

# Will precision medicine improve population health?

Sandro Galea

The loyal opposition

to the aspirations of science

The loyal opposition



to compelling ideas that do not advance health

The loyal opposition ^

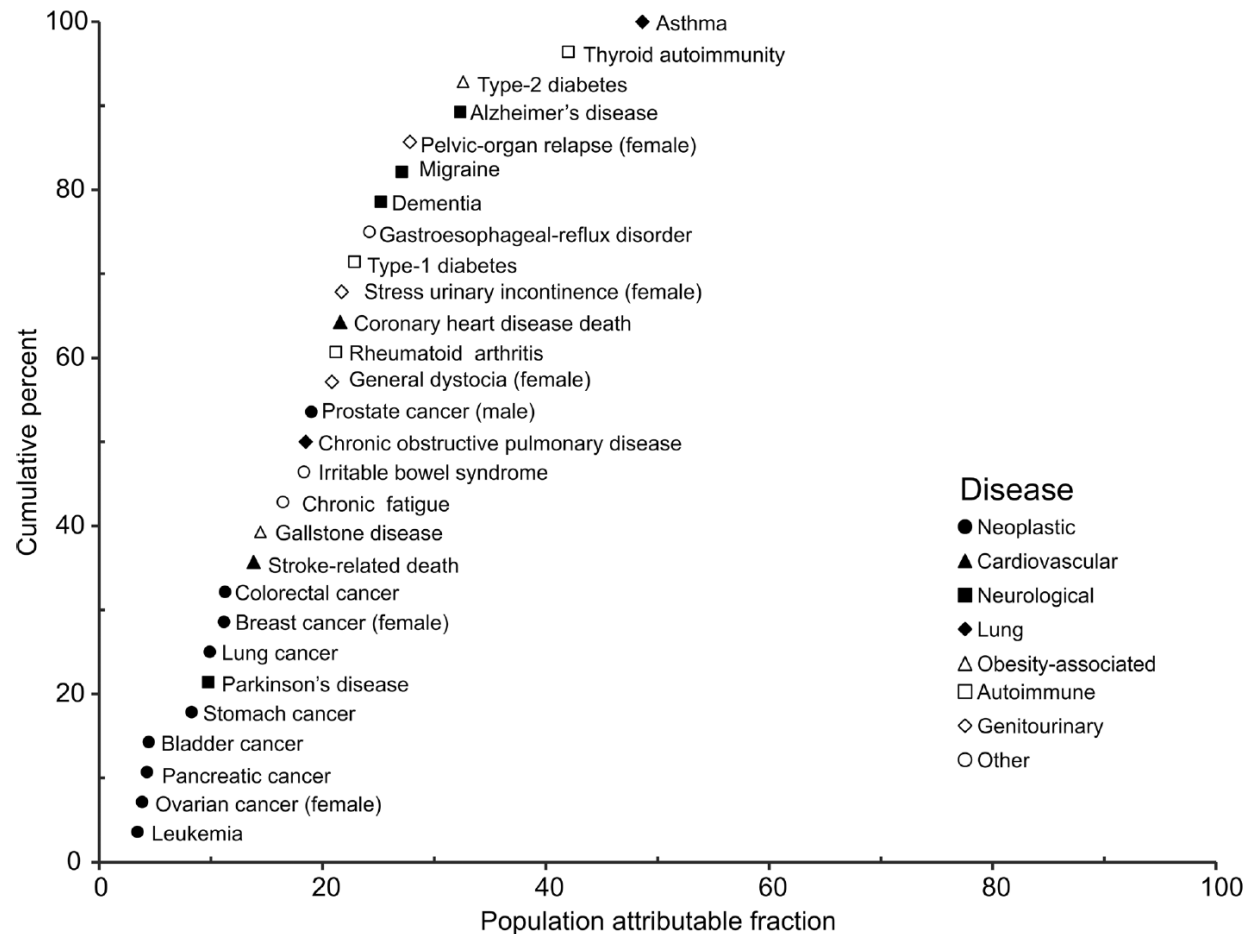
There is one question that matters. Will precision approaches improve population health?

No, unless.

Three reasons why not.

# 1. The challenges of complexity in biology

# Genes matter relatively little

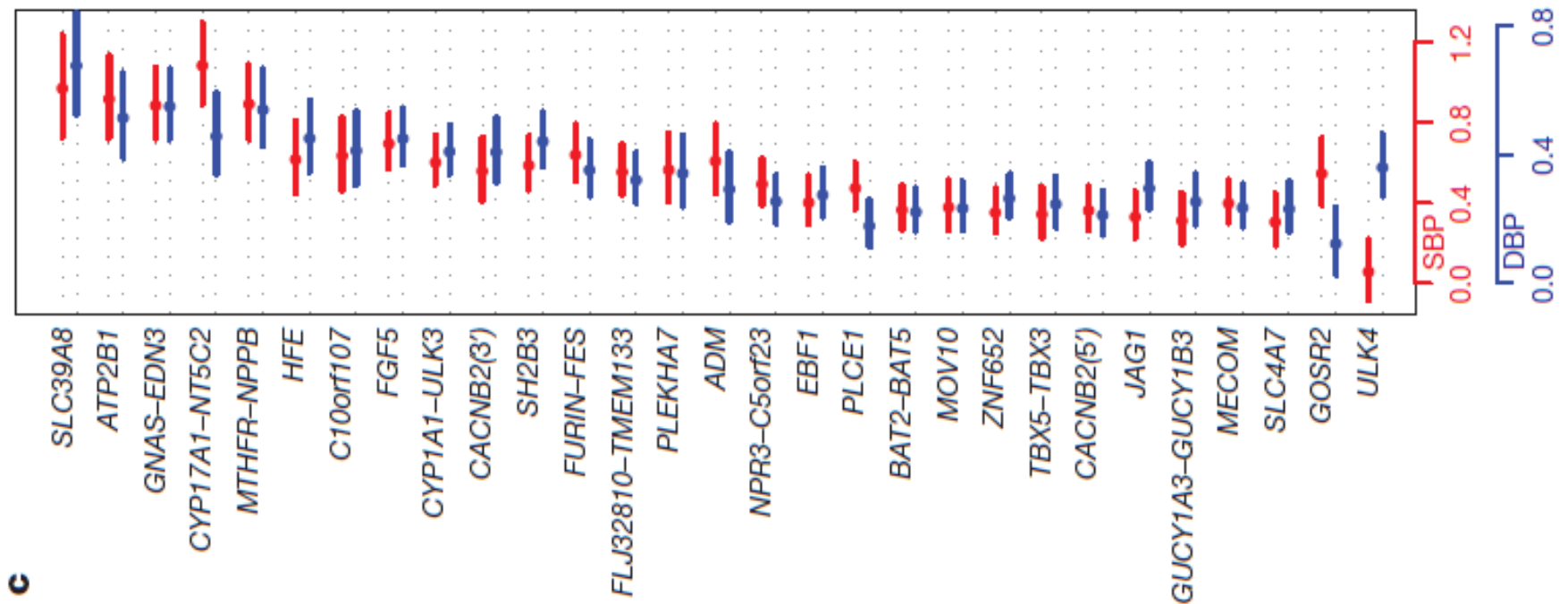


**Fig 1. Population attributable fractions (PAFs) for 28 disease phenotypes estimated from studies of monozygotic twins.** Sources of data and statistics are summarized in [Table 2](#).

