Literature review  
using Epstein et. al. as starting point  
for citations

# Starting point:

**Coupled Contagion Dynamics of Fear and Disease: Mathematical and Computational Explorations**

* Joshua M. Epstein ,
* Jon Parker,
* Derek Cummings,
* Ross A. Hammond
* Published: December 16, 2008

Abstract

**Background**

In classical mathematical epidemiology, individuals do not adapt their contact behavior during epidemics. They do not endogenously engage, for example, in social distancing based on fear. Yet, adaptive behavior is well-documented in true epidemics. We explore the effect of including such behavior in models of epidemic dynamics.

**Methodology/Principal Findings**

Using both nonlinear dynamical systems and agent-based computation, we model two interacting contagion processes: one of disease and one of fear of the disease. Individuals can “contract” fear through contact with individuals who are infected with the disease (the sick), infected with fear only (the scared), and infected with both fear and disease (the sick and scared). Scared individuals–whether sick or not–may remove themselves from circulation with some probability, which affects the contact dynamic, and thus the disease epidemic proper. If we allow individuals to recover from fear and return to circulation, the coupled dynamics become quite rich, and can include multiple waves of infection. We also study flight as a behavioral response.

**Conclusions/Significance**

In a spatially extended setting, even relatively small levels of fear-inspired flight can have a dramatic impact on spatio-temporal epidemic dynamics. Self-isolation and spatial flight are only two of many possible actions that fear-infected individuals may take. Our main point is that behavioral adaptation of some sort must be considered.

# Book

Yes, there is a book:

**Modeling the Interplay Between Human Behavior and the Spread of Infectious Diseases**

Manfredi, d’Onofrio

Springer Mathematics Subject Classification (2010)

# Psychological and social coupling

[**arxiv**](https://arxiv.org/abs/2008.06023)*[Submitted on 13 Aug 2020]*

**A Dynamical Framework for Modeling Fear of Infection and Frustration with Social Distancing in COVID-19 Spread**

[Matthew D. Johnston](https://arxiv.org/search/q-bio?searchtype=author&query=Johnston%2C+M+D), [Bruce Pell](https://arxiv.org/search/q-bio?searchtype=author&query=Pell%2C+B)

In this paper, we introduce a novel modeling framework for incorporating fear of infection and frustration with social distancing into disease dynamics. We show that the resulting SEIR behavior-perception model has three principal modes of qualitative behavior---no outbreak, controlled outbreak, and uncontrolled outbreak. We also demonstrate that the model can produce transient and sustained waves of infection consistent with secondary outbreaks. We fit the model to cumulative COVID-19 case and mortality data from several regions. Our analysis suggests that regions which experience a significant decline after the first wave of infection, such as Canada and Israel, are more likely to contain secondary waves of infection, whereas regions which only achieve moderate success in mitigating the disease's spread initially, such as the United States, are likely to experience substantial secondary waves or uncontrolled outbreaks.

A picture containing text

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Dynamics similar to ours:

Chart, surface chart

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Chart

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*[Submitted on 20 Aug 2020 (*[*v1*](https://arxiv.org/abs/2008.09109v1)*), last revised 30 Aug 2020 (this version,* [*v2*](https://arxiv.org/abs/2008.09109)*)]*

**Modeling the effects of prosocial awareness on COVID-19 dynamics: A case study on Colombia**

[Indrajit Ghosh](https://arxiv.org/search/q-bio?searchtype=author&query=Ghosh%2C+I), [Maia Martcheva](https://arxiv.org/search/q-bio?searchtype=author&query=Martcheva%2C+M)

The ongoing COVID-19 pandemic has affected most of the countries on Earth. It has become a pandemic outbreak with more than 24 million confirmed infections and above 840 thousand deaths worldwide. In this study, we consider a mathematical model on COVID-19 transmission with the prosocial awareness effect. The proposed model can have four equilibrium states based on different parametric conditions. The local and global stability conditions for awareness free, disease-free equilibrium is studied. Using Lyapunov function theory and LaSalle Invariance Principle, the disease-free equilibrium is shown globally asymptotically stable under some parametric constraints. The existence of unique awareness free, endemic equilibrium and unique endemic equilibrium is presented. We calibrate our proposed model parameters to fit daily cases and deaths from Colombia. Sensitivity analysis indicates that the transmission rate and learning factor related to awareness of susceptibles are very crucial for reduction in disease related deaths. Finally, we assess the impact of prosocial awareness during the outbreak and compare this strategy with popular control measures. Results indicate that prosocial awareness has competitive potential to flatten the curve.

