Tutorial outline

- **Core sentiment analysis (SA) methods**
  - **Simple:** using lexica (dictionaries)
  - **Aspect-based:** using information extraction
- **Machine learning for SA**
  - Unsupervised: open language SA (LDA)
  - Supervised: regression and deep learning
- **SA extensions**
  - Generalized sentiment: person and community
  - Multilingual, multimedia

Generalized sentiment: emotion, personality, and subjective well-being

Johannes Eichstaedt, Peggy Kern, Marty Seligman, Andy Schwartz

Lyle Ungar

Communication is more than facts

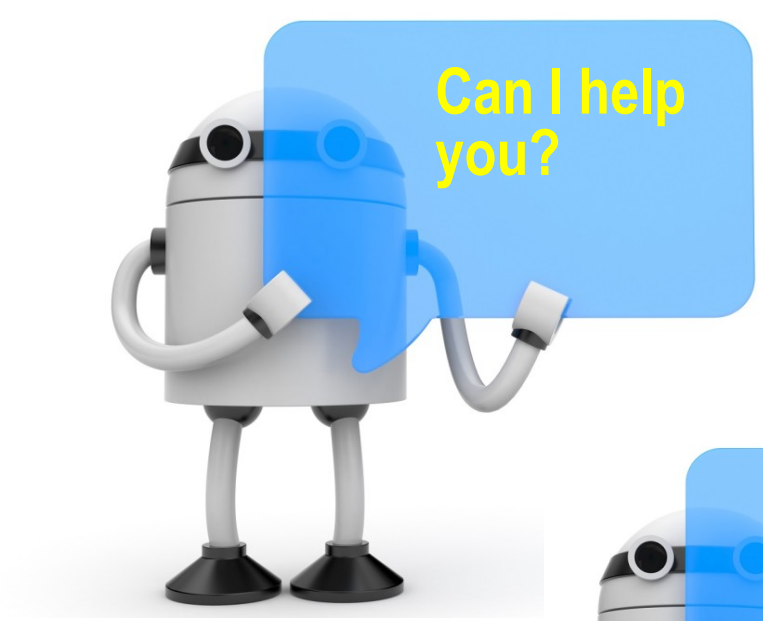


Photo credit: https://onlinelearninginsights.wordpress.com/2016/06/07/need-to-know-news-chatbots-the-new-online-teaching-assistant-and-credit-worthy-moocs-go-global/

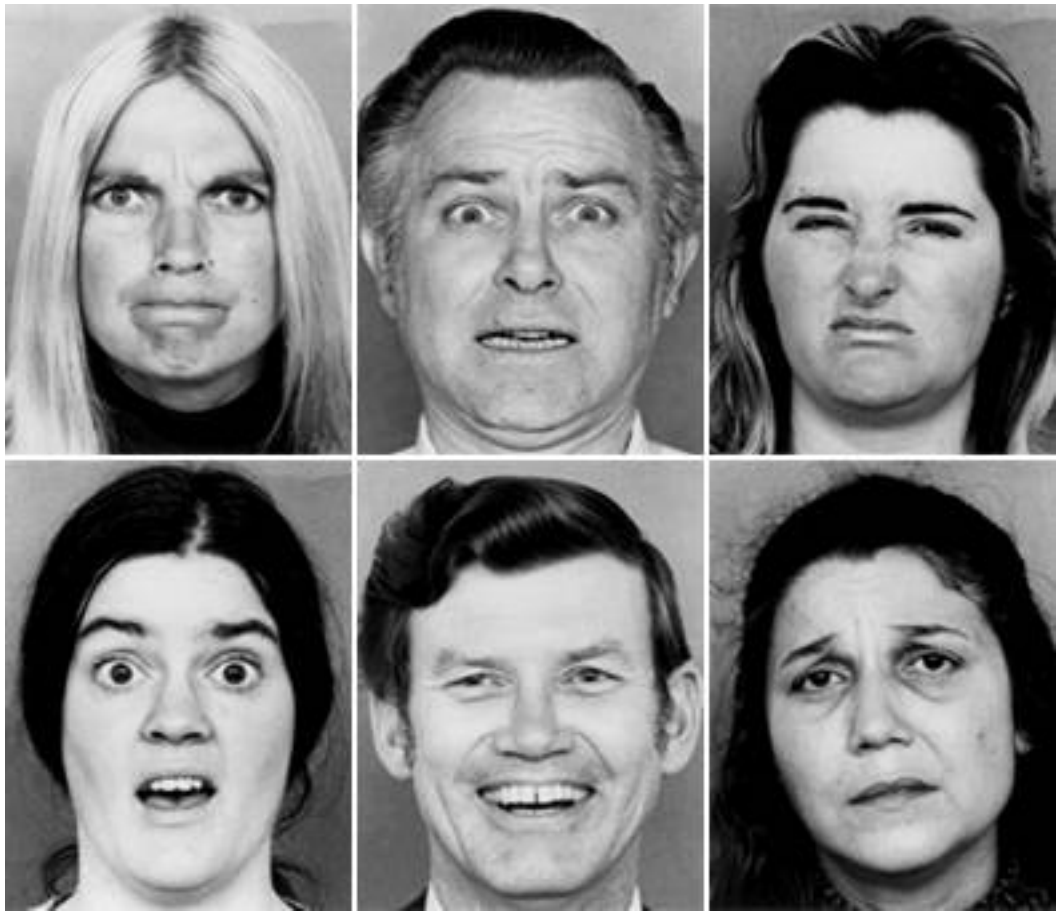
Sentiment beyond like/dislike

- **What people feel**
  - Emotion
  - Stress
  - Empathy
- **Who people are**
  - Personality
- **What communities think and feel**

States

Traits

Emotion



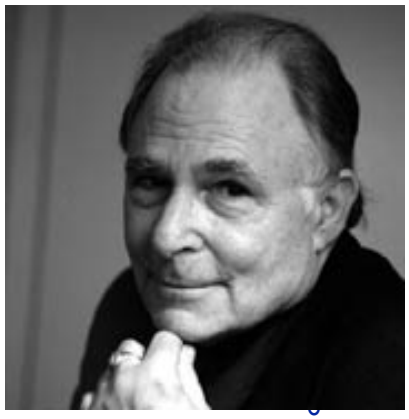
- anger,
- fear,
- disgust,
- happiness,
- sadness,
- surprise

http://www.cio.com/article/5 facial-expressions-test

Other universal emotions

- Amusement
- Contempt
- Contentment
- Embarrassment
- Excitement
- Guilt
- Pride in achievement
- Relief
- Satisfaction
- Sensory pleasure
- Shame

Paul Ekman



Use hashtags as labels

- "distant supervision"

1. *Feeling left out... #sadness*
2. *My amazing memory saves the day again! #joy*
3. *Some jerk stole my photo on tumblr. #anger*
4. *Mika used my photo on tumblr. #anger*
5. *School is very boring today :/ #joy*
6. *to me.... YOU are ur only #fear*

Using Hashtags to Capture Fine Emotion Categories from Tweets

Personality – 5 Factor Model

- **extroversion vs. introversion**
  - sociable, assertive vs. aloof, shy
- **neuroticism vs. emotional stability**
  - insecure, anxious vs. calm, unemotional
- **agreeableness (high vs. low)**
  - friendly, cooperative vs. antagonistic, fault-finding
- **conscientiousness (high vs. low)**
  - self-disciplined, organized vs. inefficient, careless
- **openness to experience vs. conventionality**
  - intellectual, insightful vs. shallow, unimaginative

Emotion correlates with personality

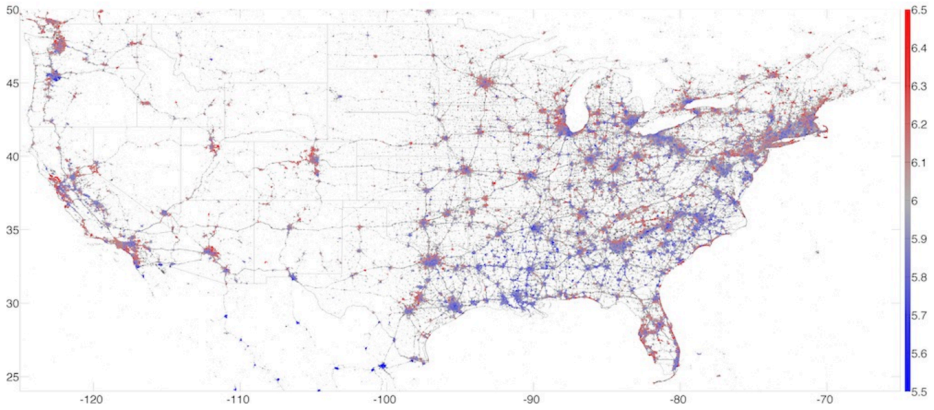
EXT	NEU	AGR	CON	OPN
#unimportant	#happiness	#like	#calm	#tranquil
#attached	#bugged	#crushed	#considerate	#lust
#destroyed	#alert	#mixed	#mean	#love
#detached	#irate	#delighted	#cowardly	#appreciative
#awful	#cold	#happiness	#bewildered	#peaceful
#lust	#anxious	#hopeful	#shunned	#jealousy
#comfortable	#weak	#blushing	#exposed	#innerpeace
#burned	#shame	#jealousy	#imperfect	#thoughtful
#troubled	#sexy	#grateful	#judged	#touched
#jumpy	#desire	#spirited	#pity	#careful

As do words, images, Facebook likes ⋯

Or get people to label words

- **Linguistic Inquiry and Word Count (LIWC)**
  - POSEMO, NEGEMO ….
- **WordNet Affect**
- **NRC Emotion Lexicon**

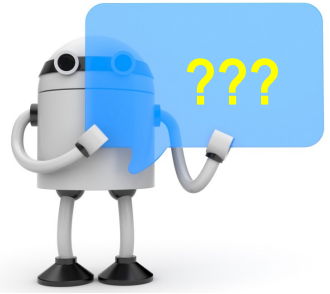
Dodds hedonometer



Like most SA, a different use of NLP

Historically:

- ***what* people say**
  - Information extraction, question answering, …



Today:

