Of love, death and money: perspectives on the ecology of fear during the covid19 epidemic

Miguel A. Acevedo,
Wildlife Ecology and Conservation,
Univ. of Florida

Panel Post COVID19

Disease Ecology

"Disease, it turns out, is largely and environmental issue"

The New York Times
SundayReview | The Opinion Pages

WORLD U.S. N.Y. / REGION BUSINESS TECHNOLOGY SCIENCE HEALTH SPORTS OPINION

SEPTEMBER SALE SAVE 60% FO
SALE ENDS SEPTEMBER 9th* ON A DIGITAL SUBSCRIPTION

NEWS ANALYSIS

The Ecology of Disease

Olaf Hajek

By JIM ROBBINS
Published: July 14, 2012 | 114 Comments

THERE'S a term biologists and economists use these days — ecosystem services — which refers to the many ways nature supports the human endeavor. Forests filter the water we drink, for example, and birds and bees pollinate crops, both of which have substantial economic as well as biological value.

FACEBOOK
TWITTER
GOOGLE+
SAVE
EMAIL
SHARE
PRINT

Multimedia

If we fail to understand and take care of the natural world, it can cause a breakdown of these systems and come

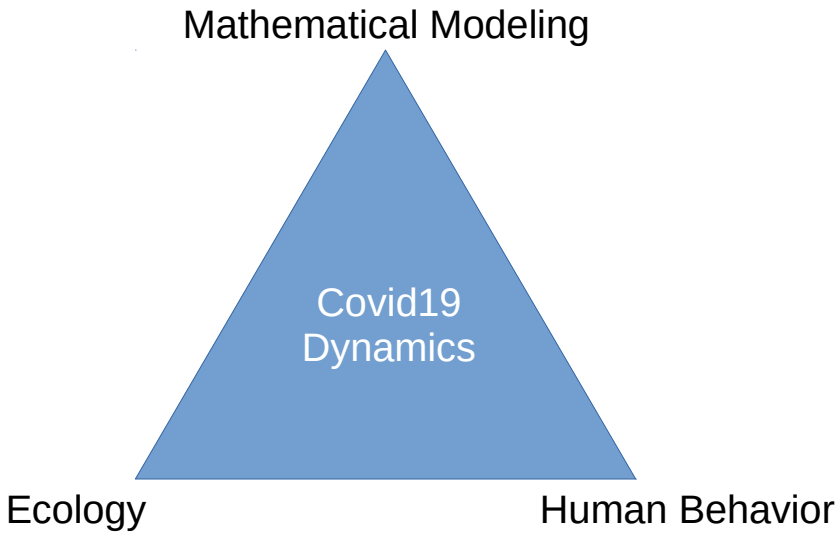
Definition

"...the ecological study of host-pathogen interactions within the context of their environment and evolution..." (Kilpatrick and Altizer 2010)

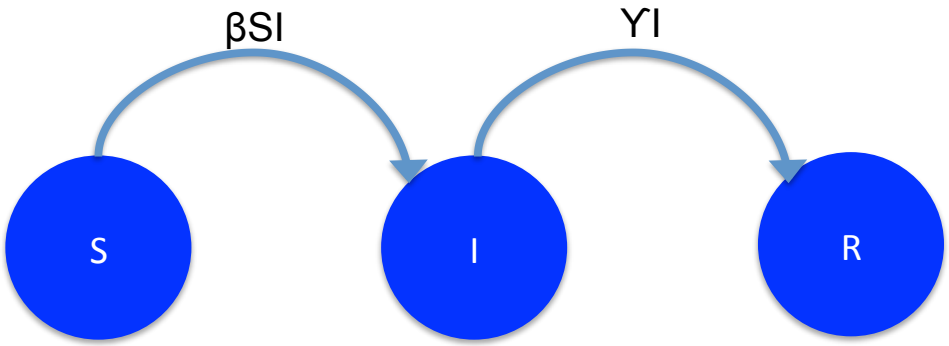
Interdisciplinary science: population ecology, epidemiology, parasitology, geography, mathematics and statistics

Purpose: understand transmission and disease spread over space and time and its impact on host dynamics.

