Sensing, Inference, and Intervention in Support of Mental Health

Eric Horvitz

Microsoft Research

HCI + AI: Growth in Resources & Competencies

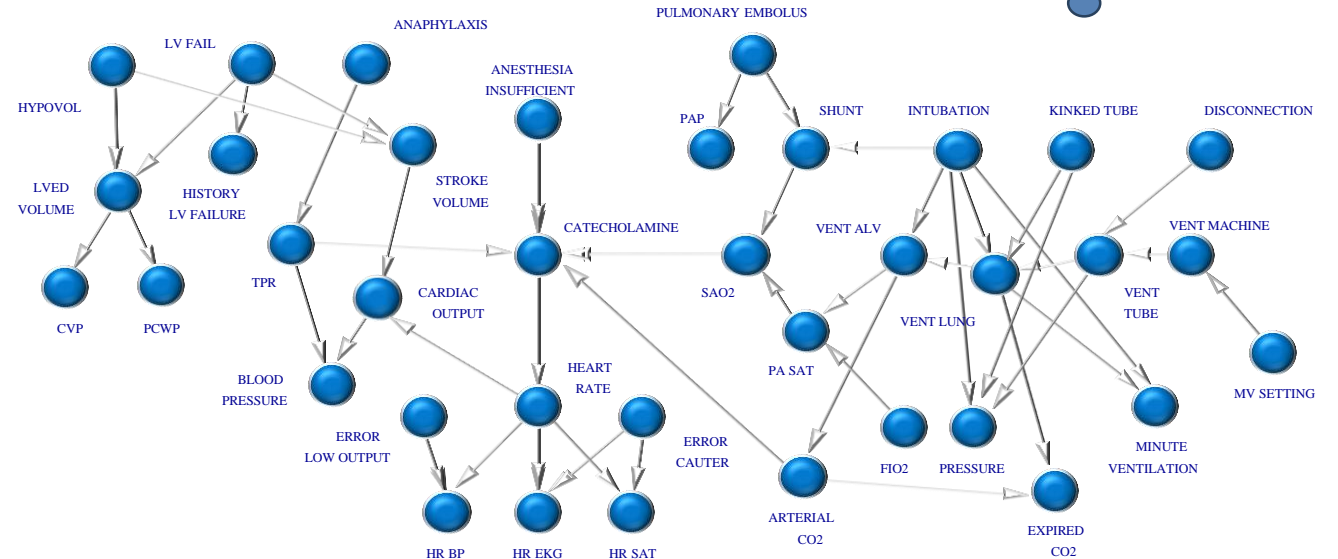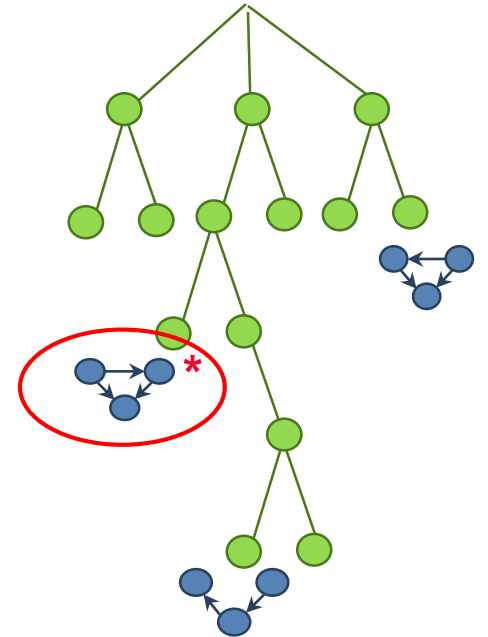Data & computation

Learning, inference, representation

Causal inference

Perception

NLP

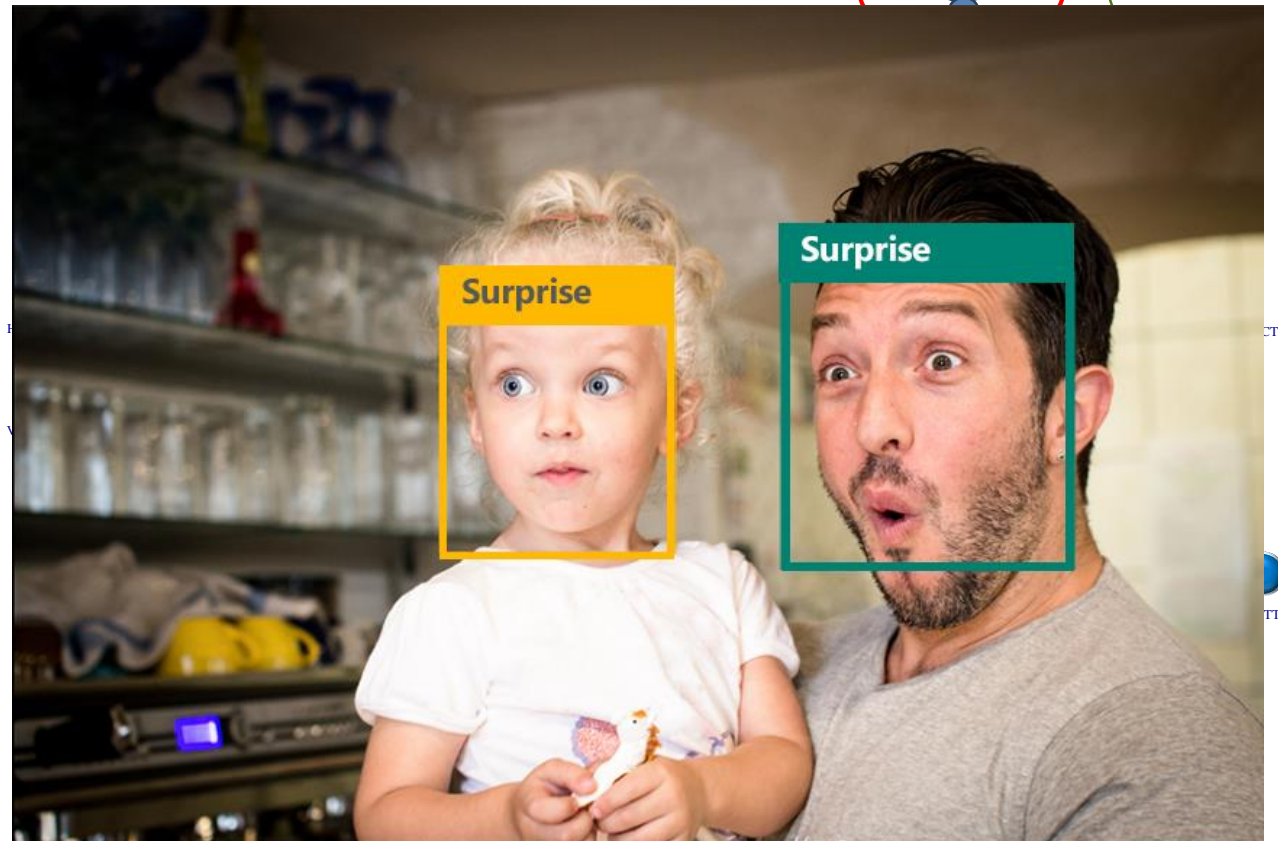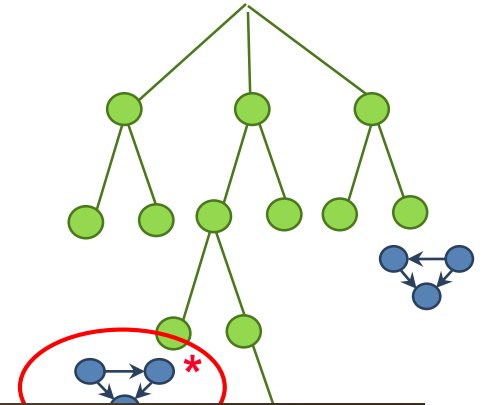# HCI + AI: Growth in Resources & Competencies