- ***how* people say it**
  - Language variation with gender, age, personality, education, mood, health, stress, optimism, empathy, depression, satisfaction with life

Closed vs. Open Language

- Closed: use a lexicon
- Open: use words, LDA topics

Person-level models require different data collection

- **Not just using people to generate labels**
- **But learning about people**
  - People share their social media and
    - take questionnaires
    - or share their medical record
    - or shopping history, …

LIWC happiness lexicon

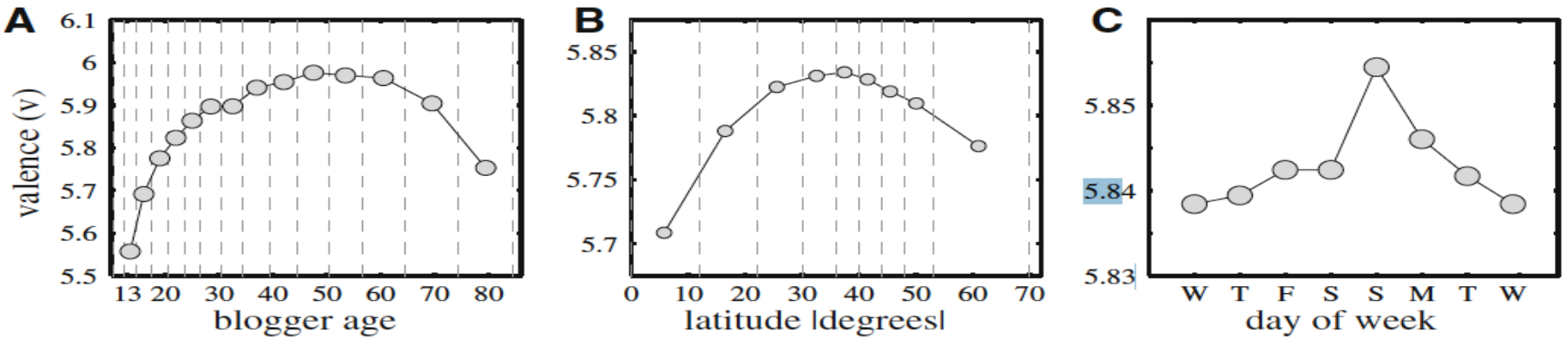
- accept
- accepta*
- accepts
- advantag*
- agreeing
- ….
- happy
- …
- merry
- ….

- heartfelt
- heaven*
- heh*
- helper*
- helps
- hilarious
- hoho*
- honest*
- honour*
- hoped
- hopefully
- hopes

- terrific*
- thank
- thanked
- thanks
- toleran*
- treasur*
- treat
- trueness
- truer
- truest
- truly
- trust*
- values
- valuing

Pennebaker

Blogger Happiness

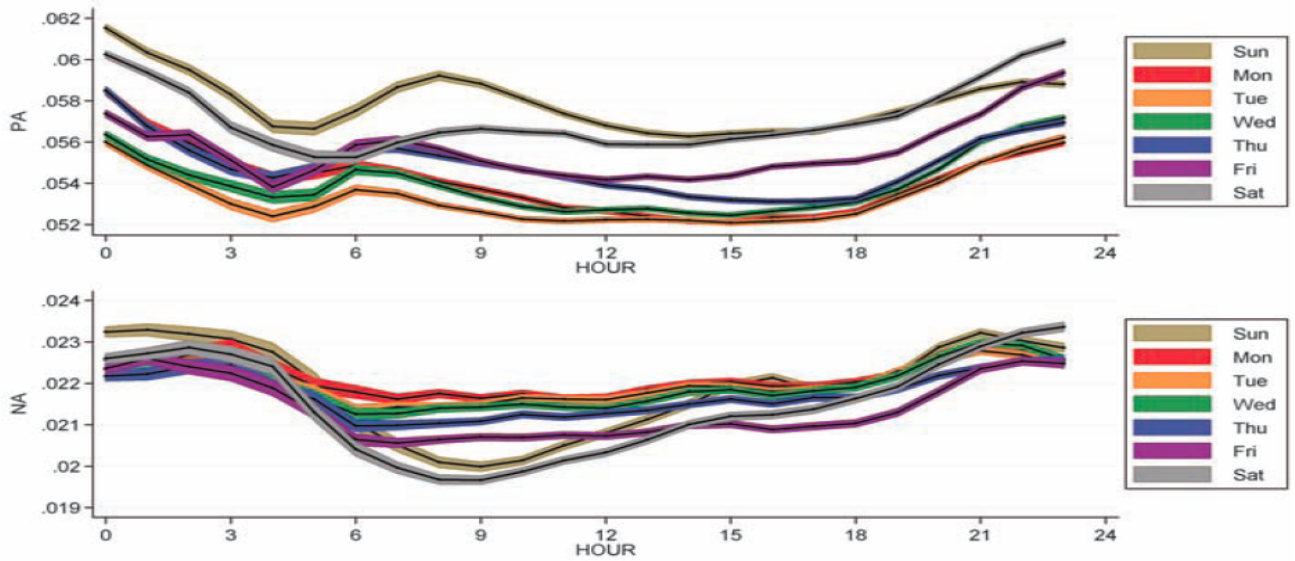


Measuring the Happiness of Large-Scale Written Expression: Songs, Blogs, and Presidents
Dodds and Danforth 2010

Twitter Happiness

Positive Affect

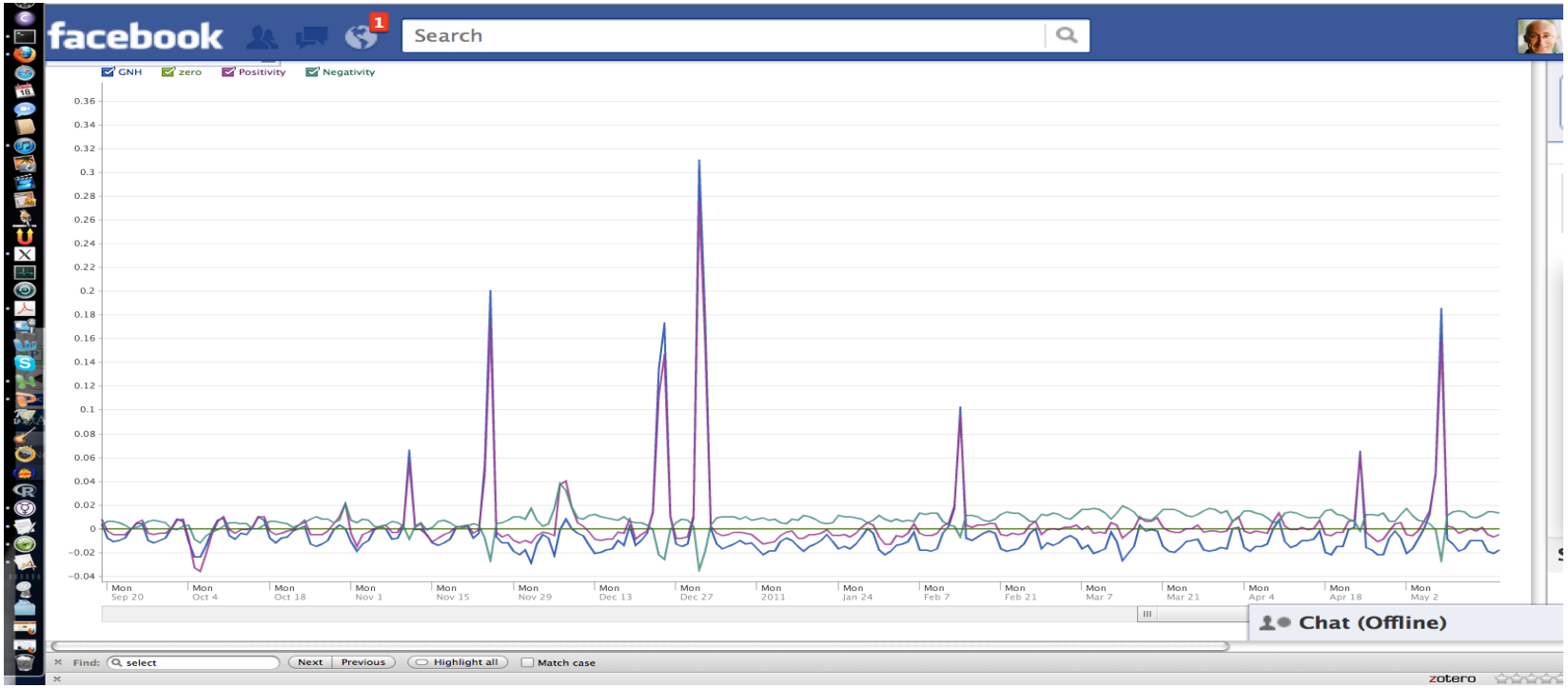
Negative Affect



Hour of day

Diurnal and Seasonal Mood Vary with Work, Sleep, and Daylength Across Diverse Cultures
Golder* and Macy (2011)

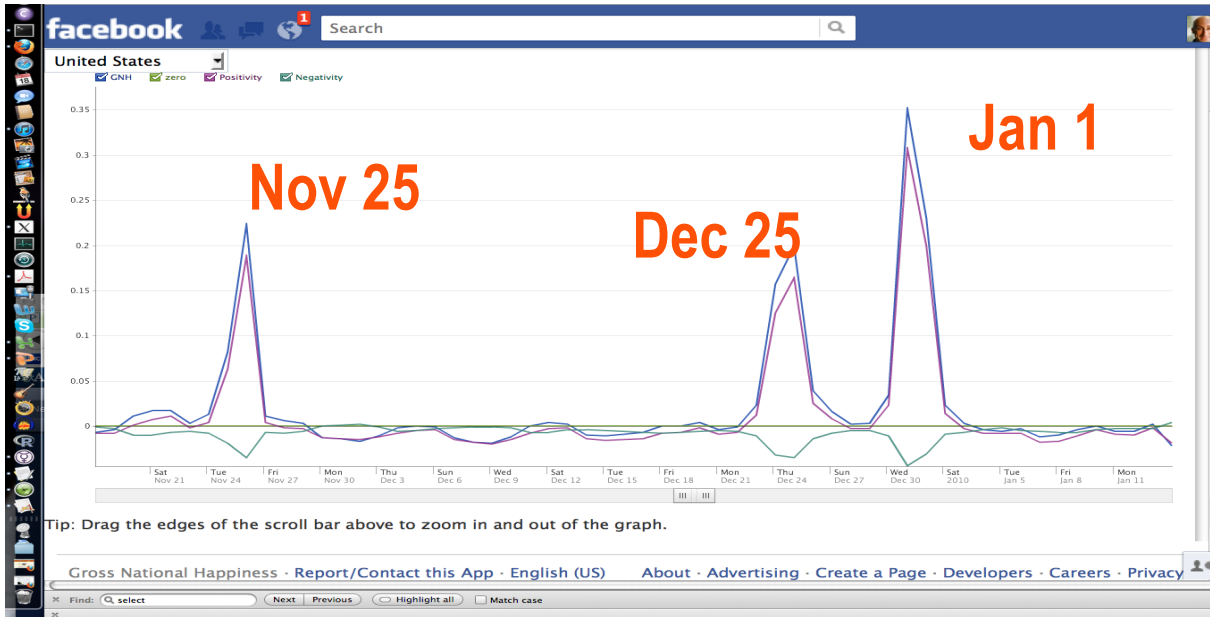
Facebook Gross National Happiness



Kramer, A. D. I. (2010). An unobtrusive model of "gross national happiness." Proc. CHI, 2010, ACM Press, 287-290.