Interdisciplinary approach

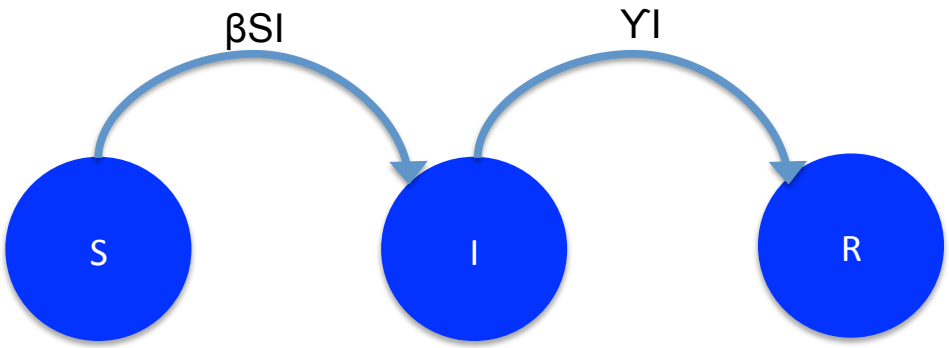


SIR models



- S: Susceptibles
- I: Infective
- R: Removed (immune or dead)

SIR models

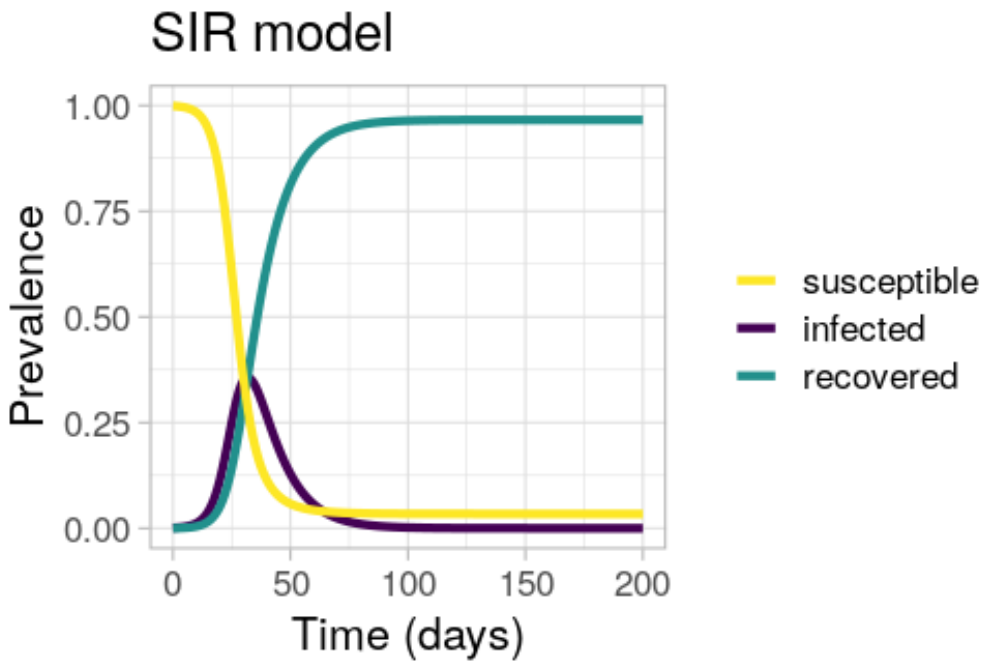


$$\frac{dS}{dt} = -\beta SI$$
$$\frac{dI}{dt} = \beta SI - \gamma I$$
$$\frac{dR}{dt} = \gamma I$$

SIR Model

A "simple" model for contact diseases

$$\frac{dS}{dt} = -\beta SI$$
$$\frac{dI}{dt} = \beta SI - \gamma I$$
$$\frac{dR}{dt} = \gamma I$$



- S:susceptibles, I: Infectious, R: Recovered
- β transmission rate
- γ: recovery rate, $1/\gamma$: infectious period

A threshold condition...R_0

For a disease to spread we need $\frac{dI}{dt} > 0$, or in other words $\beta/\gamma \geq 1$. We denote the threshold condition R_0 as

$$R_0 = \frac{\beta}{\gamma}$$

R_0 is the average number of secondary infections by a single infected individual. If $R_0 \geq 1$ we have an epidemic.