Data & computation

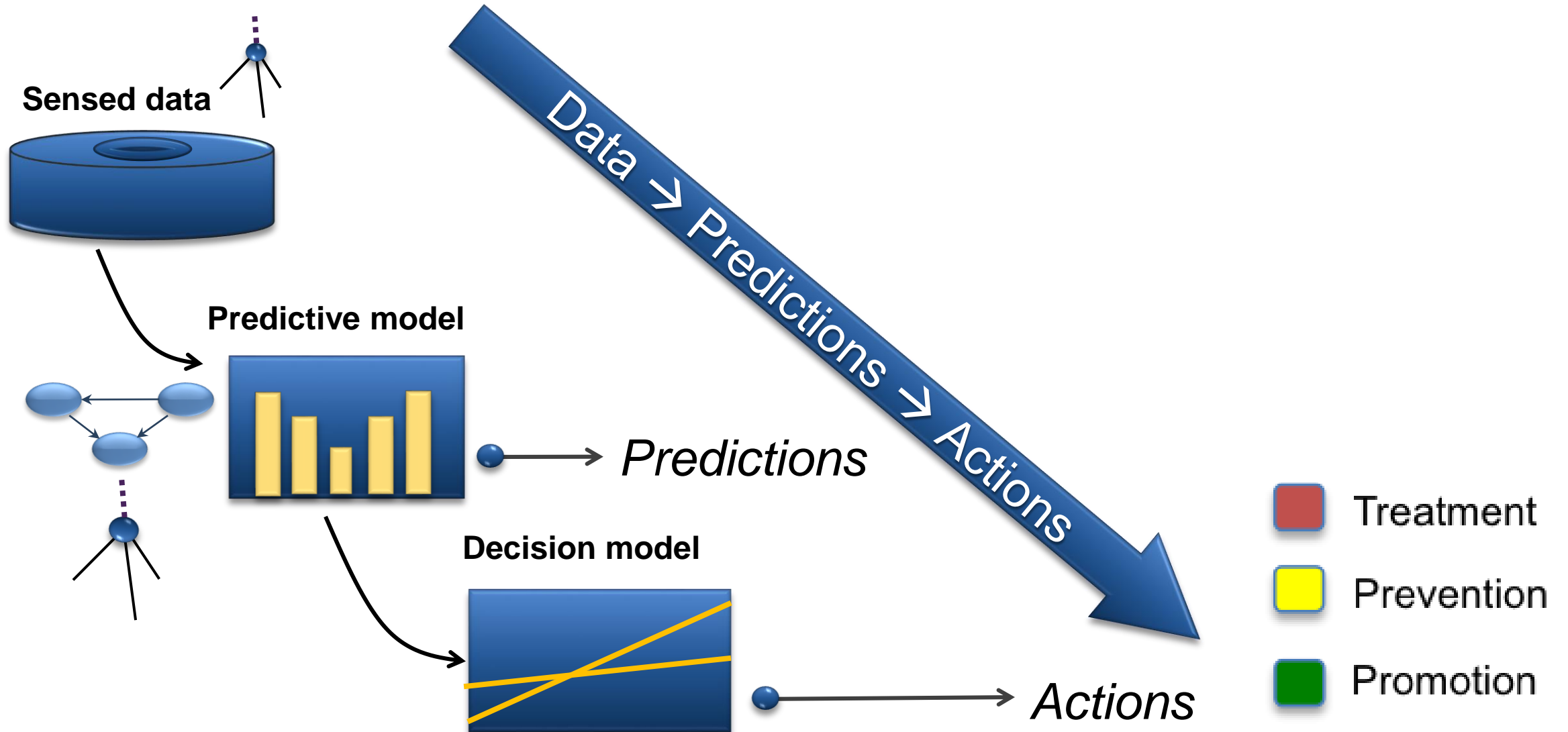Learning, inference, representation

Causal inference

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Tools & platforms

Data to Predictions to Interventions

Data to Predictions to Interventions
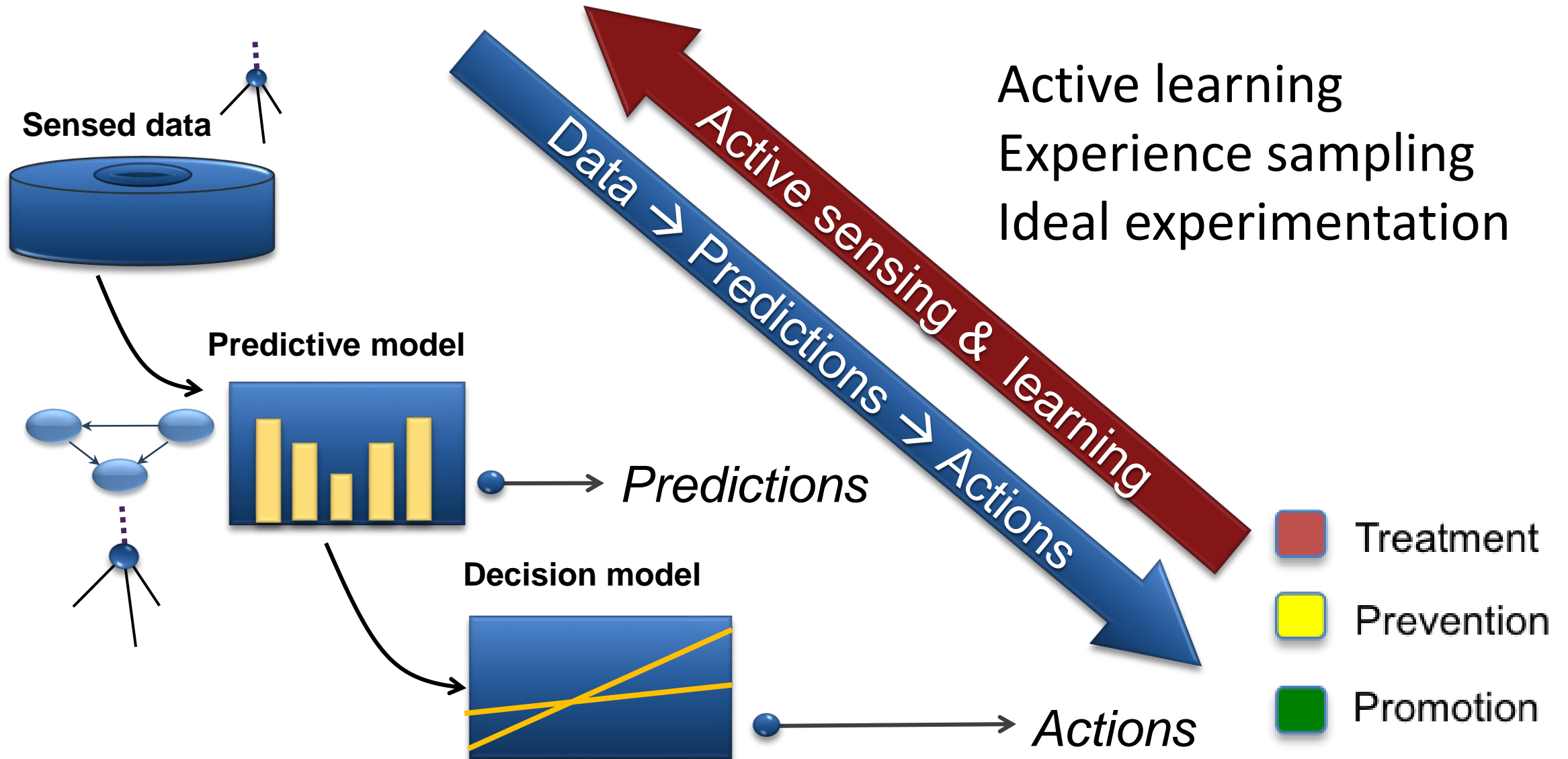
Revolution Brewing

Computational social science

Data
Devices
Life-centricity of web

Representations & models
Learning & inference
Perception, predictions, decisions

Revolutions Brewing

Computational social science

Public health & epidemiology

Data
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Representations & models
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Revolutions Brewing

Computational social science

Public health & epidemiology

Social psychology & personality

Clinical psychology & psychiatry

Data
Devices
Life-centricity of web

Representations & models
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Revolution Brewing

Mental health & wellbeing

Data
Devices
Life-centricity of web

Representations & models
Learning & inference
Perception, predictions, decisions

Evidential Streams & Inferences from Populations

e.g., Search, Twitter, Facebook, Reddit, TalkLife, Crisis Txt Line, Apps

Health insights & diagnosis

Mental health & wellness

Wrestling with (the Wild West of) Population Data

Supervised learning: experts, crowd, participants

Unsupervised learning: clustering, topic modeling

Causal modeling: propensity, Neyman-Rubin

Wrestling with (the Wild West of) Population Data

Sensitivity, robustness, error modeling

Statistics of rare events

Sequence alignment

NL psych models: LIWC, ANEW, etc.

NL topics/sentiment: Emolex, SentiWordNet, Empath

Wrestling with Large-Scale Population Data

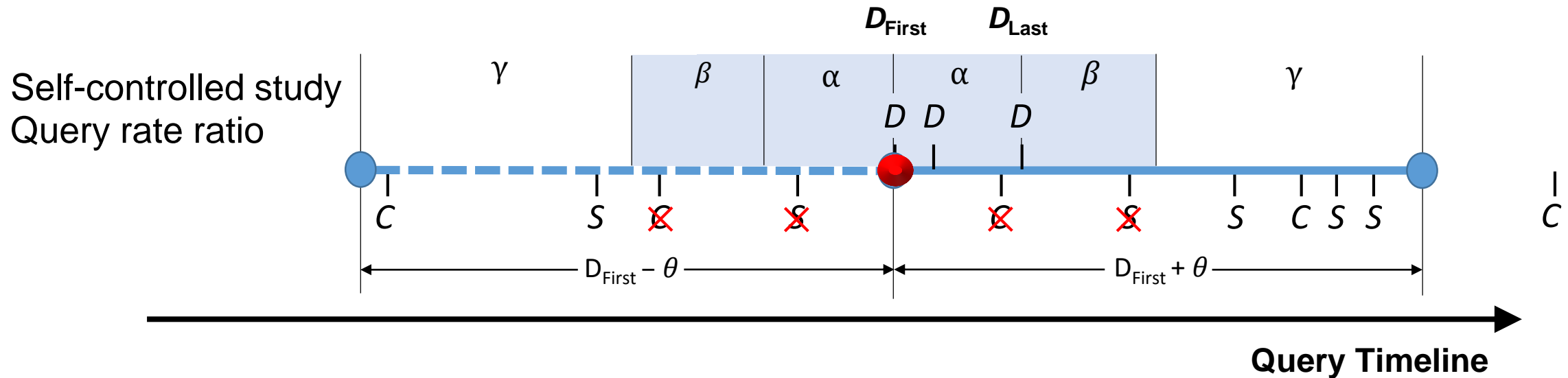Experimental design

Matched sets for studies

- Control

- Test/intervention

Example:

Rare serious adverse effects of medications

Wrestling with Large-Scale Population Data

Detect rare adverse effects of drugs

Self-controlled study
Query rate ratio

D: query for drug of interest
C: query for condition of interest
S: query for symptom of C

surveillance window post D_{First}
surveillance window pre D_{First}
× ignored C or S

$\alpha = D_{Last} - D_{First}$
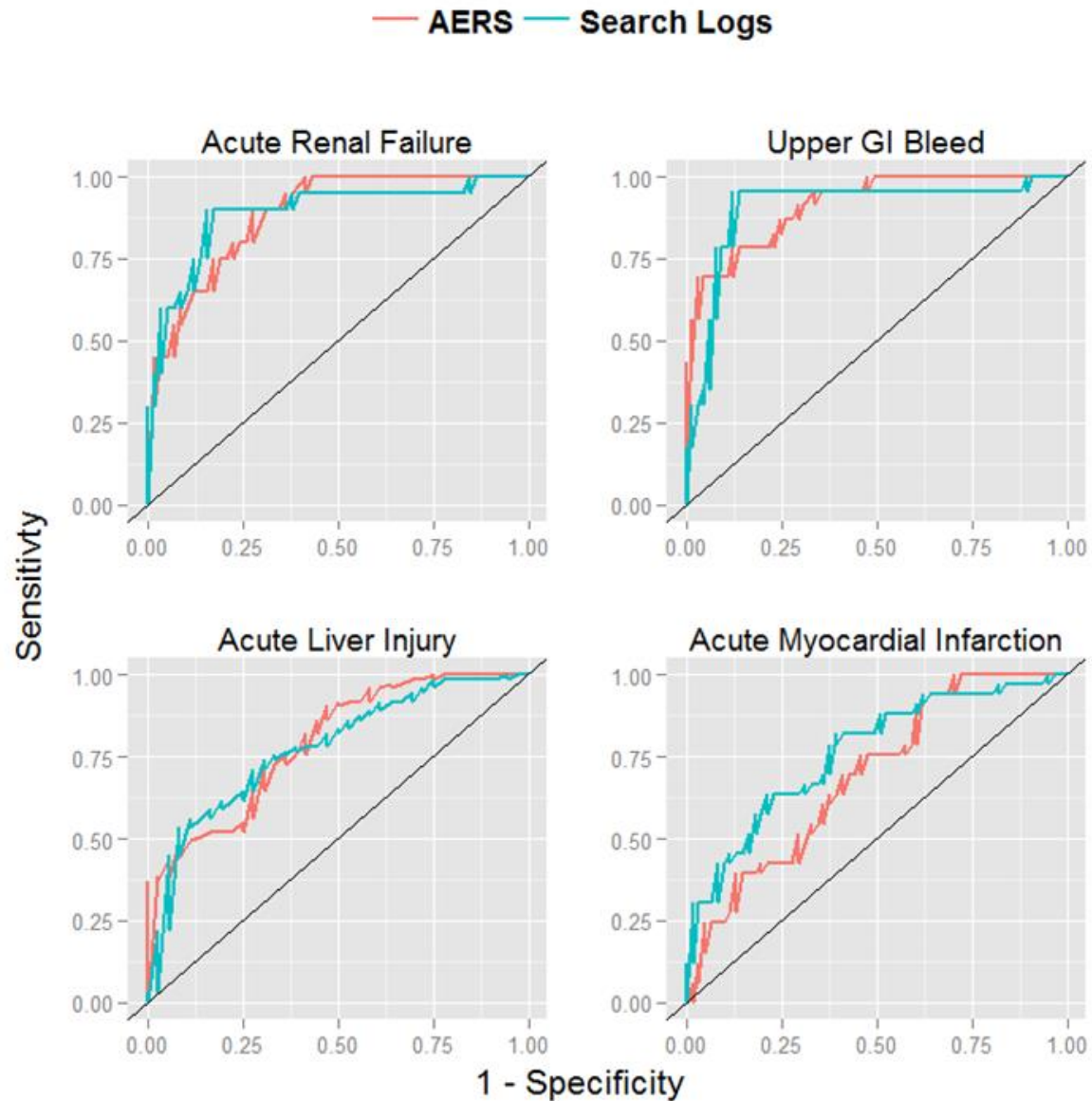$\beta = 7$ days
$\gamma = 60$ days
$\theta = (\alpha + \beta + \gamma)$

