EPISTEMOLOGY OF AN ECOYSTEMIC EPIDEMIOLOGY
Its Relevance for Efficacy of Pandemic Management: the Case of COVID-19 and its "theory-free" modeling

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Bertalanffy Center for the Study of Systems Science (Vienna)
- Vice President, since 2017.
https://www.bcsss.org/2019/towards-organismic-systems-medicine/
https://www.bcsss.org/2019/systems-medicine-comorbidity/
- President of the German Society for Human Ecology(Berlin/Augsburg). -
Research

Formerly:
- studies in analytical philosophy of science at Chair Wolfgang Stegmüller /
Muncih
- studies in medicIne and sociology
- work as brain researcher, physician and manager in health care
- active in epidemiology of addictive disorders, also simulation studies

Personal source of presentation:
* Tretter. F 2022. Wissensgesellschaft im Krisenstress. Pabst, Lengerich
* Tretter F, Marcum J. 'Medical Corona Science': Philosophical and systemic
issues: Re-thinking medicine? On the epistemology of Corona medicine. J Eval
Clin Pract. 2022 Jul 11. doi: 10.1111/jep.13734. Epub ahead of print. PMID:
35818671.

SUMMARY - EPISTEMOLOGY OF EPIDEMIOLOGY

Re-thinking epidemiology:
- **Proposition #1: (Grounded ?) Theoretical epidemiology is needed!**
- **Proposition #2: Social / Human Ecology as conceptual reference**
- **Propostion #3: Systems science as bridging method**

1. Epidemiology & Theory of Corona
- **Epidemiology as data science**
- **„Dataism"; Descriptive empiricism without explanatory theory?**
- **Problems with causal analysis**

2. Social / Human Ecology
- **Integrating natural and social sciences and integrating other perspectives**
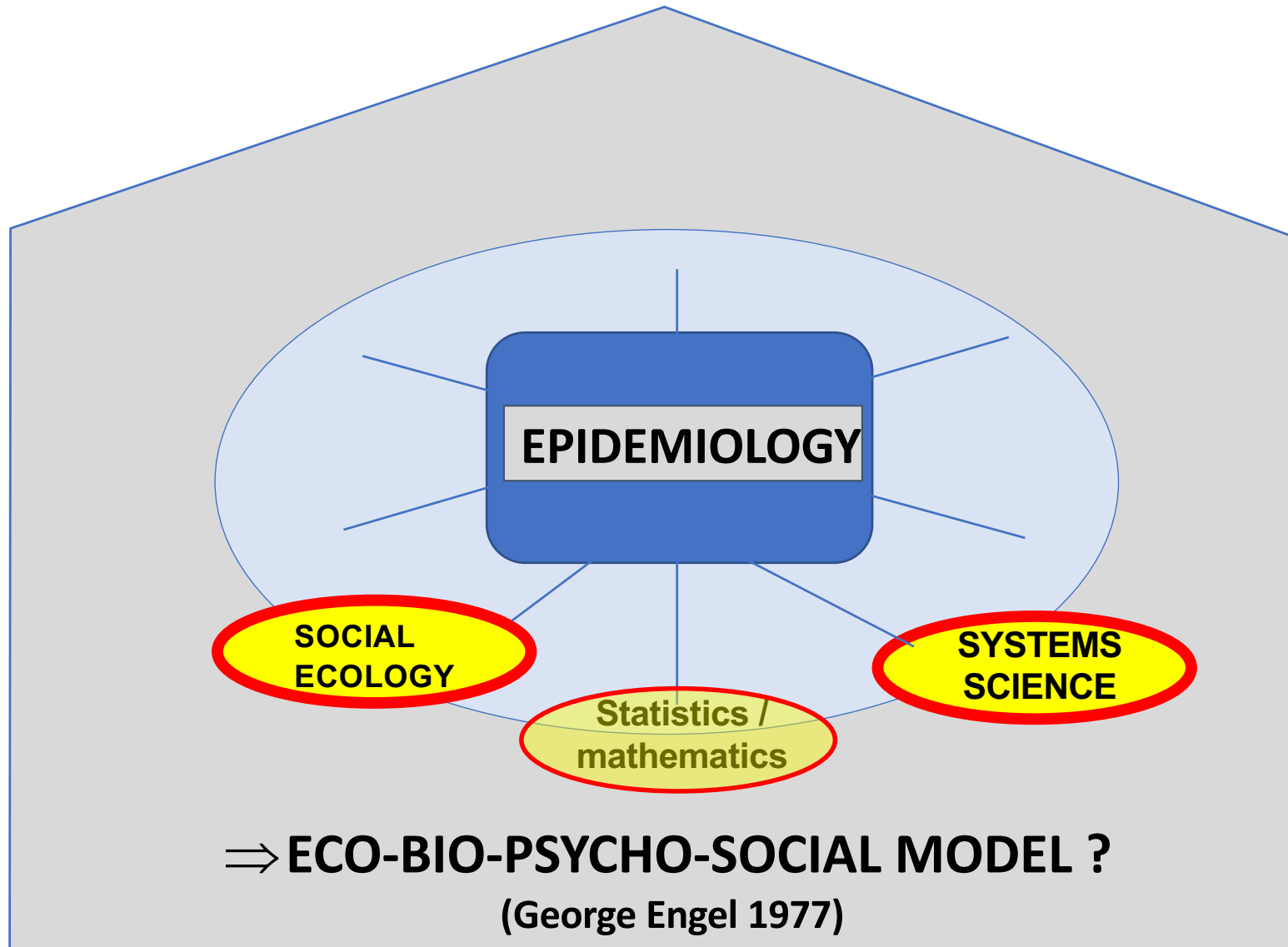- **heterogeneous evidence to be integrated ?**

3. Systems Science
- **Methodology of modellng**
- **Theoretical models (flow equilibirium): epistemic value for explanation**

4. Perspective

EPIDEMIOLOGY – based on SOCIAL ECOLOGY AND SYSTEMS SCIENCE

- Epistemologies of different disciplines -

EPIDEMIOLOGY

SOCIAL ECOLOGY

Statistics / mathematics

SYSTEMS SCIENCE

⇒ **ECO-BIO-PSYCHO-SOCIAL MODEL ?**

(George Engel 1977)

1. CORONA EPIDEMIOLOGY
1.1 Empirical research

- „Incidence" and real health state of population ?

  - **Causes of changes of „incidence"** ?
  (still is under discussion…)

  - Is mathematical epidemiology
  sufficient
  for understanding real-life epidemics ?
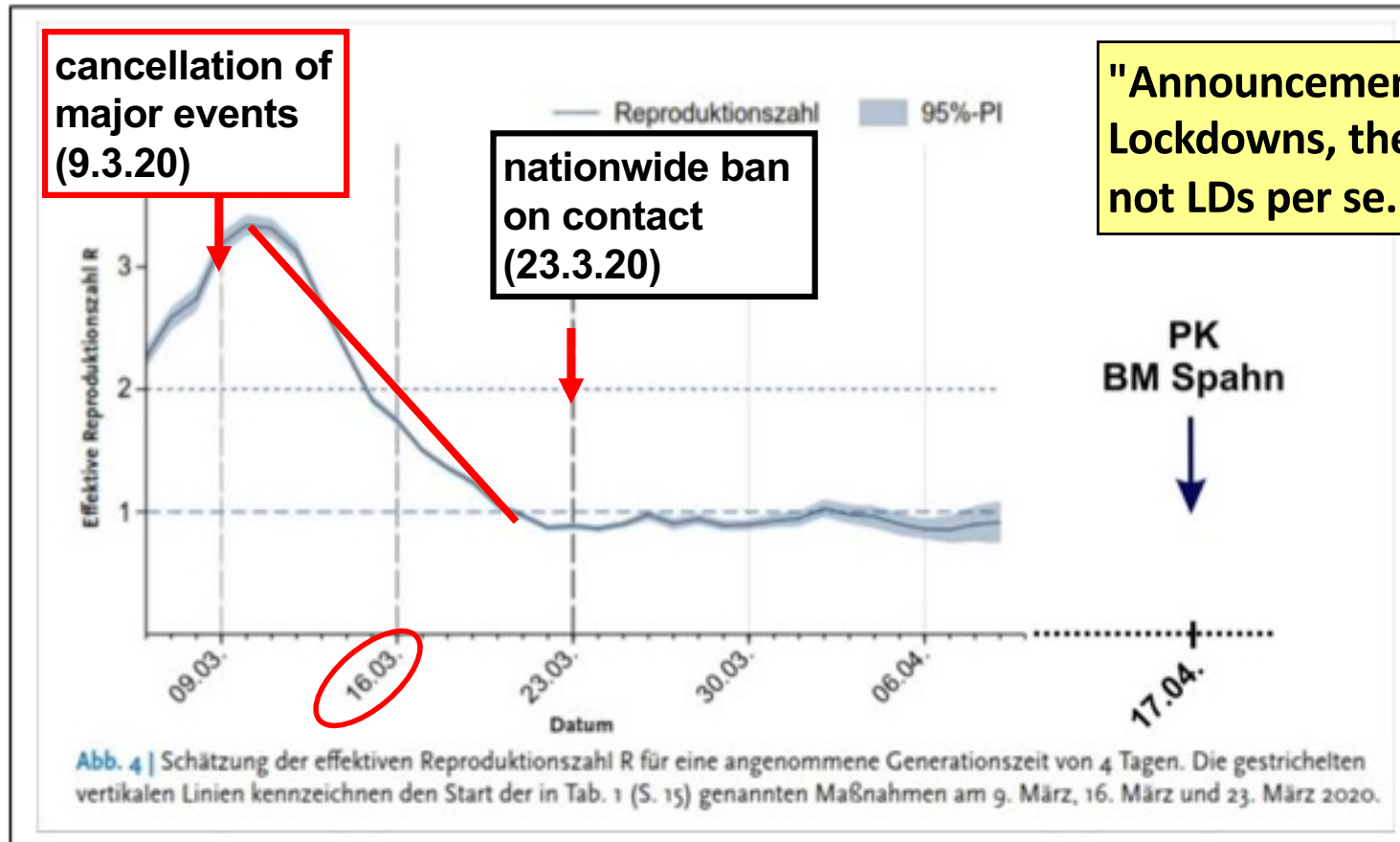
CAUSAL INFERENCE IN LATE CORONA-EPIDEMIOLOGY

- „Incidence" = test positives! Not persons who fell ill…!

- Use of „Reff" as the calculated (not „measured") restrospective number
  of test-positives; several different modes of calculation like 7 days
  average !

- Accounting the effects of different interventions like ban of major events

- Attributing a latency for change of Reff after intervention of several days!

- Inaccurate assessment of interventions by Imperail College London
  (30th March 2020)

- Correction by Swedish epidemioplogists, using the code of ICL

- To be discussed !!!

„INCIDENCE" - CAUSE AND EFFECT ?

Fig. 8: In Switzerland, similar to Germany, the **effective reproduction number** had already fallen to 1 **before the lockdown was announced** and remained at a low level there (Vernazza 2020). The reduction is most likely to be seen as a **consequence of the previously imposed ban on events.**
Modif. After Schrappe et al. 2020 TP2; p. 34

"INCIDENCE" of positive tests and Dynamics: Incidence vs. Reff ?

cancellation of major events (9.3.20)

nationwide ban on contact (23.3.20)

"Announcement of the Lockdowns, the effects, not LDs per se..."

— Reproduktionszahl   95%-PI

PK
BM Spahn

Effektive Reproduktionszahl R

09.03.   16.03.   23.03.   30.03.   06.04.   17.04.

Datum

Abb. 4 | Schätzung der effektiven Reproduktionszahl R für eine angenommene Generationszeit von 4 Tagen. Die gestrichelten vertikalen Linien kennzeichnen den Start der in Tab. 1 (S. 15) genannten Maßnahmen am 9. März, 16. März und 23. März 2020.
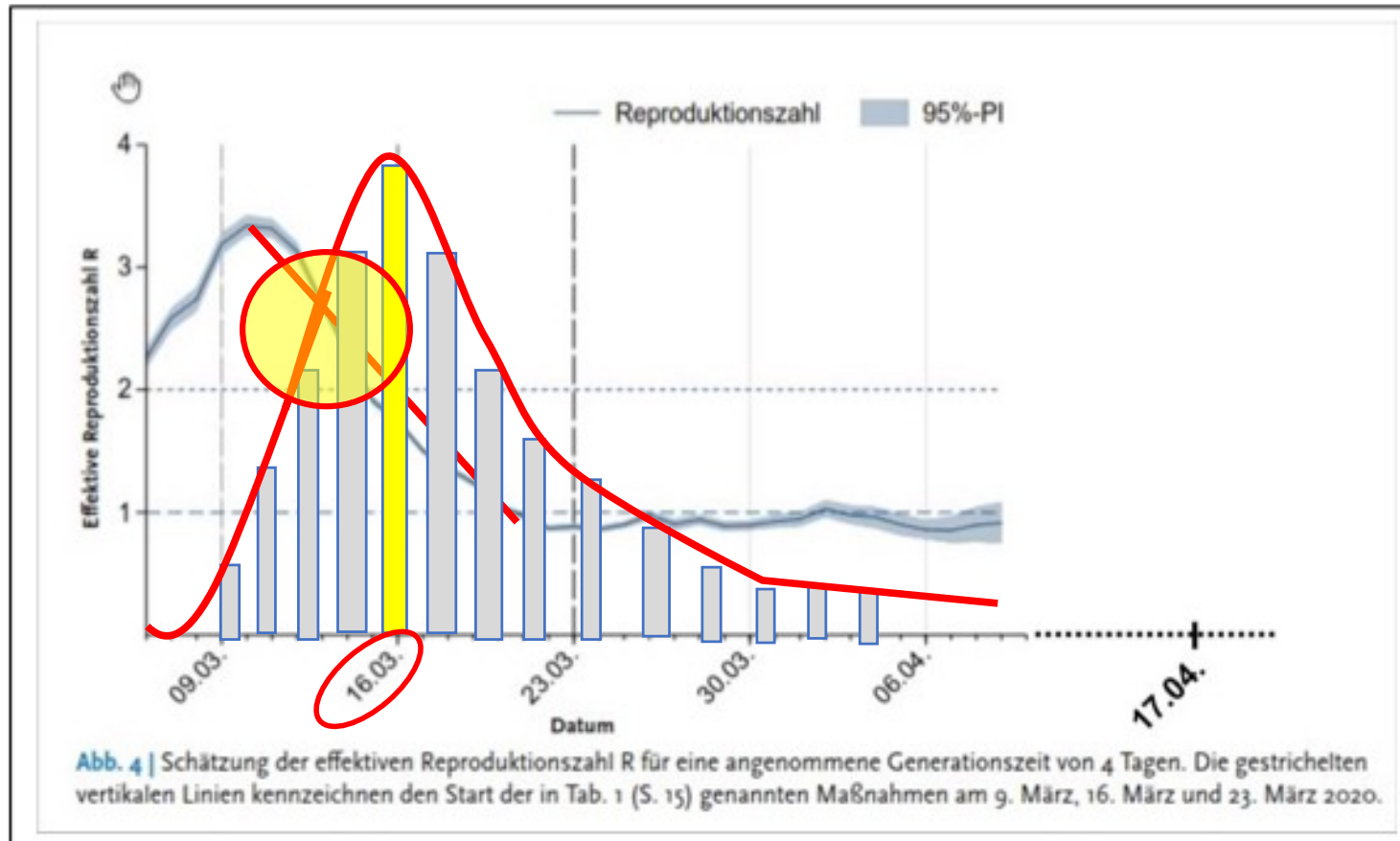
- problems with calculation of „effective reproduction number" (Reff)
- Reff indicates the speed of growth of incidence : is this a good control indicator for Public health interventions ?
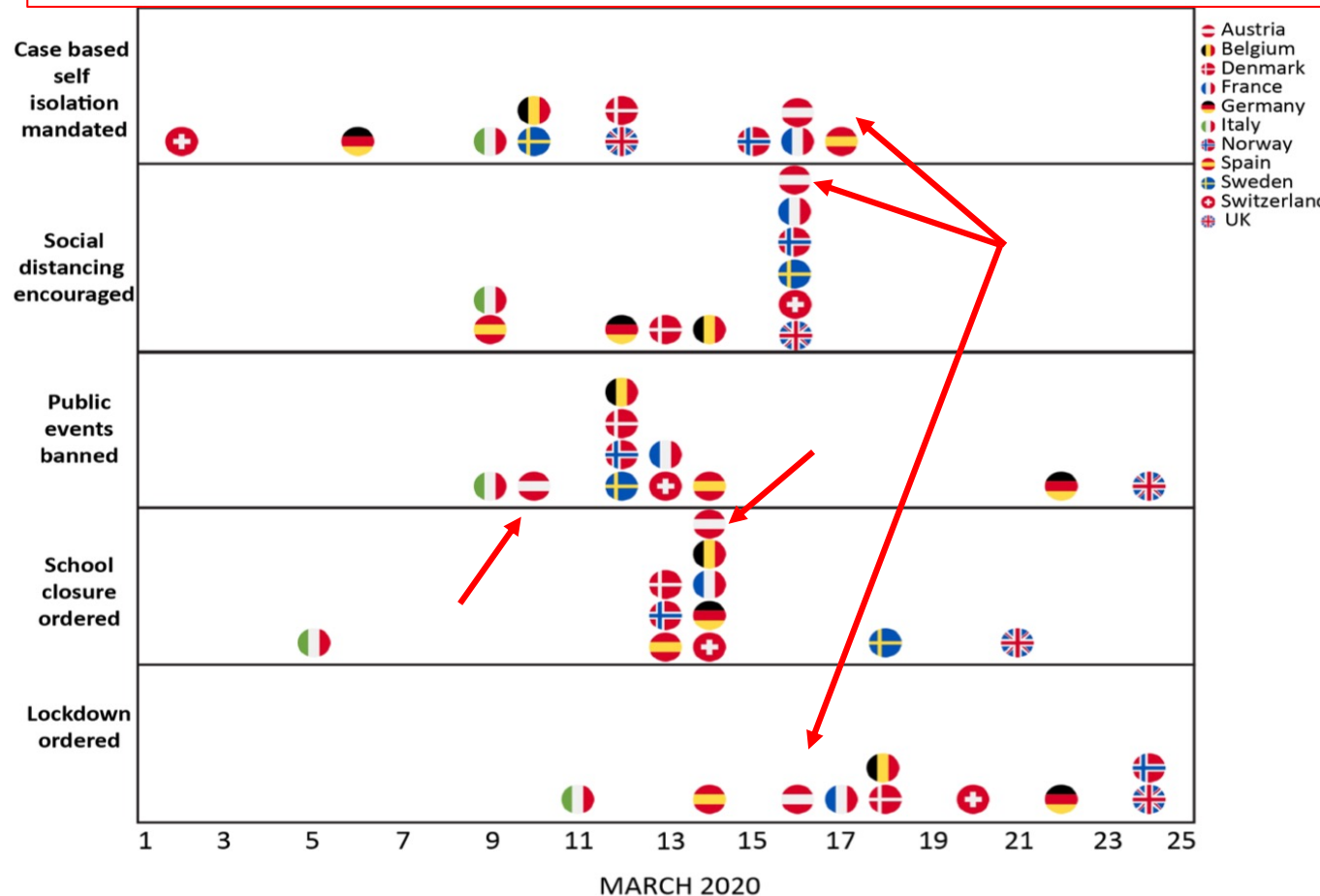
"INCIDENCE" of positive tests and Dynamics: raw data of incidence!
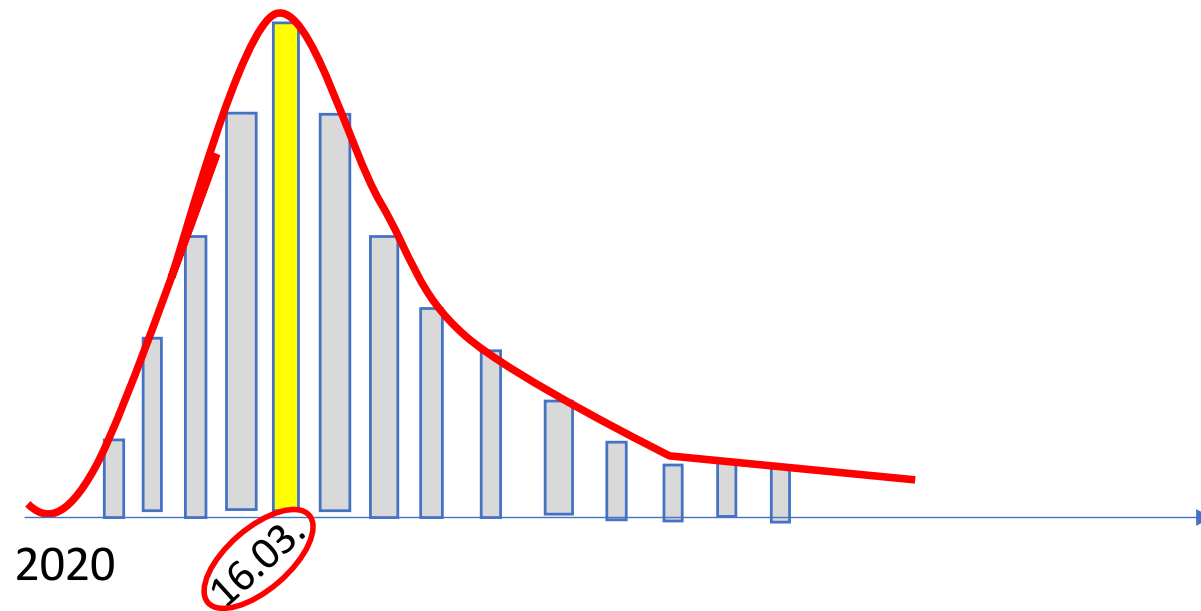
- problems with „incidence" (= positively tested persons / cases)

"INCIDENCE" of positive tests and Dynamics: Incidence vs. Reff ?

Abb. 4 | Schätzung der effektiven Reproduktionszahl R für eine angenommene Generationszeit von 4 Tagen. Die gestrichelten vertikalen Linien kennzeichnen den Start der in Tab. 1 (S. 15) genannten Maßnahmen am 9. März, 16. März und 23. März 2020.

- problems with calculation of „effective reproduction number" (Reff)
- Reff indicates the speed of growth of incidence : is this a good control
  indicator for Public health interventions ?