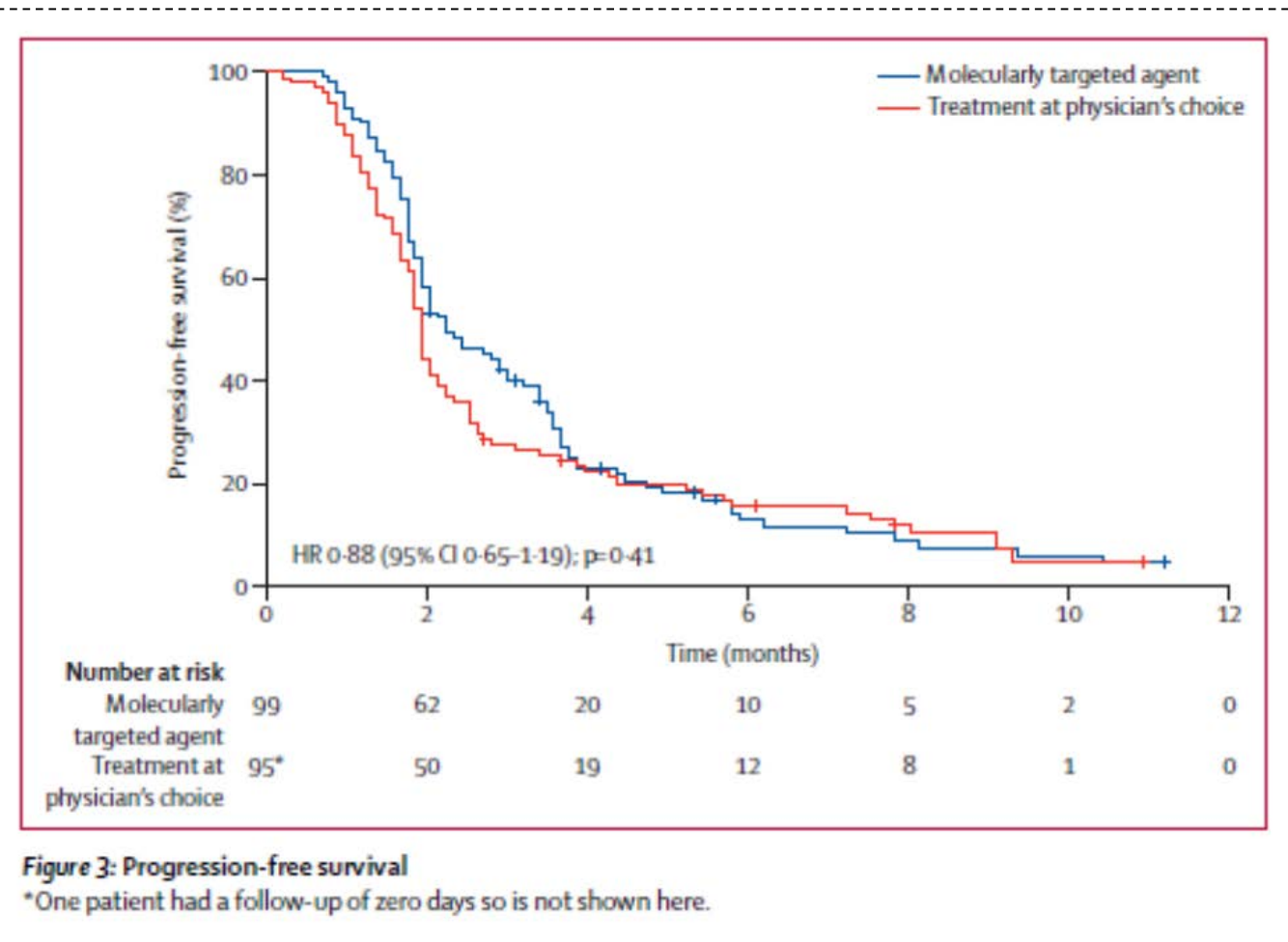
doi:10.1371/journal.pone.0154387.g001



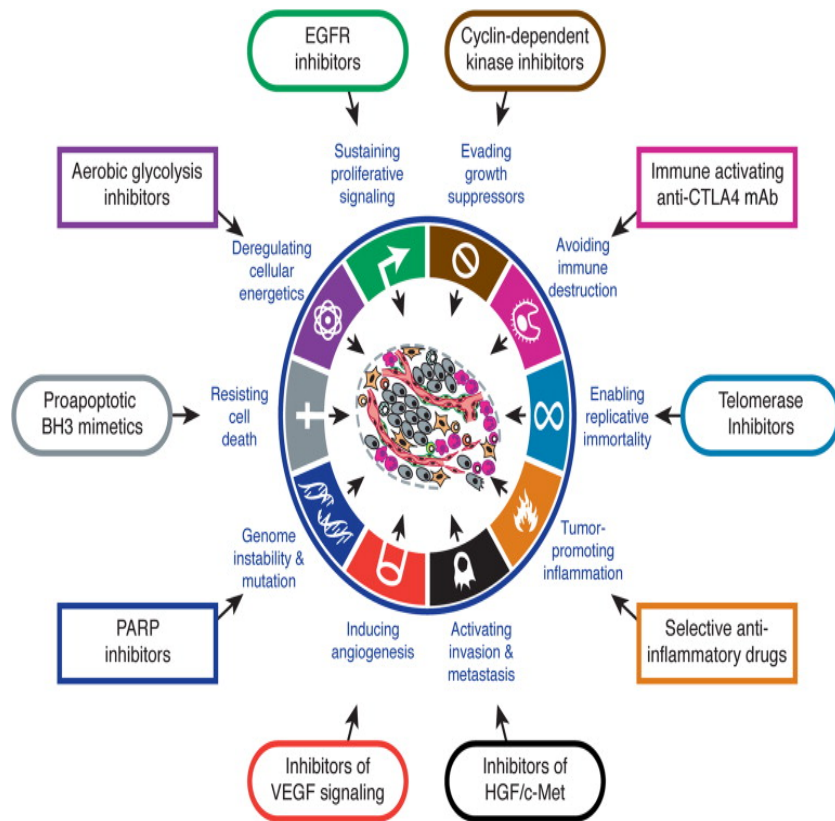
# Many variants, with very small effect



# Little evidence for efficacy of molecular targeting

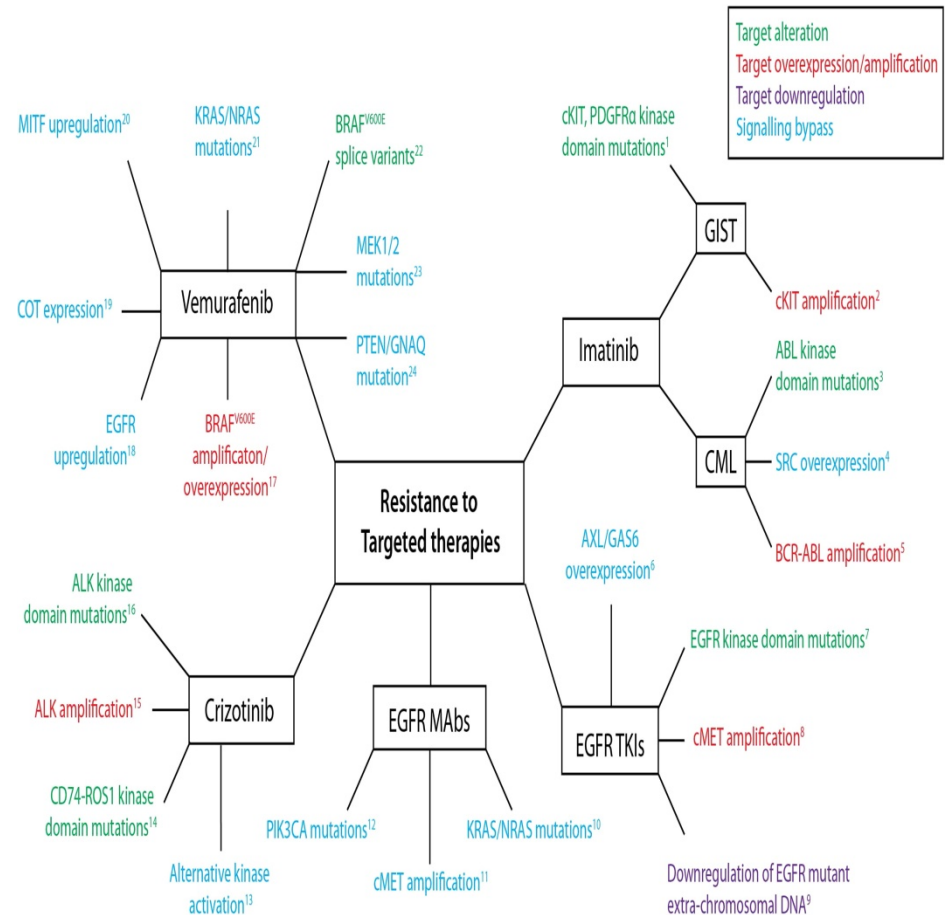


# Multimechanism diseases with predictable resistance



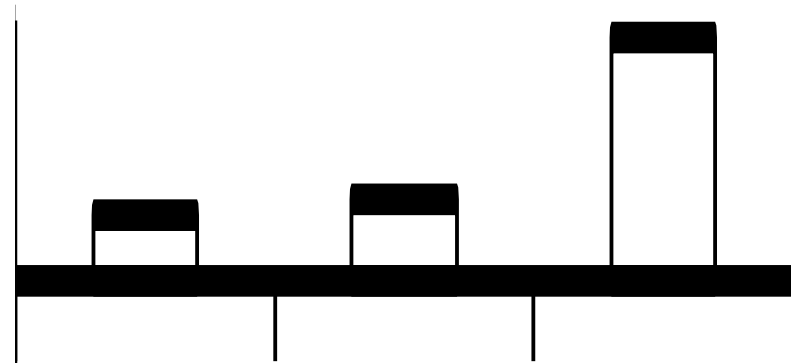