R_0

Disease	R_0
Diphteria	6-7
Measles	12-18
Smallpox	6-7
Polio	5-7
Malaria	1-18
HIV	2-5
Influenza	2-3
Ebola	1-4
covid19	2–3

Table: R_0 estimates for various diseases

The main goal to manage and epidemic is to get to $R_0 < 1$

Social distancing reduces transmission rate

Define C_β as the proportion of transmission rate reduced by social distancing

$$R_0 = \frac{\beta(1 - C_\beta)}{\gamma}$$

Social distancing and R_0

Without social distancing $R_0 > 1$

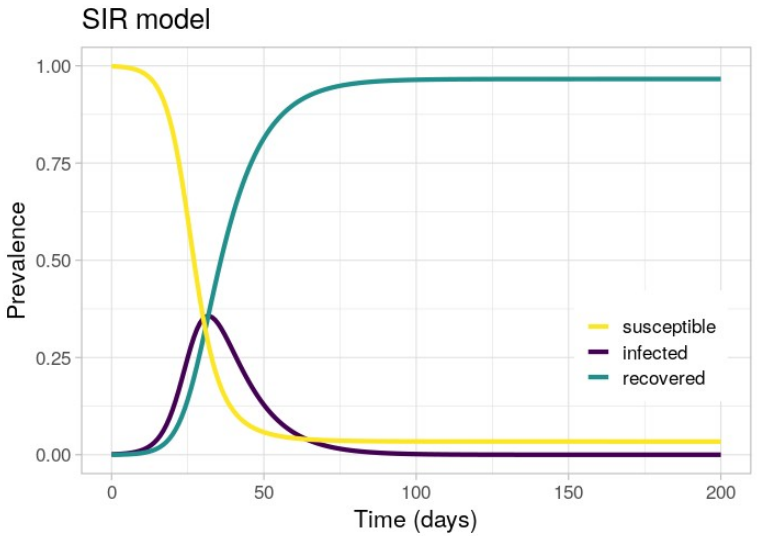
$$R_0 = \frac{\beta}{\gamma} = \frac{0.25}{0.1} = 2.5$$

With social distancing $R_0 < 1$

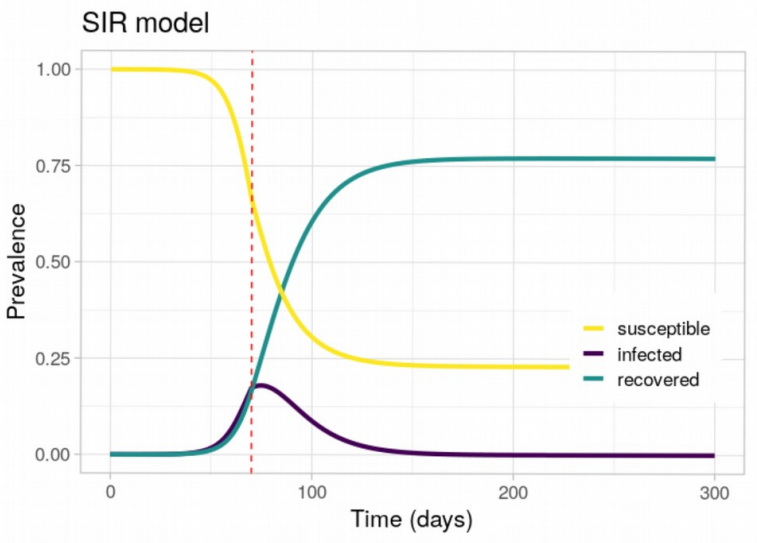
$$R_0 = \frac{\beta(1 - C_\beta)}{\gamma} = \frac{0.25(1 - 0.3)}{0.1} = 0.75$$