Facebook Gross National Happiness

What are they measuring?



Kramer, A. D. I. (2010). An unobtrusive model of "gross national happiness." Proc. CHI, 2010, ACM Press, 287-290.

Be careful about ambiguity

- *Happy* birthday
- *Merry* Christmas
- Michael Jackson is *dead*
- *Great* Britain
- Legal *tender*

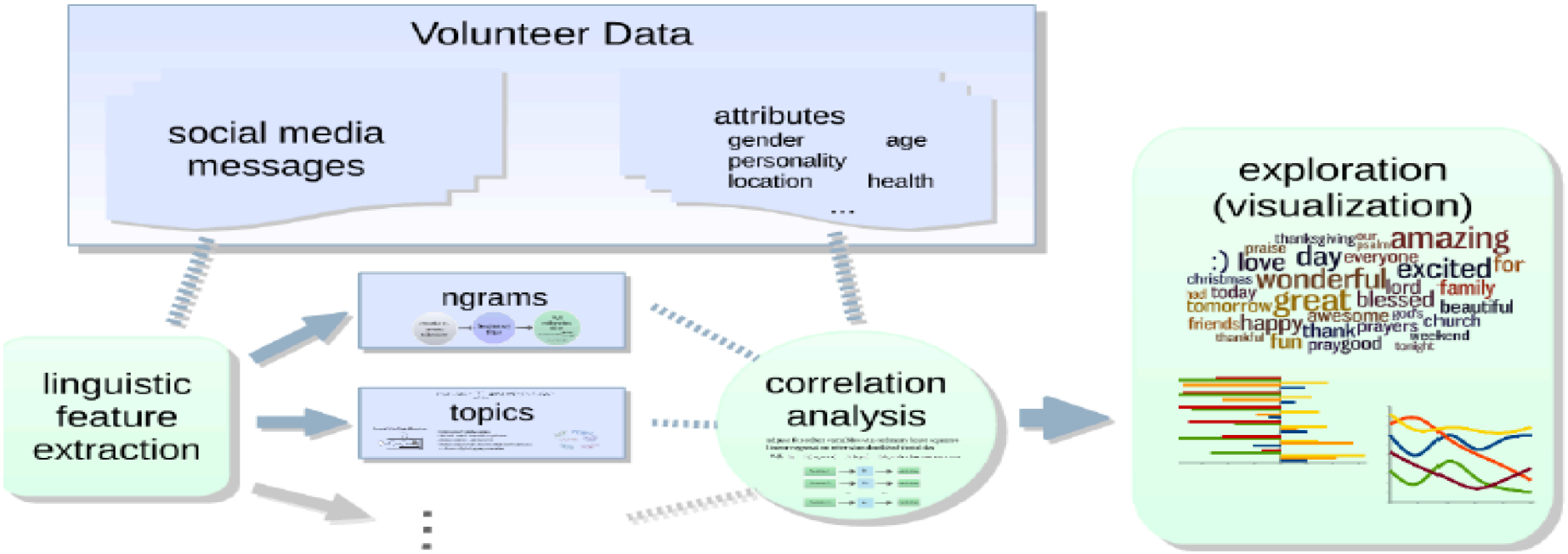
Lexicon-based results can be flawed

Open-vocabulary personality estimation from Facebook

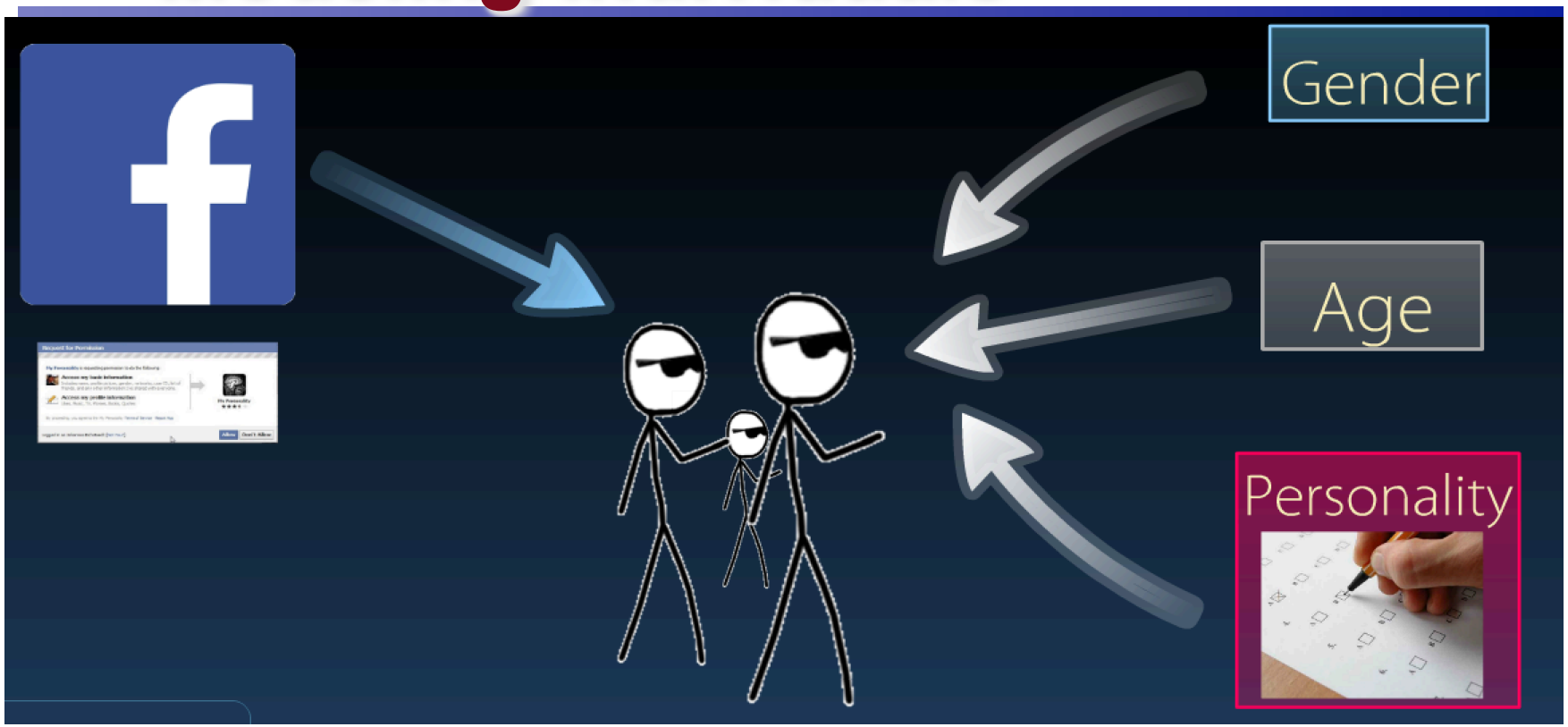
- **Use Facebook posts, demographics and personality tests from 70,000 people**
  - To find words that most correlate with sex, age, IQ, happiness, personality

wwbp.org

Open Vocabulary Analysis Method



Modeling Individuals



N=70,000

Females


ugh
:d <3
so glad
thankful
love them
am so
tummy
husband
baby
love you guys
cookies
loving
much fun
lots
with my
sooooo
so tired
cry
loved
hubby
girl
dresssherself
cleaning
having a
her first
mom
chocolate
boyfriend
yay !
my little
love him
yummy
smile
? ?
sick
cake
super excited
my family
<3
my hair
love :)
you
i'm so
laugh
to see my
;)
aunt
dinner
sad
babysitting
wonderful
:(
shopping
like it on
girls
she's
so much
soo
birthday
so happy
yum
excited
cute
bestie
make me
bed
mommy
baking
sister
such a
can't wait
loves her
my heart
her
sooo
she
wishes
she
daddy
time with
princess
beautiful
soooo
i miss
proud of
omg
babies
blessed
her new
best friend
lovely
daughter
adorable
go away
gosh
christmas
thank you
nails
relative frequency
correlation strength

Males


dick
halo
fifa
nuclear
her new
adorable
lebron
destroyed
of death
players
wins
windows 7
feature
his phone
team
war
beard
fuck yeah
brazil
victory
creed
gaming
champions
engineering
ps3
http :/
god damn
hit me up
beer
call of duty
political
his life
nahi
legend
shaved
championship
fuck
youtube
bastard
bass
ftw
government
world cup
album
loves his
player
chuck norris
speed
playoffs
win
wishes
nfl
1-0
he
xbox
holy shit
cod
fuckin
weapons
pc
fucking
black ops
league
fans
software
teams
espn
master
nba
united
modern warfare
my wife
my girlfriend
match
// www
beat
nation
shit
himself
360
vs
2-0
epic
thinks he
his mind
fucked
metal
arsenal
president
shave
legendary
politics
hell
gun
system
germany
sword
religion
cock
his own
india