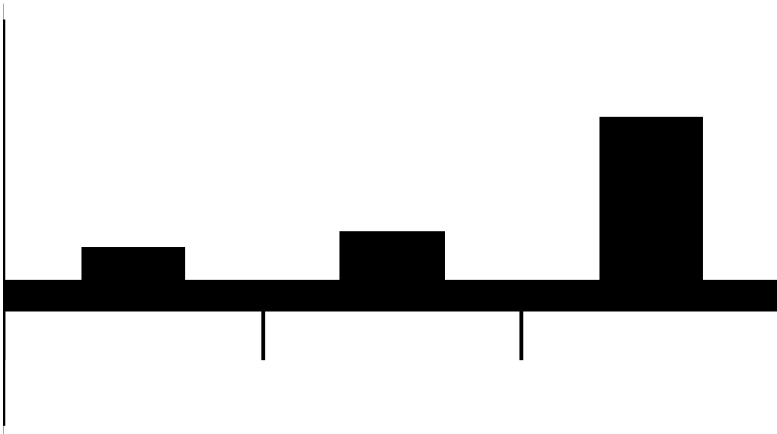
Hanahan D, Weinberg R. Cell 2011; 144: 646-774

Slide courtesy of Michael Fernandes



Burrell RA, Swanton C. Mol Oncol 2014; 8: 1095-1111

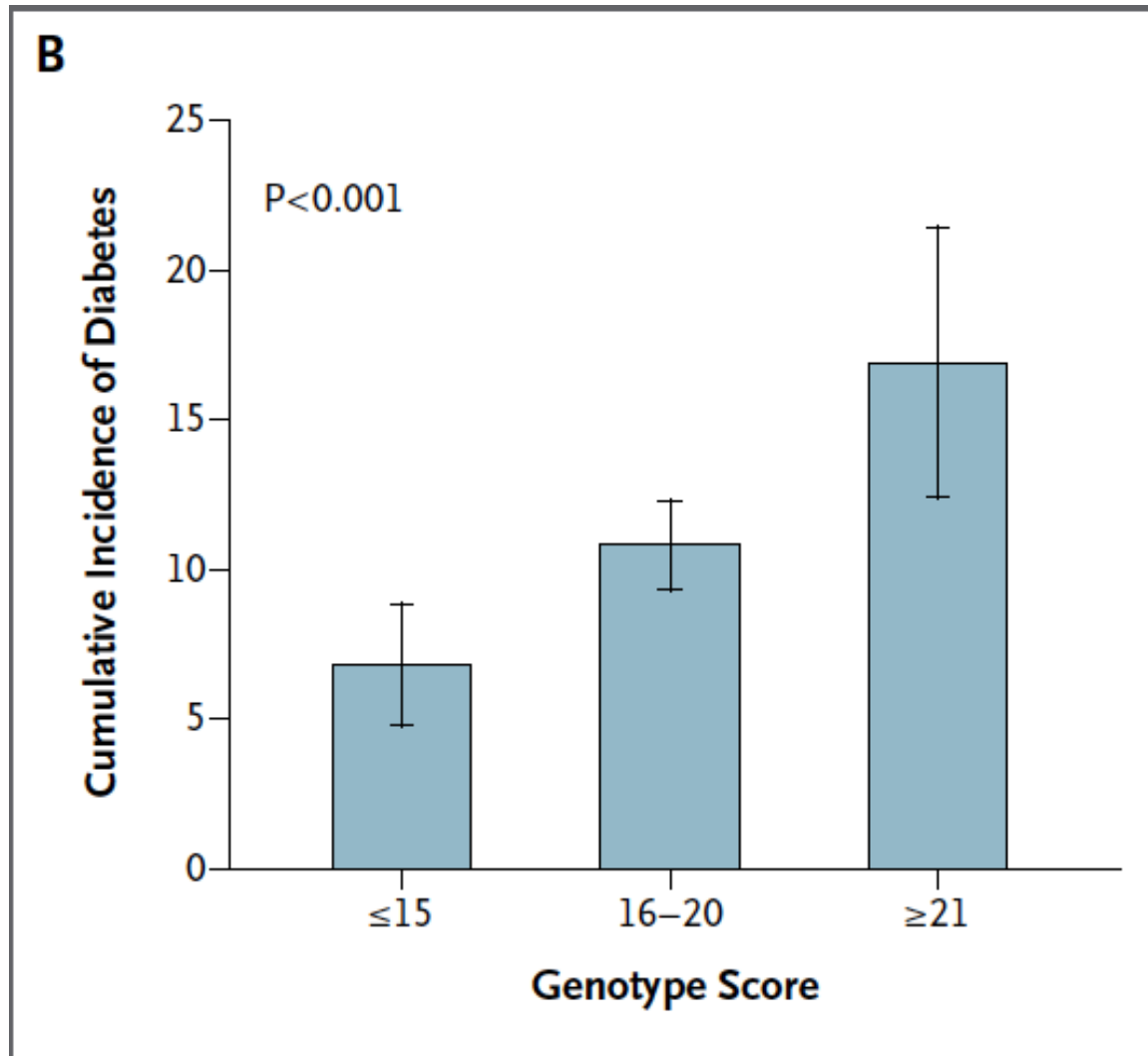
# The inevitable overwhelming role of behavior