Coronavirus measures may have already averted up to 120,000 deaths across Europe

by *Ryan O'Hare*, *Dr Sabine L. van Elsland* 30 March 2020

HomeCollege and CampusScienceEngineeringHealthBusiness

Seth Flaxman, Swapnil Mishra, Axel Gandy *et al*. Estimating the number of infections and the impact of non-pharmaceutical interventions on COVID-19 in 11 European countries. Imperial College London (30-03-2020) doi: https://doi.org/10.25561/77731. https://www.imperial.ac.uk/news/196556/coronavirus-measures-have-already-averted-120000/

WHAT HAPPENED AT MARCH 16th 2020 IN AUSTRIA /GERMANY ?

Figure 1: Intervention timings for the 11 European countries included in the analysis. For further details see Appendix 8.6.

Different measures at different times; also announcement e.g. Friday March 13th, implementation Monday 16th => behavior of the people not only through the implementation, but after announcement or even in advance; also Explanandum Δ incidence questionable (reporting delay)!

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"INCIDENCE" of positive tests and Dynamics: Incidence vs. Reff ?
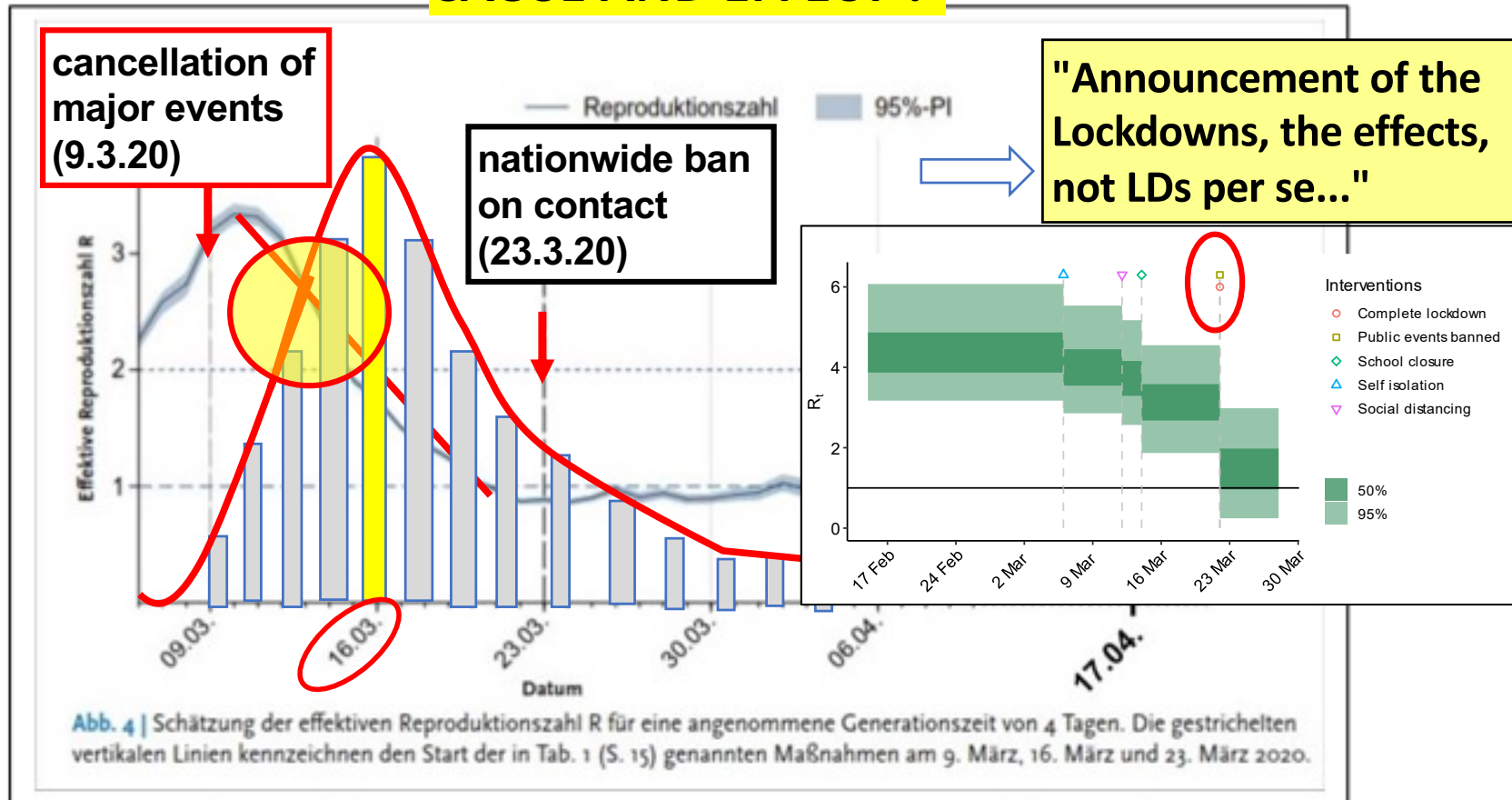## - CAUSE AND EFFECT ? -

Fig. 7: Time course of the effective reproduction number up to 9.4.2020 (modified from An der Heiden and Hamoud 2020, RKI). The vertically dashed lines correspond to the cancellation of major events (9.3.), the federal-state agreement on the guidelines (16.3.) and the nationwide ban on contact (23.3.20). The low reproduction number that has already been achieved was only communicated to the public by Federal Health Minister Spahn on 17.4.2020 (vertical arrow).
Extended after Schrappe et al. 2020; TP 2. p.33

Reff versus CHANGE POINT ANALYSIS ...
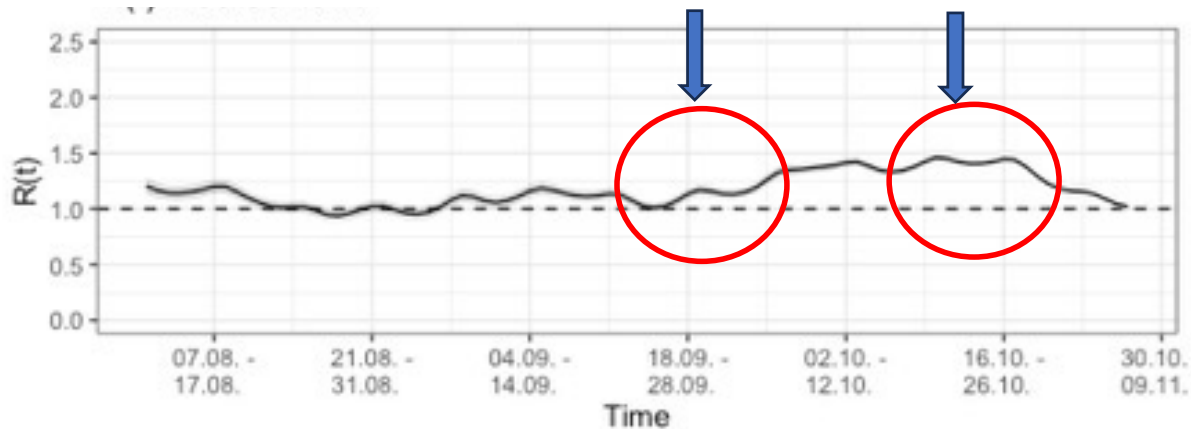
Statistisches Beratungslabor StaBLab, LMU München; Department of Mathematics, Stockholm University
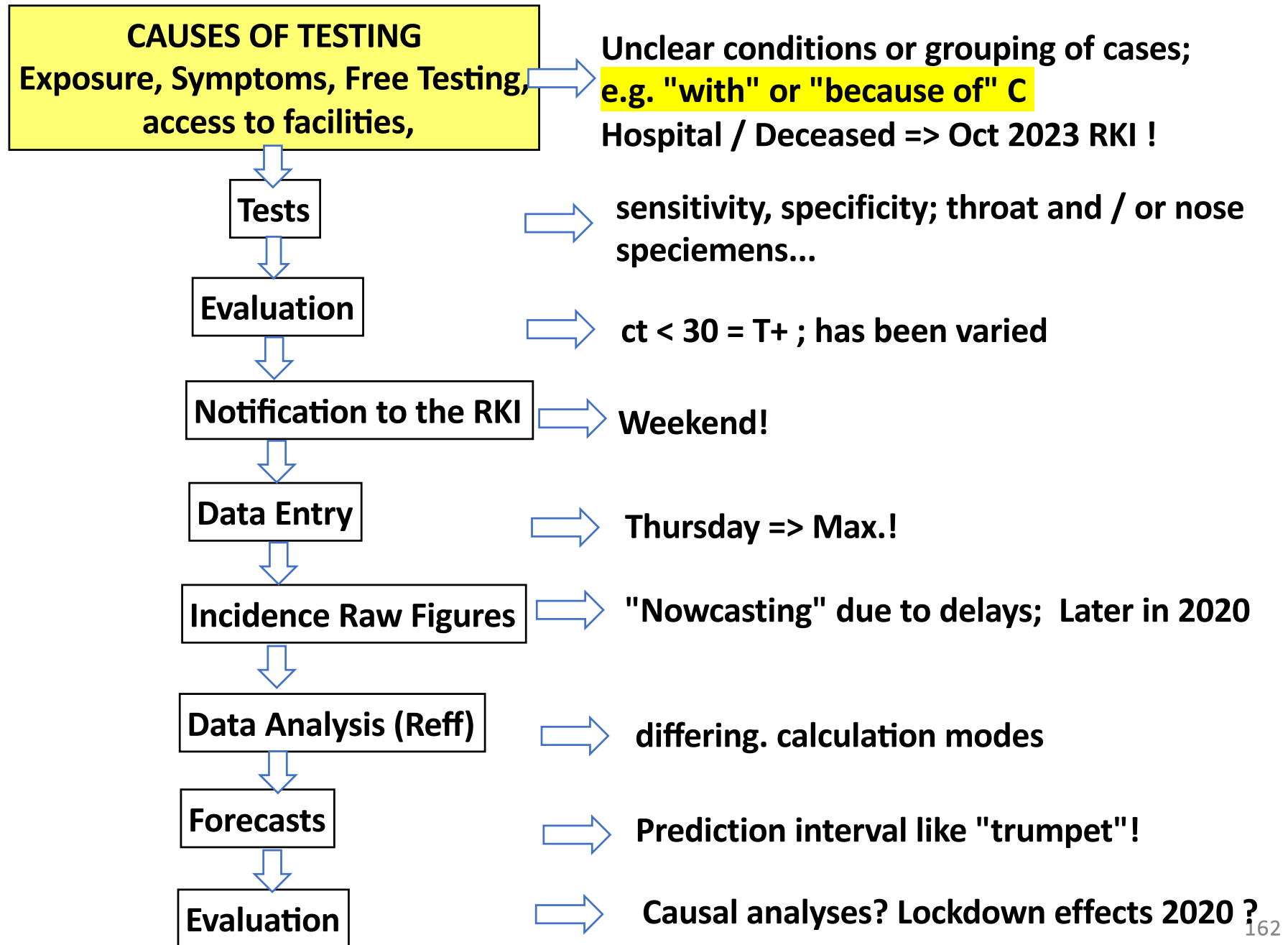Daten: Robert-Koch-Institut RKI
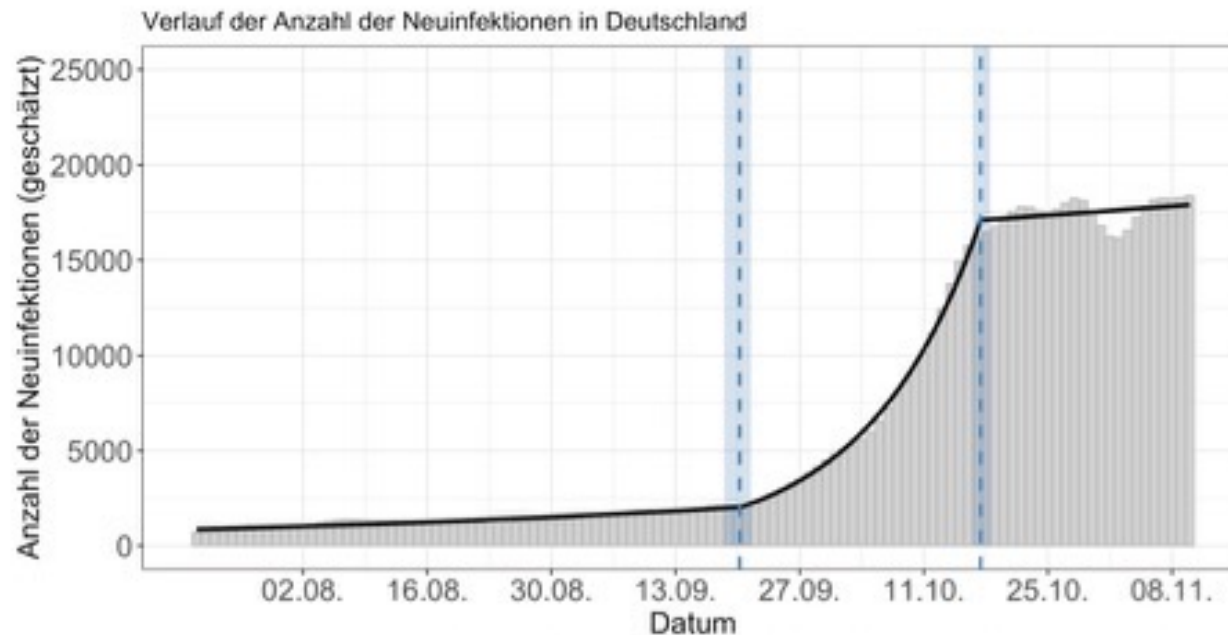
Statistisches Beratungslabor StaBLab, LMU München; Department of Mathematics, Stockholm University
Daten: Robert-Koch-Institut RKI

„Despite the limitations of the approach, we argue that it is advantageous and important to directly interpret the epidemic curve and the ==absolute number of cases, rather than indirect measures like the $R(t)$.=="
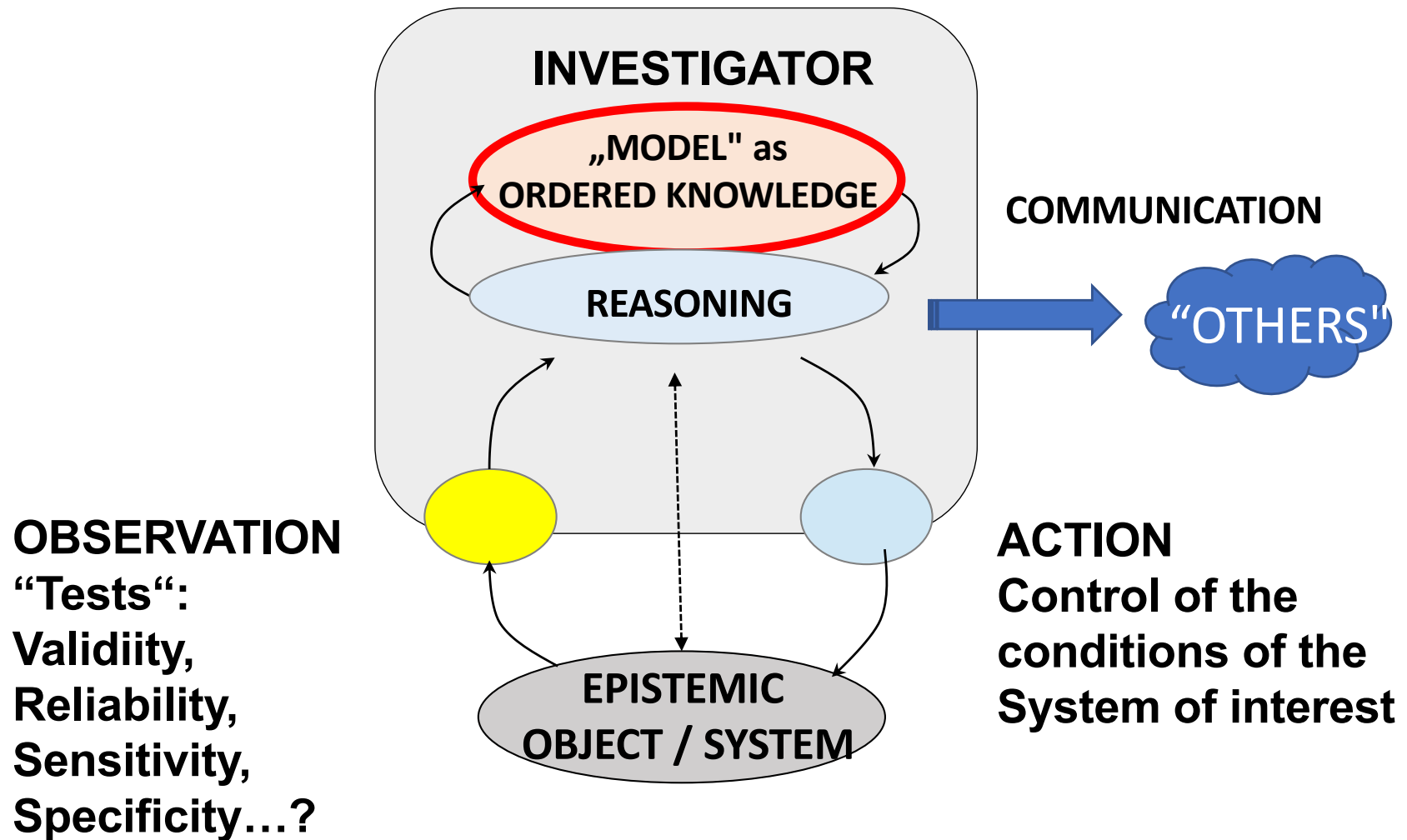
Küchenhoff H, Günther F, Höhle M, Bender A (2021). Analysis of the early COVID-19 epidemic curve in Germany by regression models with change points. Epidemiology and Infection 149, e68, 1–7.
https://doi.org/10.1017/S0950268821000558

TESTS AND TESTING AS A SOURCE OF VARIANCE (GENERATORS)

CAUSES OF TESTING
Exposure, Symptoms, Free Testing, access to facilities,

⟹ Unclear conditions or grouping of cases; e.g. "with" or "because of" C
Hospital / Deceased => Oct 2023 RKI !

Tests

⟹ sensitivity, specificity; throat and / or nose speciemens...

Evaluation

⟹ ct < 30 = T+ ; has been varied

Notification to the RKI

⟹ Weekend!

Data Entry

⟹ Thursday => Max.!

Incidence Raw Figures

⟹ "Nowcasting" due to delays; Later in 2020

Data Analysis (Reff)

⟹ differing. calculation modes

Forecasts

⟹ Prediction interval like "trumpet"!

Evaluation

⟹ Causal analyses? Lockdown effects 2020 ?

EPISTEMOLOGY: PROCESS MODEL
If the data are flaw, the conclusions AND the actions are also flaw ...

INVESTIGATOR

„MODEL" as
ORDERED KNOWLEDGE

COMMUNICATION

REASONING

"OTHERS"

OBSERVATION
"Tests":
Validiity,
Reliability,
Sensitivity,
Specificity...?