White, Harpaz, Shah, DuMouchel, Horvitz, Nature CPT, 2014

Wrestling with Large-Scale Population Data

White, Harpaz, Shah, DuMouchel, Horvitz, Nature CPT, 2014

Wrestling with Large-Scale Population Data

Alignment

Machine learning to align

Example:

Pregnancy info needs

Fourney, White, Horvitz, CHI 2015

Wrestling with Large-Scale Population Data

Alignment

Machine learning to align

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Pregnancy info needs

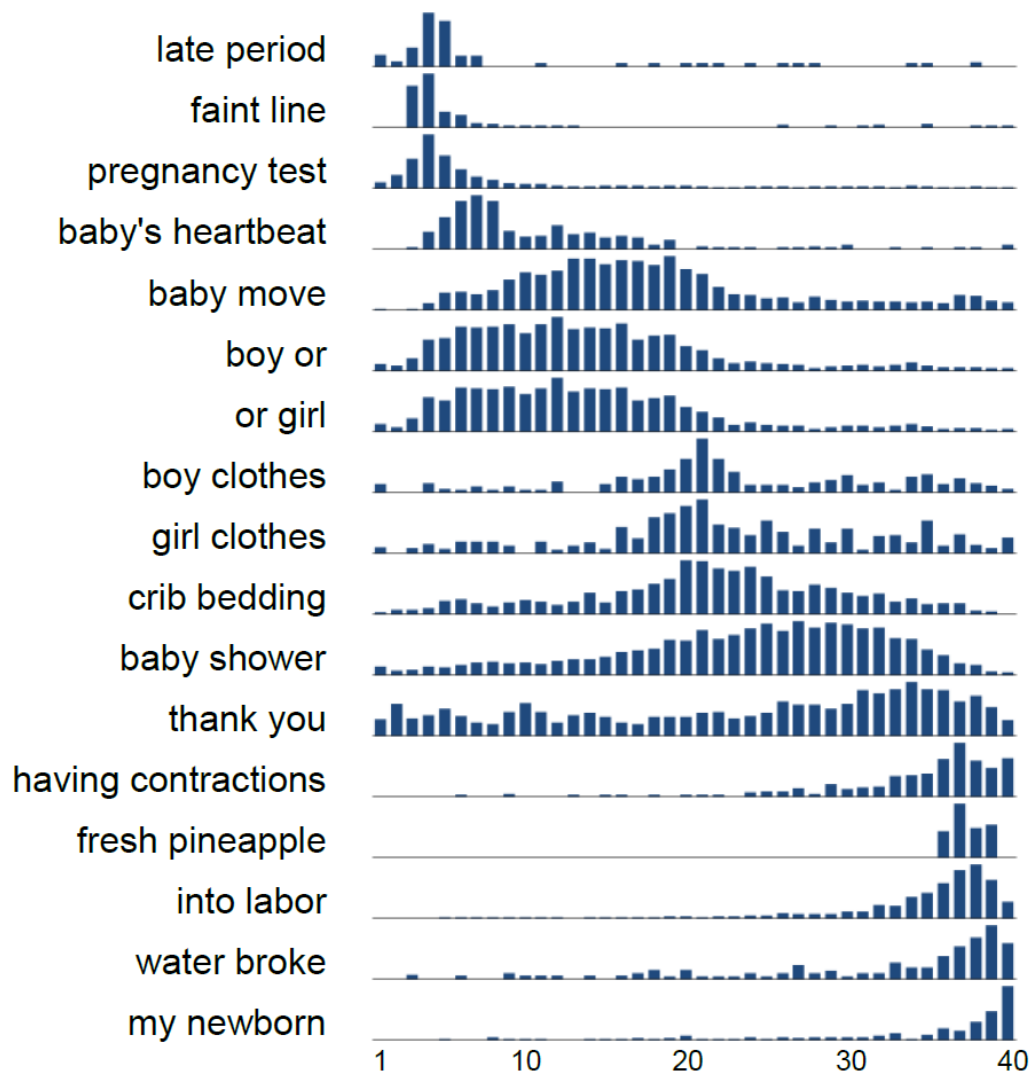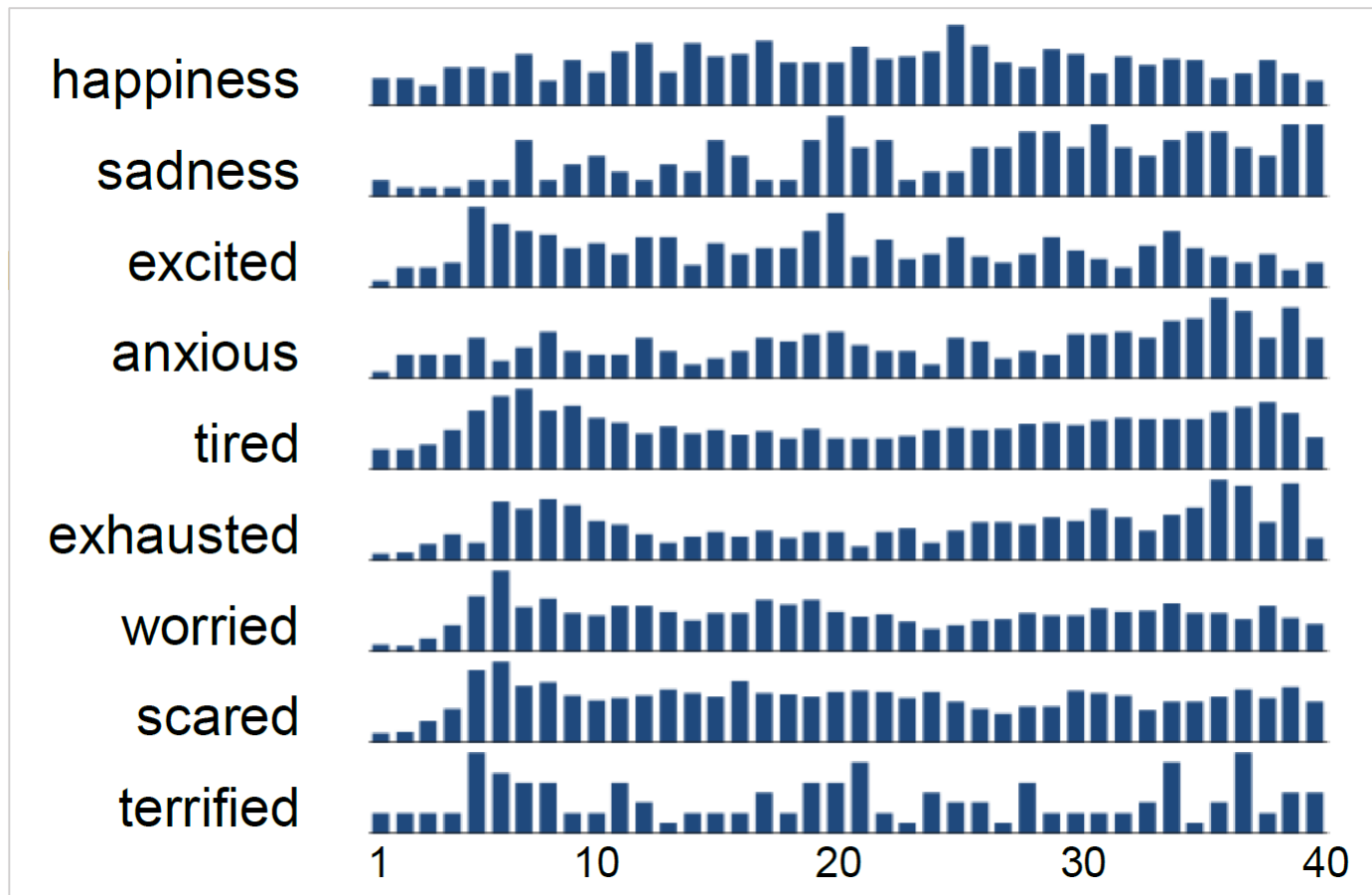A. Fourney, R. White, E. Horvitz, CHI 2015

Wrestling with Large-Scale Population Data

Alignment

Machine learning to align

Example:

