth, which would itself be a form of information control. Instead, the focus must be on cultivating the individual's capacity for critical judgment and the societal structures that foster epistemic agency—the ability of individuals to navigate complex information landscapes through their own reasoned evaluation, rather than relying on an externally imposed consistency.

The three-peak distributions emerging from multiple noise sources (Figure 10) potentially model the fragmentation of political landscapes into multiple unstable factions, none capable of sustaining dominance, leading to governance paralysis and chronic instability.

The power of the model lies in its ability to unify these interpretations into a single, quantifiable formalism. It demonstrates that regardless of the intent—be it an emergent property of a chaotic media ecosystem or a targeted strategy—the psychological outcome, as predicted by the dynamics of the emotional state x, converges predictably towards apathy or bimodal oscillation.

Finally, the operationalization of model parameters for empirical testing remains a challenge. Future research should focus on developing psychometric instruments or experimental protocols to estimate m (resilience) and b (baseline affect) for individuals, and to correlate exposure to media contradiction (e.g., via analysis of news diets) with the variance parameter σ. This would bridge the gap between our theoretical framework and testable, real-world phenomena, moving from a proof-of-concept model to a predictive tool.

B. Relation to Existing Theories

Our model synthesizes and formalizes several classic ideas:

- **Cognitive Dissonance [2]:** The stochastic term $\zeta(t)$ in the influence function continuously induces dissonance. The model's outcomes (apathy, bimodality) represent potential, non-rational resolutions to this unresolvable state.

- **Cognitive Load Theory [22, 23]:** The collapse to apathy can be interpreted as a psychological shutdown when the cognitive load of resolving constant contradictions becomes unsustainable.

- **The Thermal Grille Illusion [24]:** The model serves as a formal analog to this physiological phenomenon, demonstrating how conflicting "hot" and "cold" informational inputs can generate a novel, aversive psychological state (apathy) that is distinct from either input.

While literary concepts like Orwell's "doublethink" offer powerful metaphors, our model provides a formal, mechanistic account of how such a state could be induced and sustained at a psychological level, moving beyond analogy to testable theory.

C. Limitations and Future Research

This study has several limitations that present opportunities for future work. First, the model is a significant simplification of human psychology, and the operationalization of complex traits like resilience into a single parameter m is necessarily reductive. Future iterations could incorporate more nuanced, multi-dimensional personality models.

Second, while we have proposed empirical validation, the current work remains theoretical. The critical next step is to test the model's predictions experimentally, for instance by measuring changes in affect and political engagement in participants exposed to controlled media streams with varying degrees of contradiction.

Finally, the model currently treats individuals in isolation. A compelling extension would be to embed this

individual-level dynamics within a social network model to explore how contradictory stimulation and emergent apathy propagate through a population.

VII. IMPLICATIONS AND CONCLUSION

In conclusion, we have presented a mathematical model that translates the abstract concept of contradictory information into specific, testable predictions about its psychological impact. The model suggests that the architecture of the modern information environment may be a significant, and underappreciated, factor in fostering both political apathy and volatile polarization.

Understanding these dynamics is not merely an academic exercise. It is crucial for individuals, educators, and communities seeking to foster a resilient public sphere. By identifying contradictory stimulation as a primary driver of disengagement, we equip citizens with the self-awareness to diagnose this psychological manipulation. The goal shifts from deploying external "interventions" to cultivating *personal epistemic sovereignty*—the individual's capacity to consciously curate their information environment, recognize manipulative patterns, and maintain their capacity for reasoned judgment against the tide of engineered chaos.

Ultimately, this framework transforms abstract concerns about 'information overload' into a clear diagnosis: the parameter σ quantifies the weaponization of contradiction. The solution it points to is not less freedom of speech, but *more freedom of thought*—a return to the classical liberal ideals of individual critical capacity, intellectual courage, and the pursuit of coherent truth as the foundation of a truly engaged and emancipated citizenship.

APPENDIX

We make use of some results of the theory of stochastic processes which we summarize here.

The stationary probability distribution $P_{st}(x)$ is given by (for simplicity, $x_t \to x$) [41]

$$P_{st}(x) = \mathcal{N} \exp\{[-\mathcal{V}(x)]\}, \tag{19}$$

where $\mathcal{N}$ is the normalization constant and the *effective stochastic potential* $\mathcal{V}(x)$ is

$$\mathcal{V}(x) = -\int \frac{A(x')}{B(x')}dx' + \ln[B(x)] \tag{20}$$

with

$$\begin{aligned} A(x) &= f(x) + \sigma g_1(x)\frac{dg_1(x)}{dx} + \lambda\sqrt{\sigma\Gamma}g_1(x)\frac{dg_2(x)}{dx} \\ &+ \lambda\sqrt{\sigma\Gamma}\frac{dg_1(x)}{dx}g_2(x) + \Gamma g_2(x)\frac{dg_2(x)}{dx} \end{aligned} \tag{21}$$

and

$$B(x) = \sigma[g_1(x)]^2 + 2\lambda\sqrt{\sigma\Gamma}g_1(x)g_2(x) + \Gamma[g_2(x)]^2 \tag{22}$$

The extremes x_m of the stationary probability density function are found using the following equation [41]:

$$\begin{aligned} 0 &= f(x_m) - \sigma g_1(x_m)\frac{dg_1(x_m)}{dx_m} \\ &+ \lambda\sqrt{\sigma\Gamma}g_1(x_m)\frac{dg_2(x_m)}{dx_m} + \lambda\sqrt{\sigma\Gamma}\frac{dg_1(x_m)}{dx_m}g_2(x_m) \\ &+ \Gamma g_2(x_m)\frac{dg_2(x_m)}{dx_m}. \end{aligned} \tag{23}$$

We can obtain the mathematical expectation $\langle F \rangle$ of a function $F(x,t)$ using [42]

$$\left\langle \frac{dF}{dt} \right\rangle = \left\langle \frac{\partial F}{\partial t} + f(x,t)\frac{\partial F}{\partial x} + \frac{g(x,t)^2}{2}\frac{\partial^2 F}{\partial x^2} \right\rangle \tag{24}$$

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