ACTION
Control of the
conditions of the
System of interest

**EPISTEMIC
OBJECT / SYSTEM**

„FOLLOW THE EPIDEMIOLOGY": LOCKDOWNS:
positive biomedical and negative psychosocial effects

+

UNIDIMENSIONAL
VIEW

LOCKDOWN

−

MULTIDIMENSIONAL
VIEW

* Protection
of Health

* Loss of
Freedom
• Loss of
Education
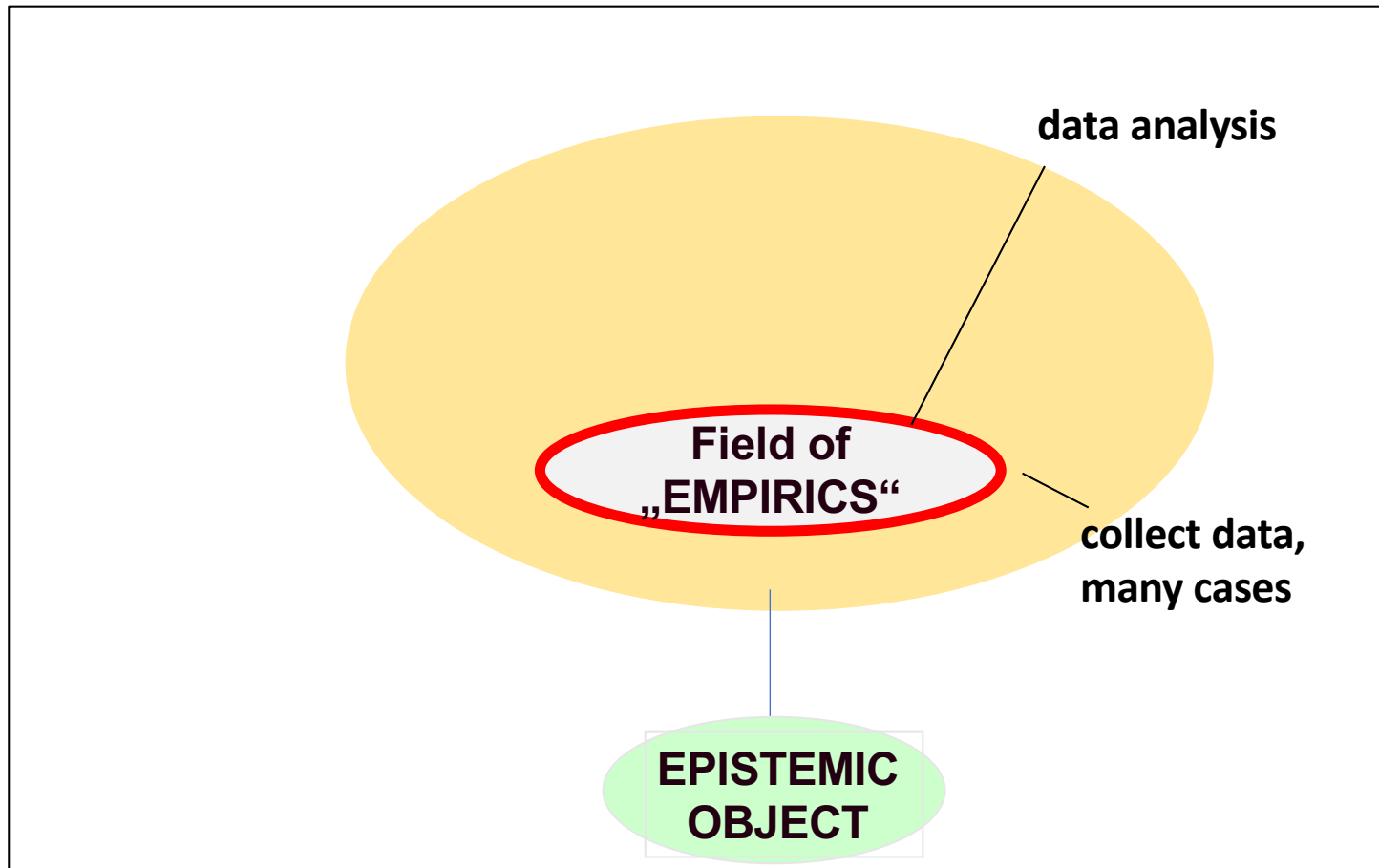• Economic
Problems
* Loss of social
contacts
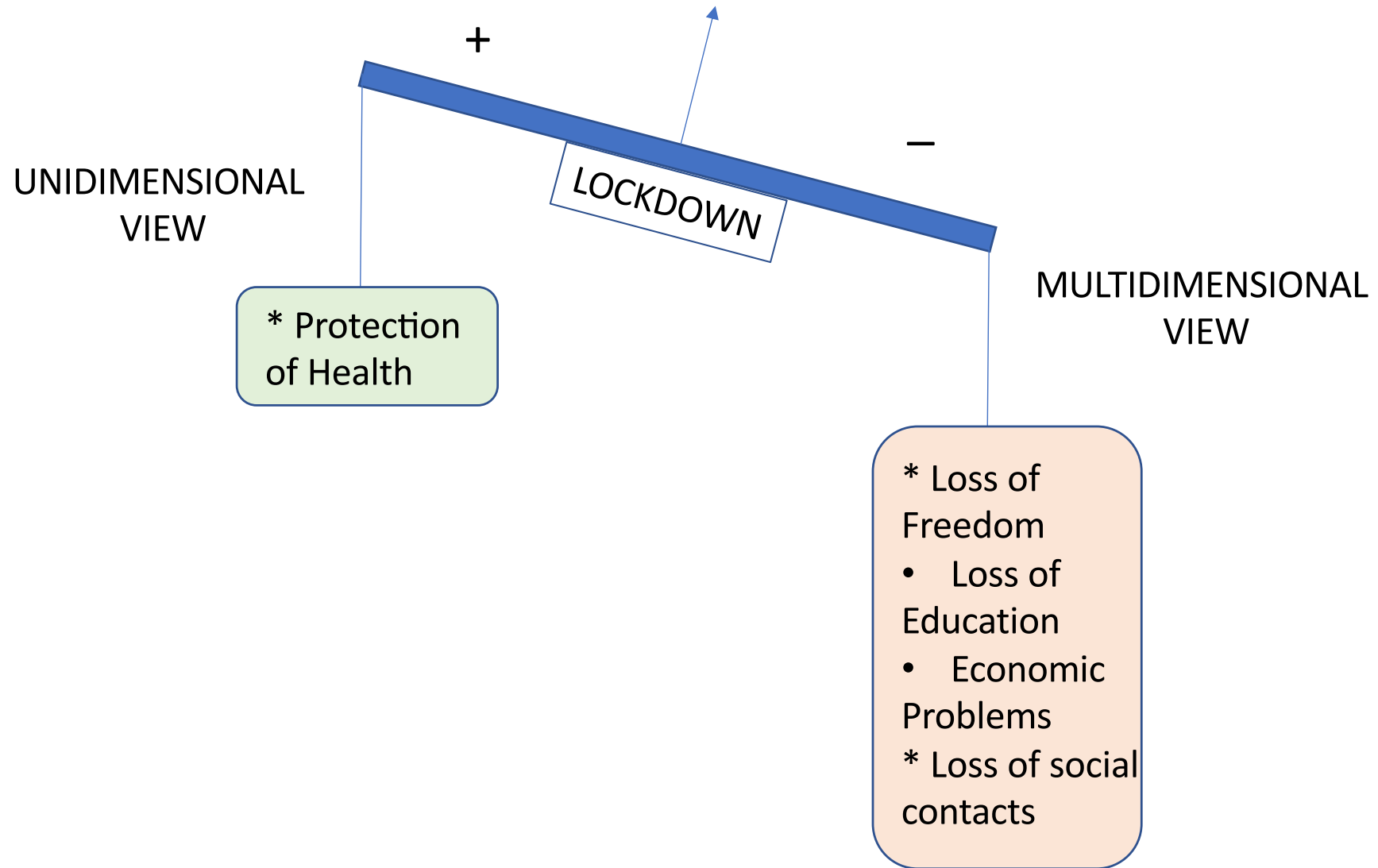
1. CORONA EPIDEMIOLOGY

1.2 Need for a Theoretical Epidemiology
Modes of intradisciplinary knowledge integration ?

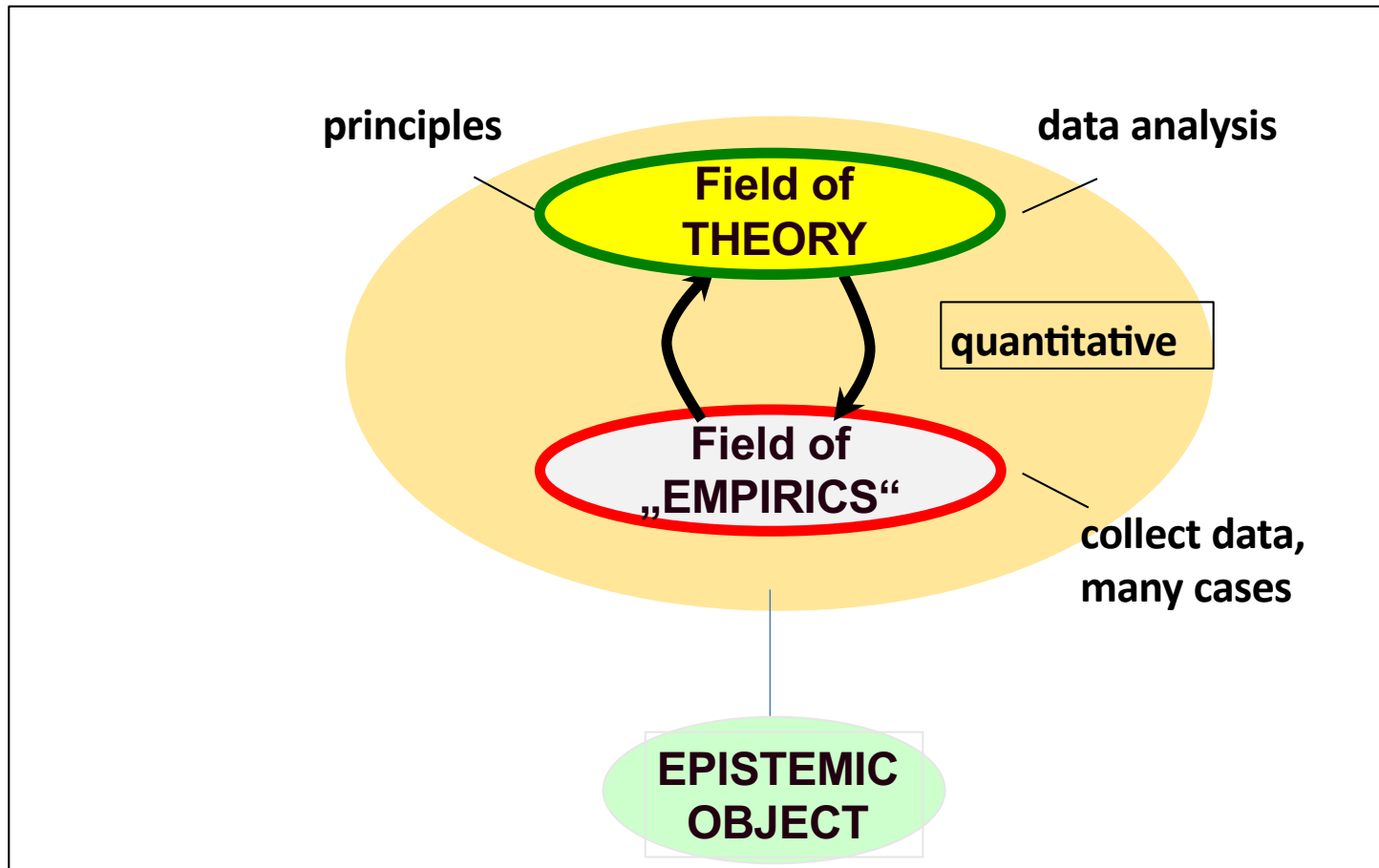# DOMINANCE OF EMPIRICAL RESEARCH
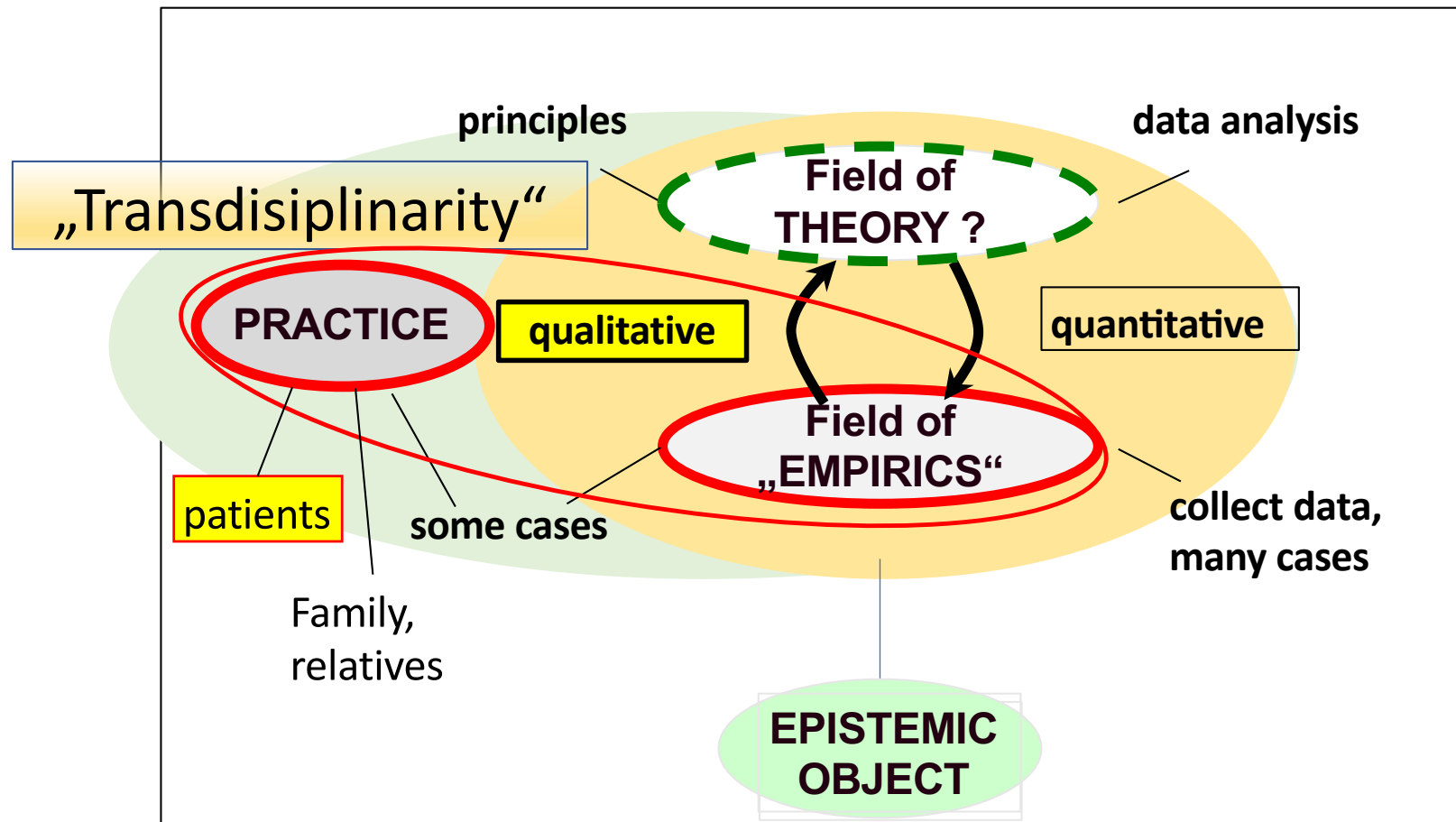## „new empiricism" by Big data and „dataism" ?

Source: Tretter 2022

EPISTEMIC CYCLE OF SCIENCE/RESEARCH (Physics)

- from *empirical observations* to *theory*;and from *Quality* to *Quantity* (and back) -

comp.. M. Bunge 1998, F. Tretter 2005

Source: Tretter 2022

EPISTEMIC CYCLE OF SCIENCE/RESEARCH (Medicine)

- from *empirical observations* to *theory*;and from *Quality* to *Quantity* (and back) -
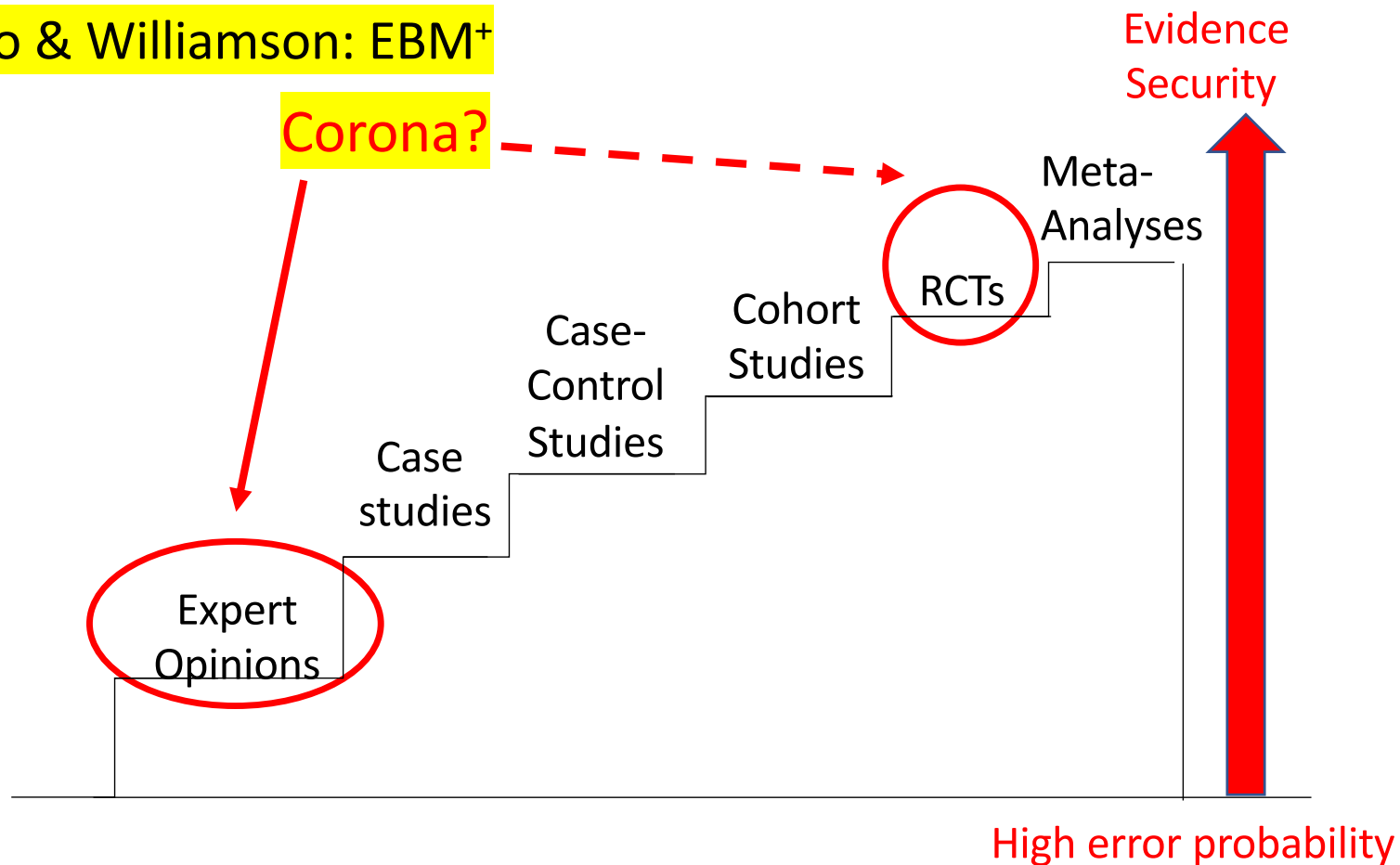comp.. M. Bunge 1998, F. Tretter 2005

principles · data analysis

„Transdisiplinarity"

Field of THEORY ?

PRACTICE · qualitative · quantitative

patients

some cases

Field of „EMPIRICS"

collect data, many cases

Family, relatives

EPISTEMIC OBJECT

Source: Tretter 2022

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KNOWLEDGE STAIR – EVIDENCE-BASED MEDICINE (EBM)

**Corona: (Laboratroy)"Experts" dominated the stairway to truth...!?**

S: Tretter 2022

Russo & Williamson: EBM+

Corona?

Evidence Security

Meta-Analyses

RCTs

Cohort Studies

Case-Control Studies

Case studies

Expert Opinions

High error probability

Medical knowledge according to evidence-based medicine – from the broad experience base with low certainty to few metaanalyses of randomized controlled trials(vgl. Sackett).

„Evidential relationships for establishing a causal claim"

THEORY ?
PATHOPHYSIOLOGY?
Pfaff & Schmitt 2022)

Russo & Williamson: EBM$^+$
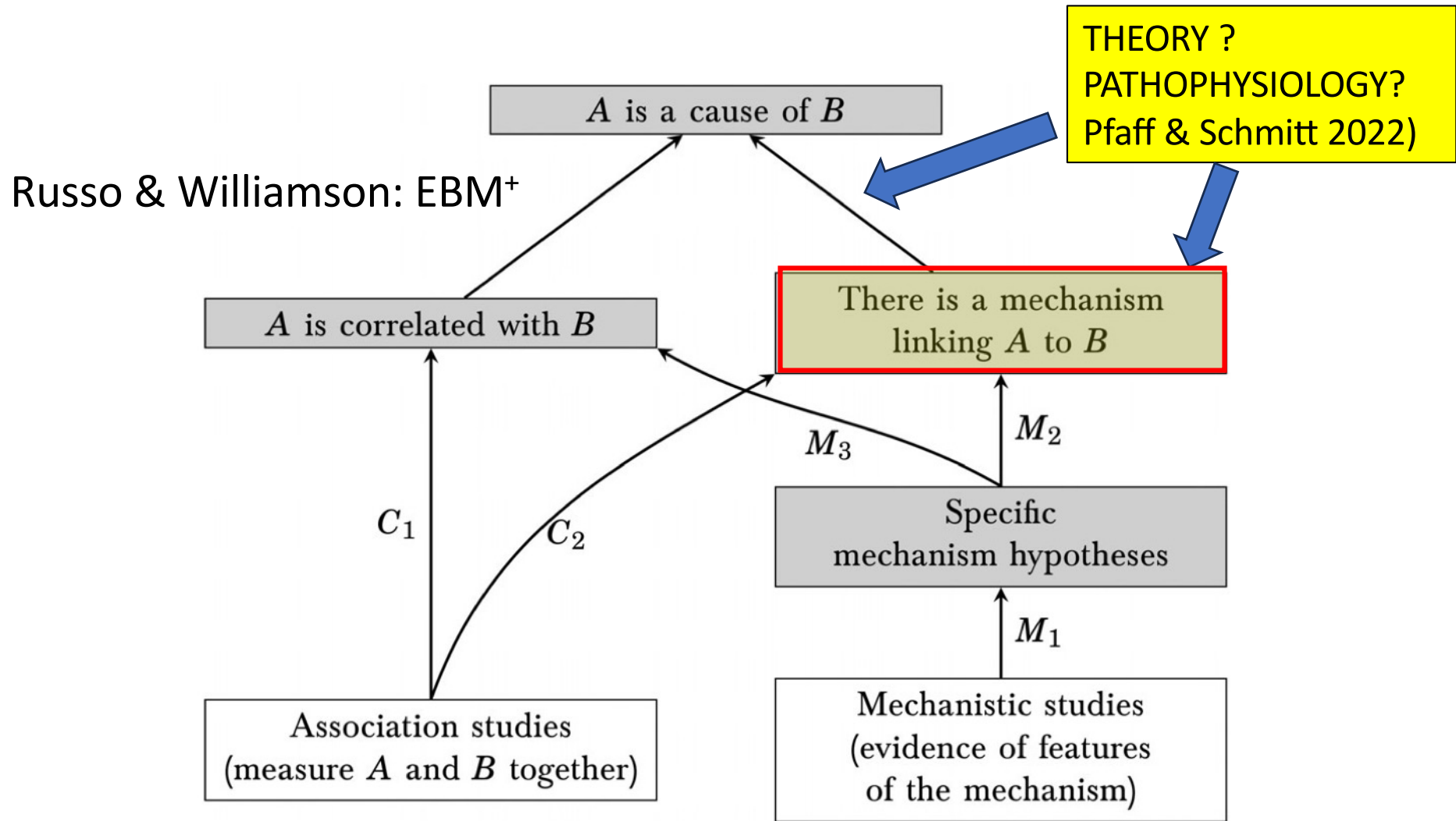
EBM++: EVIDENCE PRODUCTION IN MEDICAL SCIENCE

Russo & Williamson 2007, 2011 , Pfaff & Schmitt 2021, Greenhalgh et al. 2023,)