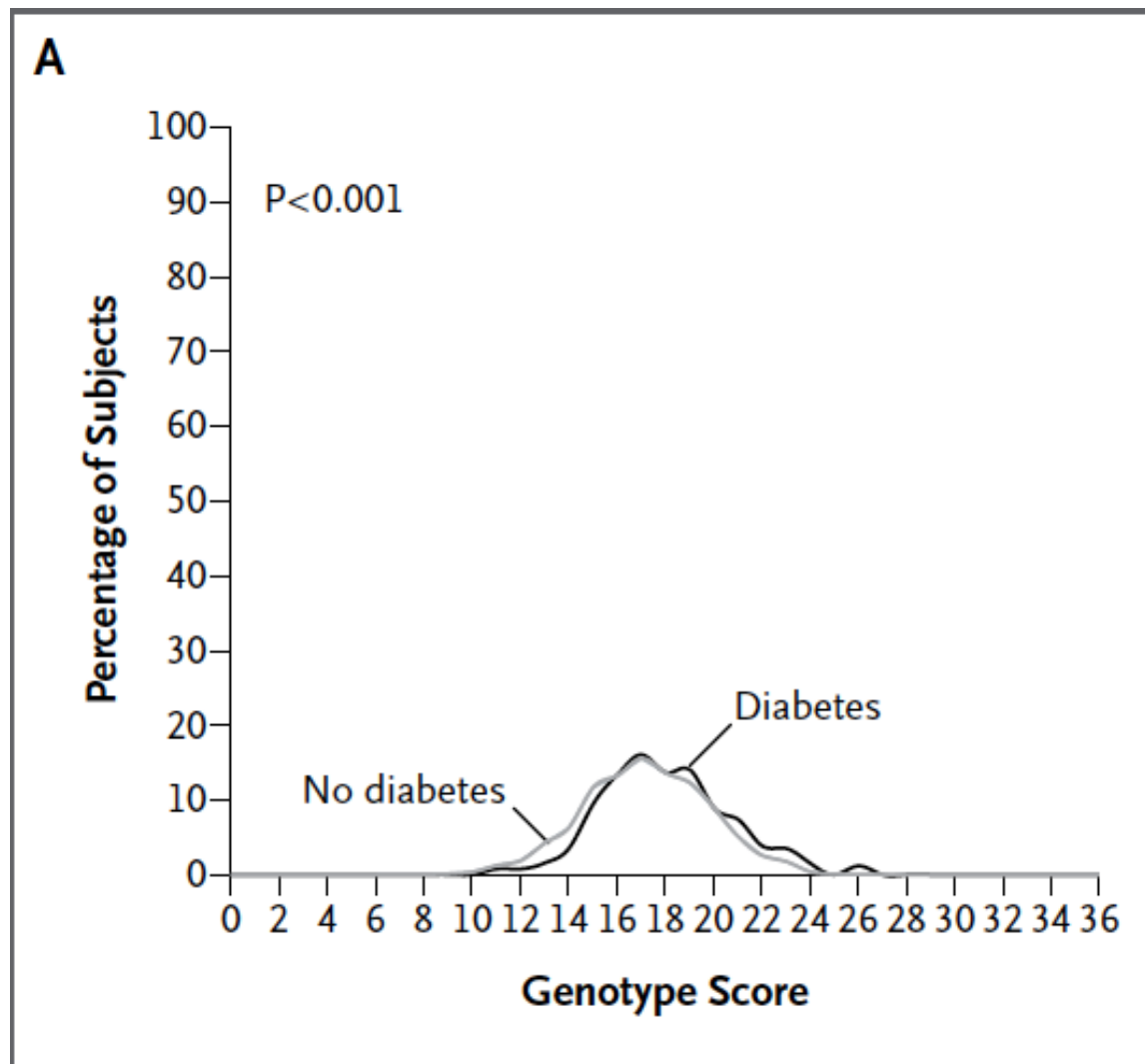


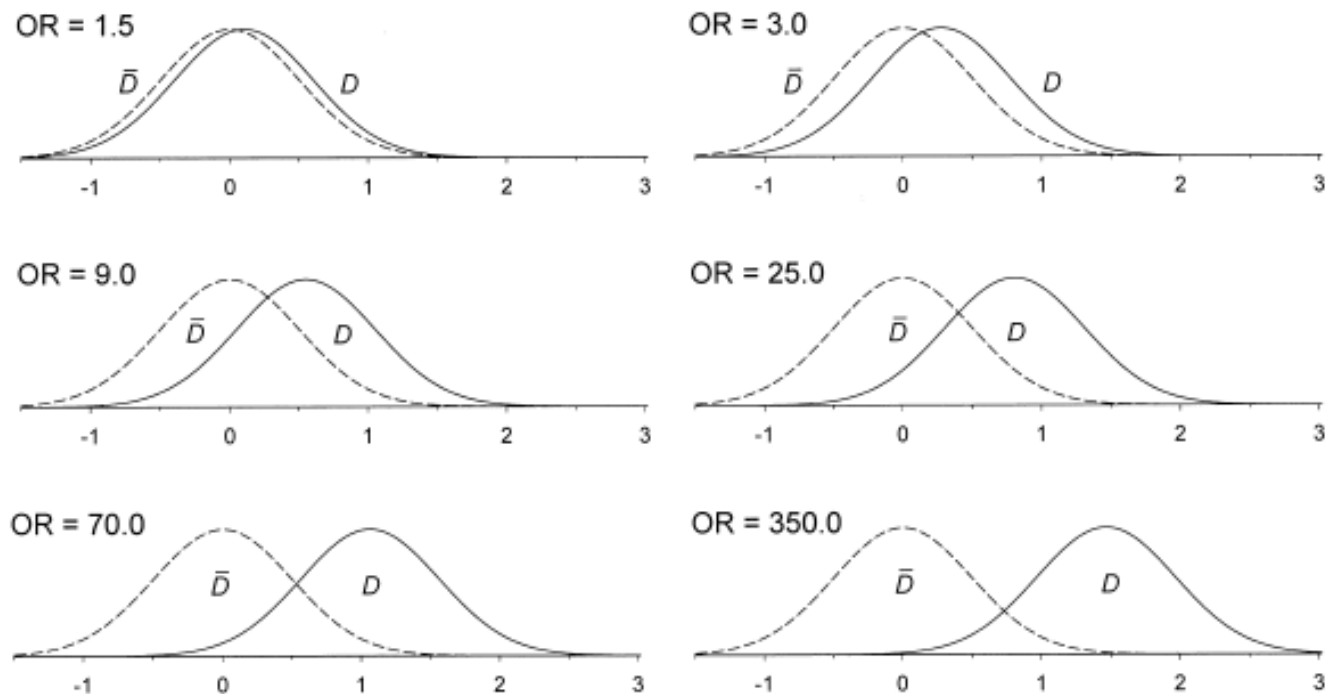
Calle et al. N. Engl. J. Med. 2003; 348: 1625-1638