Females


super sooooo
flippin uber tonight
soooo overly excited
soooooo
tomorrow ridiculously
sooo satisfying yay
excitement
hun
love ;D
girlies
^.^ <3 inlove
sweetie mucho
sweetheart
^_^
—
i'm_so
her_new
best_friend chocolate her she
with_my shopping ugh <3 sister
proud_of
mom birthday
my_hair can't_wait
loves_her wonderful
am_so
so_happy lovely excited baby
soo
hubby boyfriend love:)you much_fun
dress
soooyay_!:(cute
supportive loving
herself so_much i_miss mommy girls
wonderful
cleaning wishes_she yummy like_it_on
amazing
family husband
helped
friends thankful
truely boyfriend
blessed daughter
grateful lucky
soooo love_him my_family
omg husband loved sooooo
bestie :) hacked ar par
bestfriend
ily boyfriend =]
bf
babe besties xoxo
xo <3
cute baby
sweet
sooo adorable
hes cutest babies
soooo puppy he's
lil aww awww
soo
turns nephew
happy celebrate years
st birthday
wonderful wishing
brother daughter special
sister niece son

Males


nfl season
football baseball fantasy
sports play league player
playing
team game basketball
players coach
state
government
power country
freedom thomas
nation america political
human
rights civil democracy
liberty society
vs
engineering
call_of_duty
match his_life
win cod league nfl
hit_me_up
team
creed
xbox himself fucking
http:/ world_cup
youtube.com president
loves_his ps3
metal
my_girlfriend
black_ops shit
fans my_wife fuckin
war
dick fifa teams
championship
fuck
modern_warfare
album
government
shave
arsenal
fucked
wins
wishes_he
nba
halo
ftw holy_shit
lebron
thinks_he his_mind
360
beard
fucking
fuckers
haters sake fuck
shut bullshit fucks
bitches
outta shit
fight win fightin
won battles
defeat war battle
enemy sword
bands defeated
fought victory
online
gaming playing
fifa pc cod
live game
wii xbox playin
play ps tag
add
economy
pay public tax state cuts
country income taxes
debt government
obama budget health
benefits

Gender

Accuracy:
92%

Extraversion

Intraversion

Neurotic words

Well-adjusted (non-neurotic) words

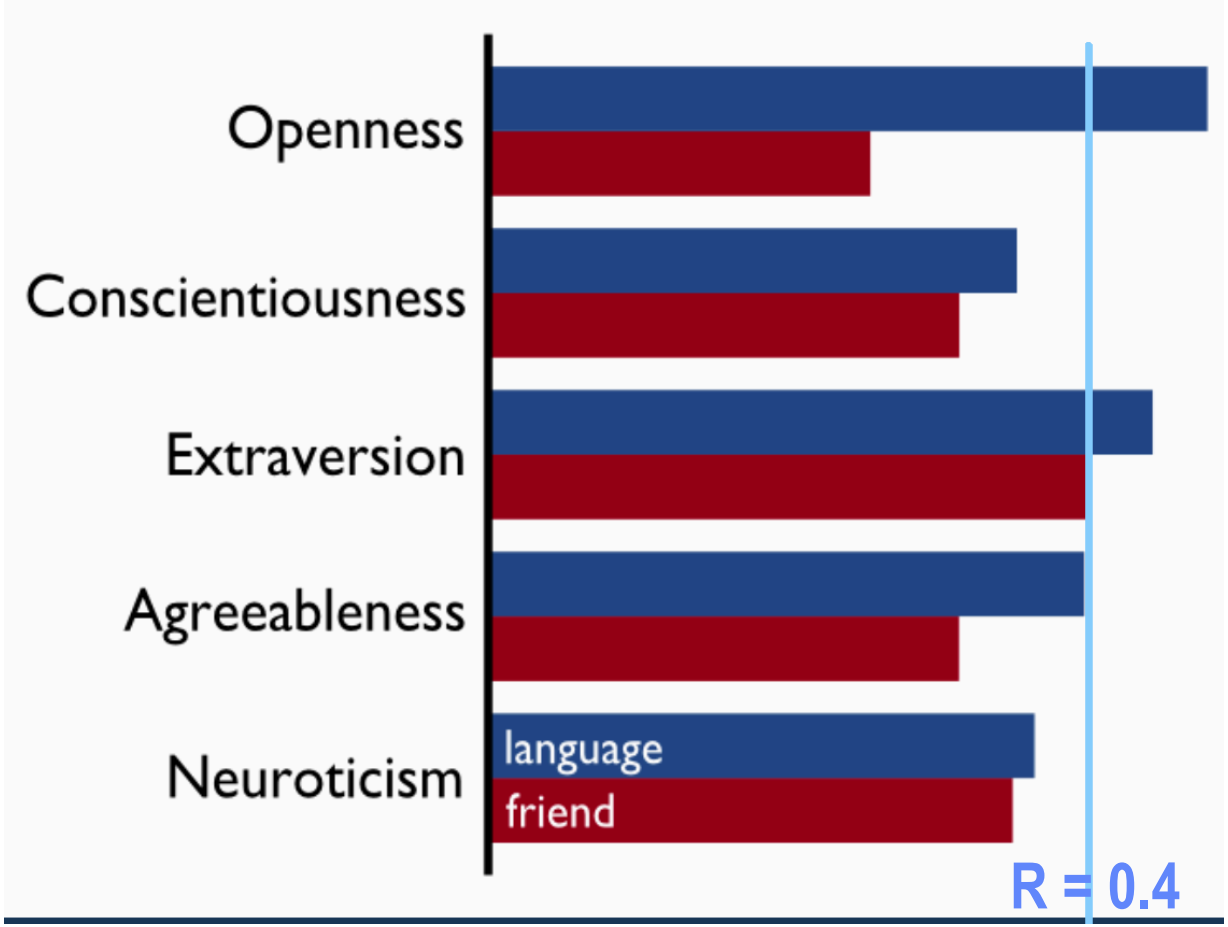

vacation
relaxing
excited
to work
finals
success
day off
forward
weekend
great day
workout
thanksgiving
busy
ready for
blessings
long day
work tomorrow
beautiful day
thankful
the gym
blessed
a blast
time with
prayers
semester
enjoying
dinner with
wonderful
studying for
headed to
done with
training
wait to
relax
graduation
Conscientiousness
omfg
dead
i hate
wtf
internet
shit
o.o
:d
goddamn
songs
stupid
xp
gay
dx
youtube
cat
fucked
fuck
emo
pokemon
random
facebook
ftw
meh
bitch
anime
penis
i'd
www
fucking
xd
bored
watch
zombie
dick
3
die
manga
bieber
dammit
msn
bloody
computer
<3
o_o
http
kill
weird