Pregnancy info needs
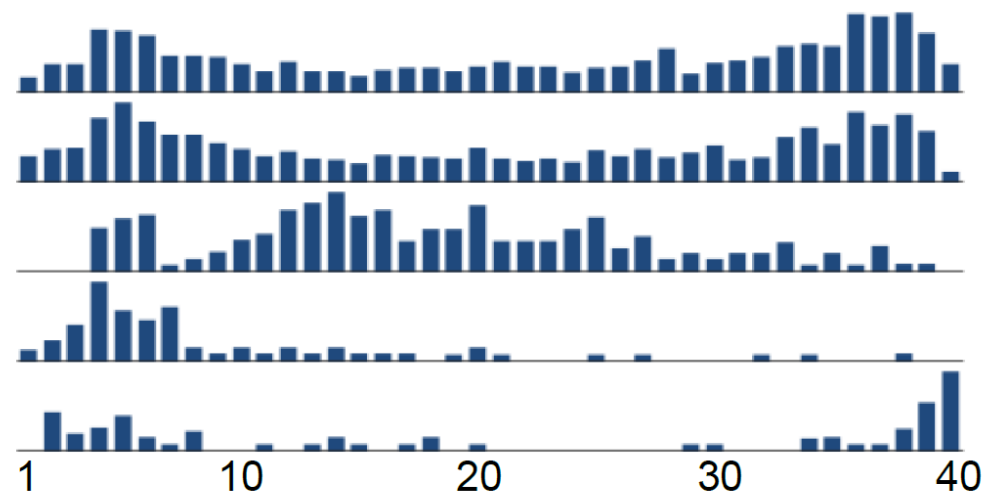
Wrestling with Large-Scale Population Data

Synthetic (per privacy), yet representative set of queries

Alignment

Episodic structure

Time	Query
Nov 13 2013 7:40pm	feels like lump in breast
Dec 1 2013 11:21am	pain after biopsy
Dec 1 2013 11:31am	what happens after breast biopsy
Dec 9 2013 6:33pm	how often are breast lumps cancer
Dec 9 2013 6:45pm	does cancer make you thirsty
Dec 9 2013 6:49pm	how long does it take for biopsy results
Dec 12 2013 12:08pm	stage 2a breast cancer
Dec 12 2013 12:15pm	invasive ductal carcinoma
Dec 12 2013 12:17pm	poorly differentiated idc breast cancer
Dec 12 2013 12:29pm	breast cancer survival rate
Dec 12 2013 12:32pm	stage 2 breast cancer survival rate
Dec 12 2013 7:44pm	breast reconstruction surgery
Dec 12 2013 7:46pm	breast reconstruction after cancer
Dec 13 2013 8:05am	breast cancer treatment
Dec 13 2013 8:16am	recovering from breast cancer
Dec 15 2013 09:20am	breast cancer surgeon
Dec 15 2013 10:22am	full mastectomy
Dec 15 2013 10:23am	mastectomy pros and cons
Dec 15 2013 10:29am	do you need chemo after mastectomy

Example:

Breast cancer

Wrestling with Large-Scale Population Data

Alignment

Episodic structure

Key pivot points

Diagnosis date
Screening
Surgery
Chemotherapy

Example:

Breast cancer

Paul, White, Horvitz, TWEB 2016

Wrestling with Large-Scale Population Data

Alignment

Episodic structure

Example:

Breast cancer

Paul, White, Horvitz, TWEB 2016

Wrestling with Large-Scale Population Data

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Episodic structure

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Breast cancer

Paul, White, Horvitz, TWEB 2016

Wrestling with Large-Scale Population Data

Alignment

Episodic structure

Example:

Breast cancer

Paul, White, Horvitz, TWEB 2016

Propensity: Normalizing cohorts to understand influences

u_1 timeline

u_2

u_3
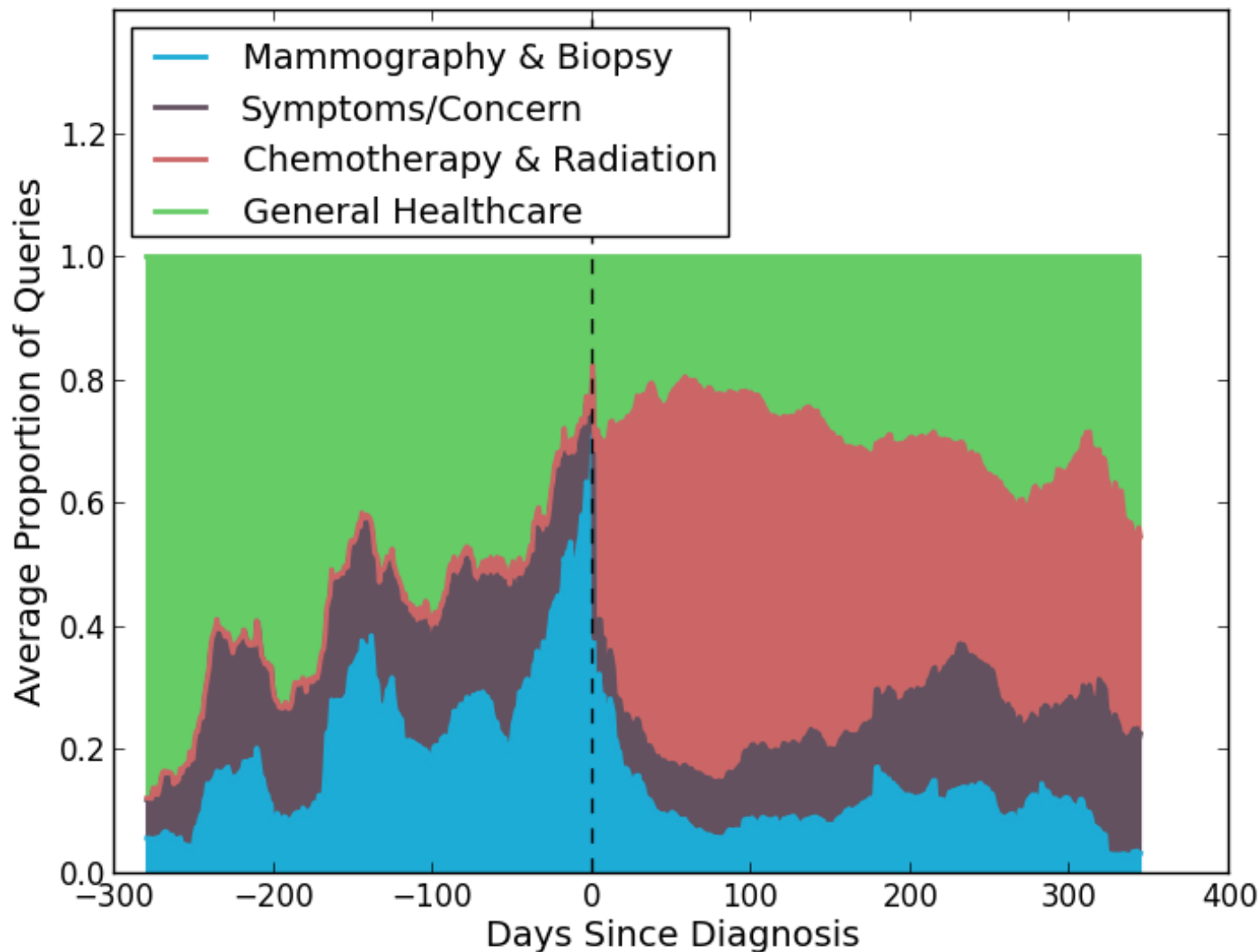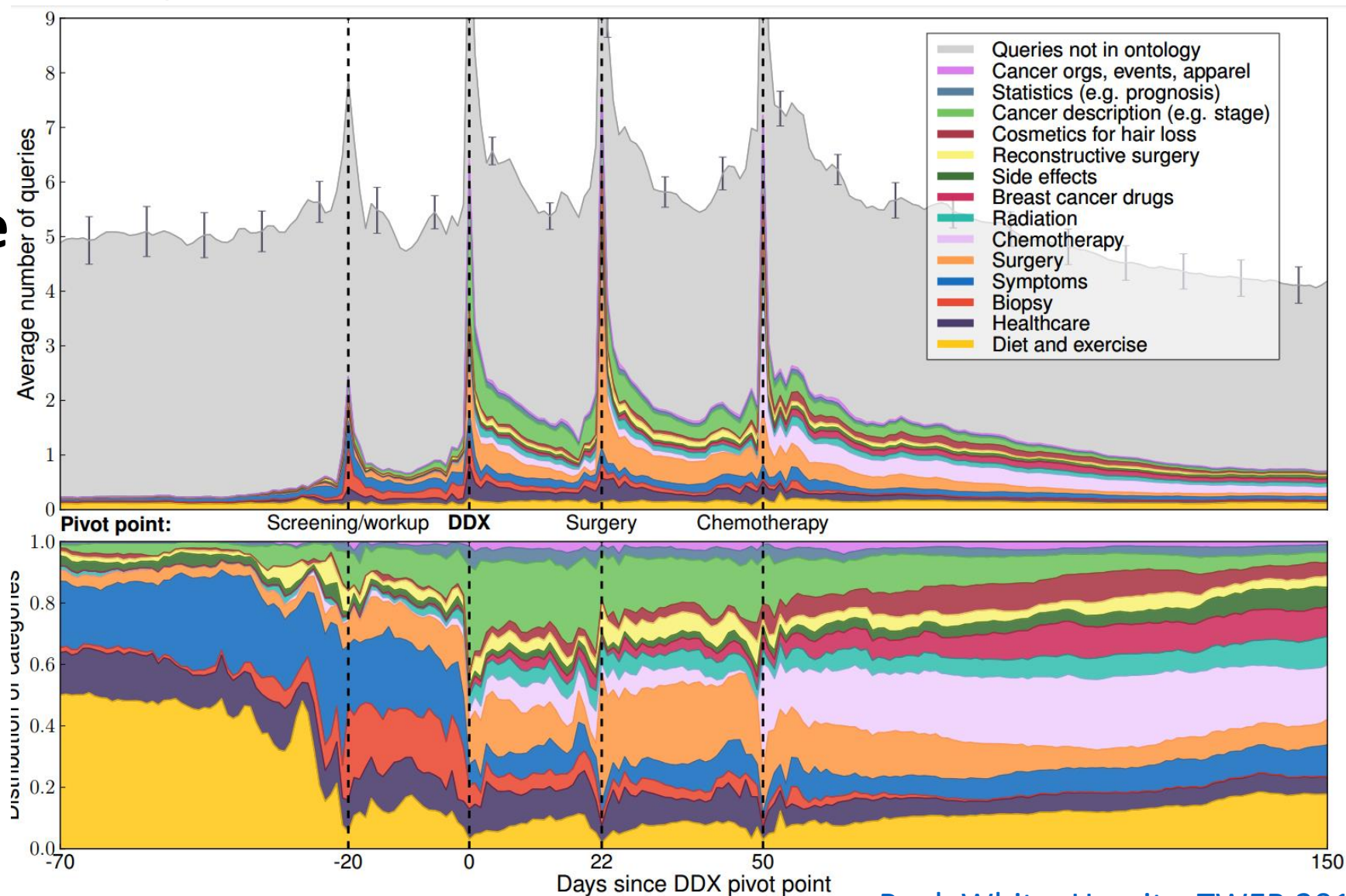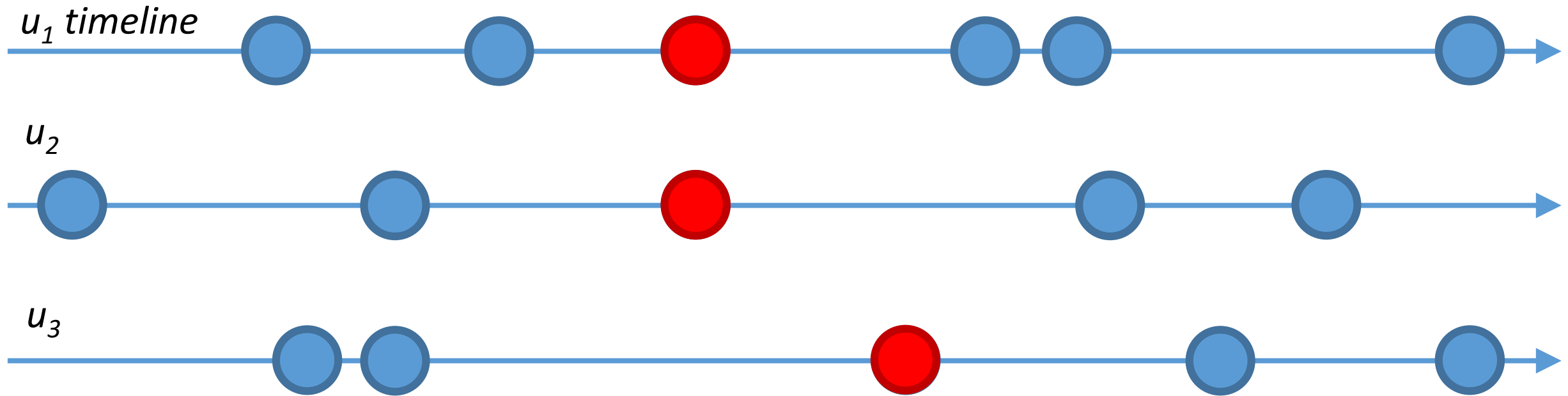
Learning outcome of action