Slide courtesy of Michael Joyner

## 2. The conflation of the individual and population



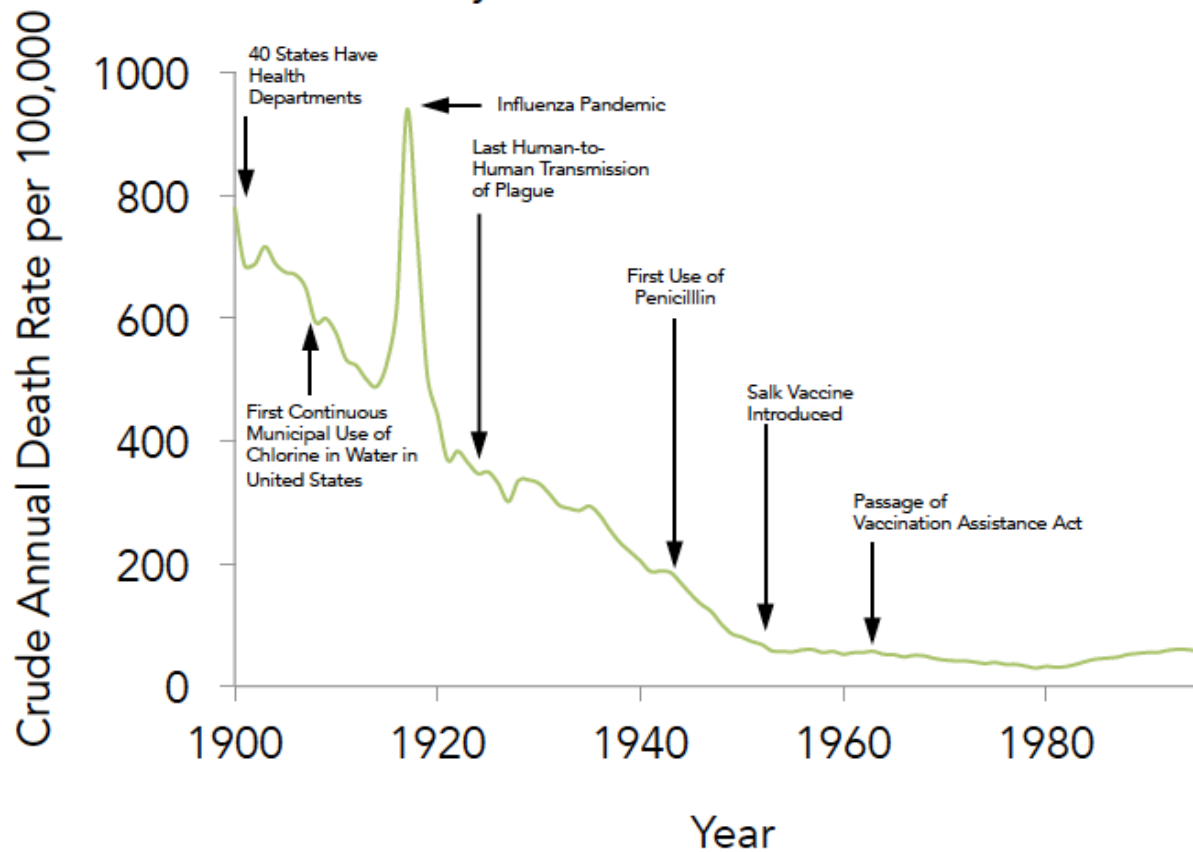




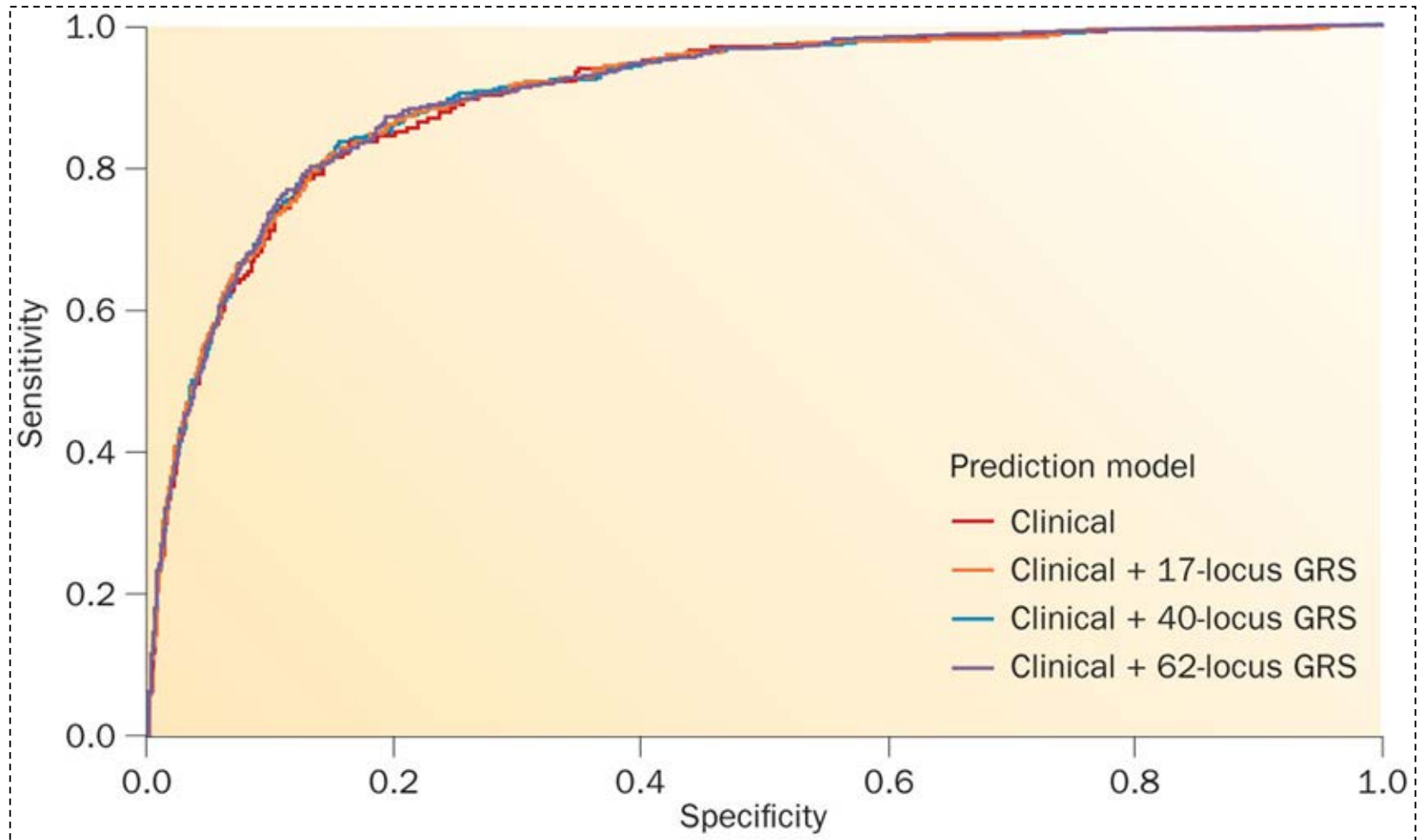
**FIGURE 2.** Probability distributions of a marker,  $X$ , in cases (solid curves) and controls (dashed curves) consistent with the logistic model  $\log P(D=1|X) = \alpha + \beta X$ . It has been assumed that  $X$  has a mean of 0 and a standard deviation of 0.5 in controls so that a unit increase represents the difference between the 84th and 16th percentiles of  $X$  in controls. The marker is normally distributed, with the same variance in cases. The odds ratio (OR) per unit increase in  $X$  is shown.