Language vs. Friends

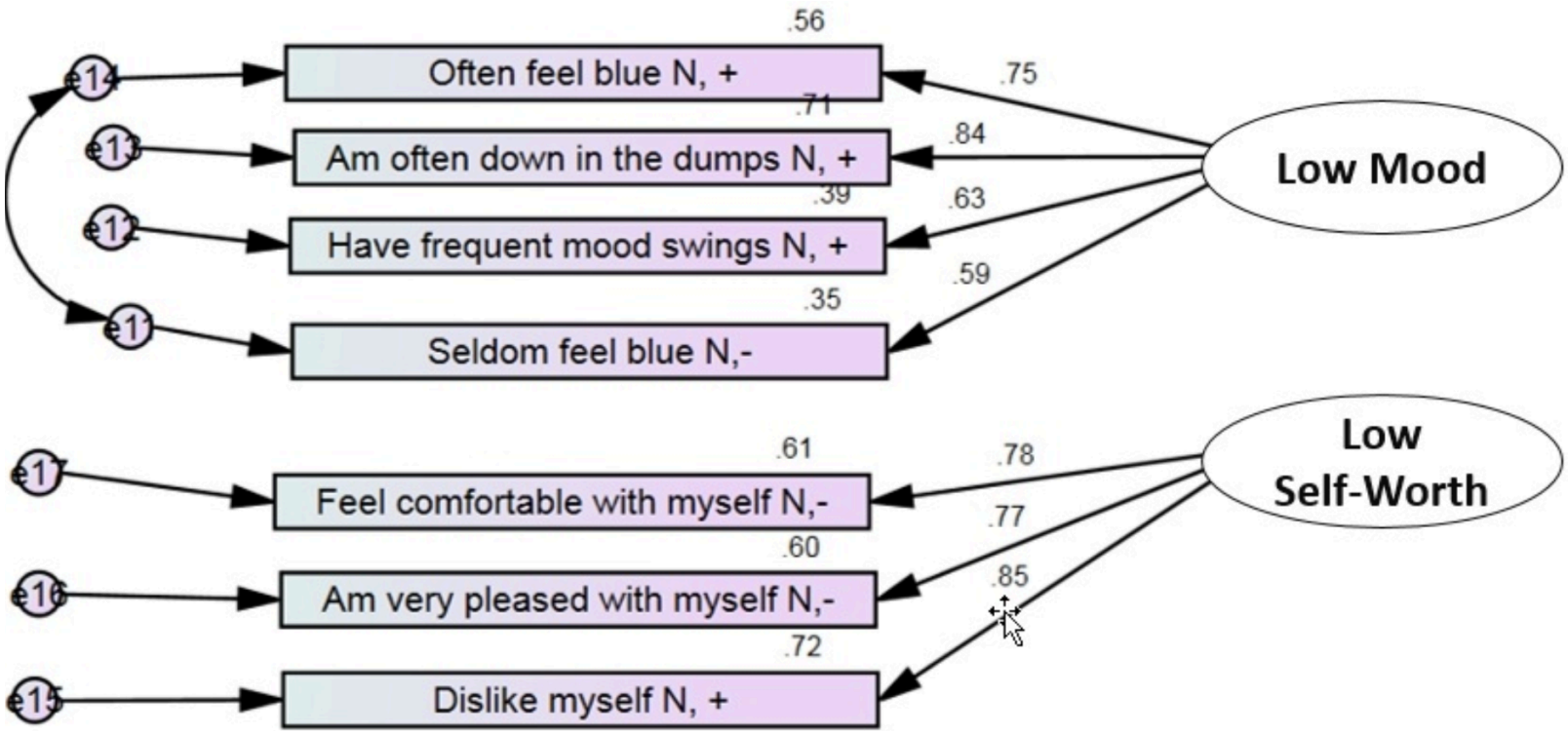
Language predicts

Personality as well

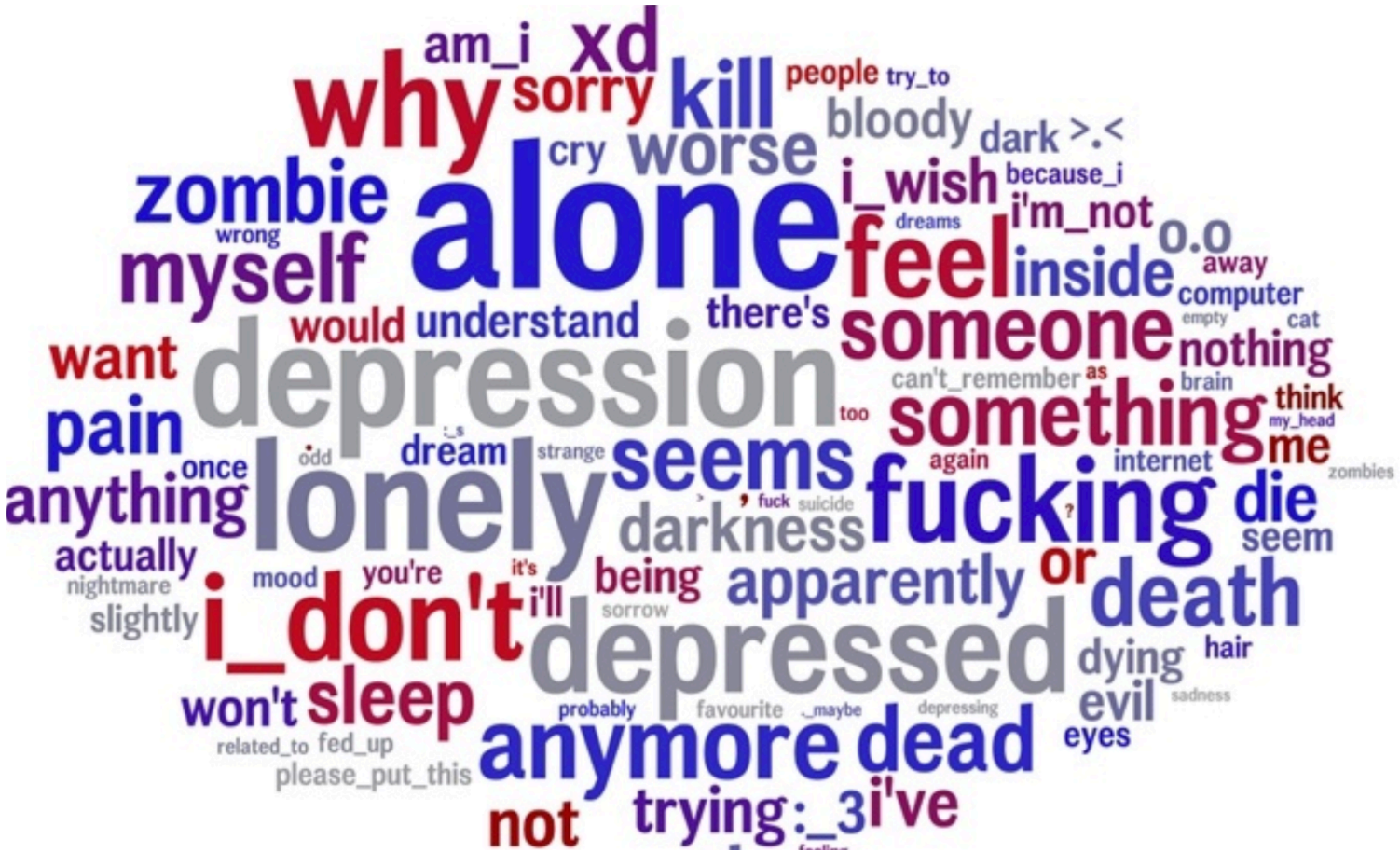
As friends do.



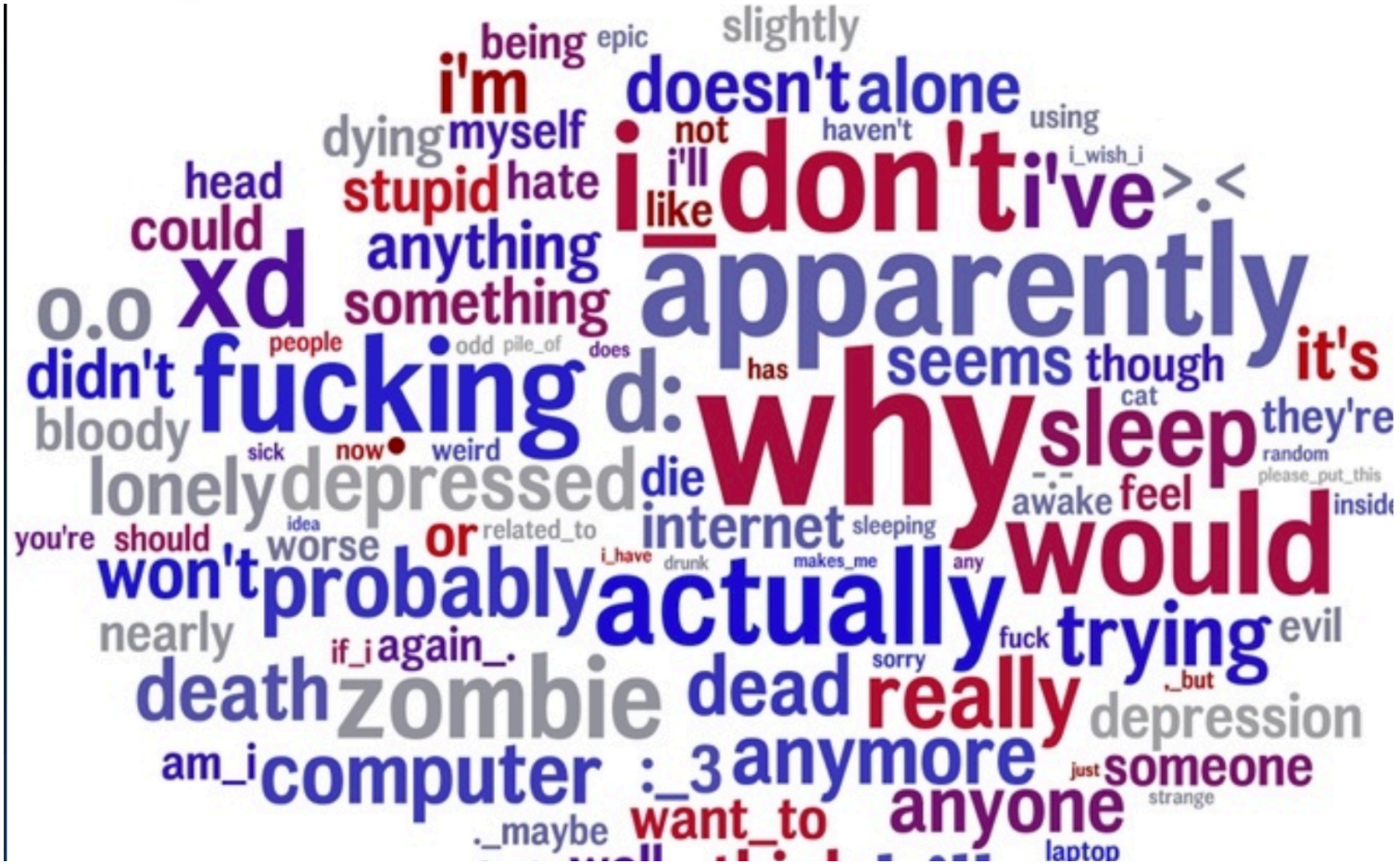
Depression


.56
Often feel blue N, +
.75
.71
Am often down in the dumps N, +
.84
.39
Have frequent mood swings N, +
.63
.59
.35
Seldom feel blue N,-
Low Mood
.61
Feel comfortable with myself N,-
.78
.77
.60
Am very pleased with myself N,-
.85
.72
Dislike myself N, +
Low Self-Worth

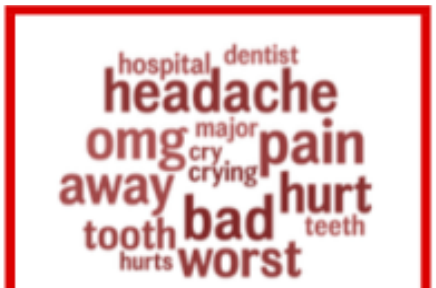
Depression – low mood



Depression – low self-worth



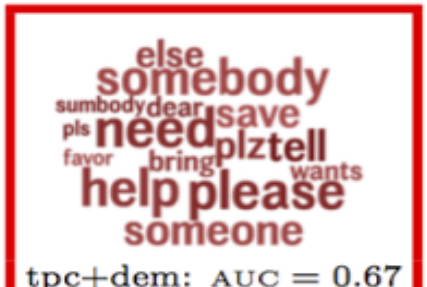
Depression (ER sample)