Kiciman and Richardson, KDD 2015

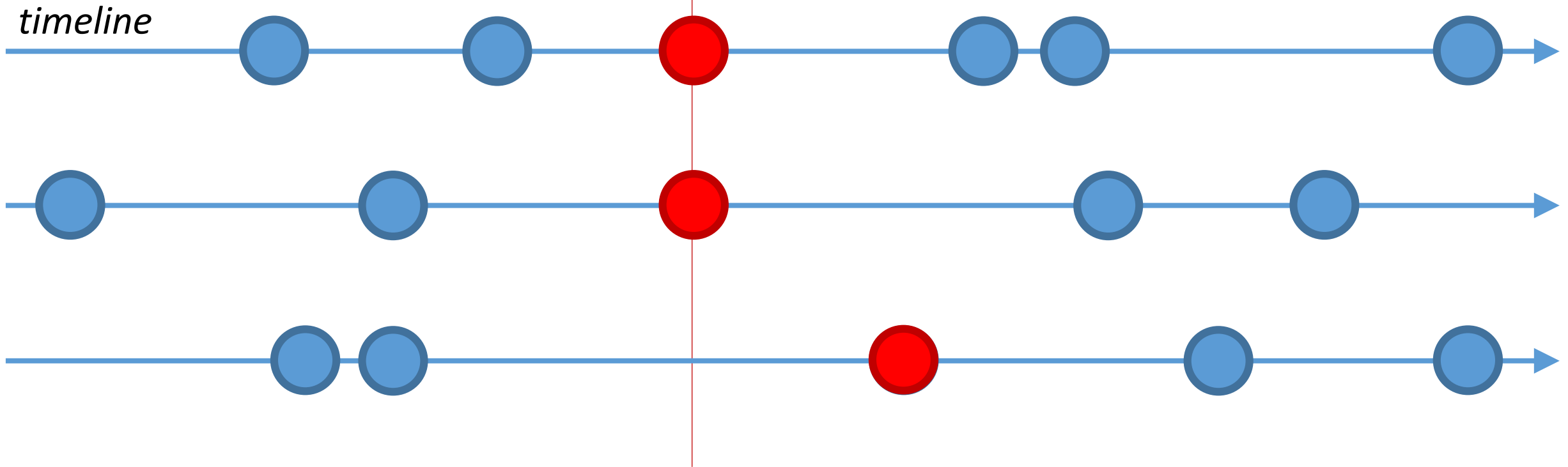# Propensity: Normalizing cohorts to understand influences

timeline
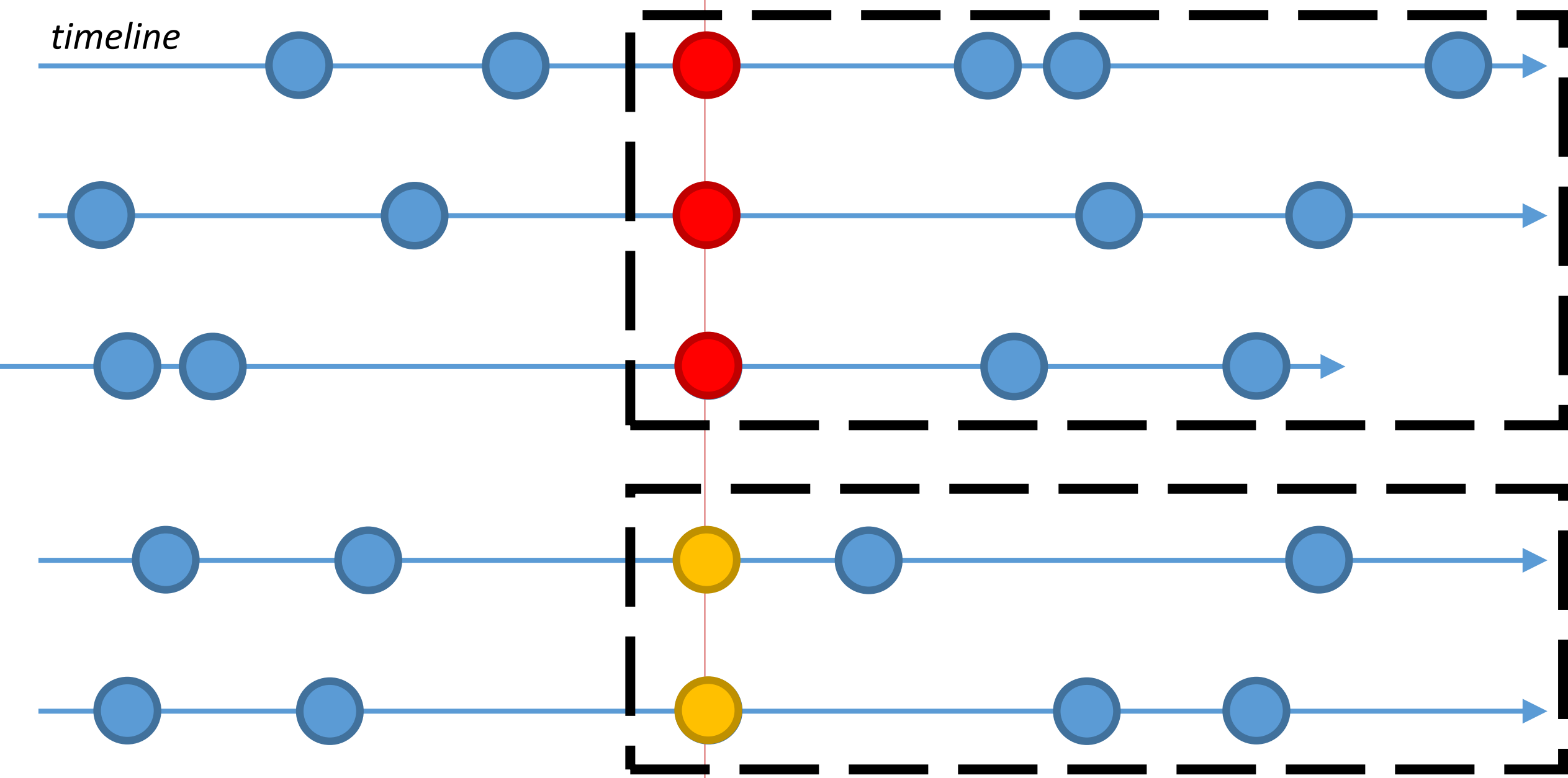
Propensity: Normalizing cohorts to understand influences

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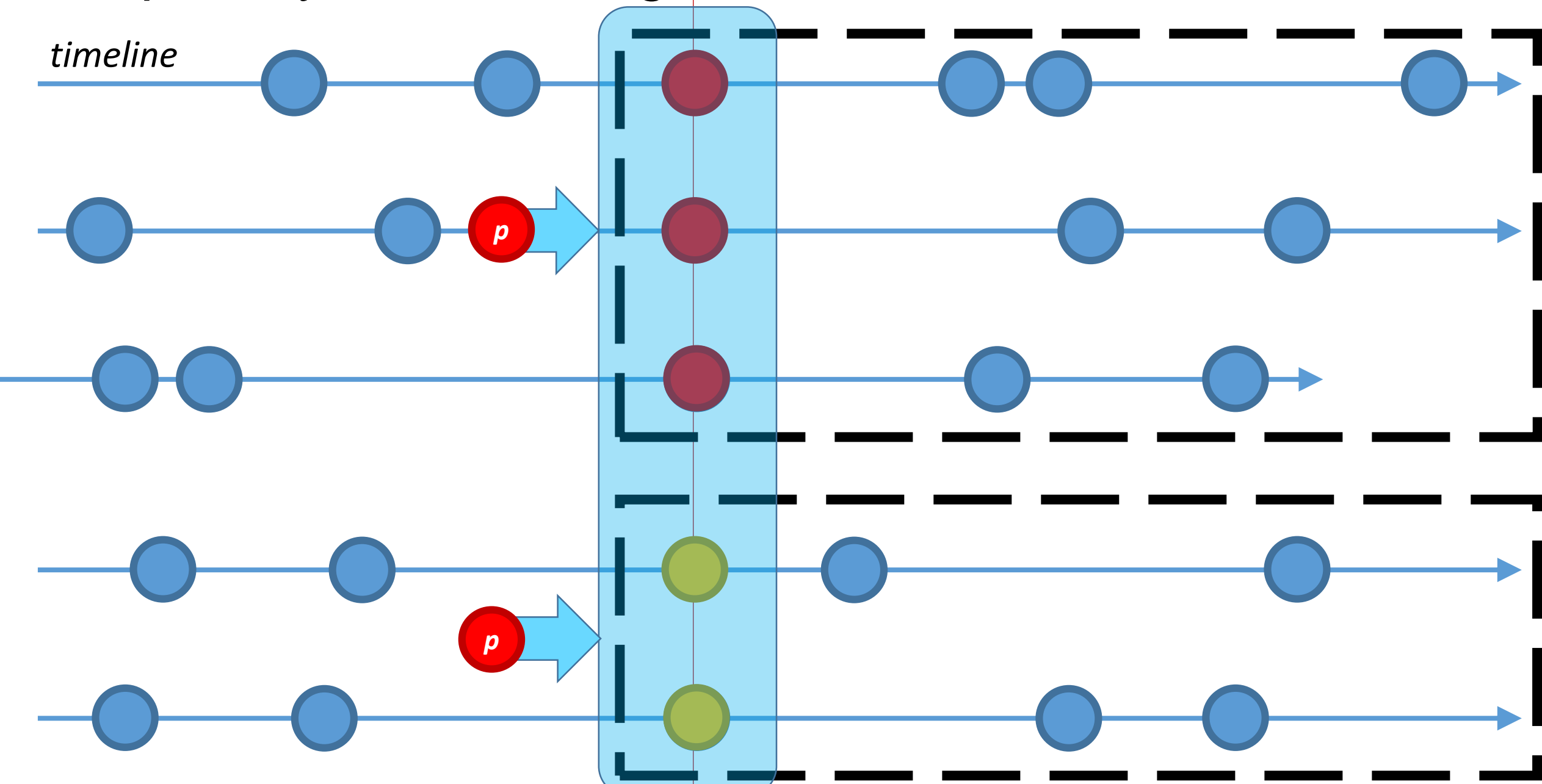
Pharmacy/Lorazapam, outcome:medication
Max. exp. tweets: 1.00