Unaware vs aware susceptibles:

Text, letter

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**Towards a Characterization of Behavior-Disease Models**

* Nicola Perra ,
* Duygu Balcan,
* Bruno Gonçalves,
* Alessandro Vespignani
* Published: August 3, 2011
* <https://doi.org/10.1371/journal.pone.0023084>

## **Abstract**

The last decade saw the advent of increasingly realistic epidemic models that leverage on the availability of highly detailed census and human mobility data. Data-driven models aim at a granularity down to the level of households or single individuals. However, relatively little systematic work has been done to provide coupled behavior-disease models able to close the feedback loop between behavioral changes triggered in the population by an individual's perception of the disease spread and the actual disease spread itself. While models lacking this coupling can be extremely successful in mild epidemics, they obviously will be of limited use in situations where social disruption or behavioral alterations are induced in the population by knowledge of the disease. Here we propose a characterization of a set of prototypical mechanisms for self-initiated social distancing induced by local and non-local prevalence-based information available to individuals in the population. We characterize the effects of these mechanisms in the framework of a compartmental scheme that enlarges the basic SIR model by considering separate behavioral classes within the population. The transition of individuals in/out of behavioral classes is coupled with the spreading of the disease and provides a rich phase space with multiple epidemic peaks and tipping points. The class of models presented here can be used in the case of data-driven computational approaches to analyze scenarios of social adaptation and behavioral change.

These models are very close in spirit to ours.

“For this reason we will assume that individuals affected by the fear of the disease will be grouped in a specific compartment  of susceptible individuals.”

Table

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Model I:

Diagram

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Graphical user interface

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Model III:

Diagram, schematic

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Graphical user interface, application

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[**Link**](https://www.pnas.org/content/108/15/6306.short)

**Adaptive human behavior in epidemiological models**

Eli P. Fenichel, Carlos Castillo-Chavez, M. G. Ceddia, Gerardo Chowell, Paula A. Gonzalez Parra, Graham J. Hickling, Garth Holloway, Richard Horan, Benjamin Morin, Charles Perrings, Michael Springborn, Leticia Velazquez, and Cristina Villalobos

PNAS April 12, 2011 108 (15) 6306-6311; <https://doi.org/10.1073/pnas.1011250108>

**Abstract**

The science and management of infectious disease are entering a new stage. Increasingly public policy to manage epidemics focuses on motivating people, through social distancing policies, to alter their behavior to reduce contacts and reduce public disease risk. Person-to-person contacts drive human disease dynamics. People value such contacts and are willing to accept some disease risk to gain contact-related benefits. The cost–benefit trade-offs that shape contact behavior, and hence the course of epidemics, are often only implicitly incorporated in epidemiological models. This approach creates difficulty in parsing out the effects of adaptive behavior. We use an epidemiological–economic model of disease dynamics to explicitly model the trade-offs that drive person-to-person contact decisions. Results indicate that including adaptive human behavior significantly changes the predicted course of epidemics and that this inclusion has implications for parameter estimation and interpretation and for the development of social distancing policies. Acknowledging adaptive behavior requires a shift in thinking about epidemiological processes and parameters.

We have this somewhere…

Note Chowell author.

Not sure their Cmn partitioning is really equivalent to our cautioned susceptibles

Text, letter

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Text, letter

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Their observed dynamics is somewhat uninteresting…

Chart, histogram

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[**Link**](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372)

**Coupled disease–behavior dynamics on complex networks: A review**

Author links open overlay panel[ZhenWang](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[ab](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[Michael A.Andrews](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[c](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[Zhi-XiWu](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[d](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[LinWang](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[e](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[Chris T.Bauch](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)[f](https://www.sciencedirect.com/science/article/abs/pii/S1571064515001372" \l "!)