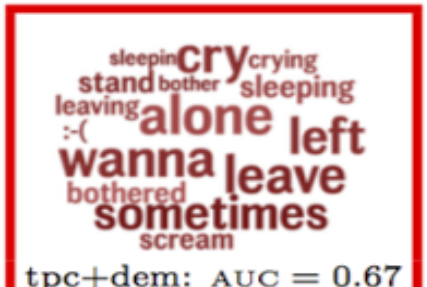
tpc+dem: AUC = 0.71
tpc alone: AUC = 0.65
dem profile: ♀ ↓ B

tpc+dem: AUC = 0.69
tpc alone: AUC = 0.62
dem profile: ♀ ↓ B

tpc+dem: AUC = 0.69
tpc alone: AUC = 0.63
dem profile: ♀ ↑ W

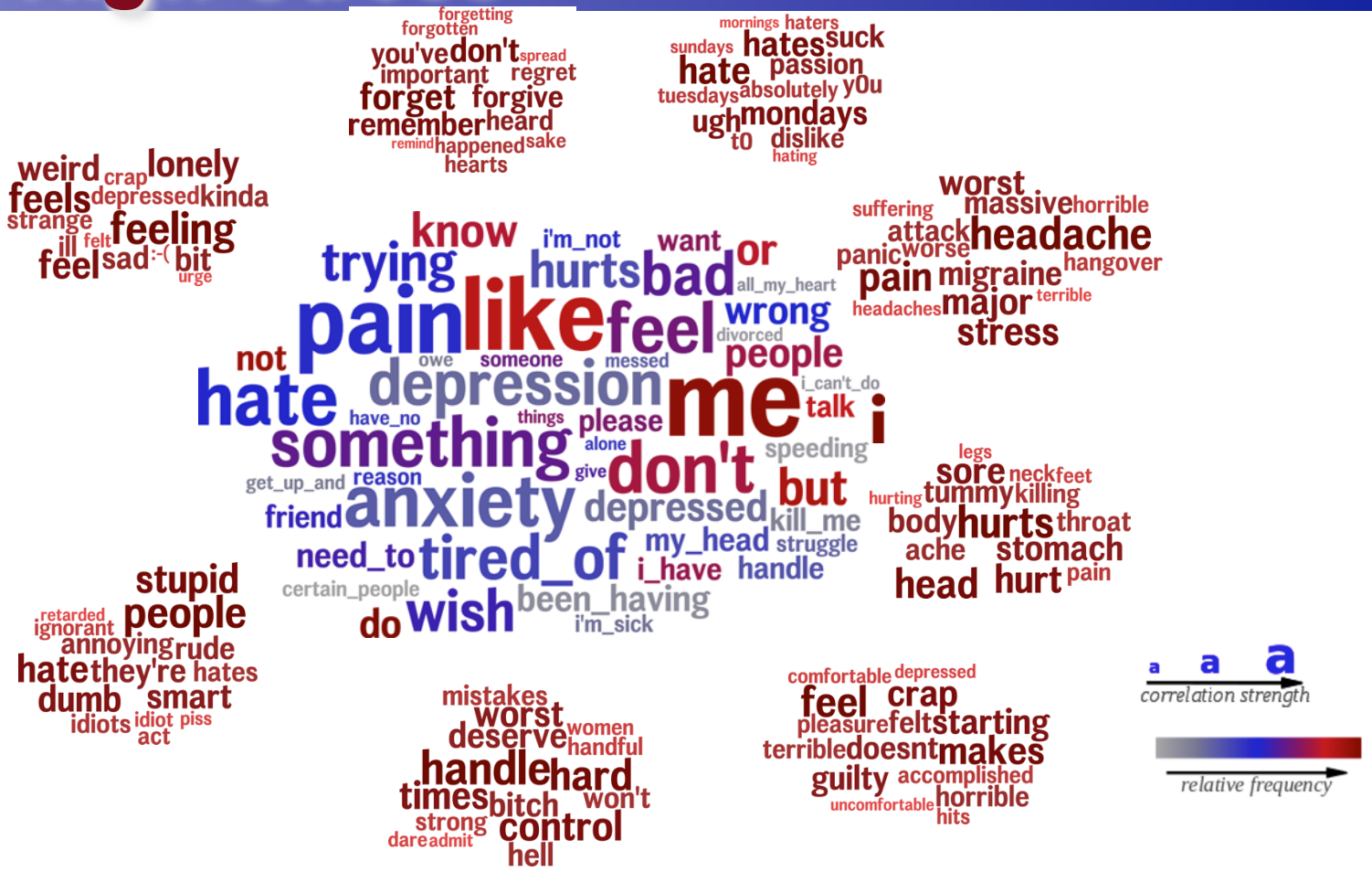


tpc+dem: AUC = 0.67
tpc alone: AUC = 0.62
dem profile: ♀ B



tpc+dem: AUC = 0.67
tpc alone: AUC = 0.57
dem profile: ♀ ↓ B

High Stress

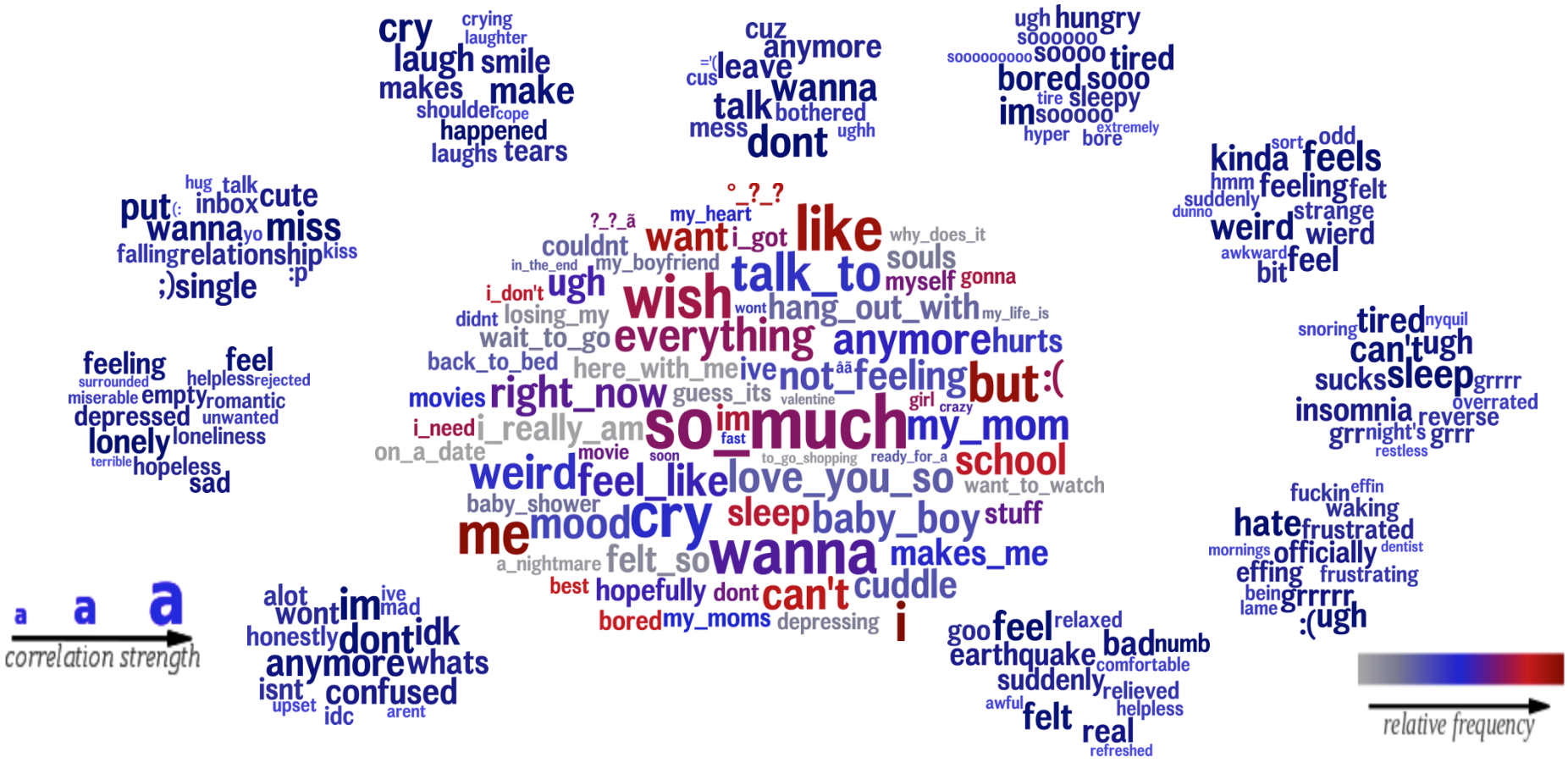

forgetting
forgotten
you've
don't
spread
important
regret
forget
forgive
remember
heard
remind
happened
sake
hearts
mornings
haters
sundays
hates
suck
hate
passion
tuesdays
absolutely
y0u
ugh
mondays
t0
dislike
hating
weird
crap
lonely
feels
depressed
kinda
strange
feeling
ill
felt
feel
sad
:-(
bit
urge
know
i'm_not
want
trying
hurts
bad
or
all_my_heart
pain
like
feel
wrong
divorced
not
owe
someone
messed
people
hate
depression
me
i_can't_do
talk
i
have_no
things
please
alone
something
speeding
get_up_and
reason
give
don't
but
friend
anxiety
depressed
kill_me
need_to
tired_of
my_head
struggle
i_have
handle
certain_people
do
wish
been_having
i'm_sick
worst
massive
horrible
suffering
attack
headache
panic
worse
hangover
pain
migraine
headaches
major
terrible
stress
legs
sore
neck
feet
hurting
tummy
killing
body
hurts
throat
ache
stomach
head
hurt
pain
stupid
people
retarded
ignorant
annoying
rude
hate
they're
hates
dumb
smart
idiots
idiot
piss
act
mistakes
worst
women
deserve
handful
handle
hard
times
bitch
won't
strong
control
dare
admit
hell
comfortable
depressed
feel
crap
pleasure
felt
starting
terrible
doesnt
makes
guilty
accomplished
uncomfortable
horrible
hits
a
a
a
correlation strength
relative frequency

Low Stress


trip
shutter
cruise
trips
adventure
mini
florida
road
camping
field
vacation
planning
packing
island
mission
feeling
lot
bla
feels
today
mission
motivated
felt
accomplished
alot
helped
productive
relaxed
lazy
worked
karaoke
dj
join
pub
drinks
drink
cover
lounge
mic
free
ladies
tonight
bar
club
tonite
bones
uber
sooooo
excite
bowl
soooo
duper
pumped
sooo
excited
soooooo
super
nervous
soo
stoked
afternoon
breakfast
accidents
in_the
airport
excited
trip_to
tonight's
first
today
six_months
this_morning
taking_a_nap
the
grounds
center
keen
woohoo
lookin.
pumped
excited
partying
foward
who's
tonight
drinks
tonite
whos
forward
town
fest
late
bright
clock
morning
mornings
awake
alarm
wake
o'clock
savings
daylight
waking
early
woke
bed
gift
present
conquered
mystery
greatest
army
opera
yesterday
history
worry
tomorrow
today
called
today's
master
sandwich
nom
eating
bacon
egg
breakfast
cheese
sausage
pancakes
toast
yum
french
eggs
waffles
mmm
a
a
a
correlation strength
relative frequency