Pharmacy/Tramadol, outcome:pain
Max. exp. tweets: 1.61
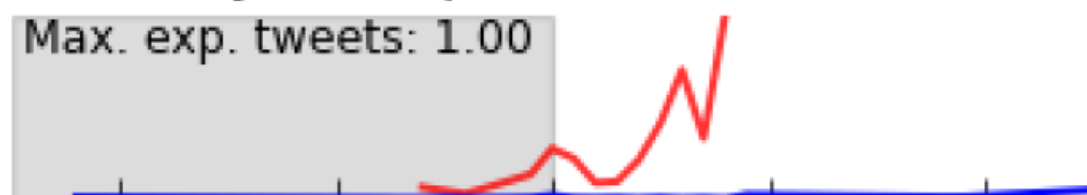
Pharmacy/Tramadol, outcome:painkiller
Max. exp. tweets: 0.12
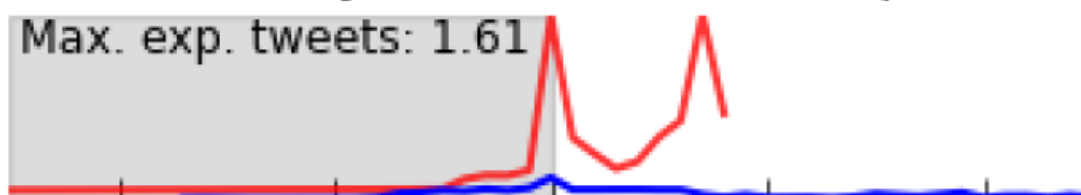
Pharmacy/Xanax, outcome:weed
Max. exp. tweets: 0.51

no. days before and after treatment
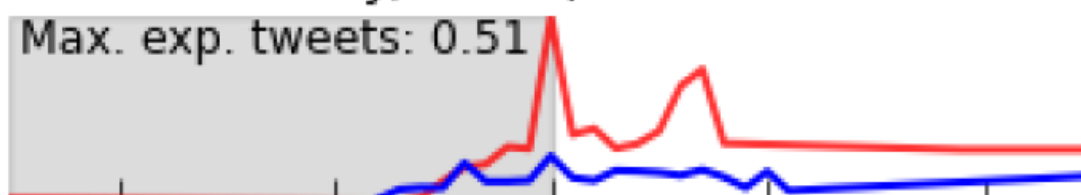
no. days before and after treatment

Opportunity: Major Life Changes

Understand, support through difficult life changes

Major illness
Loss
Death
Divorce
Birth

Example: Birth of child

Postpartum depression (PPD)

CDC: ~15%

50% cases unreported

De Choudhury, Counts, Horvitz. CSCW 2013, CHI 2013

Identifying Multiple Dimensions of a Life Change

Identify tweets about births: Twitter Firehose

2,929 new mother candidates

Gender classifier

10 tweets per candidate & profile

376 new mothers

Birth!

-3 months * **+ 3 months**

1st person pronoun
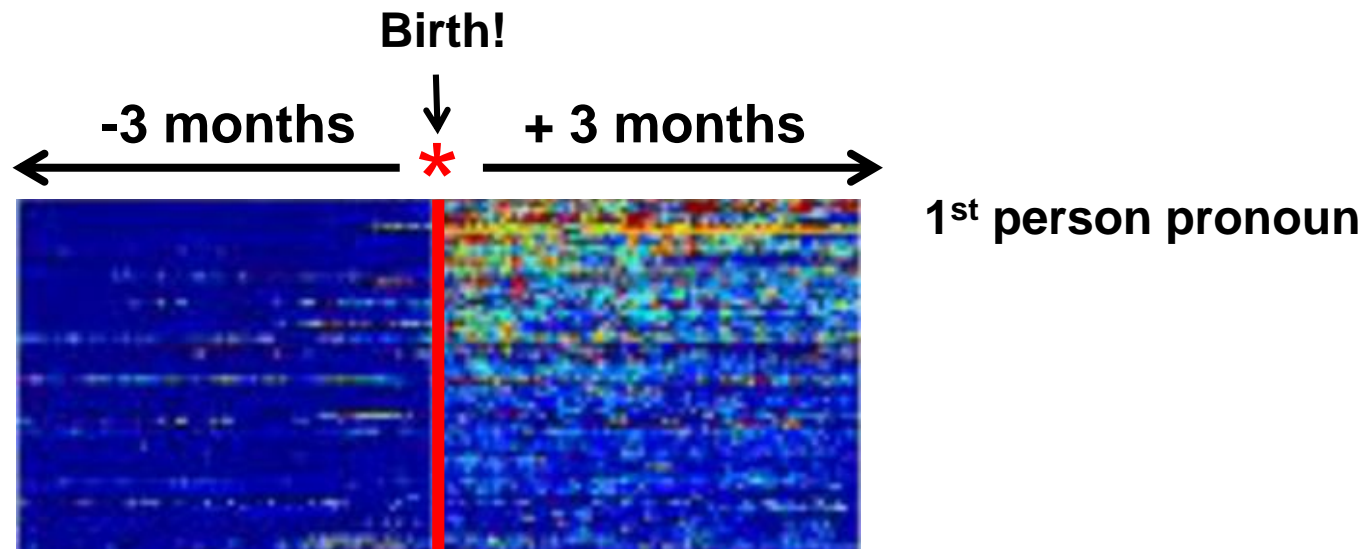
Structure & Dynamics of Engagement on Social Graph

Engagement.

Volume: mean normalized number of posts per day

Replies, retweets, questions, shared links

Ego network

#inlinks; #outlinks

De Choudhury, Counts, Horvitz. CSCW 2013, CHI 2013
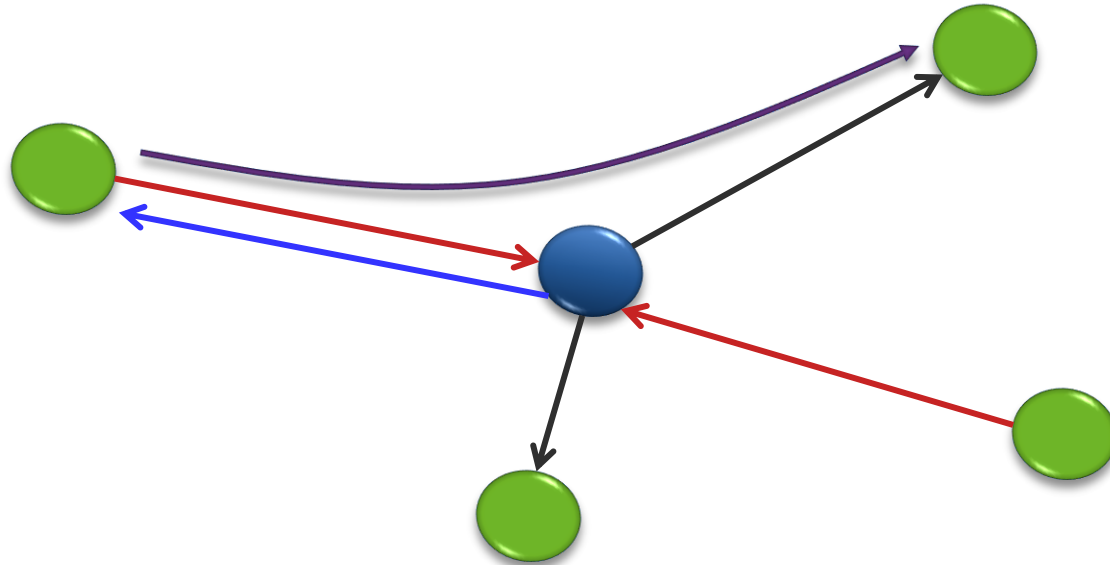
Linguistic Analysis

1) [high NA] Ugh, my daughter hates her bassinet. I hate disappointing her. What a miserable day.