**The Talk of the Town: Modelling the Spread of Information and Changes in Behaviour**

**Sebastian Funk and Vincent A.A. Jansen**

**Abstract** Changesinhostbehaviourcaninfluencethecourseofadiseaseoutbreak. These changes can be triggered not only by public campaigns and mass media reporting, but also by person-to-person communication and influence from peers. Here, we describe a model in which awareness of the presence of a disease can spread in a population and influence the spread of the disease itself through protective measures that people can take. We describe the dynamics of disease spread, focusing, in particular, on the relation between awareness and proximity of disease in the network.

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Simulations are on a spatial lattice.

# Agent-based models / Networks

**Coupled disease-behavior dynamics on complex networks: A review**

Zhen Wang, Michael A. Andrews, Zhi-Xi Wu, Lin Wang, Chris T. Bauch

http://dx.doi.org/10.1016/j.plrev.2015.07.006

PLREV 645

*Physics of Life Reviews*

2 April 2015 24 June 2015 25 June 2015

Abstract

It is increasingly recognized that a key component of successful infection control efforts is understanding the complex, two-way interaction between disease dynamics and human behavioral and social dynamics. Human behavior such as contact precautions and social distancing clearly influence disease prevalence, but disease prevalence can in turn alter human behavior, forming a coupled, nonlinear system. Moreover, in many cases, the spatial structure of the population cannot be ignored, such that social and behavioral processes and/or transmission of infection must be represented with complex networks. Research on studying coupled disease-behavior dynamics in complex networks in particular is growing rapidly, and frequently makes use of analysis methods and concepts from statistical physics. Here, we review some of the growing literature in this area. We contrast network-based approaches to homogeneous-mixing approaches, point out how their predictions differ, and describe the rich and often surprising behavior of disease-behavior dynamics on complex networks, and compare them to processes in statistical physics. We discuss how these models can capture the dynamics that characterize many real-world scenarios, thereby suggesting ways that policy makers can better design effective prevention strategies. We also describe the growing sources of digital data that are facilitating research in this area. Finally, we suggest pitfalls which might be faced by researchers in the field, and we suggest several ways in which the field could move forward in the coming years.

---Mostly agent based models and networks.

# Economic models

**A Tale of Two Crises: Financial Constraint and Beliefs about the Spread of COVID-19**

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FINANCIAL CONSTRAINT AND BELIEFS ABOUT COVID-19 2

Abstract

In early March 2020, two crises quickly emerged: the COVID-19 public health crisis and a corresponding economic crisis resulting from business closures and skyrocketing job losses. While the link between socioeconomic status and infectious disease is well-documented, the psychological impacts of financial constraint on perceptions of disease spread and subsequent actions is not well understood. We show that financial constraint predicts people’s beliefs about both their personal risk of infection and the national spread of the virus as well as their social distancing behavior. In addition, we compare the predictive utility of financial constraint to two other commonly studied factors: political partisanship and local disease severity. The strength of the effect of financial constraint equals or eclipses the influence of partisanship on beliefs and is much larger than that of local disease severity. We also show that negative affect partially mediates the relationship between financial constraint and COVID-19 beliefs and social distancing behaviors. These results suggest the economic crisis created by COVID-19 is spilling over into people’s beliefs about the health crisis and their behaviors. Correspondingly, variables related to the economic crisis created by COVID-19 can be used to predict both people’s beliefs about the health crisis as well as relevant behaviors.

# Are we still alive?

Main points shift a little, but we still have the highlights

* richer dynamics that match with observed dynamics
* 2nd wave has been discovered in various reactive models
* but long linear zone has really not been flagged.
* No systematic classification of country dynamics like our FPCA stuff
* No systematic fitting of country dynamics like our fit stuff (wants to be...)
* So no conclusion that the richer dynamics of the reactive models can actually fit data better.