With social distancing $C_\beta = 0.3$ starting in day 70

No Social Distancing

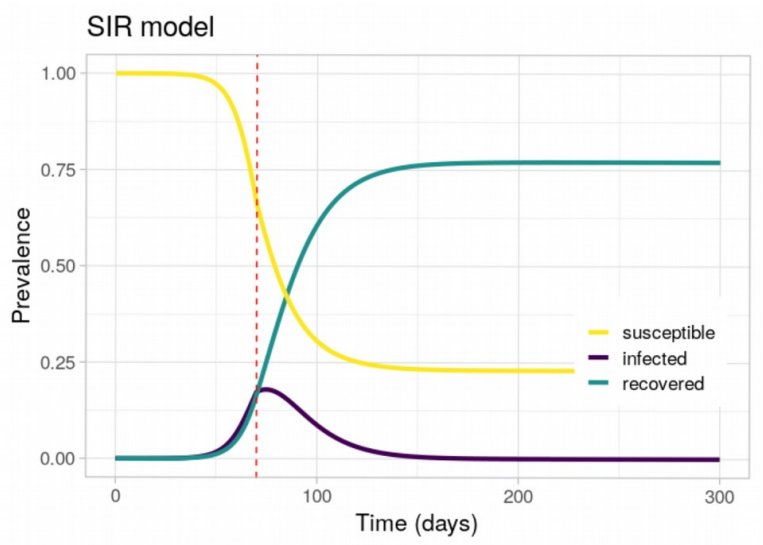


Social Distancing
Starting at day 70

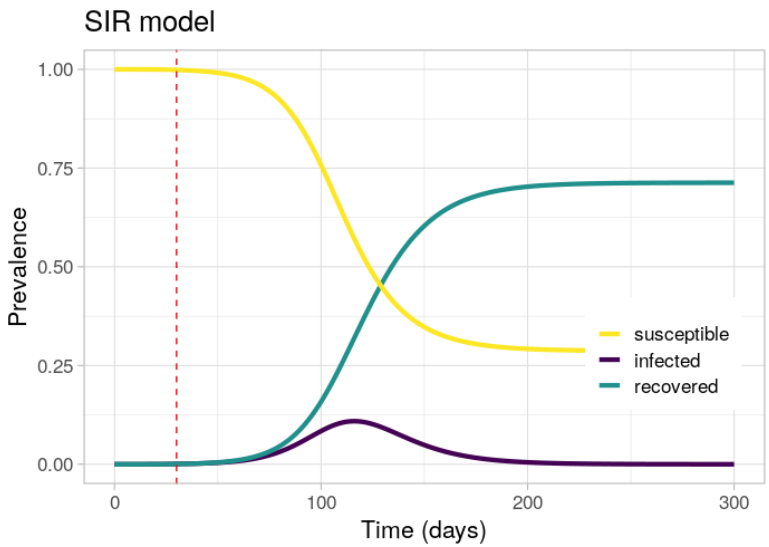


When do you start social distancing matters

Social Distancing Starting at day 70



Social Distancing Starting at day 30



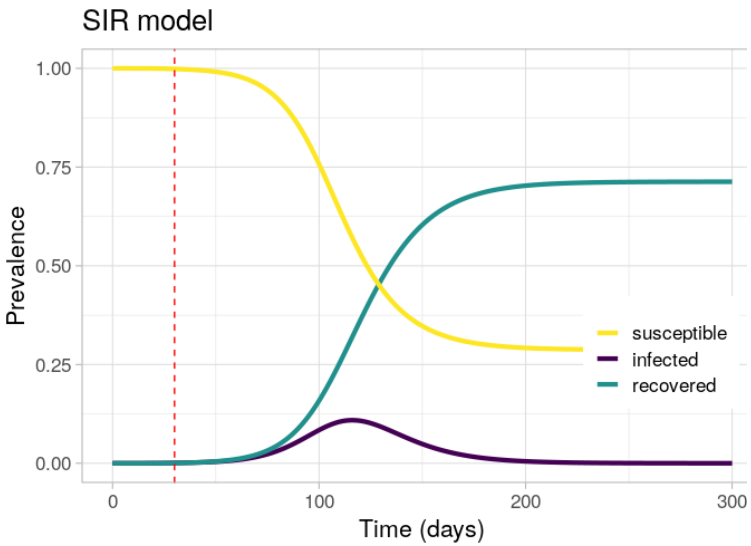
Adding quarantine to social distancing

Define C_γ as the proportional effect of quarantine decreasing the length of the infectious period $(1/\gamma)$