2) [low activation] My baby is only catnapping during the day. That's so sad and depressing. I feel helpless

3) [low dominance] Anxiety/panic attacks need to eff off!!!!!!!!!!!!!! I'm trying to lead a somewhat normal life with my baby!!!! #frustrated #miserable

4) [high 1st person pronoun use] No lie I fuckin miss all socializing..... my daughter keeps me occupied and exhausted. I have all my moments of the day

De Choudhury, Counts, Horvitz. CSCW 2013, CHI 2013

Volume
PA
NA
Activation
Dominance
1st pronouns
3rd pronouns
2nd pronouns
Indefinite pronouns
Articles
Verbs
Aux-verbs
Adverbs
Tentative
Func. Words
Negation
Inhibition
Assent
Certainty
Conjunction
Preposition
Inclusive
Exclusive
Swear
Quantifier
Non-fluency
Filler

3º

1º
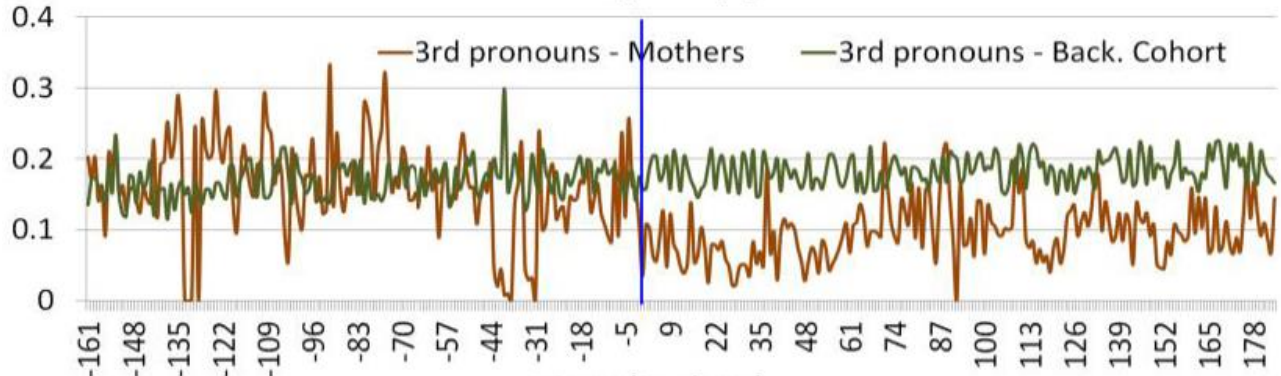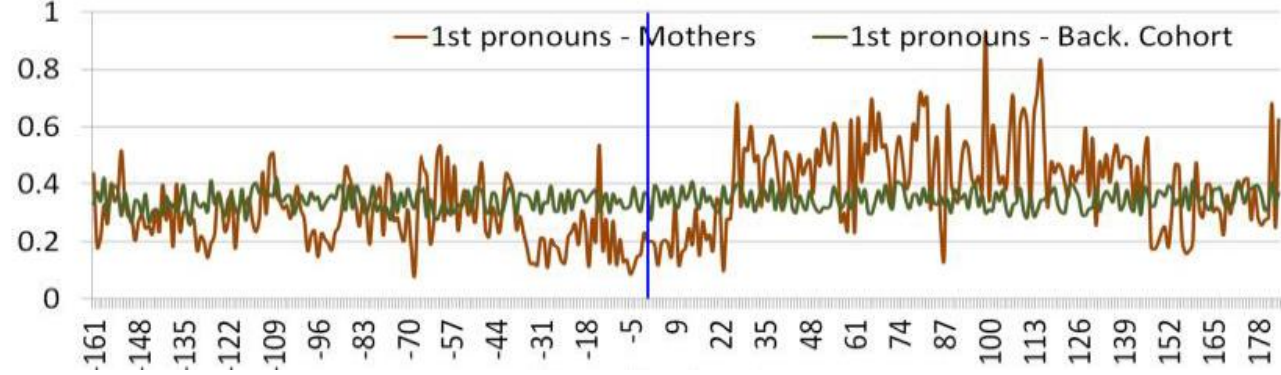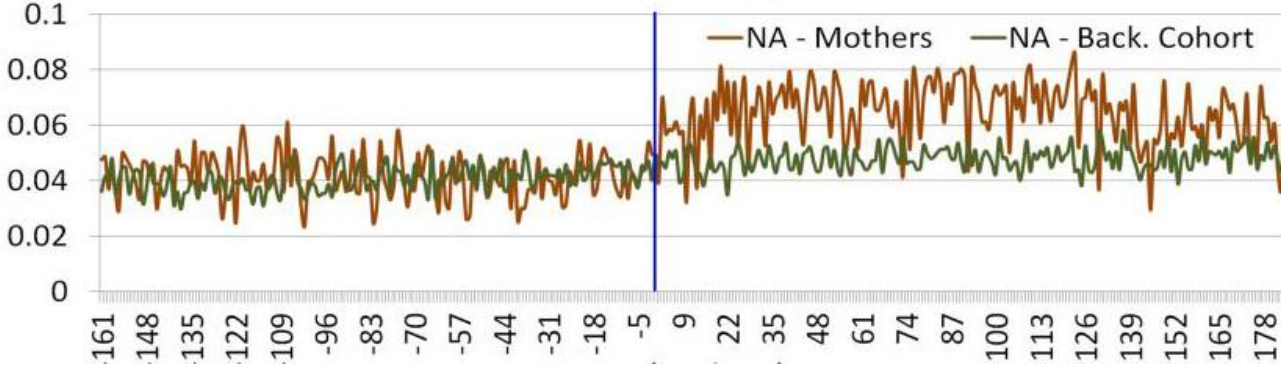
Neg. Affect

Patterns and Outcomes

~15% of new mothers: severe changes

- Activity level down,
- Language usage: 1st person up, 3rd person down,
- Negative affect up, positive affect down
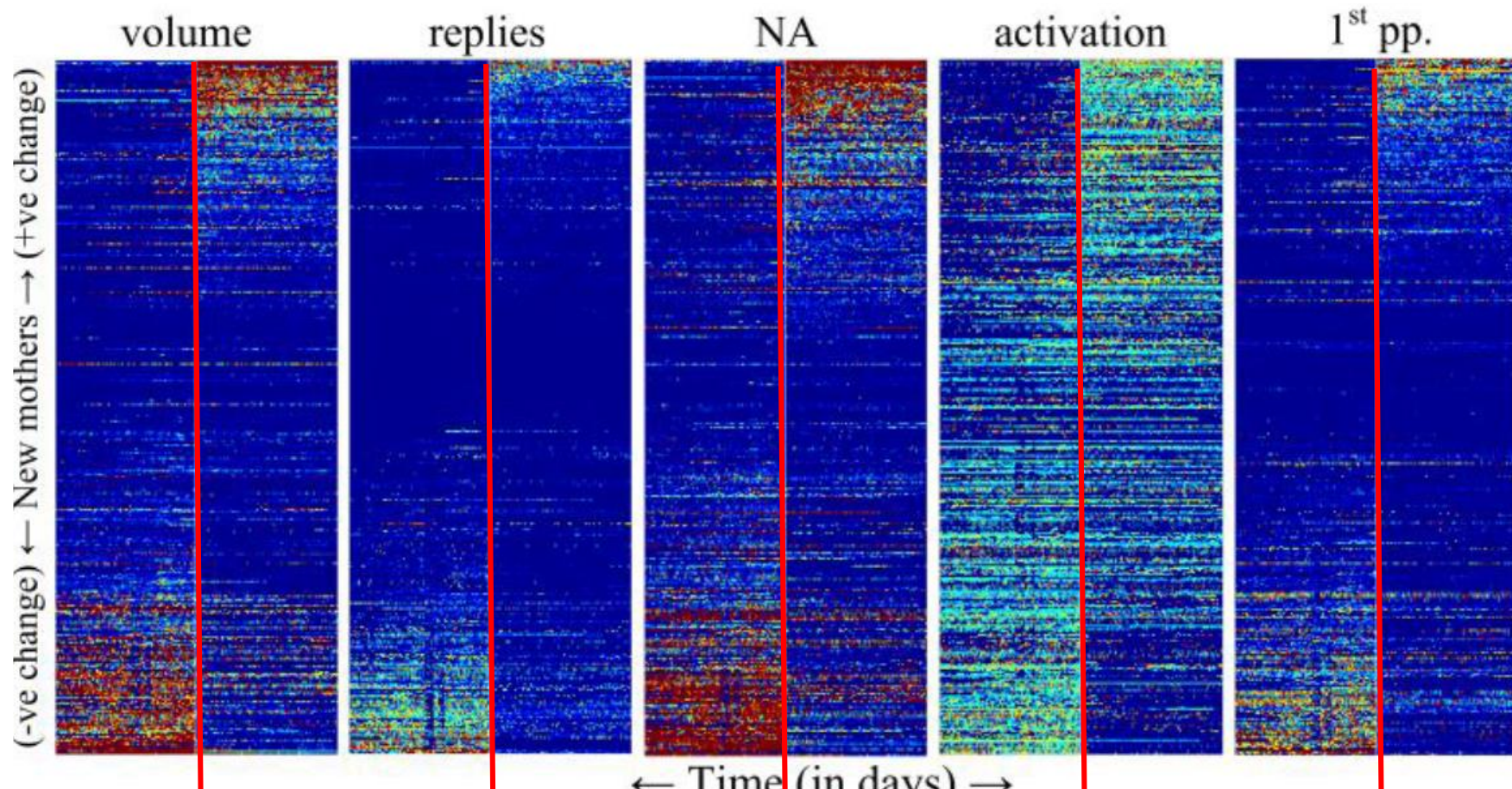
Predicting Postnatal Outcomes

Predicting postpartum changes with data drawn <u>before</u> birth.
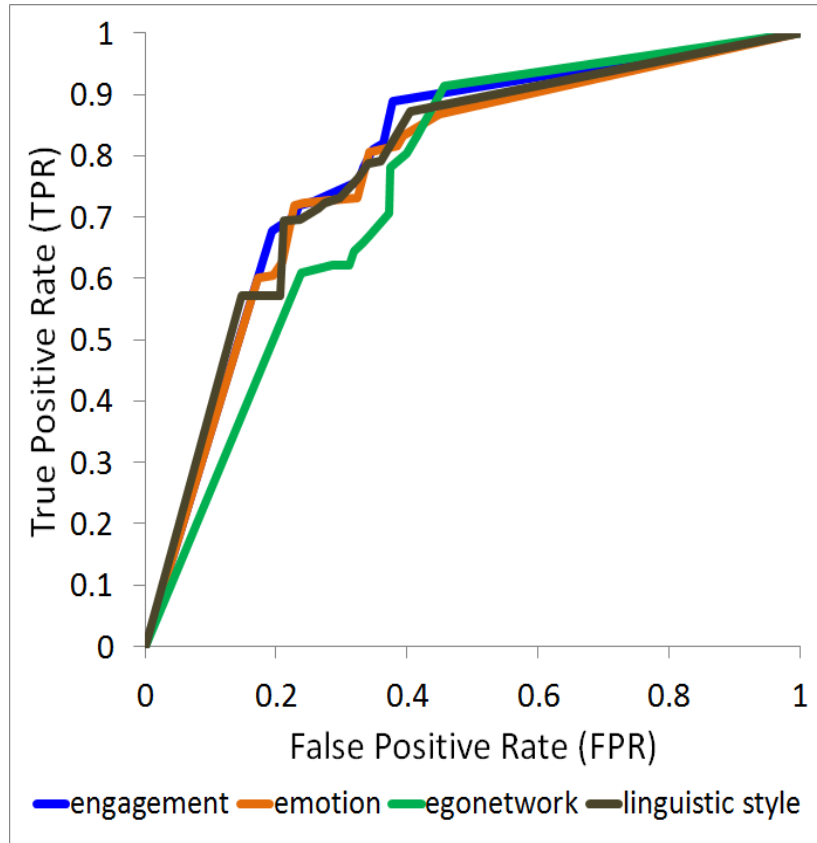
Prenatal evidence