Scientific knowledge =
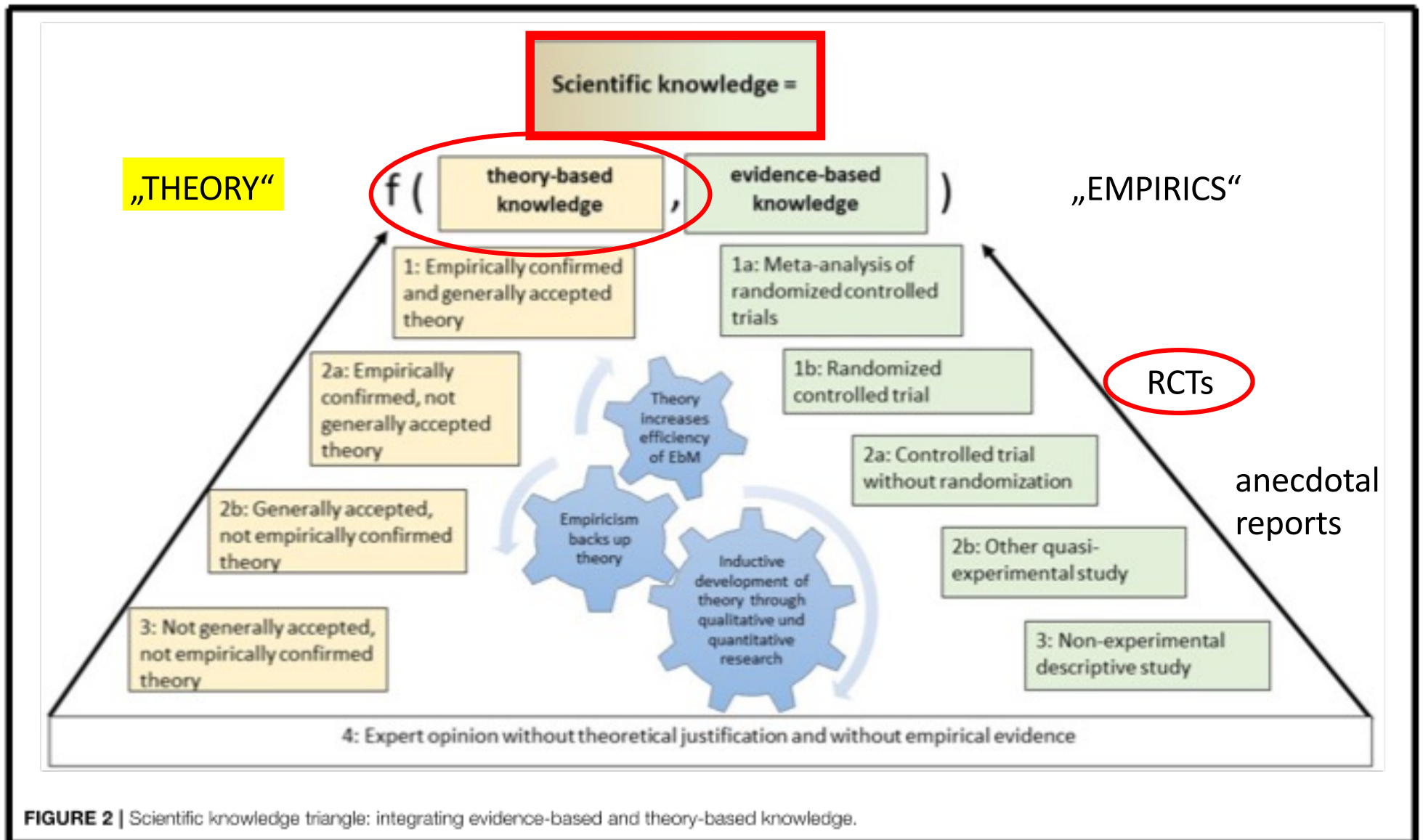
„THEORY"   f (theory-based knowledge , evidence-based knowledge)   „EMPIRICS"

1: Empirically confirmed and generally accepted theory

1a: Meta-analysis of randomized controlled trials

2a: Empirically confirmed, not generally accepted theory

1b: Randomized controlled trial

RCTs

Theory increases efficiency of EbM

2a: Controlled trial without randomization

2b: Generally accepted, not empirically confirmed theory

Empiricism backs up theory

2b: Other quasi-experimental study

anecdotal reports

3: Not generally accepted, not empirically confirmed theory

Inductive development of theory through qualitative und quantitative research

3: Non-experimental descriptive study

4: Expert opinion without theoretical justification and without empirical evidence

FIGURE 2 | Scientific knowledge triangle: integrating evidence-based and theory-based knowledge.

THEORY - THEORETICAL MODELS: their epistemic function

General:
- **order function for observations**
- = „laws", „principles", „rules"...
- E.g. :"Virus mutations mostly convert to lower pathogenity"

- x => y ; „if x then y"; „y because of x";
- $y = a*x1 + b*x2...+k*xn$
  (hypothetical master equ.)

- theoretical terms

- hypotheses / conjectures

- conceptual framework

- **mechanistic models** (of a theory
  (Machamer, Woodward, Wimsatt, Craver, Bechtel..)

- „ A theory is a well-substantiated explanation of an aspect of the natural world that can incorporate laws, hypotheses and facts. "
  (American Museaum of natirural hitory: https://www.amnh.org/exhibitions/darwin/evolution-today/what-is-a-theory)

- "Explaining" : deductive-nomological, mechanistic E.
      (Craver, Machamer,...)

- "Understanding": interpreting, hermeneutics,
      also: empathetic understanding...

- "Predictions" : ??

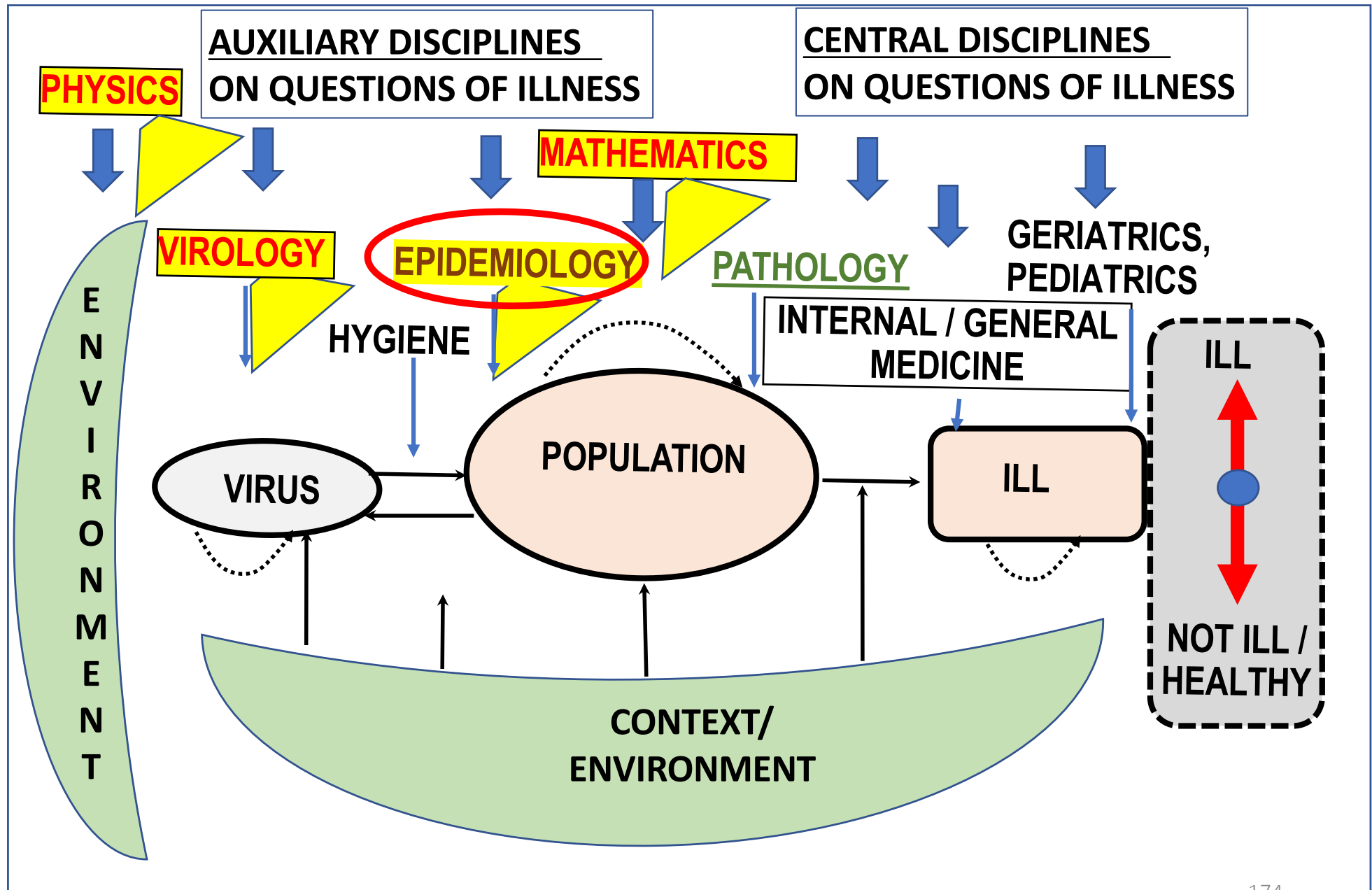- Heuristic function: Generating new hypotheses

1. CORONA EPIDEMIOLOGY

1.3 Inter-/Transdisciplinary Knowledge Integration

- **formal sciences, natural sciences, behavioral s. , social s. …
& stakeholders -**

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemmet, S., Grossenbacher-Mansuy W., Joye D., Pohl, C., Wiesmann, U., & Zemp, E. (Eds.) (2008). *Handbook of Transdisciplinary Research*. Leipzig: Springer

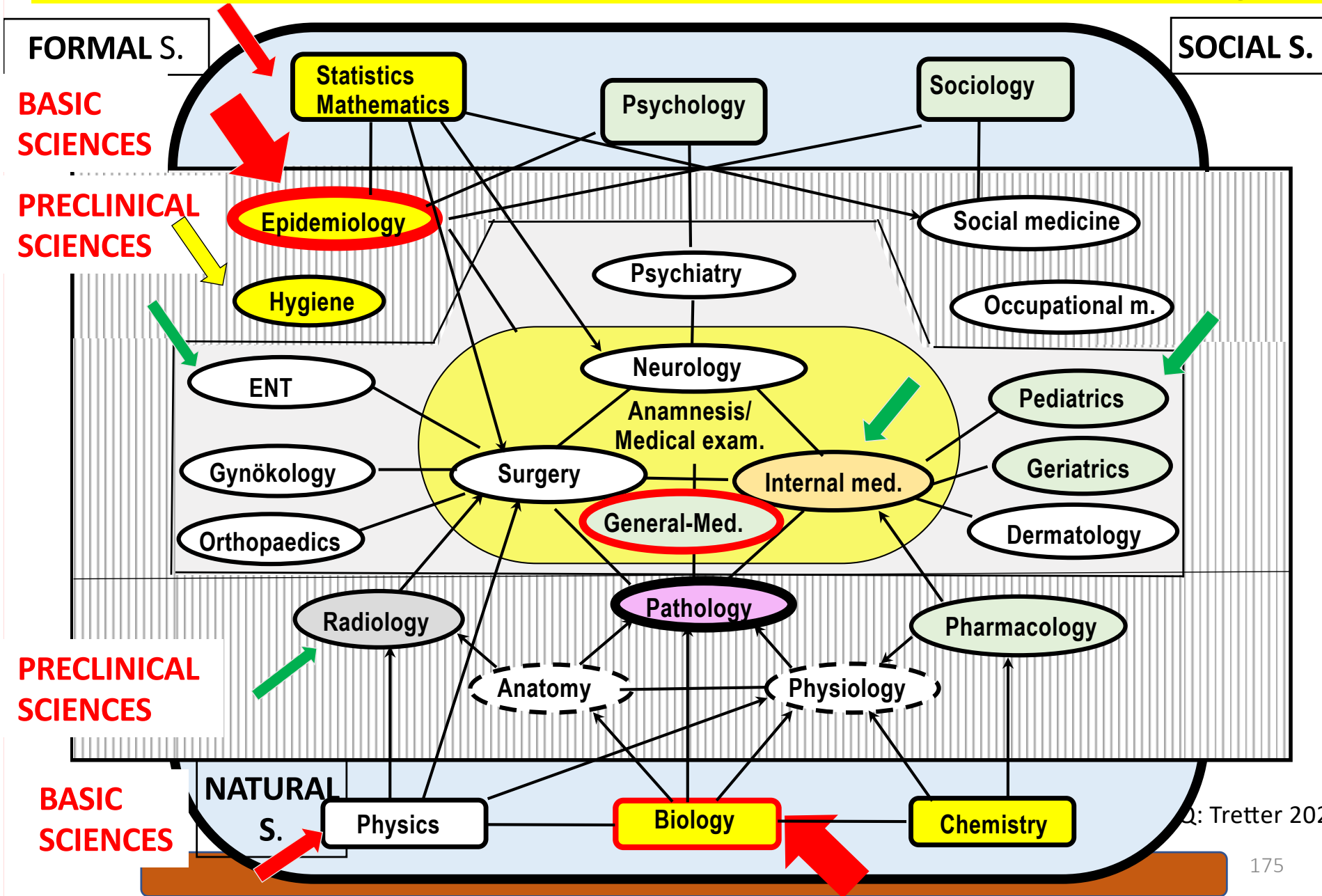Schmidt, J.C.: Philosophy of Interdisciplinarity. Studies in Science, Society, and Sustainability. Routledge, London and New York, 2022,

CORONA SCIENCE ? - "undisciplined extradisciplinarity" ?

PHYSICS

AUXILIARY DISCIPLINES
ON QUESTIONS OF ILLNESS

CENTRAL DISCIPLINES
ON QUESTIONS OF ILLNESS

MATHEMATICS

VIROLOGY

EPIDEMIOLOGY

PATHOLOGY

GERIATRICS,
PEDIATRICS

ENVIRONMENT

HYGIENE

INTERNAL / GENERAL
MEDICINE

ILL

VIRUS

POPULATION

ILL

NOT ILL /
HEALTHY

CONTEXT/
ENVIRONMENT

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The fragmented architecture of the „HOUSE OF MEDICINE":
AUXILIARY / BOUNDARY SCIENCES of COVID-19
=> reduction („inner circle"; PATHOLOGY, INTERNAL MEDICINE &CO) or integration ?

FORMAL S.
SOCIAL S.
BASIC SCIENCES
PRECLINICAL SCIENCES
PRECLINICAL SCIENCES
BASIC SCIENCES
NATURAL S.

Statistics Mathematics
Psychology
Sociology
Epidemiology
Social medicine
Hygiene
Psychiatry
Occupational m.
ENT
Neurology
Anamnesis/ Medical exam.
Pediatrics
Gynökology
Surgery
Internal med.
Geriatrics
Orthopaedics
General-Med.
Dermatology
Radiology
Pathology
Pharmacology
Anatomy
Physiology
Physics
Biology
Chemistry

Q: Tretter 2022
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EPIDEMIOLOGY - Aspects / Dimensions / Issues /contexts
- Epistemologies of different disciplines -

BEHAVIORAL SCIENCES

FORMAL SCIENCES

Psychology

Philosophy (Anthropologiy)

Statistics / mathematics

Self-help

Health economics

EPIDEMIOLOGY

Clinical Medicine

Health care research

Pathology

NATURAL SCIENCES

Sociology

Microbiology

SOCIAL SCIENCES

Public health

$\Rightarrow$ **ECO-BIO-PSYCHO-SOCIAL MODEL ?**

(George Engel 1977)
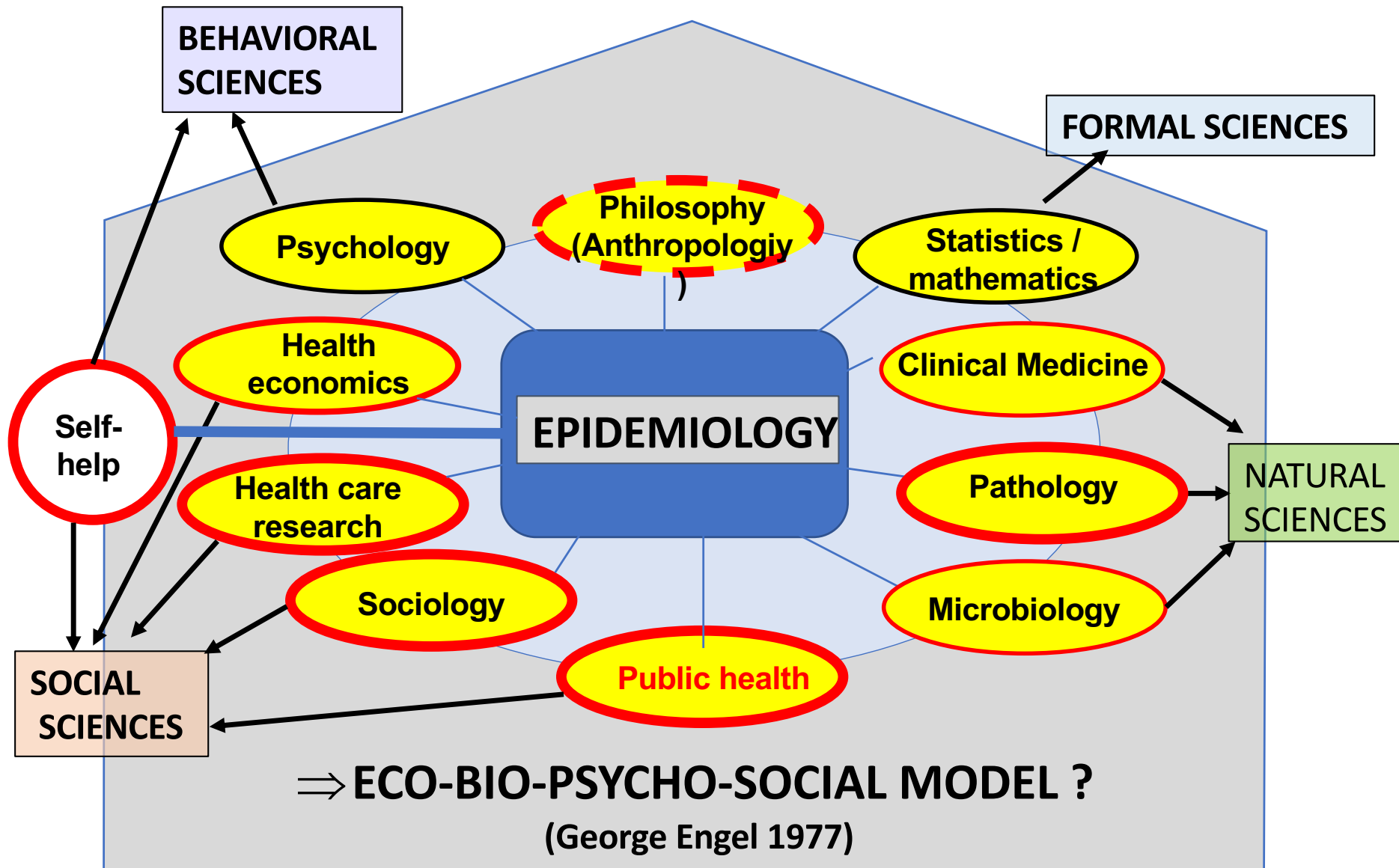
INTEGRATION OF THE SCIENCES – WHO... WHOM.. WHY..?

"MIND" SCIENCES

FORMAL SCIENCES

Exclusion

Overlapping

Inclusion

PHILO-SOPHY

PSYCHO-LOGY

MATHE-MATICS

BIOLOGY

CHEMIS-TRY

PHYSICS

SOCIO-LOGY

ECONO-MICS

NATURAL SCIENCES

SOCIALSCIENCES
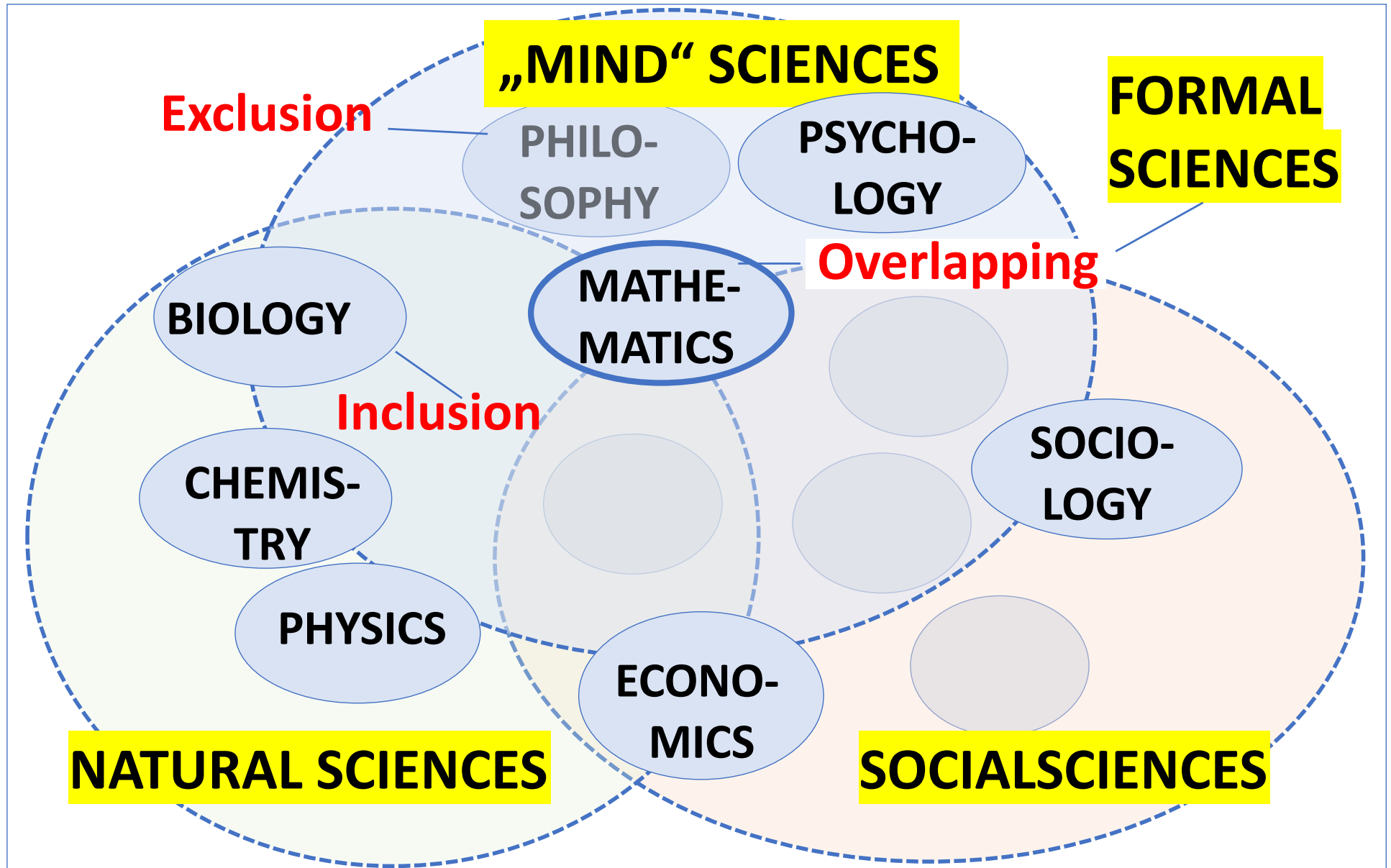
2. SOCIAL / HUMAN ECOLOGY
and
EPIDEMIOLOGY

An epidemic / pandemic is a natural AND cultural phenomenon

=> Social & spatio-temporal issues

=> Geographical and social perspectives....