Salutogenic empathy

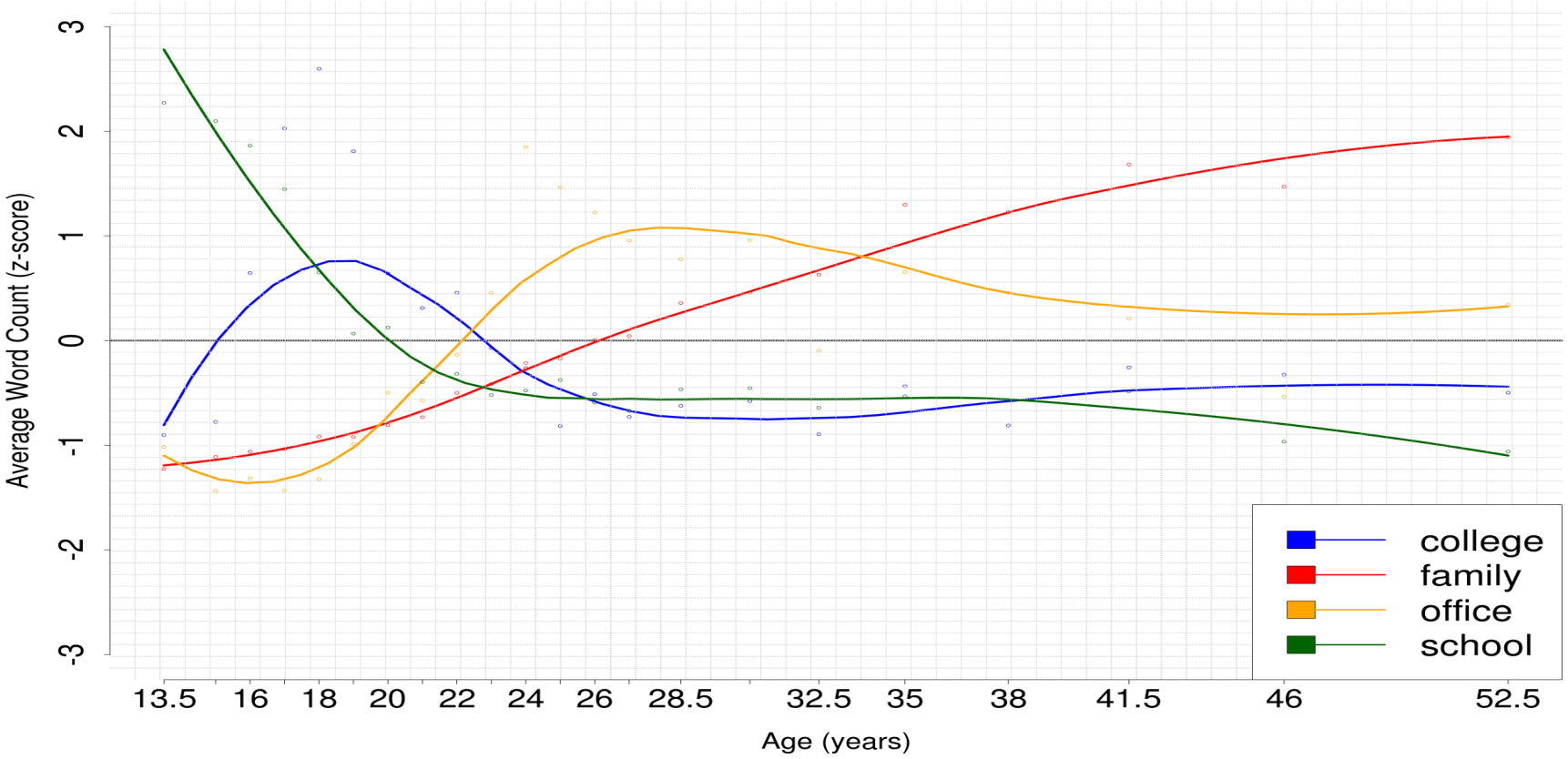
Pathogenic empathy



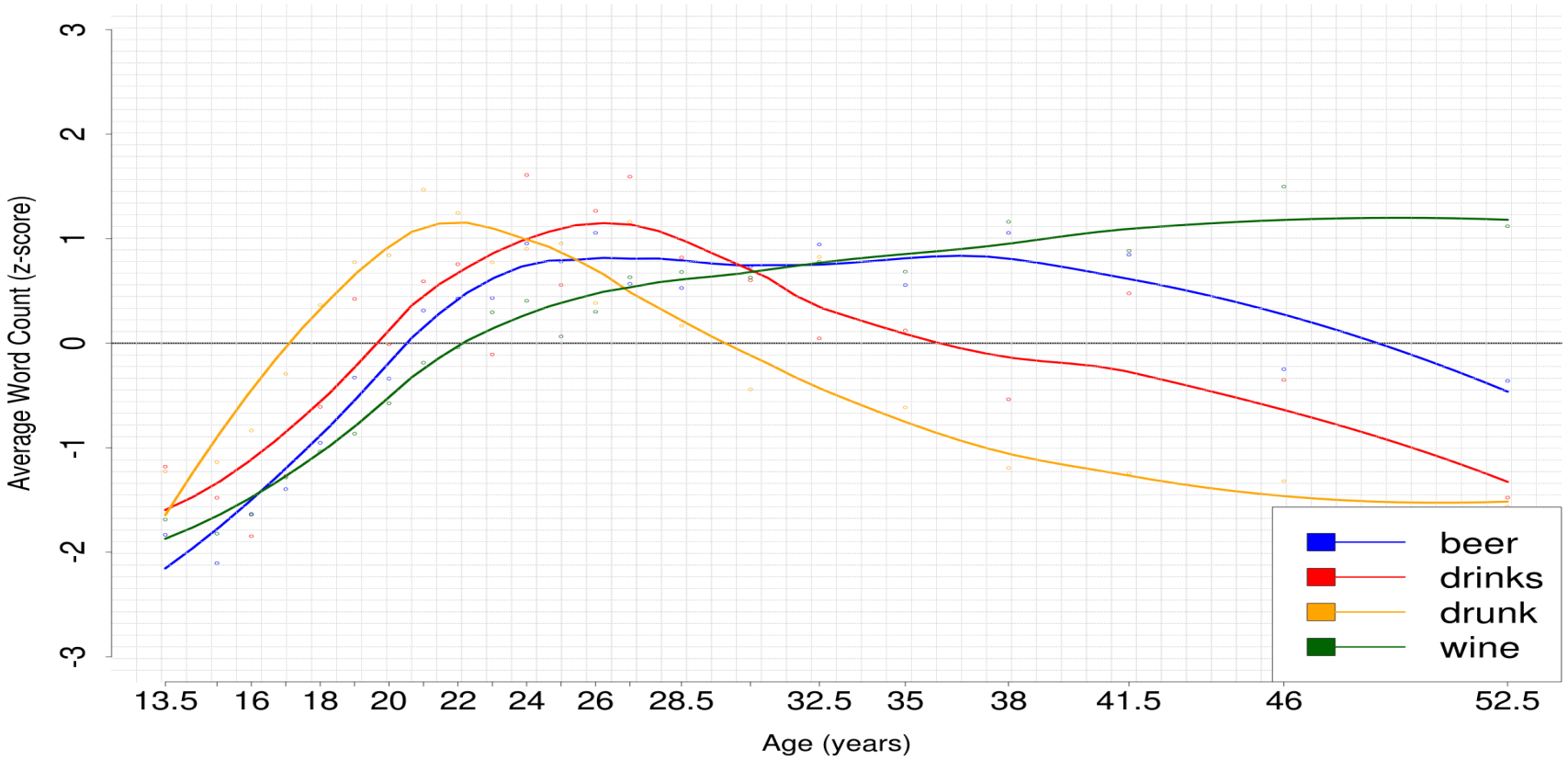
Visualization is important

- **Changes in sentiment over time**
- **Differences between populations by**
  - Demography etc.
    - Age, sex, country of origin
    - Income, education, political orientation
  - Location
  - Time of day
  - Device
  - …