## Infectious Disease Mortality in the United States: 20<sup>th</sup> Century



# Predicting diabetes



### 3. The fallacy of individual behavior change



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ectations that such interventions could play  
a major role in motivating behaviour change to improve population health

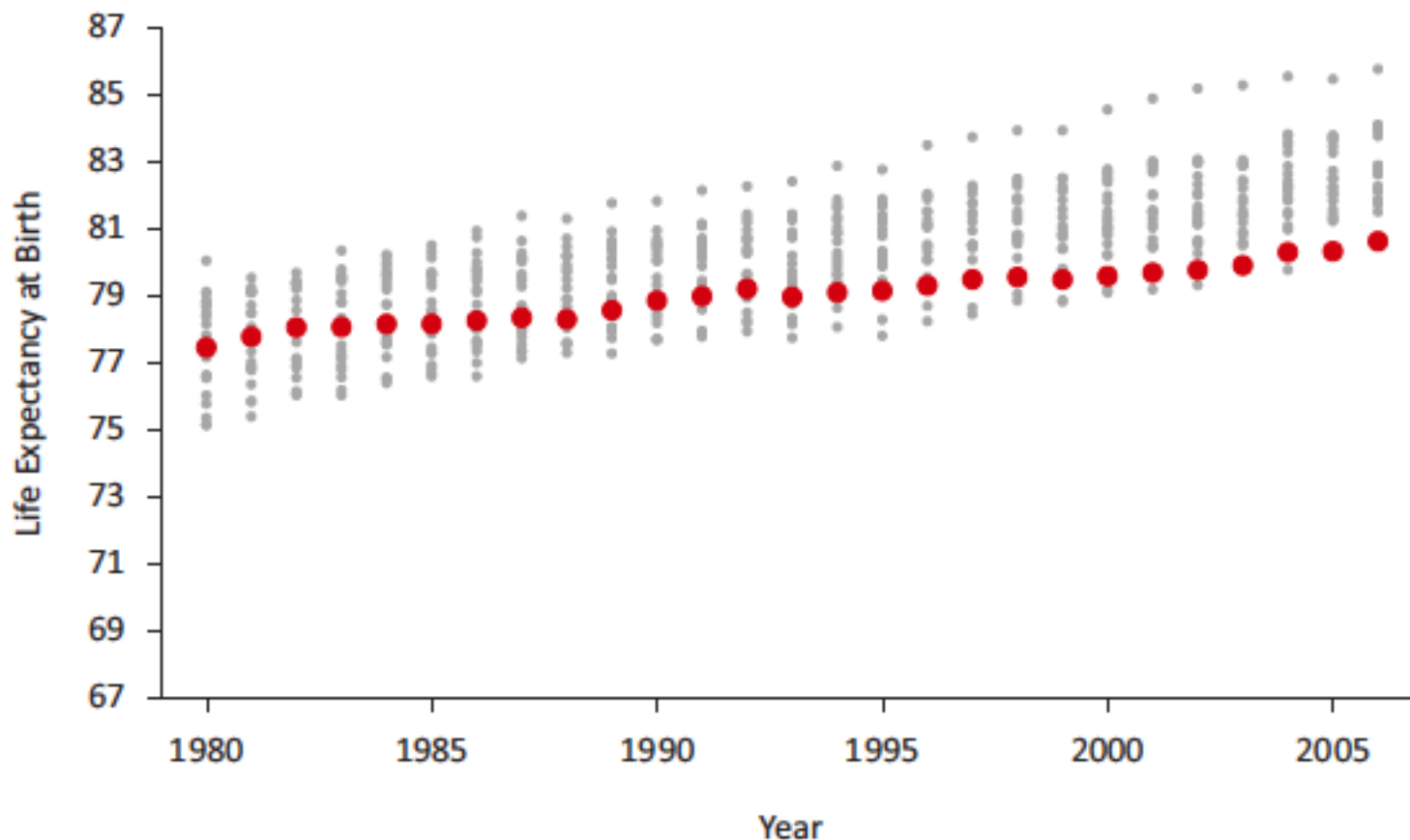
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Expectations that communicating DNA based risk estimates changes behaviour is not supported by existing evidence

Expectations that such interventions could play a major role in motivating behaviour change to improve population health

This discussion is not academic. Three reasons why it matters.