⟹ **Social Ecology / Human Ecology / Chicago School**

- **Men-Environment-Relationship (H. Knötig; B. Glaeser)**

- **„Systemic Systainability Science" (R. Dyball & B. Newell)**

- -

* **Social Metabolism ("Social Ecology"/Vienna; M. Fischer-Kowalski)**

* **Social-Nature-Relationship ("Social Ecology"/ Frankfurt; E. Becker & T. Jahn)**

Epistemology:

⟹ **Knowledge integration is necessary: natural & social sciences et al. ....**

⟹ **also transdisciplinarity: laymen stakeholders! (e.g. patients...)**

Rem.: Social = Society, Institutions/Organisations, Groups...

SYSTEM MODELS & POPULATION – numbers without theory ?:
From S-I-R model to S-(E-C)-I-D-H-C-R-F- Model
(e.g. Meyer-Hermann-Group; Helmholtz Inst., Braunschweig)

Compartment model
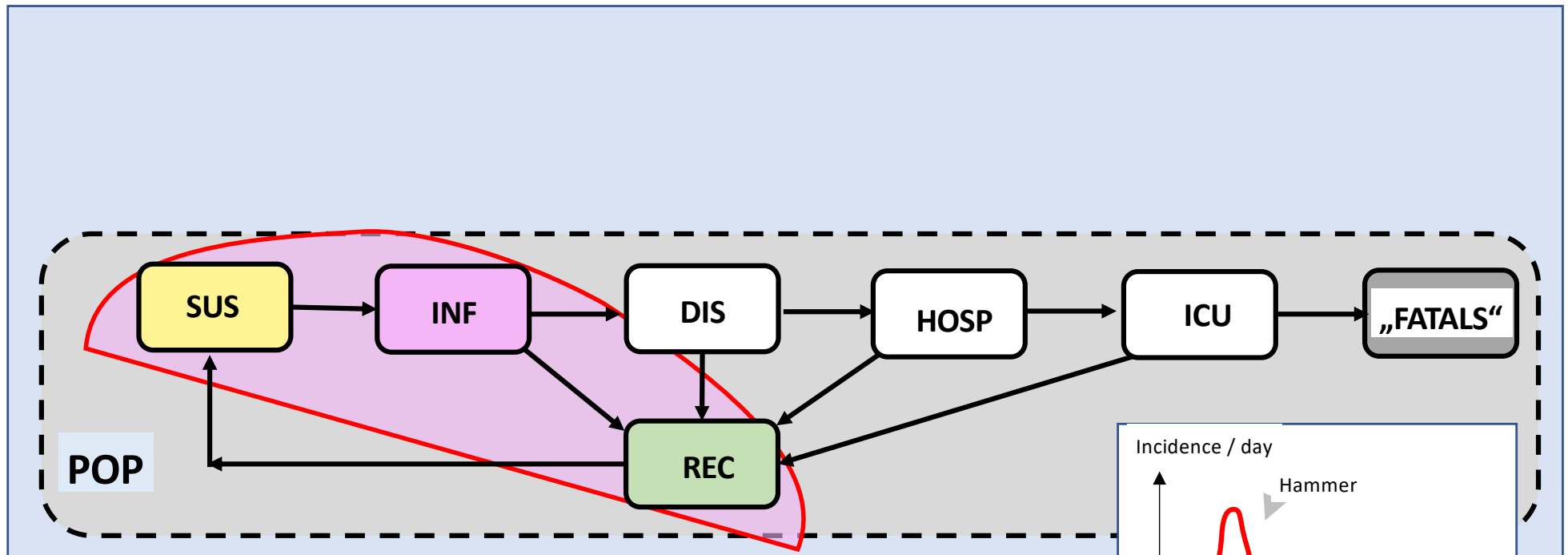
(non-linear) differential equations, but too simple conceptualization !

HC & Sociocultural variables not explicitly integrated!
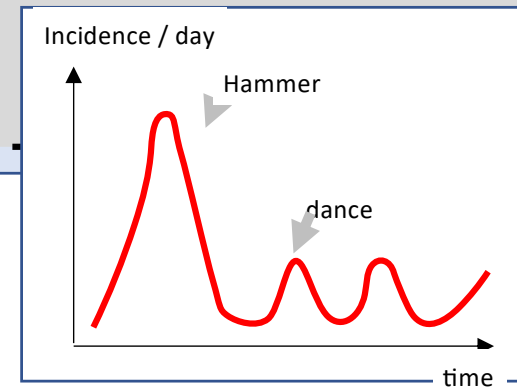
Source: F. Tretter 2022
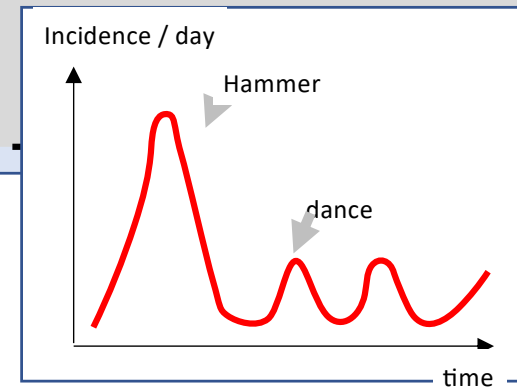
SYSTEM MODELS & POPULATION – numbers without theory ?:
From S-I-R model to S-(E-C)-I-D-H-C-R-F- Model
(e.g. Meyer-Hermann-Group; Helmholtz Inst., Braunschweig)

Compartment model (and implicit moderator variable by HC system)
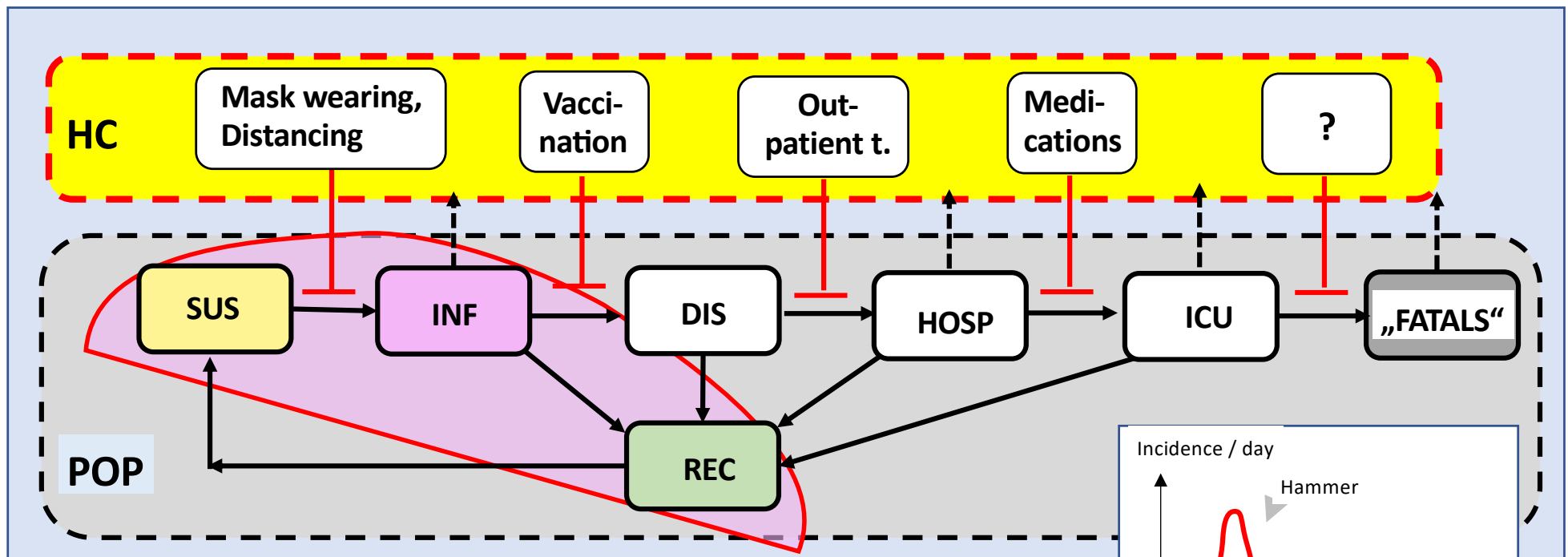
HC
- Mask wearing, Distancing
- Vacci-nation
- Out-patient t.
- Medi-cations
- ?

POP
- SUS → INF → DIS → HOSP → ICU → „FATALS"
- REC

Incidence / day — Hammer — dance — time

(non-linear) differential equations, but too simple conceptualization !

HC & Sociocultural variables not explicitly integrated!

Source: F. Tretter 2022

PUBLIC HEALTH/EPIDEMIOLOGY & SOCIAL-ECOLOGICAL MODELS

Dahlgren G, Whitehead M. The Dahlgren-Whitehead model of health determinants: 30 years on and still chasing rainbows. Public Health. 2021 Oct;199:20-24. doi: 10.1016/j.puhe.2021.08.009. Epub 2021 Sep 14. PMID: 34534885.

Rainbow model:
The main determinants of health.

Krieger N. Theoretical frameworks and cancer inequities. In: Vaccarella S, Lortet-Tieulent J, Saracci R, Conway DI, Straif K, Wild CP, editors. Reducing social inequalities in cancer: evidence and priorities for research. Lyon (FR): International Agency for Research on Cancer; 2019. Chapter 8.. PMID: 33534476.

Ecosocial model:
Societal and ecological context;
- historical generation;
- spatiotemporal scales
- levels of analysis;
- life-course
- patho-genesis; and
- diverse forms of inequitable
- political economy,
- racism,
- class,
- sex, and
- sexuality
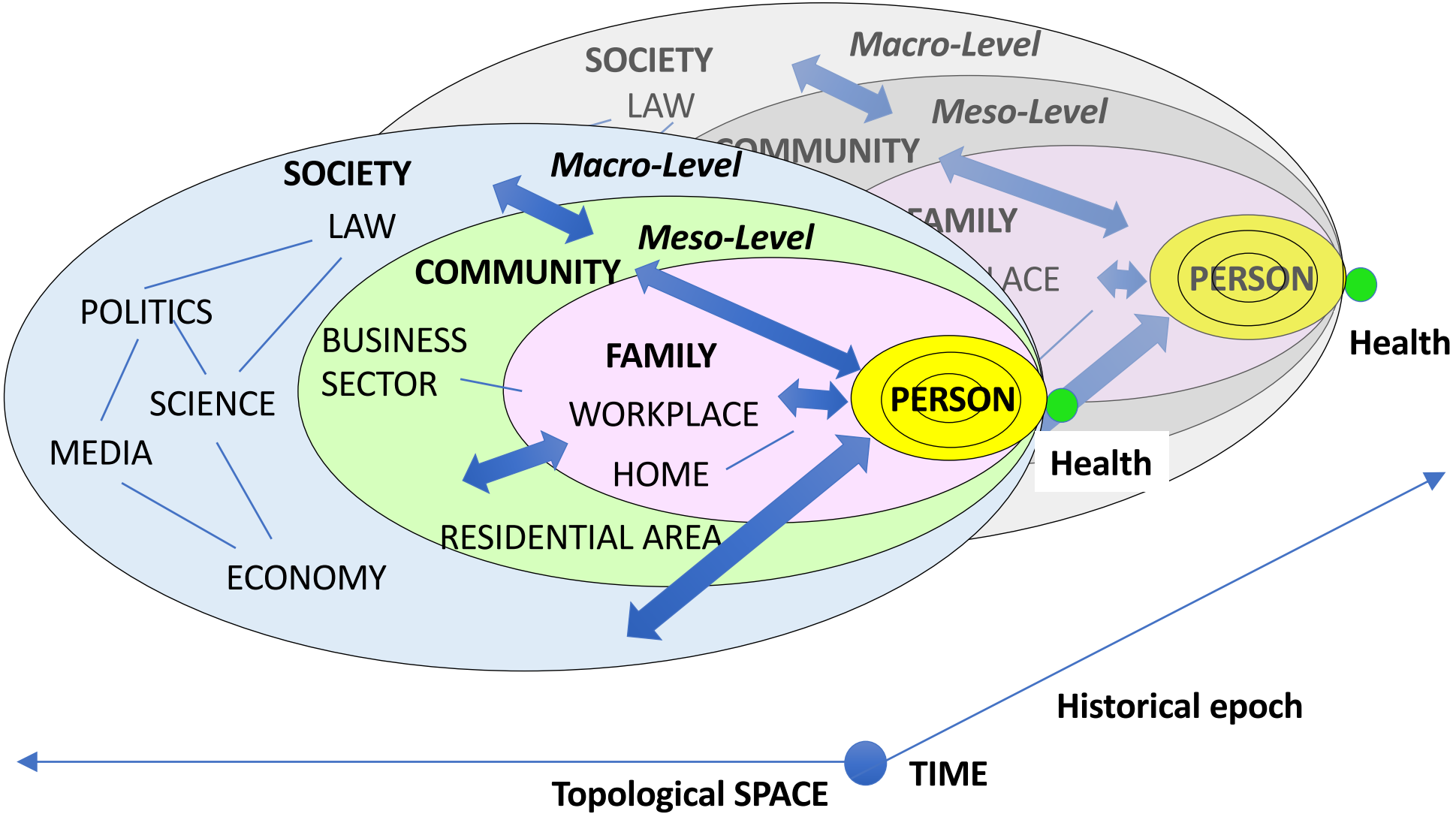- relationships within and between countries,
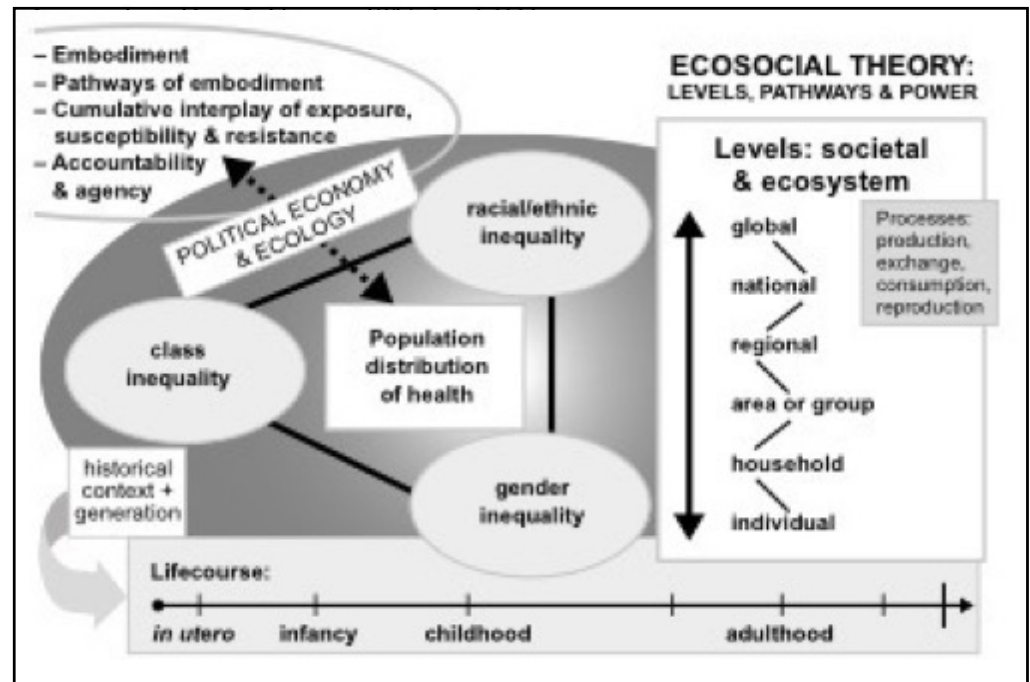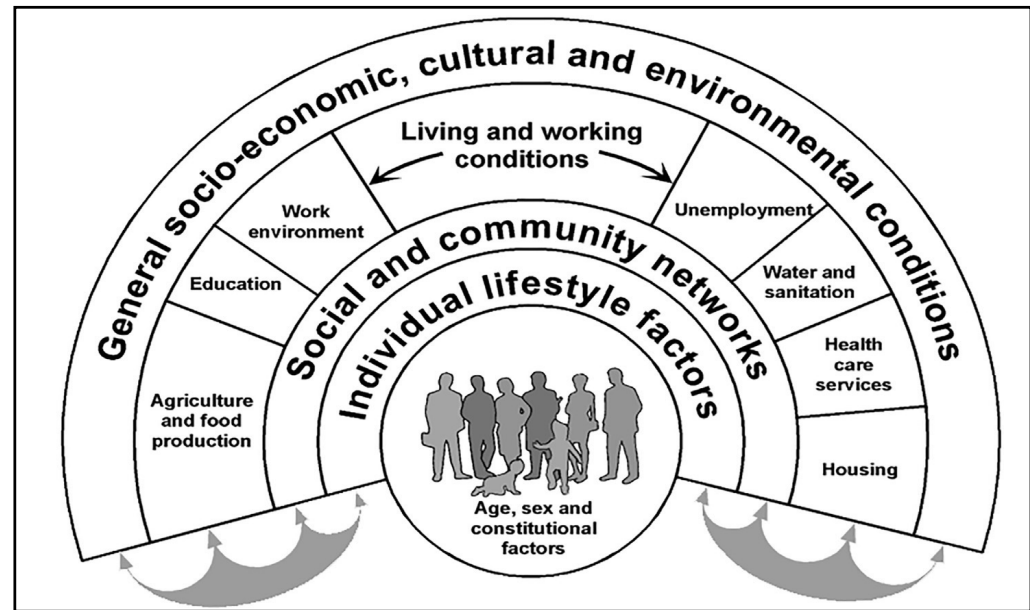
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HUMAN ECOLOGICAL FRAMEWORK
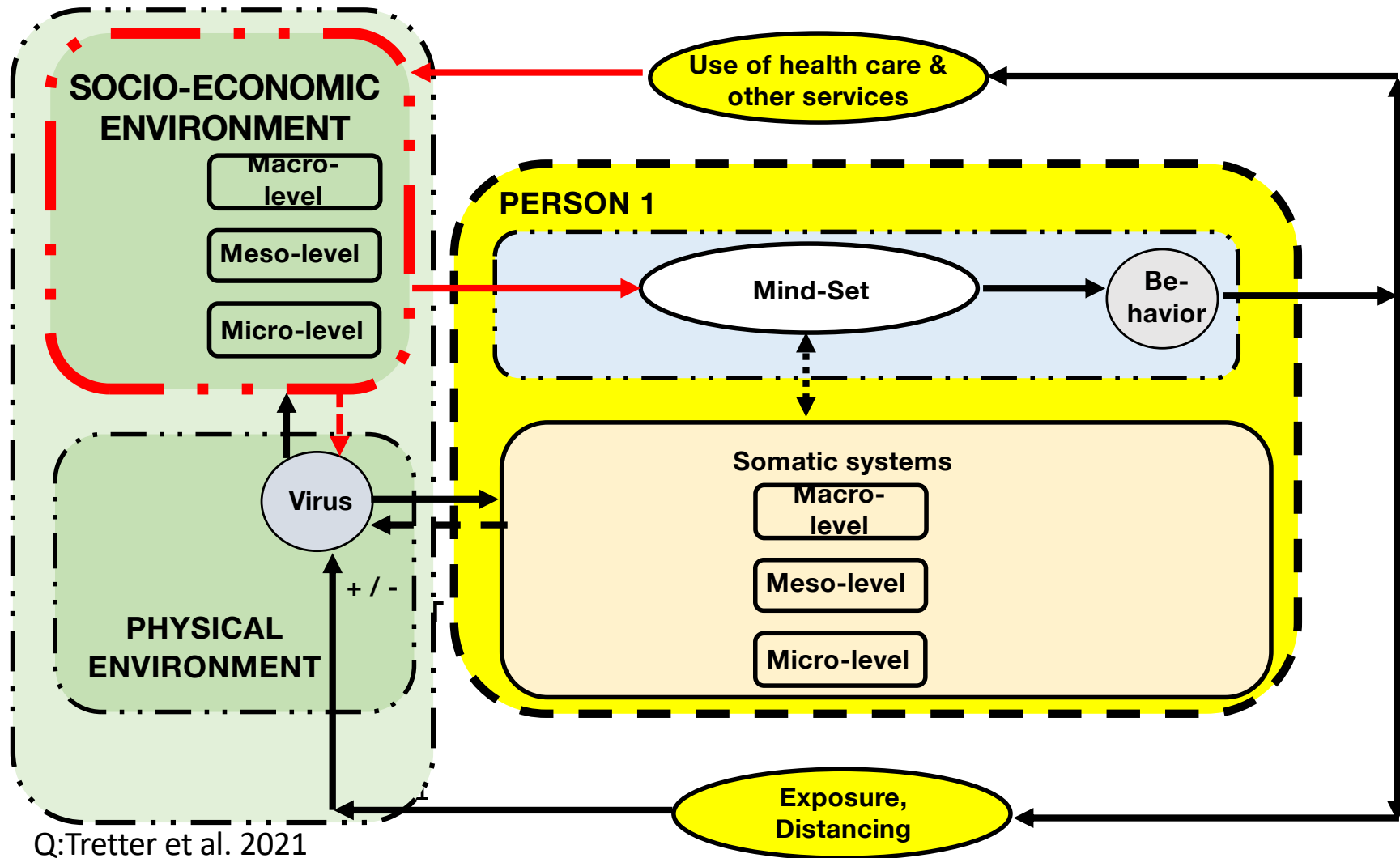## Disease as result of men-environment relations