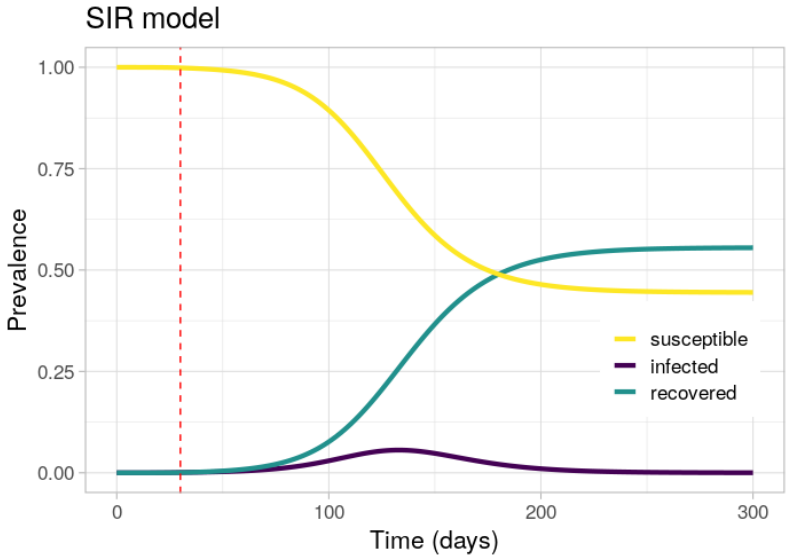
$$R_0 = \frac{\beta(1 - C_\beta)}{\gamma(1 + C_\gamma)}$$

Combining social distancing and quarantine

Social Distancing Starting at day 30



Social Distancing and quarantine



In sum...

- Social distancing can be used to decrease R_0
- When do you start social distancing matters
- Combined with quarantine increases the duration of epidemic but significantly reduces prevalence

This model is wrong!!

Remember that all models are wrong; the practical question is how wrong do they have to be to not be useful.

Statistician George Box in his 1987 book, Empirical Model-Building and Response Surfaces (which was co-authored with Norman Draper).

Assumptions...

Assumptions of the basic SIR model

- Closed population
- No demographics (no births or natural deaths)
- Large naive population
- Quick epidemic (demographics are not important)
- **Homogeneous mixing**

Homogeneous mixing: Every individual has the same probability of infection

Probability of infection is often driven by risk behavior

How much risk are you willing to take? Trade-off between survival and resources.

Ecology of Fear: Predator-Prey

Prey: Needs to balance level of vigilance in response to their perceptions of a predator's whereabouts.

Ecology of Fear: Host-Pathogen

Host: Needs to balance level of vigilance in response to their perceptions of a pathogen's whereabouts.

Decision is made based on *information*

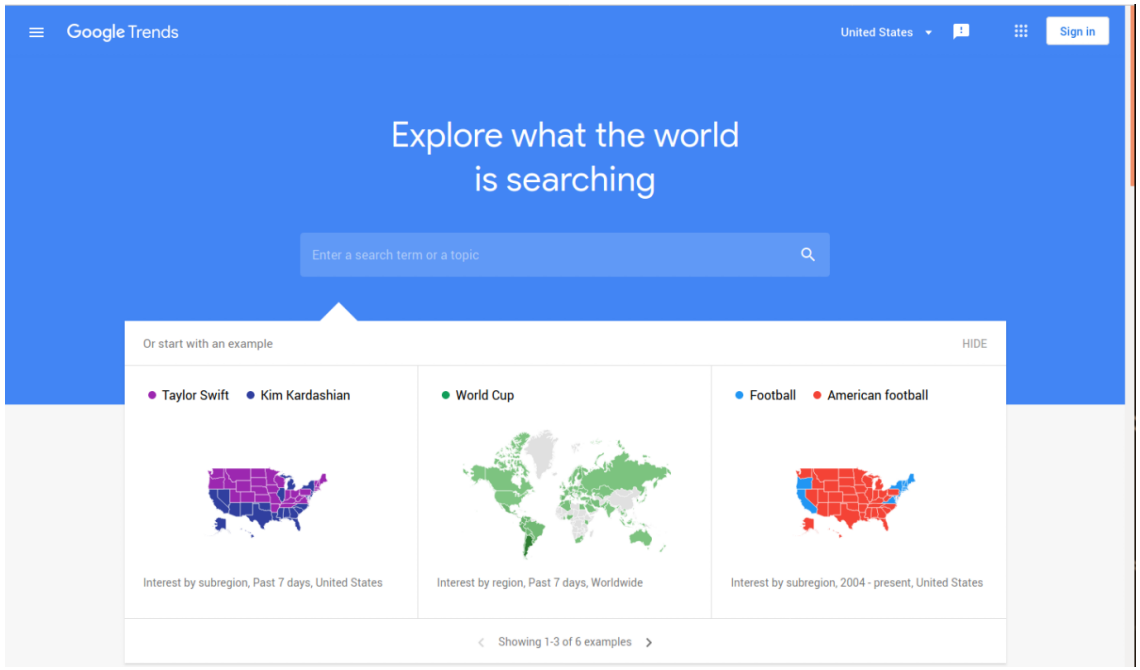
In animals life is a balance between...