Exciting family of results

Human subjects + online:

New mothers w/ FB timeline, Twitter

Major depressive episodes

De Choudhury, Gamon, Counts, Horvitz. ICWSM 2013

De Choudhury, Counts, Horvitz, Hoff. ICWSM 2014

Major Life Challenges: Major Illness

Grappling with diagnosis & treatment

Queries before & after inferred breast CA diagnoses
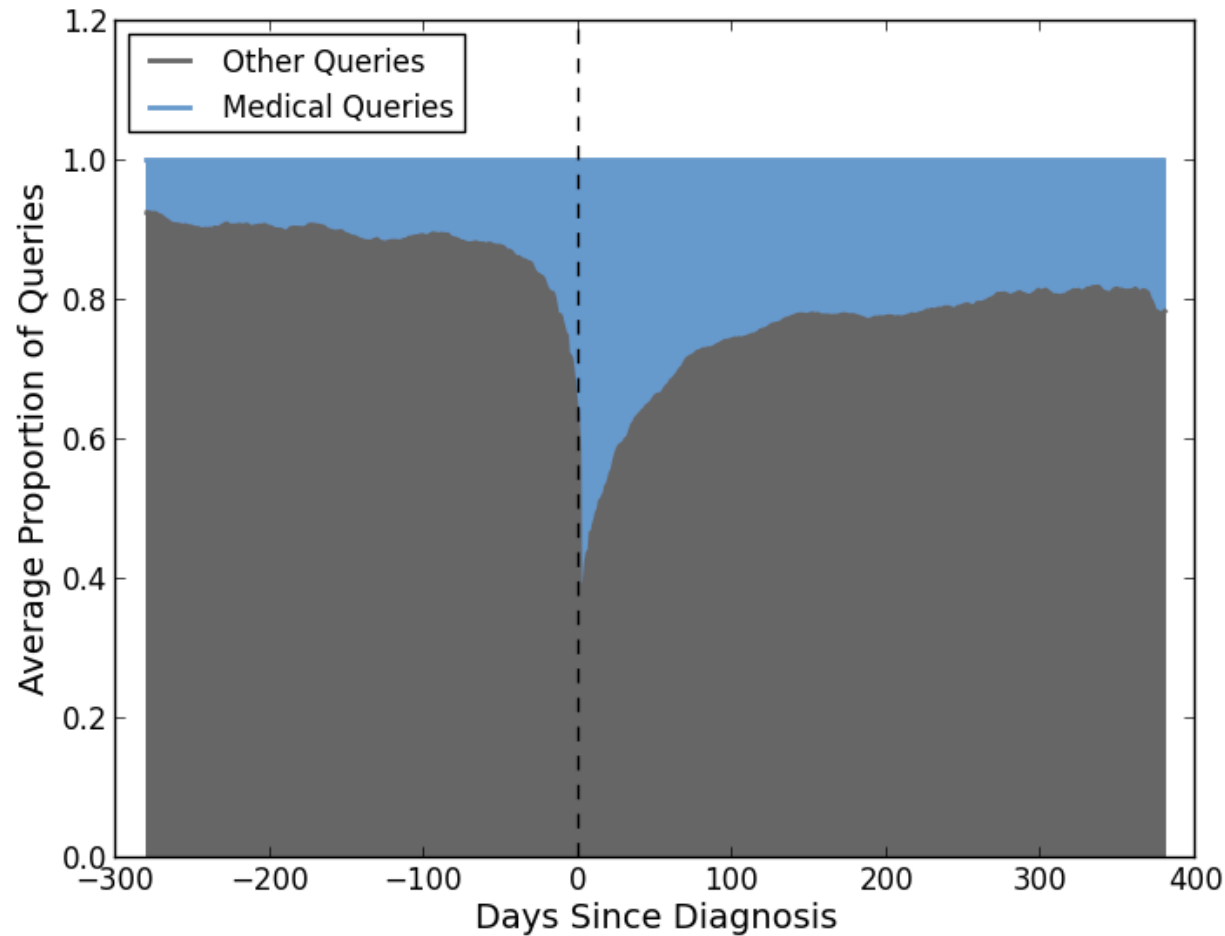
Proxy for understanding if, how, and when life may return to normal?

Paul, White, Horvitz, TWEB 2016

Paul, White, Horvitz, WWW 2015

Major Life Challenges: Grieving

THE STANDARD EDITION
OF THE COMPLETE PSYCHOLOGICAL WORKS OF

SIGMUND FREUD

Translated from the German under the General Editorship of

JAMES STRACHEY

In Collaboration with

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Assisted by

ALIX STRACHEY and ALAN TYSON

VOLUME XIV

(1914–1916)

On the History of the Psycho-Analytic
Movement

Papers on Metapsychology

and

Other Works

MOURNING AND MELANCHOLIA

DREAMS having served us as the prototype in normal life of narcissistic mental disorders, we will now try to throw some light on the nature of melancholia by comparing it with the normal affect of mourning.[1] This time, however, we must begin by making an admission, as a warning against any over-estimation of the value of our conclusions. Melancholia, whose definition fluctuates even in descriptive psychiatry, takes on various clinical forms the grouping together of which into a single unity does not seem to be established with certainty; and some of these forms suggest somatic rather than psychogenic affections. Our material, apart from such impressions as are open to every observer, is limited to a small number of cases whose psychogenic nature was indisputable. We shall, therefore, from the outset drop all claim to general validity for our conclusions, and we shall console ourselves by reflecting that, with the means of investigation at our disposal to-day, we could hardly discover anything that was not typical, if not of a whole class of disorders, at least of a small group of them.

The correlation of melancholia and mourning seems justified by the general picture of the two conditions.[2] Moreover, the exciting causes due to environmental influences are, so far as we can discern them at all, the same for both conditions. Mourning is regularly the reaction to the loss of a loved person, or to the loss of some abstraction which has taken the place of one, such as one's country, liberty, an ideal, and so on. In some people the same influences produce melancholia instead of mourning and we consequently suspect them of a pathological disposition. It is also well worth notice that, although mourning involves grave departures from the normal attitude to life, it never occurs to us to regard it as a pathological condition and to

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In reality, however, this presentation is made up of innumerable single impressions (or unconscious traces of them) , and this withdrawal of libido is not a process that can be accomplished in a moment, but most certainly, as in mourning, be one in which progress is long-drawn-out and gradual.

Opportunity: Assist with Complicated Grief

CLINICAL PRACTICE

Caren G. Solomon, M.D., M.P.H., *Editor*

Complicated Grief

M. Katherine Shear, M.D.

Unusually severe & prolonged grieving that impairs function

2 to 3% of population worldwide

Death: Child or life partner, sudden violent death

High rates of suicidal ideation, risk-taking

Value of psychotherapy

Opportunity: Assist with Complicated Grief

Table 3. Core Components of Treatment for Complicated Grief.

Component	Description	Evidence from Randomized, Controlled Trials
Establishing lay of the land	Discussion of the nature of loss, grief, and adaptation to loss; description of complications of grief and their effects; description of the treatment and rationale for procedures in the treatment	Shear et al.,[30] Shear et al.,[35] Boelen et al.,[36] Acierno et al.,[37] Rosner et al.,[38] Bryant et al.,[39] Kersting et al.,[40] Litz et al.,[41] Wagner et al.,[42] Papa et al.,[43] Shear et al.[44]
Promoting self-regulation	Self-monitoring, self-observation, and reflection; re-appraisal of troubling thoughts and beliefs; extending compassion to oneself; "dosing" emotional pain by confronting it and setting it aside	Shear et al.,[30] Shear et al.,[35] Boelen et al.,[36] Rosner et al.,[38] Bryant et al.,[39] Kersting et al.,[40] Litz et al.,[41] Wagner et al.,[42] Rosner et al.[45]
Building connections	Strategies for meaningful connections with others; sharing pain and letting others help	Shear et al.,[30] Shear et al.,[35] Rosner et al.,[38] Kersting et al.,[40] Wagner et al.,[42] Rosner et al.[45]
Setting aspirational goals	Exploring ambition for personal goals and activities that engender eagerness and hope; generating enthusiasm and other positive emotions in ongoing life; creating sense of purpose and possibilities for future happiness	Shear et al.,[30] Shear et al.,[35] Acierno et al.,[37] Bryant et al.,[39] Litz et al.,[41] Papa et al.[43]
Revisiting the world	Strategies for confronting or revisiting avoided situations	Shear et al.,[30] Shear et al.,[35] Boelen et al.,[36] Acierno et al.,[37] Rosner et al.,[38] Bryant et al.,[39] Kersting et al.,[40] Rosner et al.[45]
Storytelling	Recounting and reflecting on the story of the death in order to create an acceptable account; practice in confronting pain and setting it aside	Shear et al.,[30] Shear et al.,[35] Boelen et al.,[36] Rosner et al.,[38] Bryant et al.,[39] Wagner et al.,[42] Rosner et al.[45]
Using memory	Reviewing positive memories of the deceased and inviting reminiscence of negative memories; describing an imagined conversation with the deceased	Shear et al.,[30] Shear et al.,[35] Rosner et al.,[38] Bryant et al.,[39] Wagner et al.,[42] Rosner et al.[45]

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Storytelling	Recounting and reflecting on the st... order to create an acceptable ac... confronting pain and setting it a...
Using memory	Reviewing positive memories of the... ing reminiscence of negative m... an imagined conversation with the deceased

AREAS OF UNCERTAINTY

Data are lacking on risk factors for complicated grief, its frequency among bereaved persons in various age groups, and its natural history. Consensus is needed regarding diagnostic criteria. Data are also lacking on associated sleep disturbance and its treatment, as are data from randomized, double-blind trials evaluating the effects of antidepressants and other medications (e.g., oxytocin) on patients with complicated grief. A multicenter trial (ClinicalTrials.gov number, NCT01179568) is under way to assess the efficacy of antidepressant medication alone or in combination with therapy for complicated grief.

On Sensitivity, Ethics, Disclosure

Seeking Insights About Cycling Mood Disorders via Anonymized Search Logs

Elad Yom-Tov[1], PhD; Ryen W White[2], PhD; Eric Horvitz[2], MD, PhD

[1]Microsoft Research, Herzeliya, Israel

[2]Microsoft Research, Redmond, WA, United States

On Sensitivity, Ethics, Disclosure

d Disorders via