ENVIRONMENT

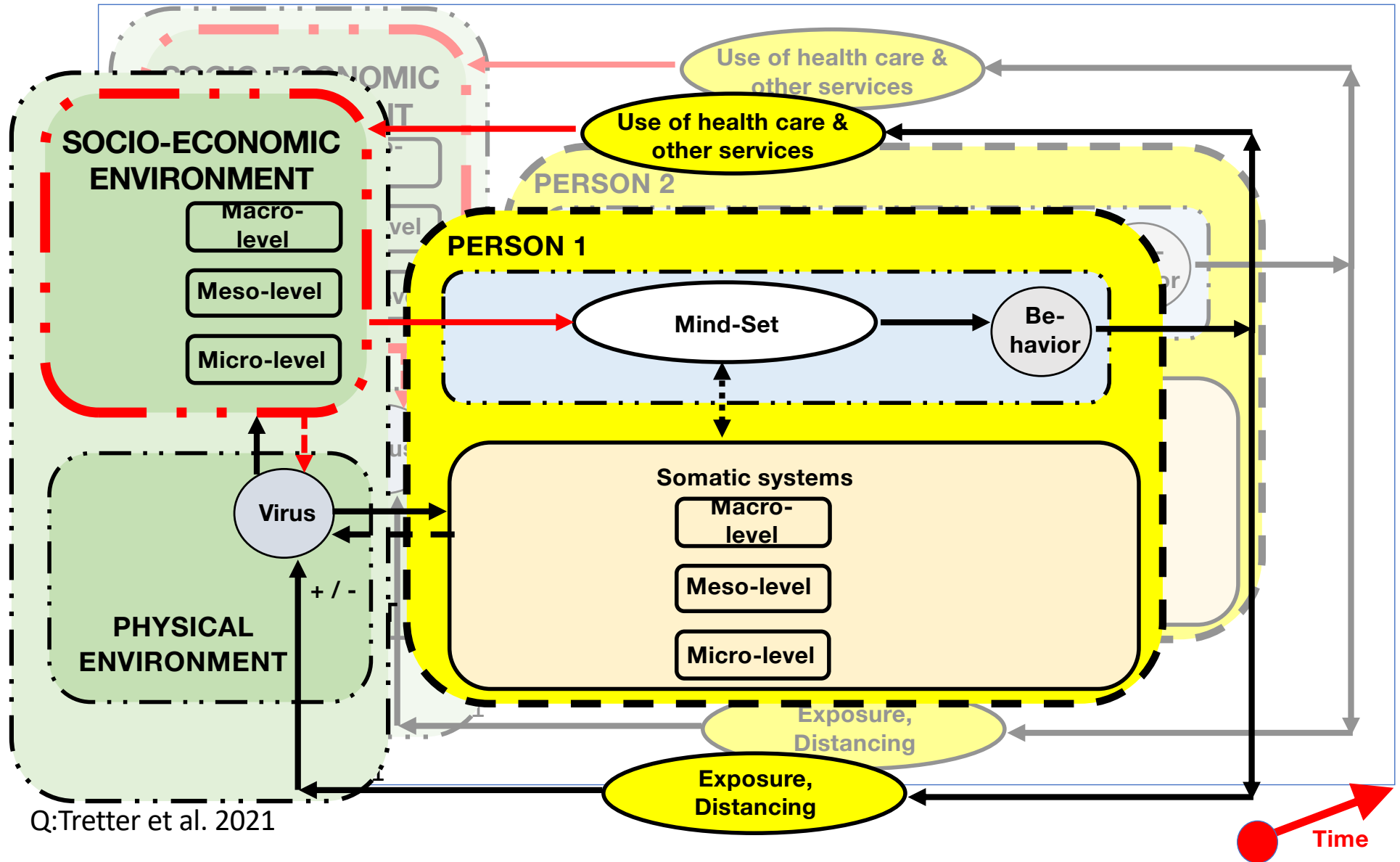Macro-sphere

Meso-sphere

Micro-sphere

SOCIAL

PERSON

Health / Disease

PHYSICAL

Historical epoch

Topological SPACE

TIME

HUMAN ECOLOGICAL FRAMEWORK
Disease as result of men-environment relations

SOCIETY
LAW
Macro-Level
COMMUNITY
Meso-Level
FAMILY
WORKPLACE

PERSON

Health

SOCIETY
LAW
Macro-Level
POLITICS
COMMUNITY
Meso-Level
SCIENCE
BUSINESS SECTOR
FAMILY
MEDIA
WORKPLACE
HOME
PERSON
ECONOMY
RESIDENTIAL AREA

Health

Historical epoch

Topological SPACE   **TIME**

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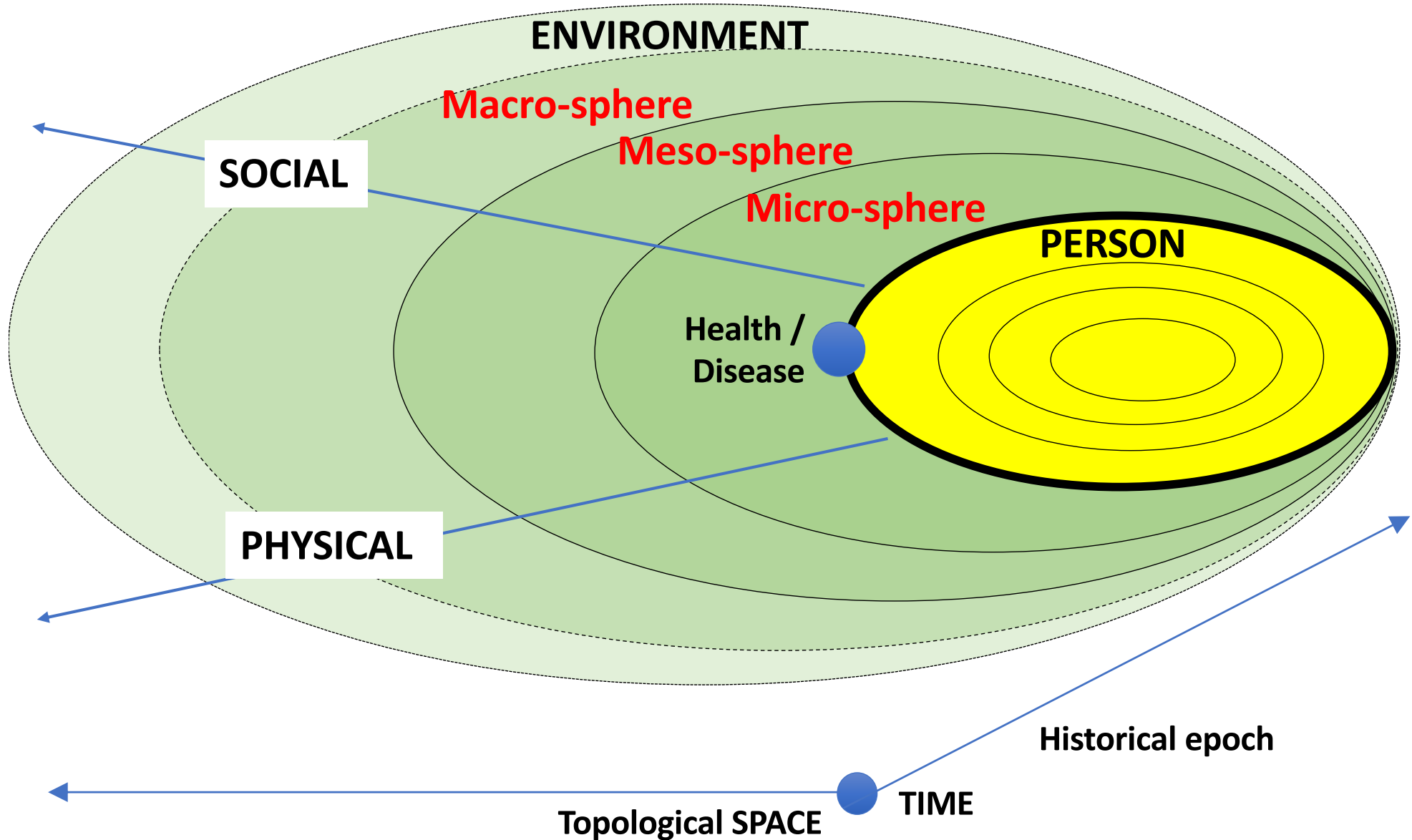
ECO-SYSTEMS MEDICINE: MULTI-LEVEL MODEL

Q:Tretter et al. 2021

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SYSTEMS MEDICINE: ECOLOGICAL MULTI-LEVEL MODEL

Q:Tretter et al. 2021

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3. SYSTEMS SCIENCE:

Bridge over troubled water ?

METHODS AND MODELS

Complexity of variables and their relations

An epidemic is a complex dynamic system
(T. Greenhalgh, H. Rutter, etc.)

$\Rightarrow$**Systems Science** should be used!

(J. Forrester, D.&D. Meadows, J. Sterman, etc.; „Systems Dynamics"/MIT)

- Integrated multi-level view on complex processes

- **Methodology of stepwise modeling** (circular process)
    1. Observations (plurality by different stakeholders)
    2. Data set,
    3. Verbal formulation of contexts and principles (dynamic equilibrium),
    4. Graphical model
    5. Formal description,
    6. Computer simulation
    7. => back to data

- Knowledge base: Pool of models

„SYSTEMS" EPISTEMOLOGY / METHODOLOGY / THINKING / MODELLING

Epistemology:
(see v. Bertalanffy, v. Foerster, Pouverau, Bunge)

- constructivism,
- holism /
- complexity issues
- multiperspectivity (ID + TD),
- circular causality
- contextualism

ICEBERG OF SYSTEMIC EPISTEMOLOGY
(comp. P. Senge)

Event

Trend, Pattern

Systemic Core Structure, Network, Hubs

Generic system, Function generator
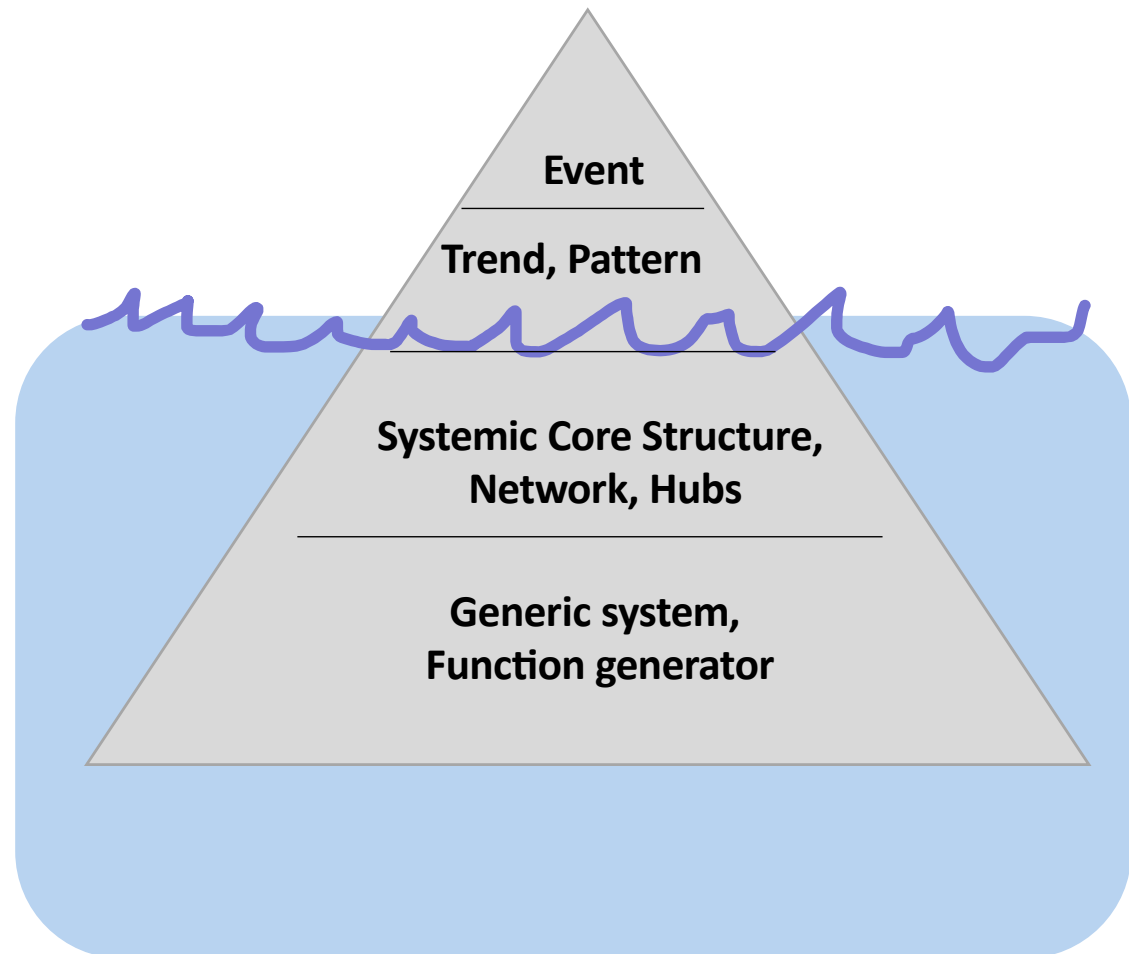
Source: Tretter 2022

MULTIVARIATE ANALYSIS: LATENT STRUCTURE APPROACH

VanderWeele, T.J. (2022). Constructed measures and causal inference: towards a new model of measurement for psychosocial constructs. *Epidemiology*, 33:141–151.
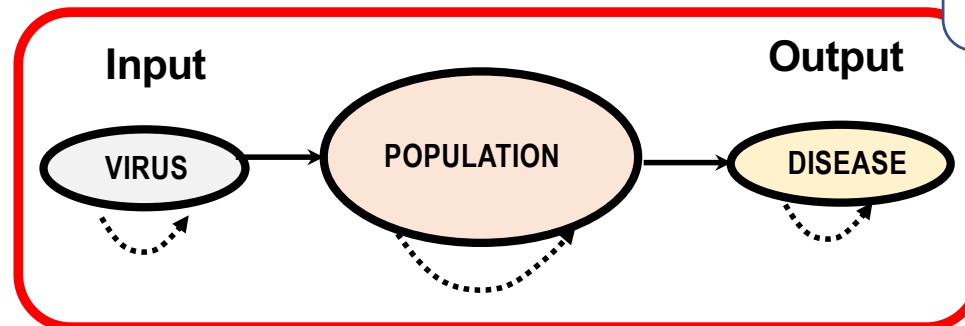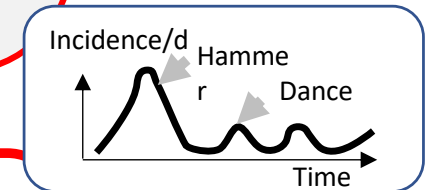https://journals.lww.com/epidem/Fulltext/2022/01000/Constructed_Measures_and_Causal_Inference__Towards.17.aspx
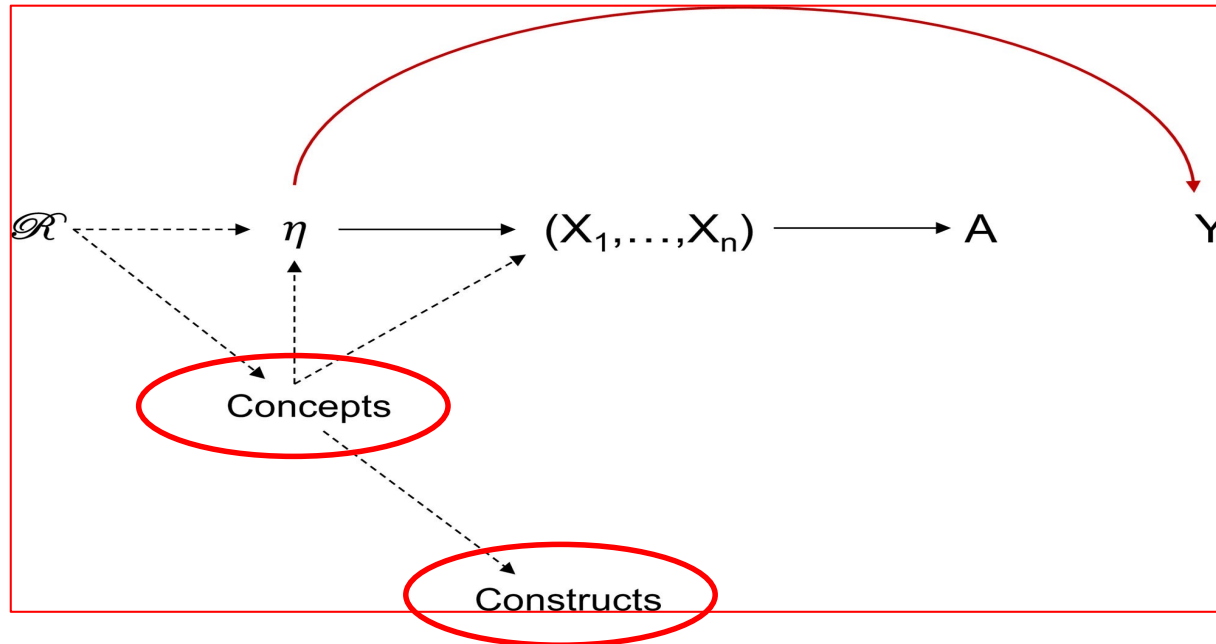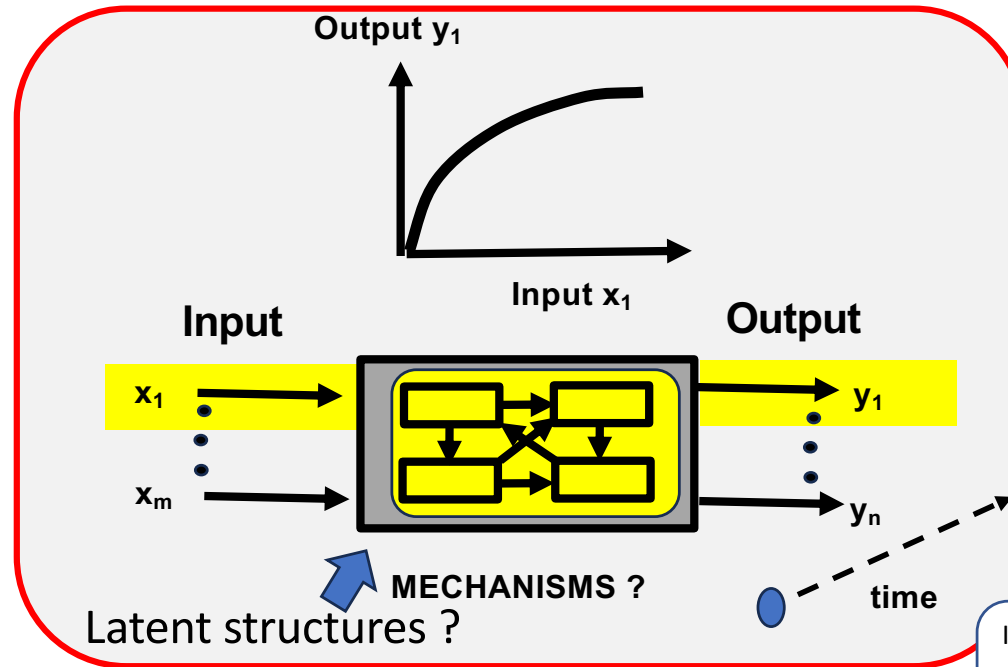

Fig. 8: A proposed new model of measure construction wherein complex underlying reality, R contains certain aspects of this reality (represented by the multidimensional variable η) relevant to the construct. These relevant aspects of reality give rise to a set of observed indicators (X1, … , Xn), from which we form a measure *A* (The dotted arrows, while in some sense causal, correspond to those relations that are not explicitly between variables.).

SYSTEMS METHODS:
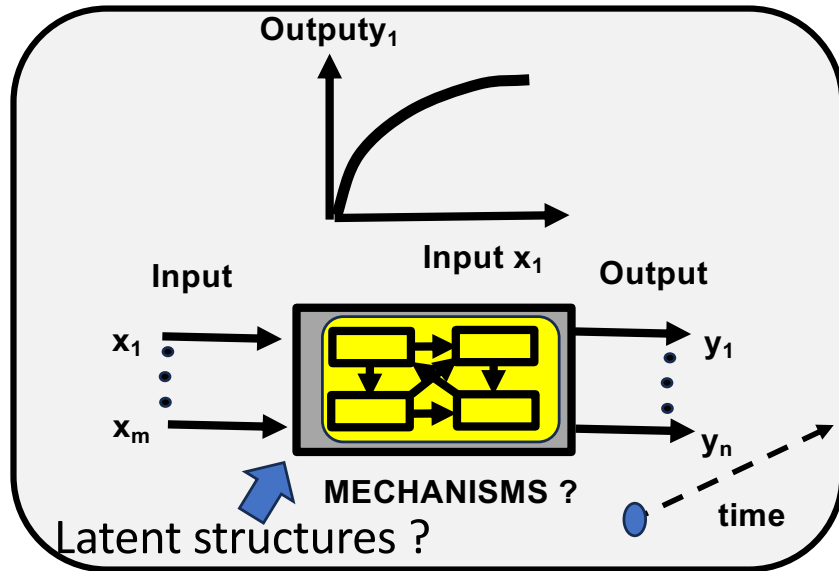# (CONTEXTUALIZED) BLACK BOX METHODOLOGY

* Variation of inputs
by **experiments** (RCTs)
result
In difference of
outputs?