Survival vs. food and mates

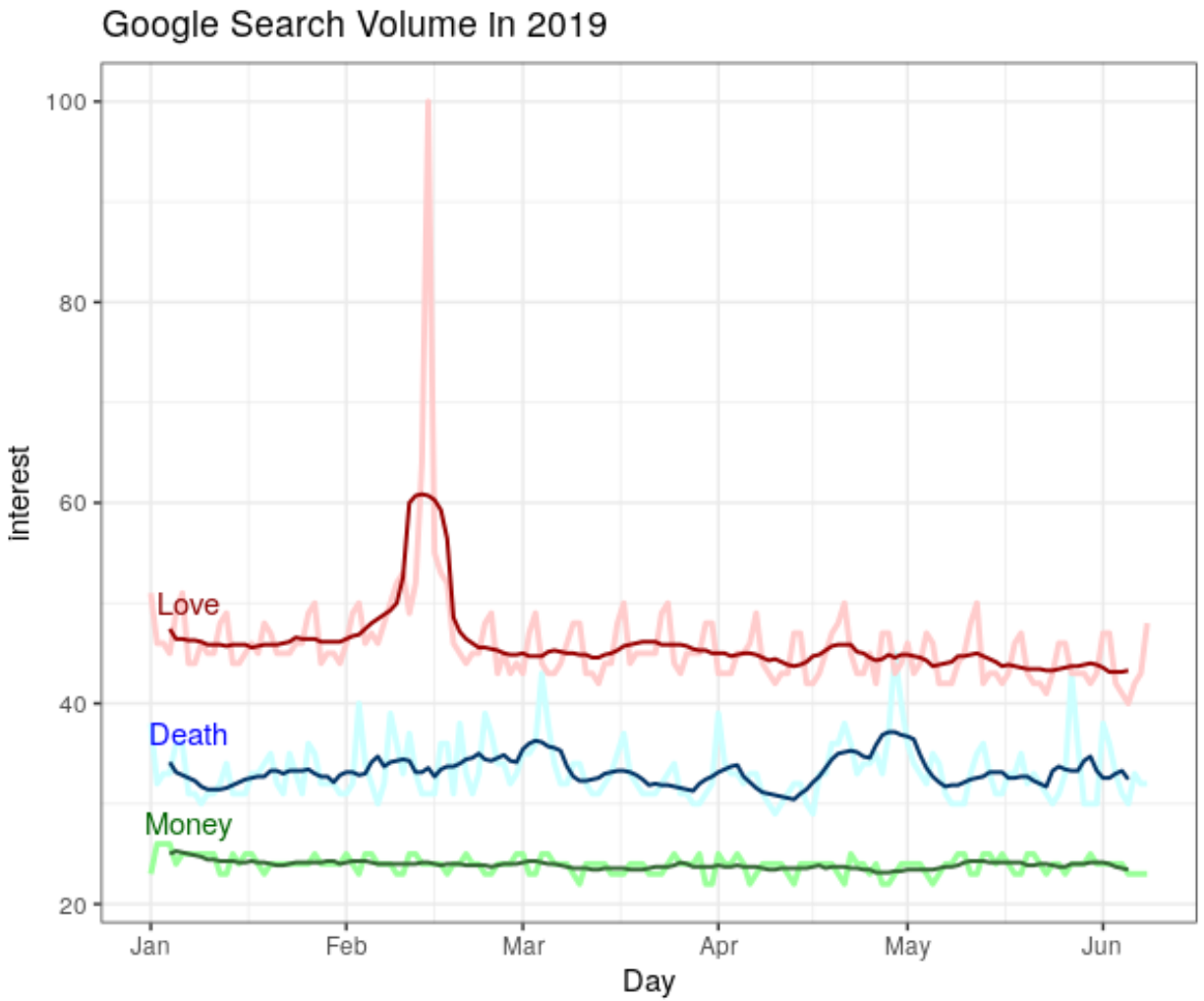
How are humans gathering information to inform this balance during covid19? What are human perceptions changing?