1. Missing the important, on compelling distraction



**FIGURE 1-6** U.S. female life expectancy at birth relative to 21 other high-income countries, 1980-2006.

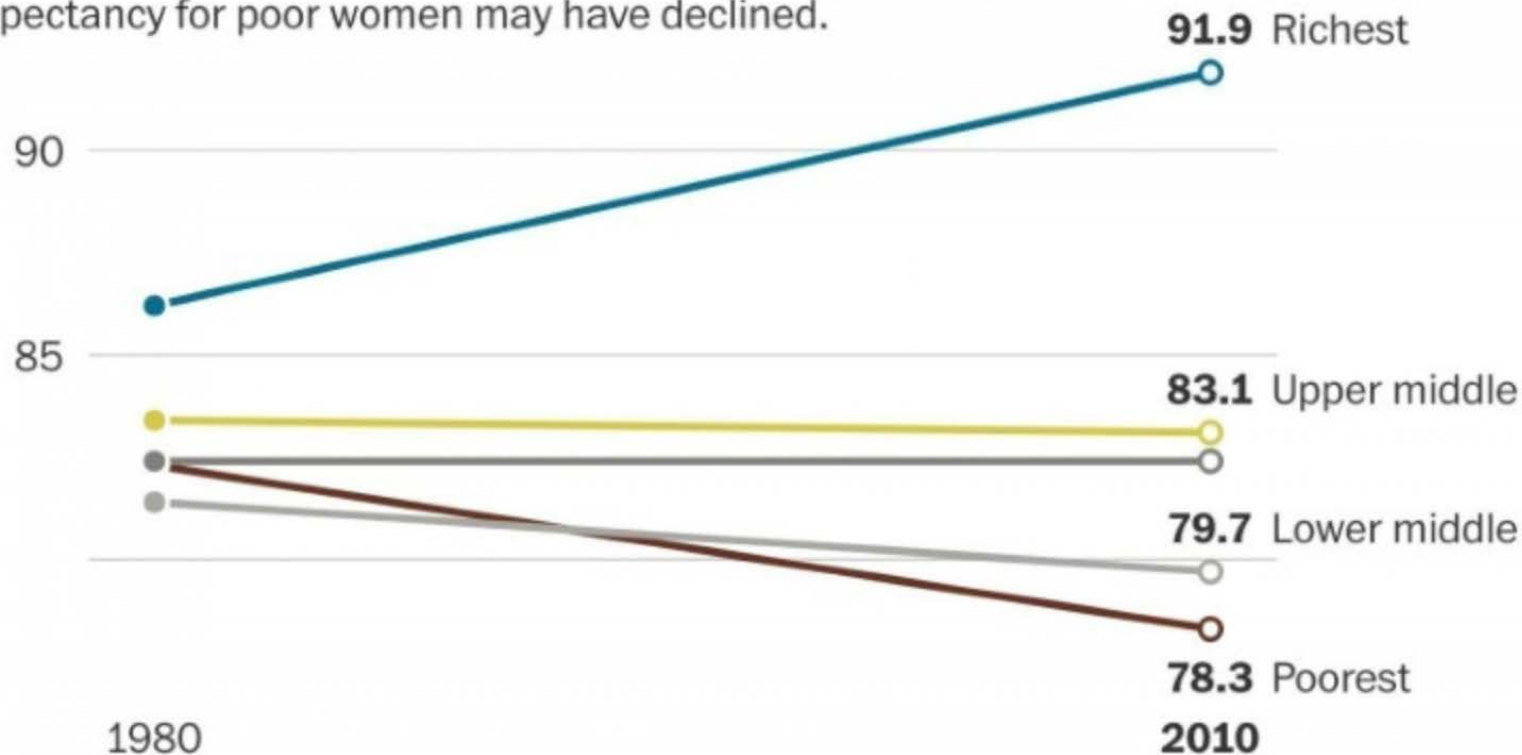
**NOTES:** Red circles depict newborn life expectancy in the United States. Grey circles depict life expectancy values for Australia, Austria, Belgium, Canada, Denmark, Finland, France, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and West Germany.

**SOURCE:** National Research Council (2011, Figure 1-4).



## Inequality in life expectancy widens for women

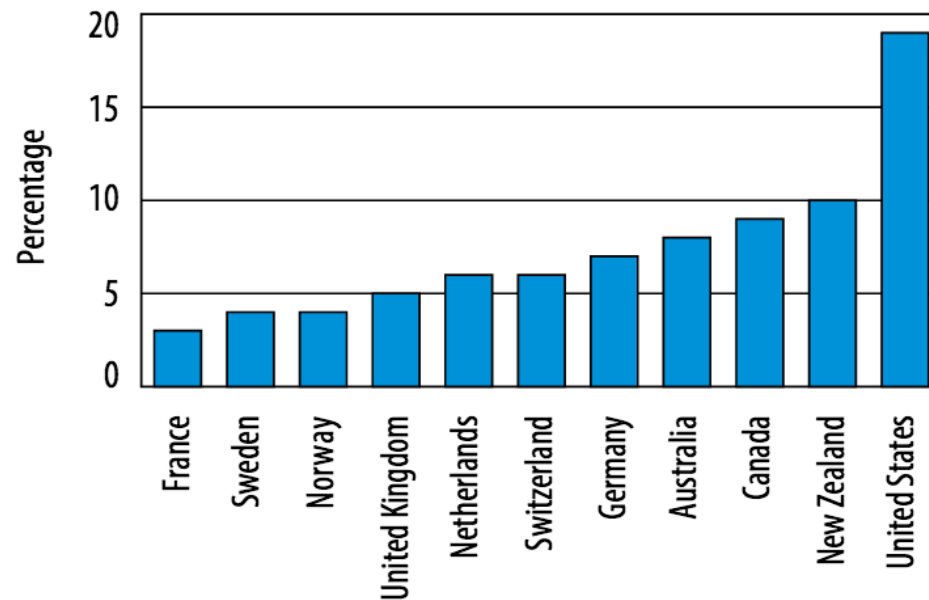
Wealthier women can expect to live longer than their parents did, while life expectancy for poor women may have declined.



Life expectancy for 50-year-olds in a given year, by quintile of income over the previous 10 years

Source: National Academies of Science, Engineering and Medicine

**Fig. 4.3.** Percentage of adults aged 65 years or older who had problems accessing health-care services during the past year due to their cost, 11 countries, 2014