* Difference of inputs
by **comparison**
correspond
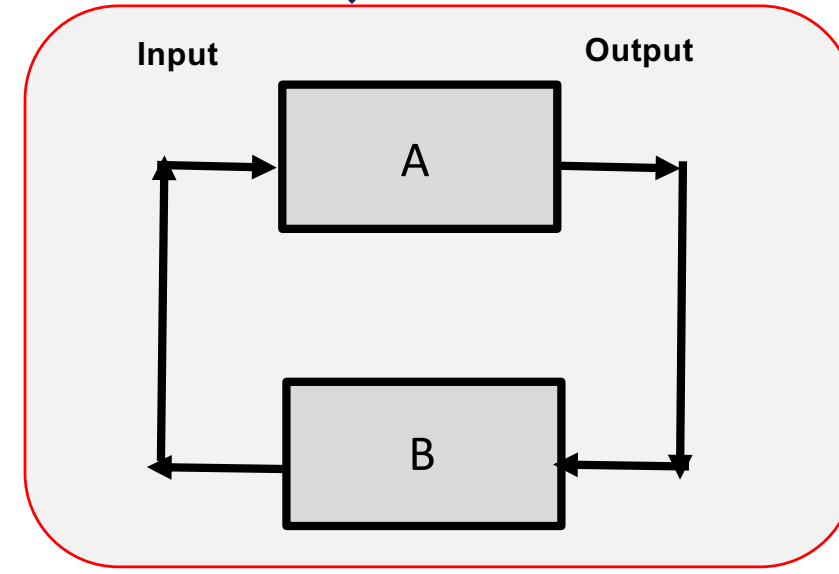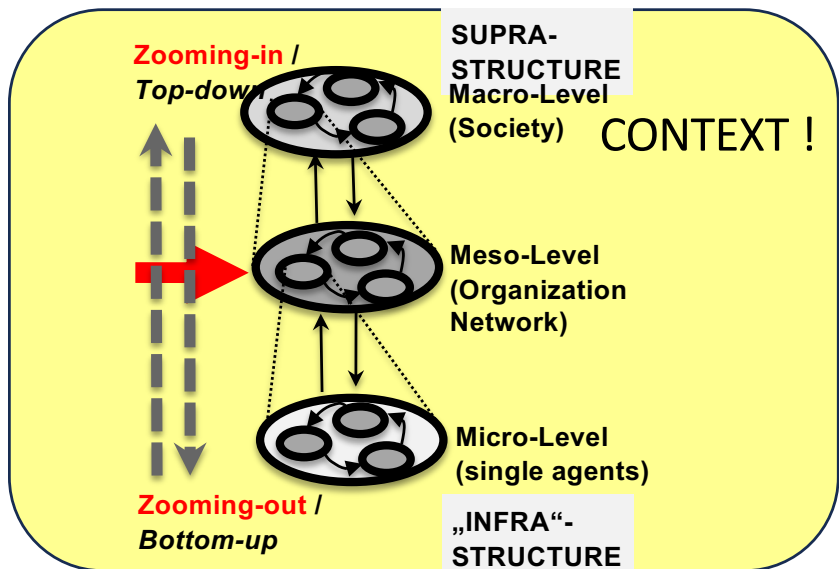to difference of
outputs?
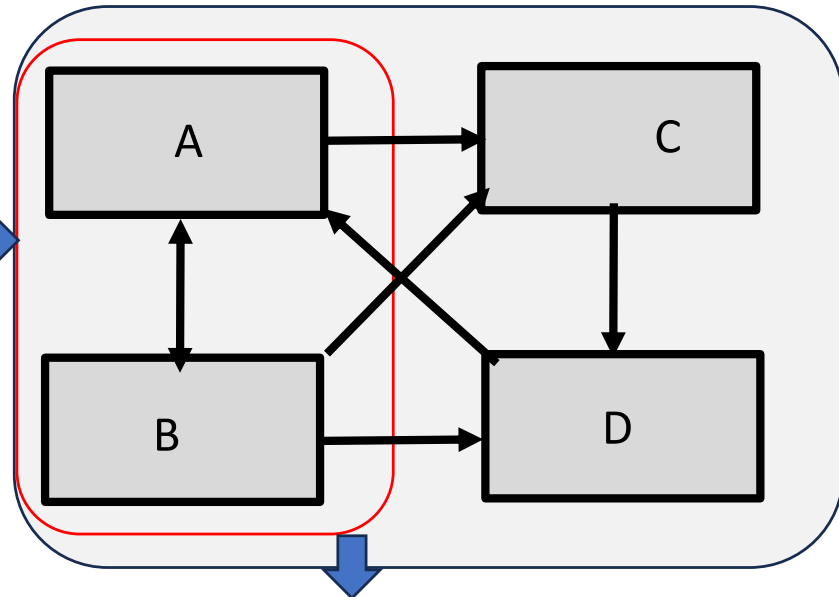(urban / regional
epidemiology)

Output y_1

Input x_1

Input   **Output**

x_1 → → y_1

x_m → → y_n

MECHANISMS ?

Latent structures ?

time

Incidence/d   Hammer   Dance

Time

Input   **Output**

VIRUS → POPULATION → DISEASE

SYSTEMS METHODS AND MODELS

BLACK BOX METHODOLOGY

Output y_1

Input x_1

Input

Output

x_1

x_m

y_1

y_n

MECHANISMS ?

Latent structures ?

time

NETWORK MODEL

A

C

B

D

CONTEXT !

Zooming-in /
Top-down

SUPRA-
STRUCTURE
Macro-Level
(Society)

Meso-Level
(Organization
Network)

Micro-Level
(single agents)

Zooming-out /
Bottom-up

„INFRA"-
STRUCTURE

CONTROL LOOP MODEL

Input

Output
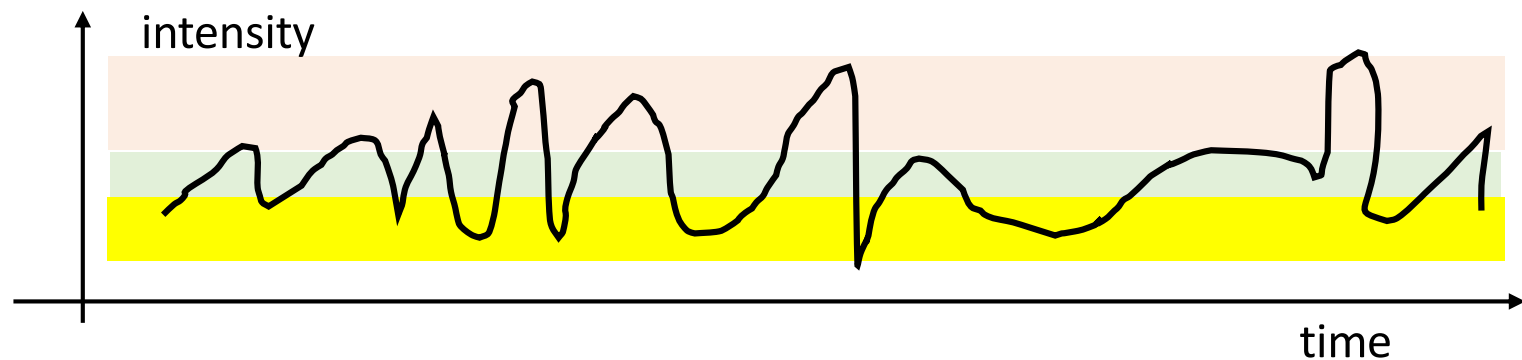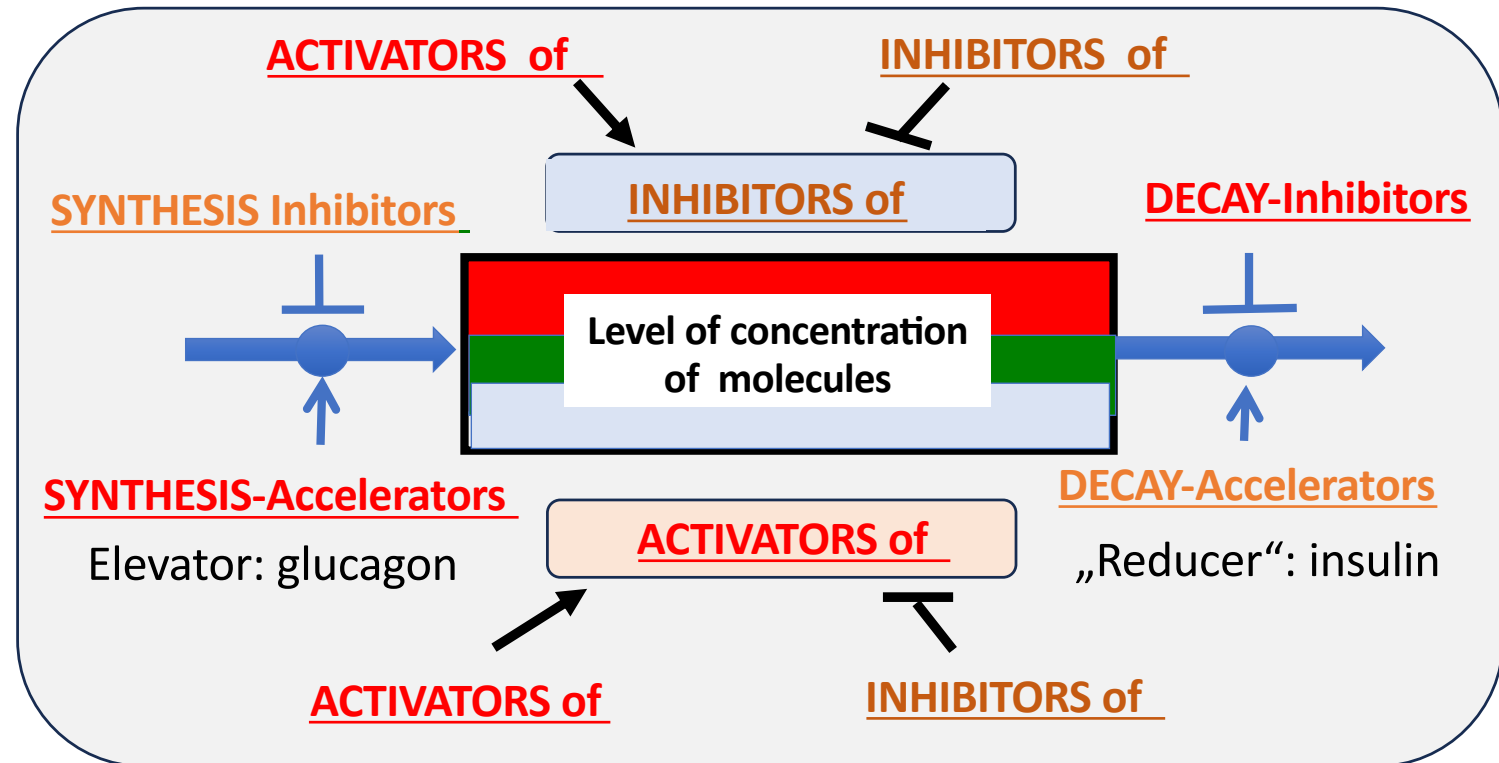
A

B

BLACK BOX ANALYSIS AND MODELING
Biochemical levels: ups & downs of concentrations by temporary imbalances of activators and inhibitors of the respective substance

e.g. :
Level of glucose
is raised by
glucagon and/or
by blocking insulin

ACTIVATORS of

INHIBITORS of

SYNTHESIS Inhibitors

INHIBITORS of

DECAY-Inhibitors

Level of concentration of molecules

SYNTHESIS-Accelerators

Elevator: glucagon

ACTIVATORS of

DECAY-Accelerators

„Reducer": insulin

ACTIVATORS of

INHIBITORS of

intensity

time

THE CORONA-PROBLEM and its MANAGEMENT

Source: F. Tretter 2022

Cascade model

Systems thinking:
From linear to loop
to circular
array
of components =>

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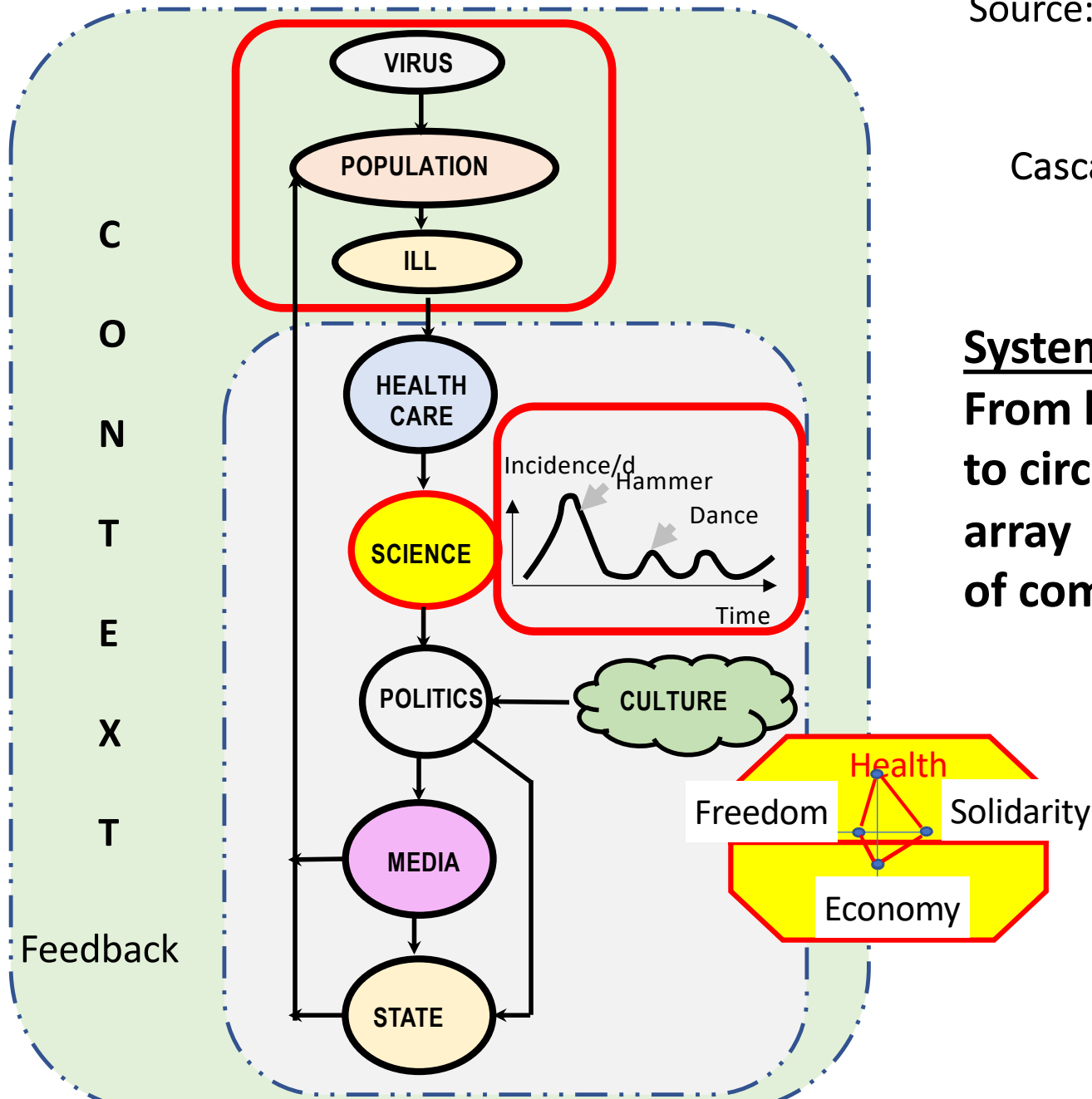
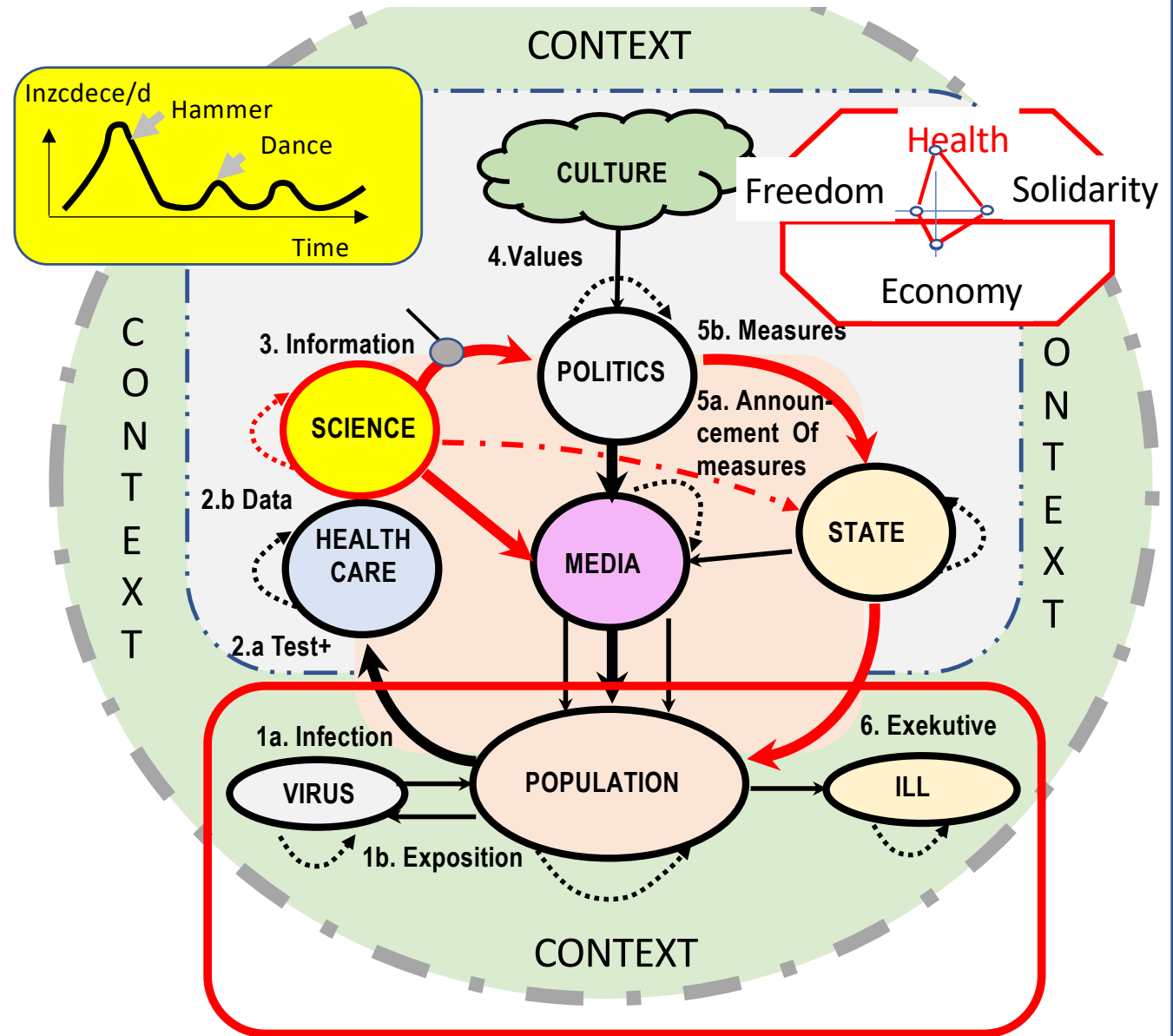CORONA MANAGEMENT CYCLE with intrinsic dynamics (dotted arrows) in a Systemic control loop model: "Follow the Science" as focus

DELAYS !!!