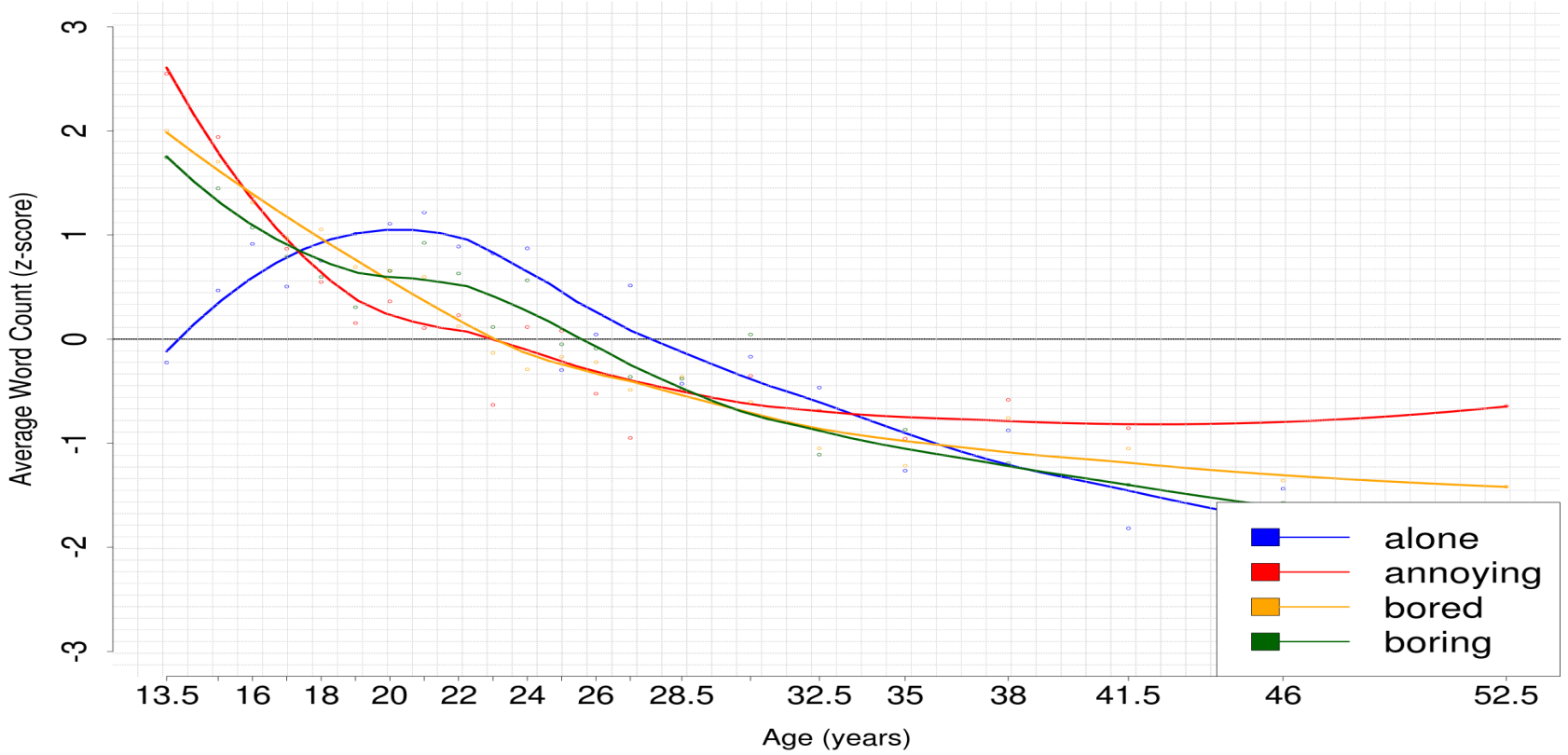
Life stages


Average Word Count (z-score)
3
2
1
0
-1
-2
-3
13.5
16
18
20
22
24
26
28.5
32.5
35
38
41.5
46
52.5
Age (years)
college
family
office
school

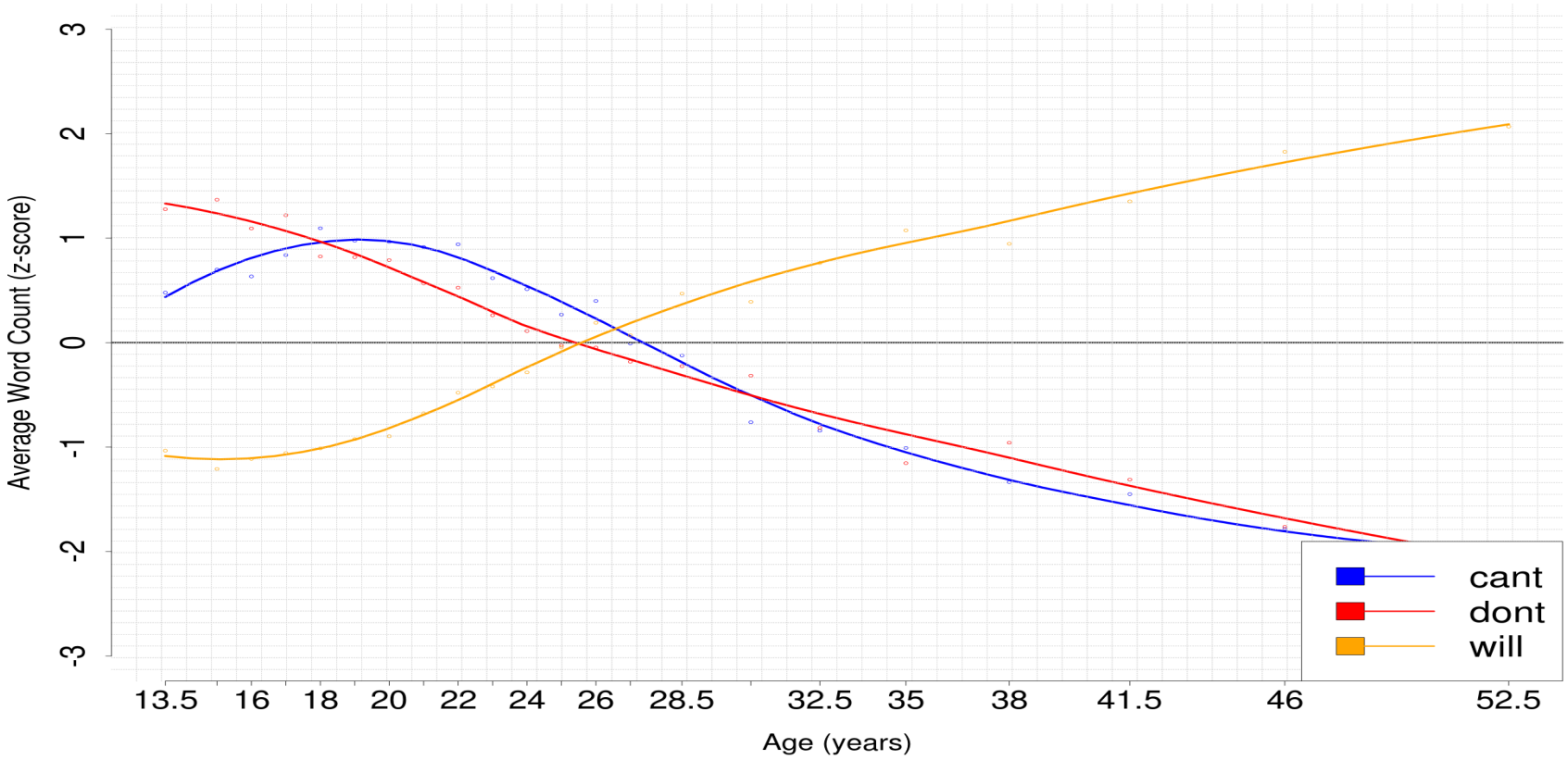
Alcohol consumption



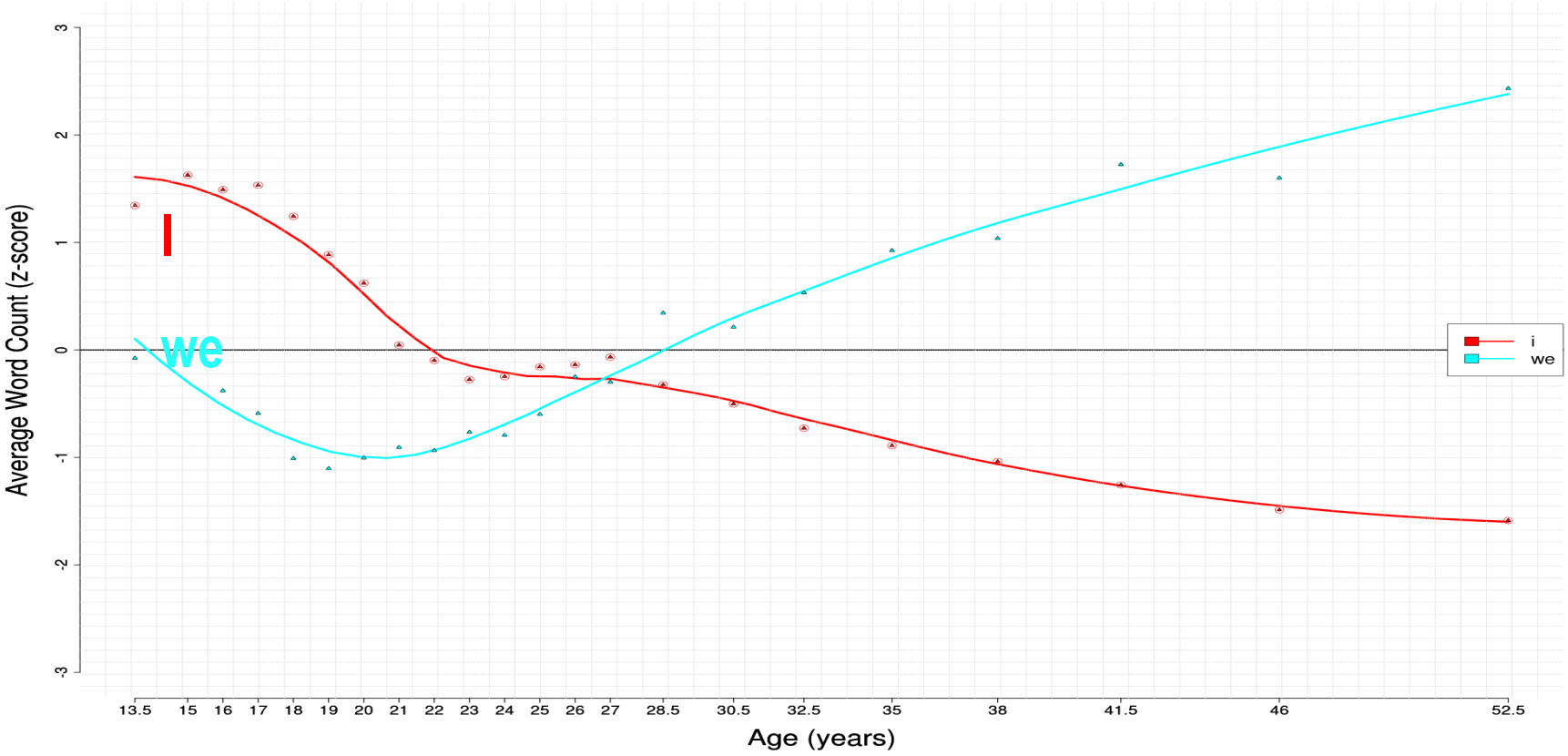
Older people are less negative



Older people are more positive



Older people are more other-oriented



Person-level Takeaways

- **Language reveals personality, conveys emotions**
  - Images do too!
- **Crowdsourcing lets us predict personal traits from language**
  - Age, sex, race
  - Personality
  - Stress, burnout, emotion, life satisfaction
  - Political beliefs
  - Mental and physical health

The World Well Being Project