Google trends

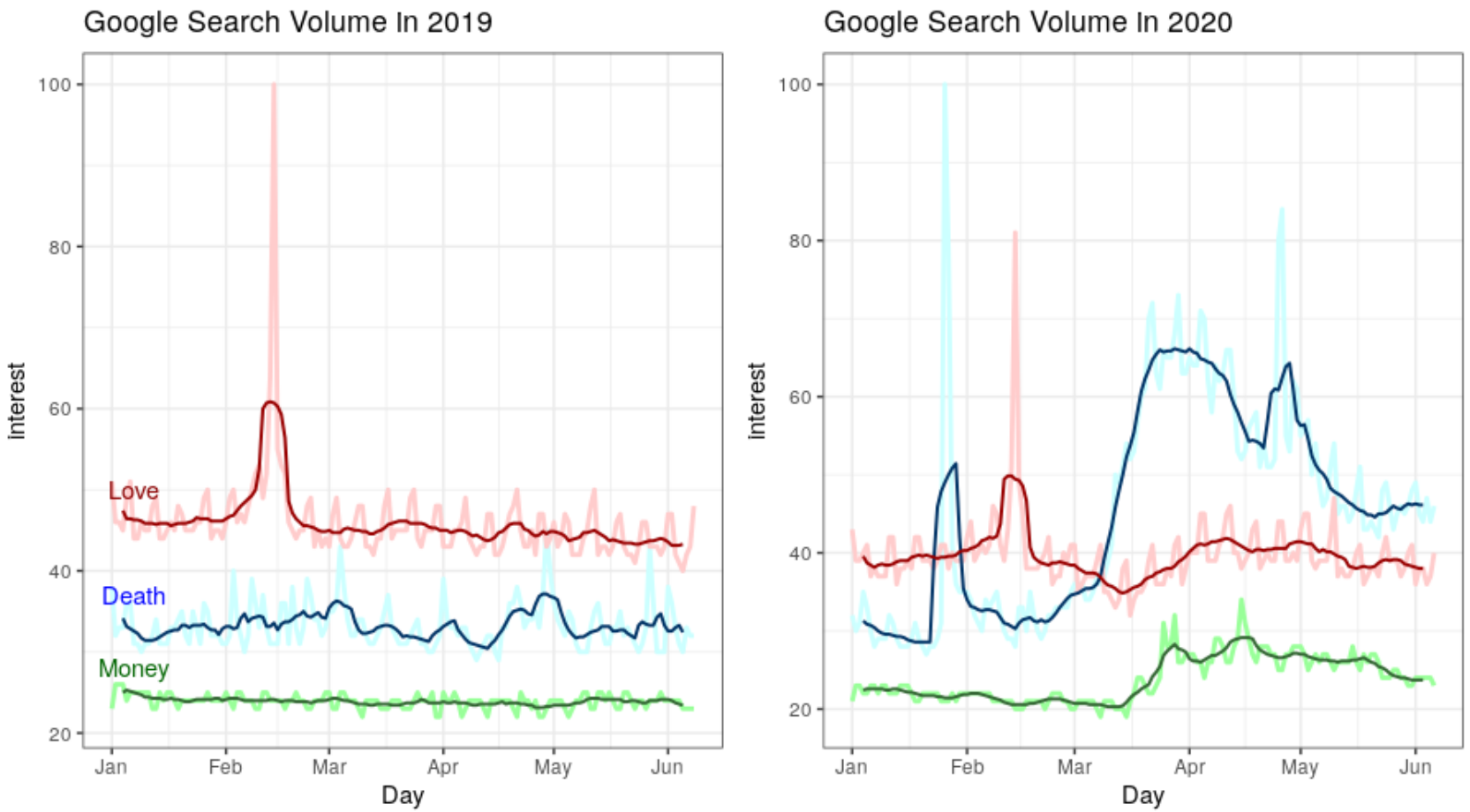
How are humans gathering information to inform this balance during covid19? What are human perceptions changing?



Money, love and death this period last year...



Money, love and death this period last year...



Information, behavior and disease control

Variability in human behavior, driven by available information and individual perspectives, results in variability in disease risk and management response.

The future of covid19 research is interdisciplinary