- dynamics also by regulation

=> over- and under-regulation

Source: F. Tretter 2022

Sphere of activity: Population and Virus, Health care and Science, Politics, Media & Public Administration and Population

CONTEXT

Inzcdece/d — Hammer — Dance — Time

CULTURE
Health
Freedom — Solidarity
Economy

4. Values

3. Information

5b. Measures

POLITICS

5a. Announcement Of measures

SCIENCE

2.b Data

HEALTH CARE

MEDIA

STATE

2.a Test+

1a. Infection

POPULATION

6. Exekutive

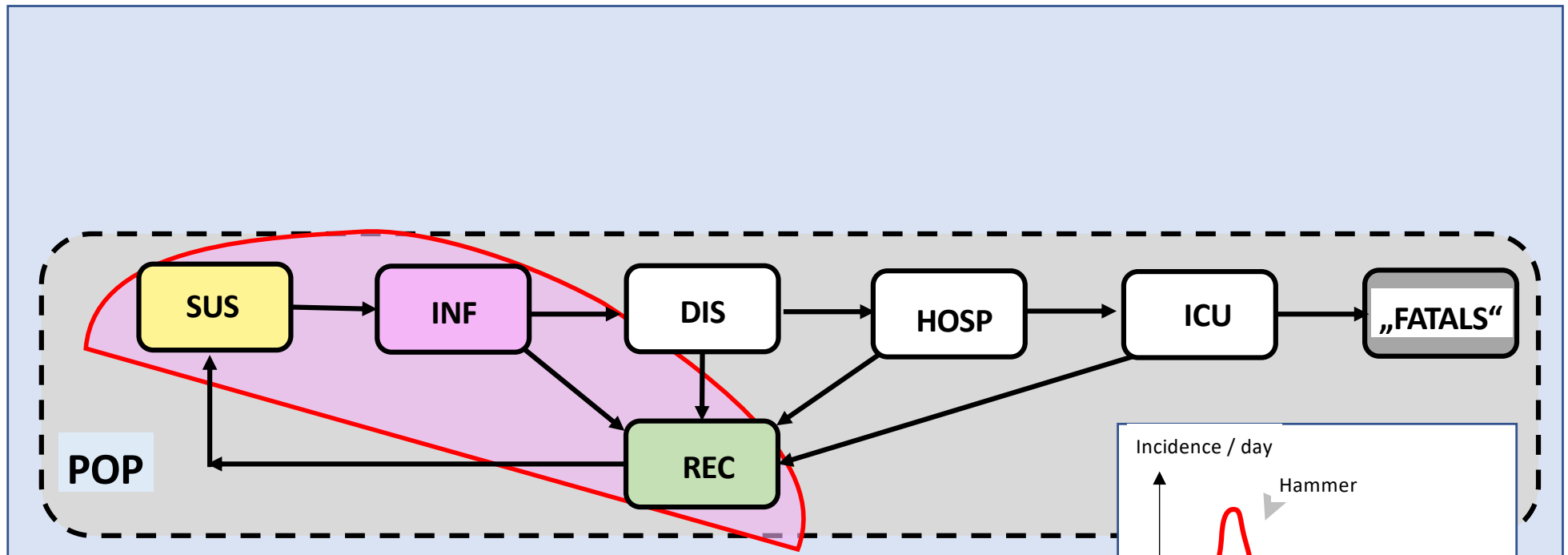VIRUS

ILL

1b. Exposition

CONTEXT

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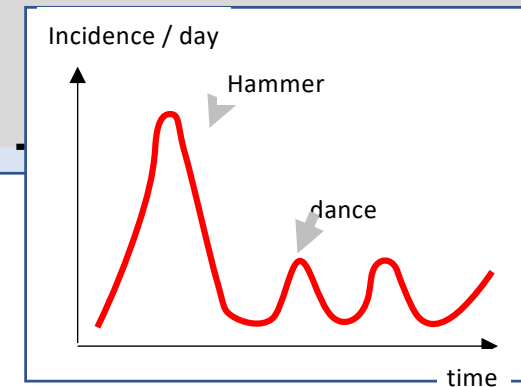# SYSTEM MODELS & POPULATION – numbers without theory ?:
From S-I-R model to S-(E-C)-I-D-H-C-R-F- Model
(e.g. Meyer-Hermann-Group; Helmholtz Inst., Braunschweig)
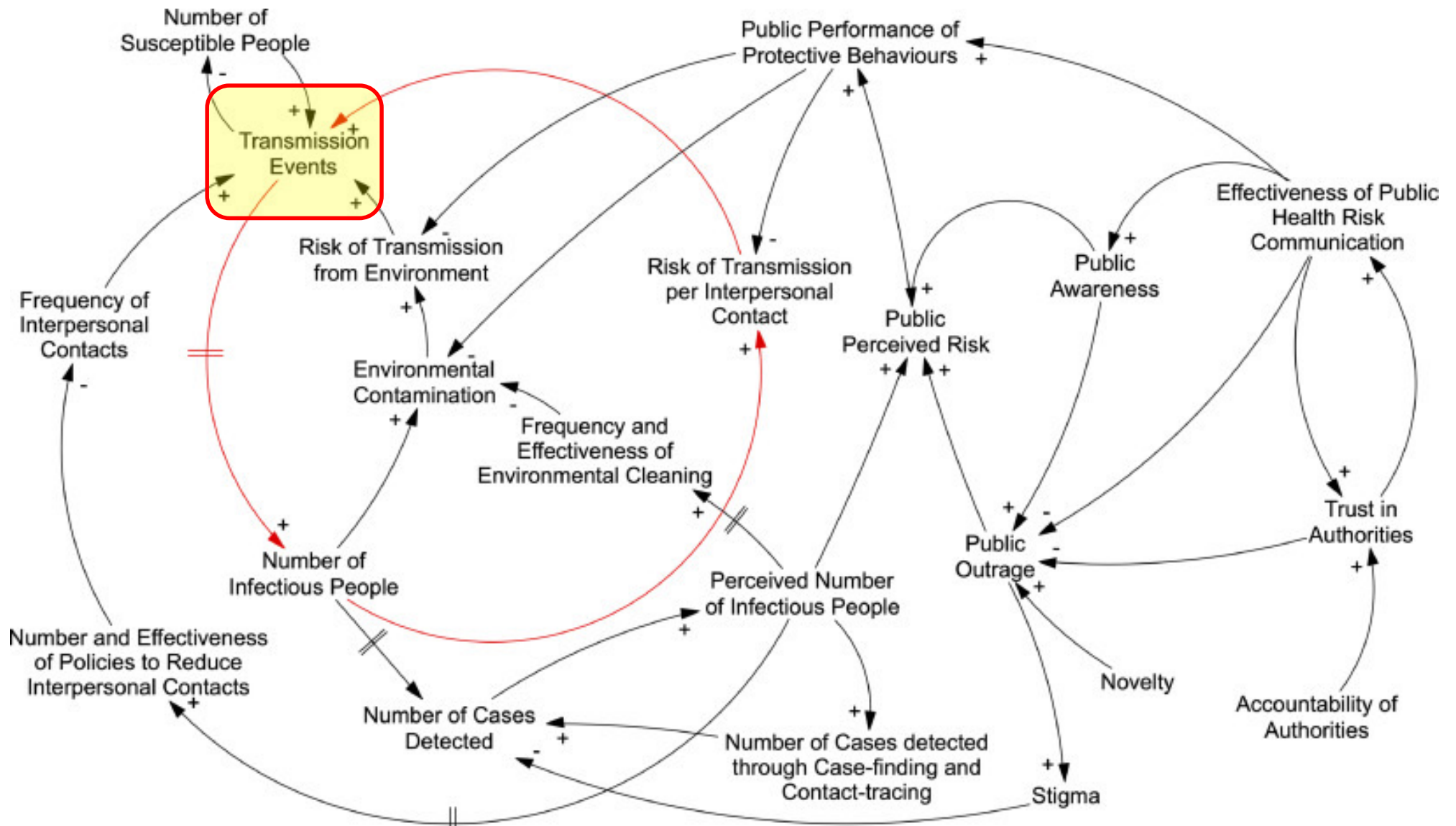
Compartment model

(non-linear) differential equations, but too simple conceptualization !

HC & Sociocultural variables not explicitly integrated!

Source: F. Tretter 2022

Bradley et al. 2020, Lancet
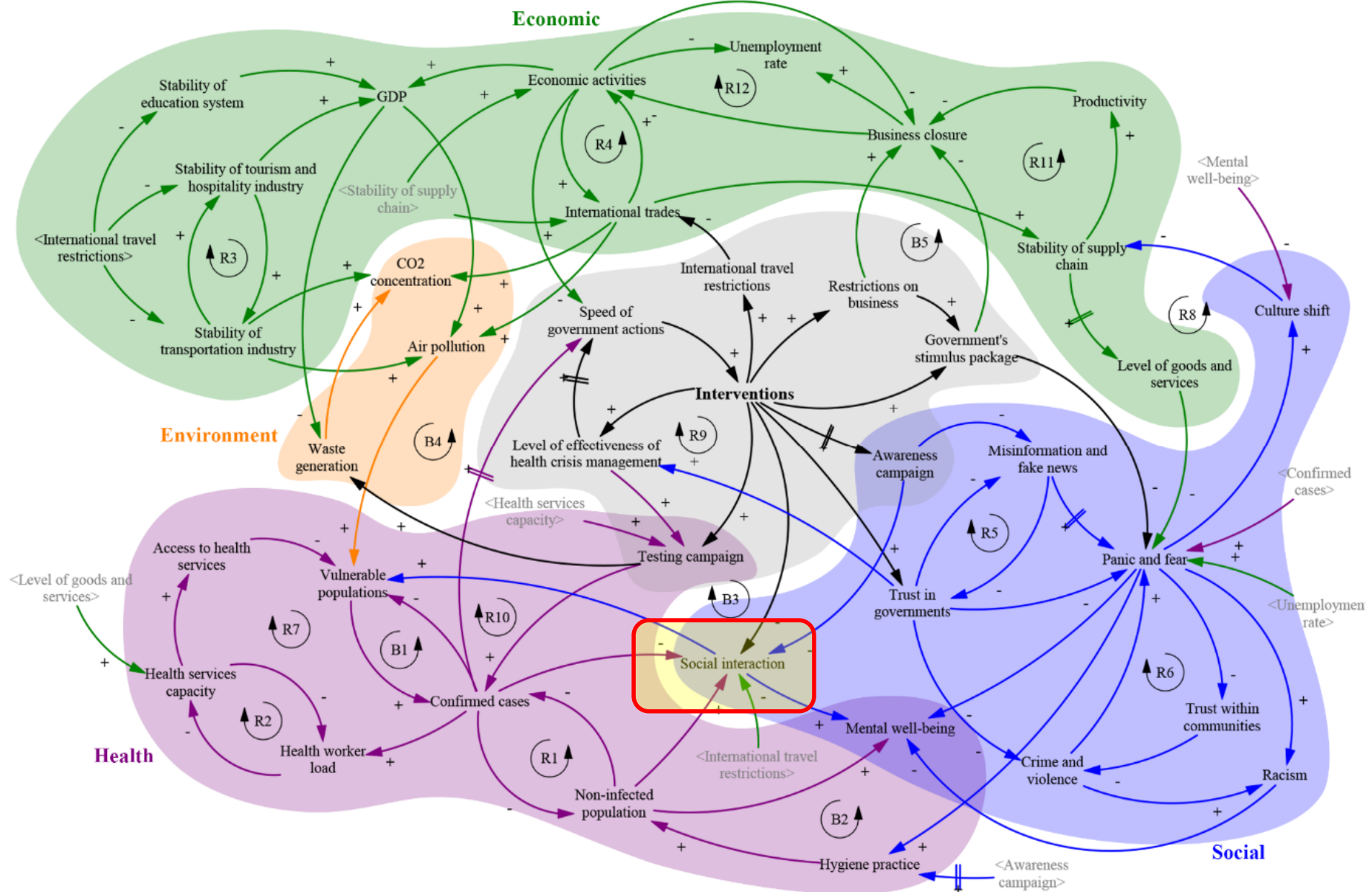
Figure 1. A preliminary causal loop diagram demonstrating the complexity of the COVID-19 pandemic environmental–health–socio–economic system.
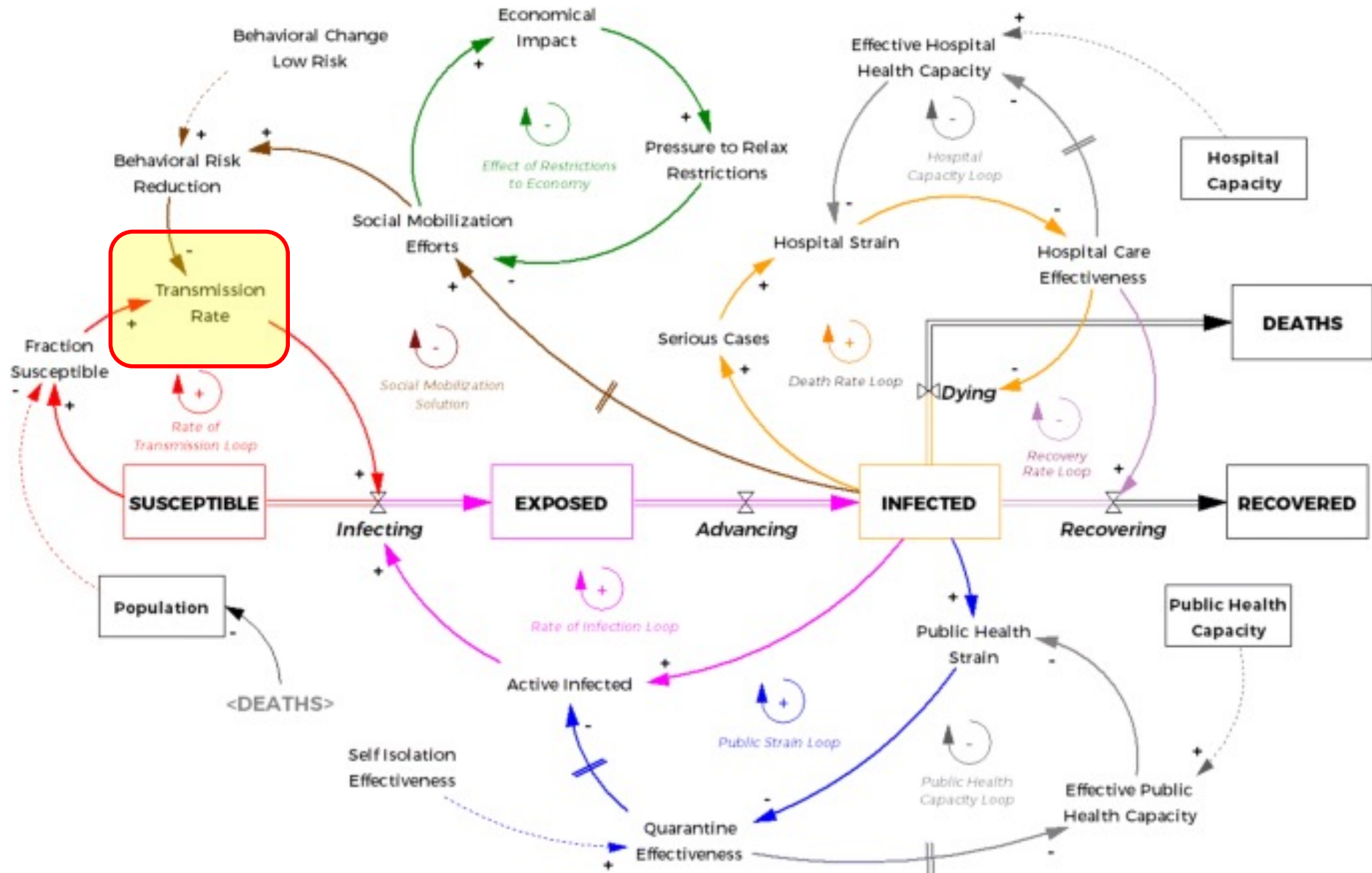
A model of COVID-19 in the US
with endogenous testing, containment measures, and social distancing

An SIR model with endogenous responses

Rectangle=stock; Double-black arrow=flow; Blue arrow=causal link; Red/brown text=input constant/series; Blue text=nonlinear X-Y function; <Green text>=defined elsewhere in diagram.

Wang & Mansouri 2021, IS

No response and action:exponential increse

Susceptible people

Number of vulnerable people

Infectivity

Number of infectious people

<Number of recovered people>

Number of cases detected/tested

<Number of death>

Efficiency of work/stay at home policies

<Online education>

Interpersonal contacts

Mass gartherings and events

<Mobility via public transportation>

Risk of transmission

<Culture and customs>
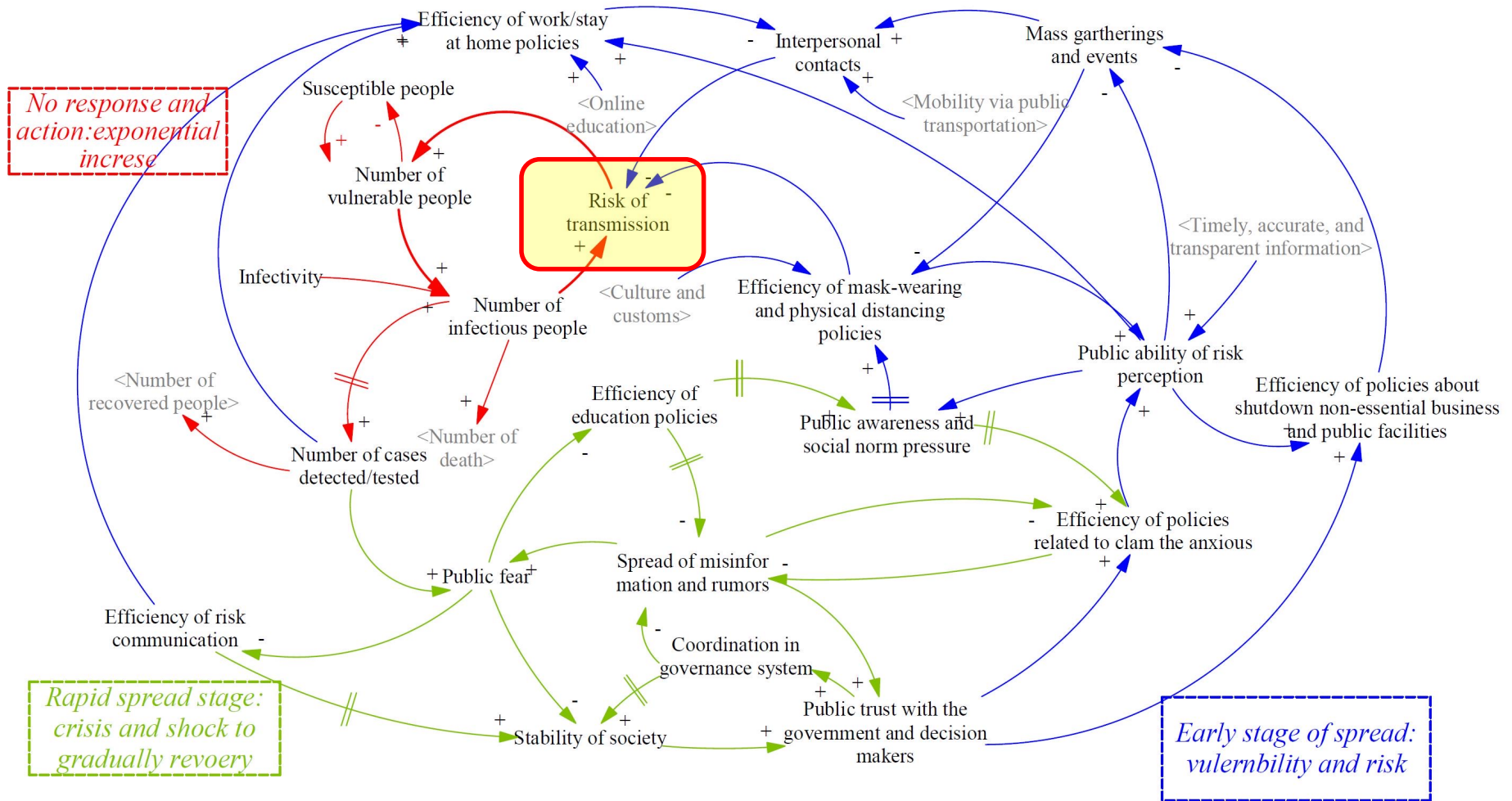
Efficiency of mask-wearing and physical distancing policies

<Timely, accurate, and transparent information>

Public ability of risk perception

Efficiency of policies about shutdown non-essential business and public facilities

Efficiency of education policies

Public awareness and social norm pressure

Efficiency of policies related to clam the anxious

Public fear

Spread of misinformation and rumors

Efficiency of risk communication

Coordination in governance system

Public trust with the government and decision makers

Rapid spread stage: crisis and shock to gradually revoery

Stability of society

Early stage of spread: vulernbility and risk

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Li et al. 2019 !!! **System dynamics modeling of public health services provided by china cDc to control infectious and endemic diseases in china** https://www.dovepress.com/cr_data/article_fulltext/s185000/185177/img/idr-185177_F001.jpg
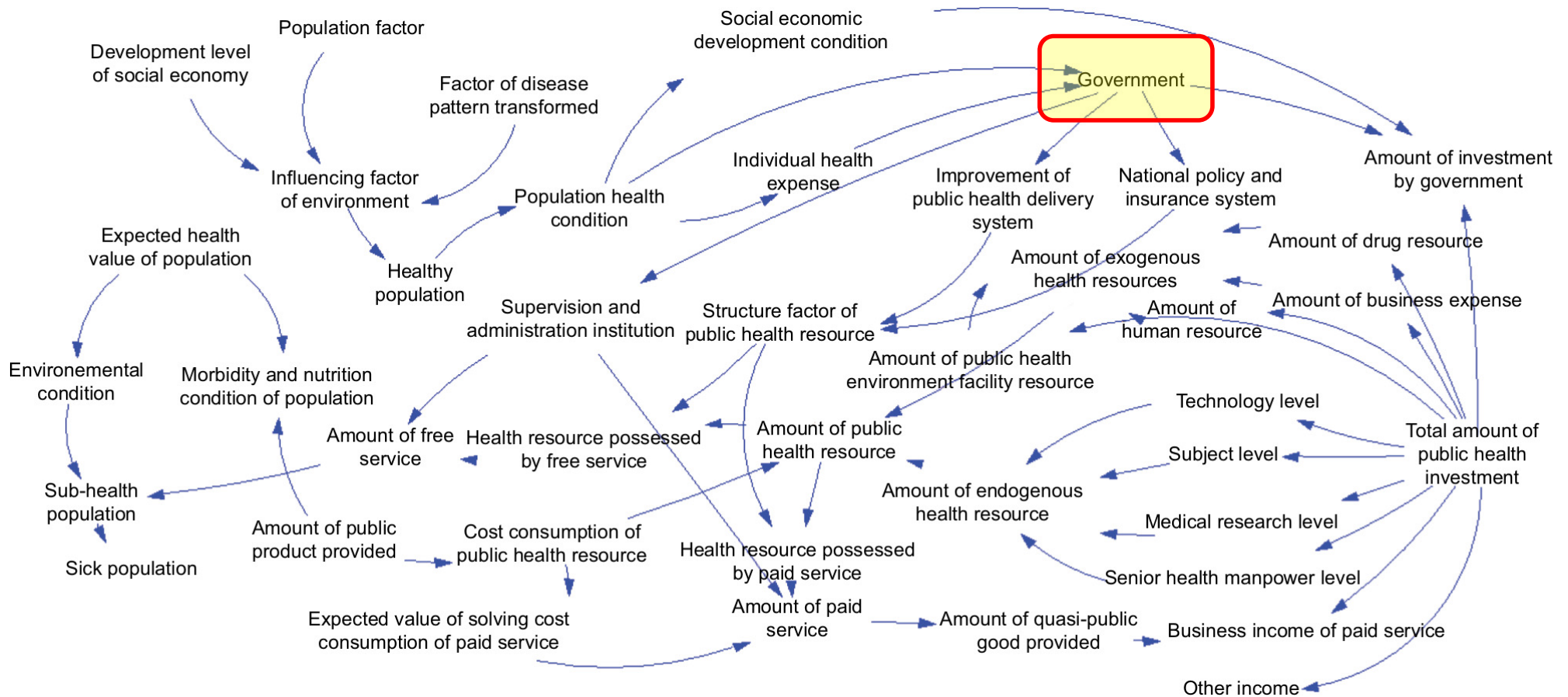
SUMMARY / PERSPECTIVE

CONSEQUENCE:
A SYSTEMIC-HUMAN-ECOLOGICAL PERSPECTIVE FOR EPIDEMIOLOGY/ THE HEALTH SCIENCES / MEDICINE

(1) **Transdisciplinarity** as an epistemic basis ! (TD > ID!)
- Laboratory perspective + field perspective (practice, affected persons...)

(2) **Human beings** as subjects at the centre (population vs. anthropology):
- re-establish "personalized medicine"
- "Subjects" who act are carriers of health problems.

(3) A **(human) ecological framework** is necessary

(4) Use the **systemic methodology** explicitly for dynamics

=> institutions?
=> Is "the" society interested in this? ....

THANK YOU FOR YOUR ATTENTION

felix.tretter@bcsss.org

Computation ?   **OR /(AND)**   **Conceptual modeling?**

UNIDIMENSIONAL
VIEW

"And that's why we need a computer."