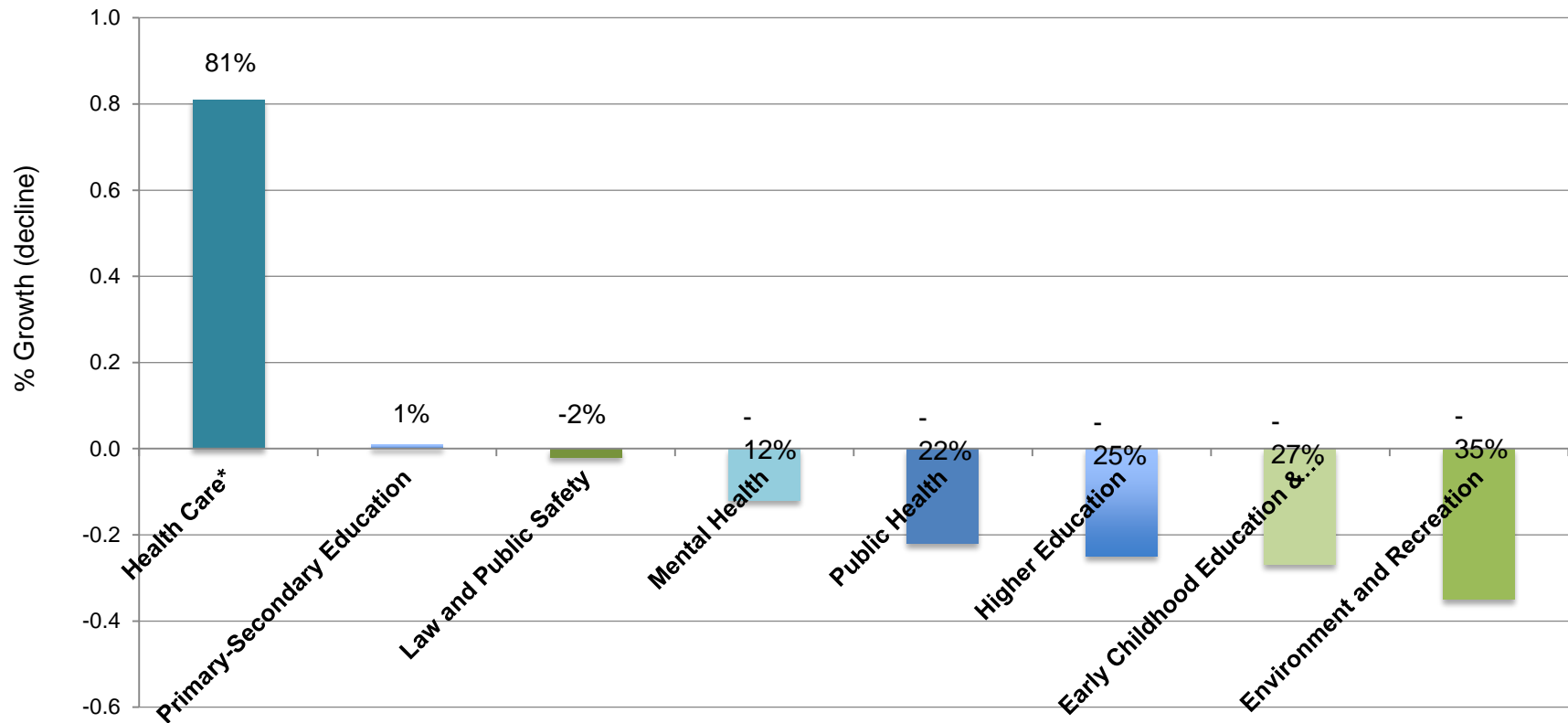


Note: Because of the cost, respondents with a medical problem did not visit a doctor, missed a medical test or treatment recommended by a doctor, did not fill out a prescription or missed a dose of medicine, or a combination of these.

Source: (6).

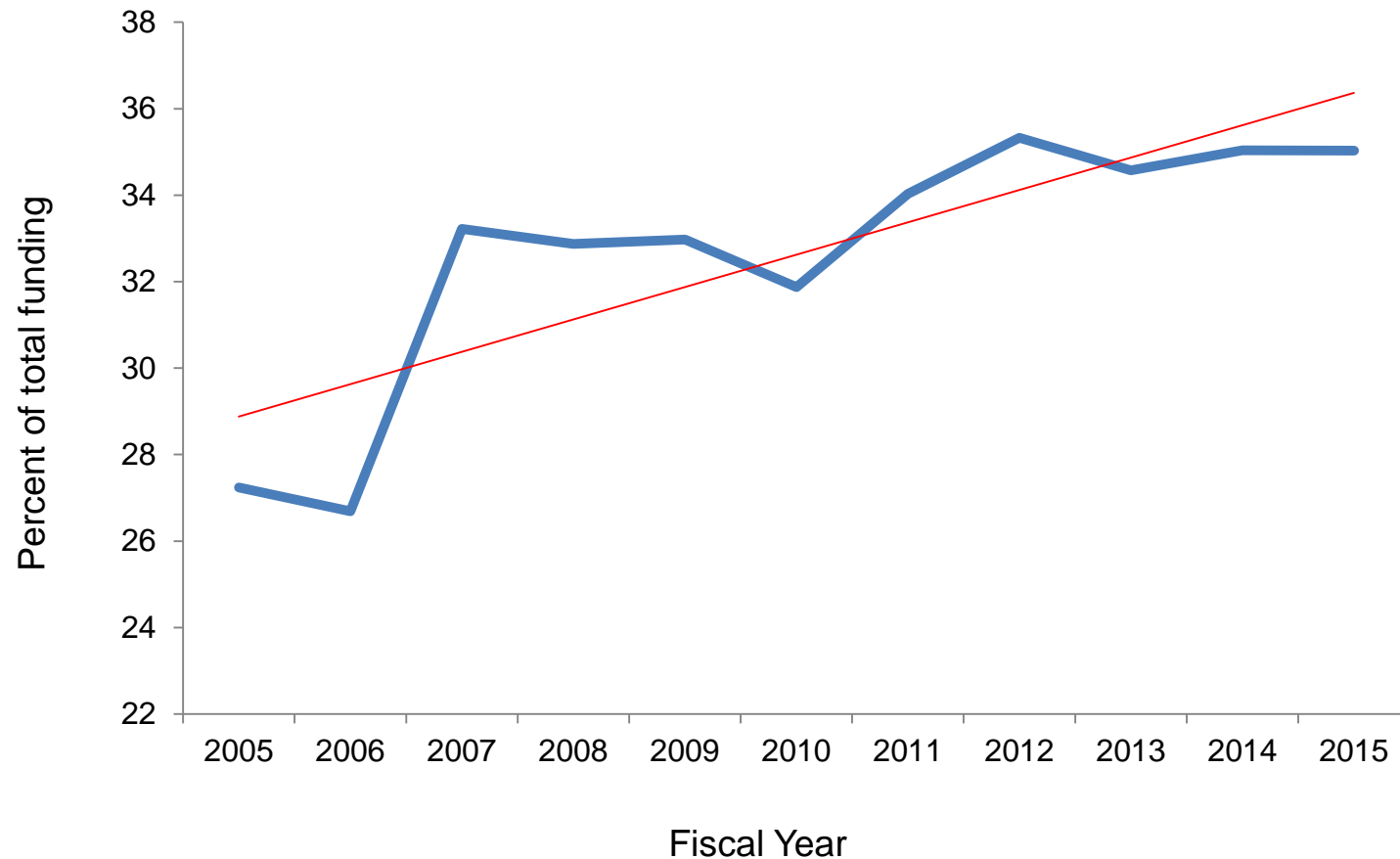
## 2. Resource allocation, investing in the future

# Change in Massachusetts State Government spending: 2001-14

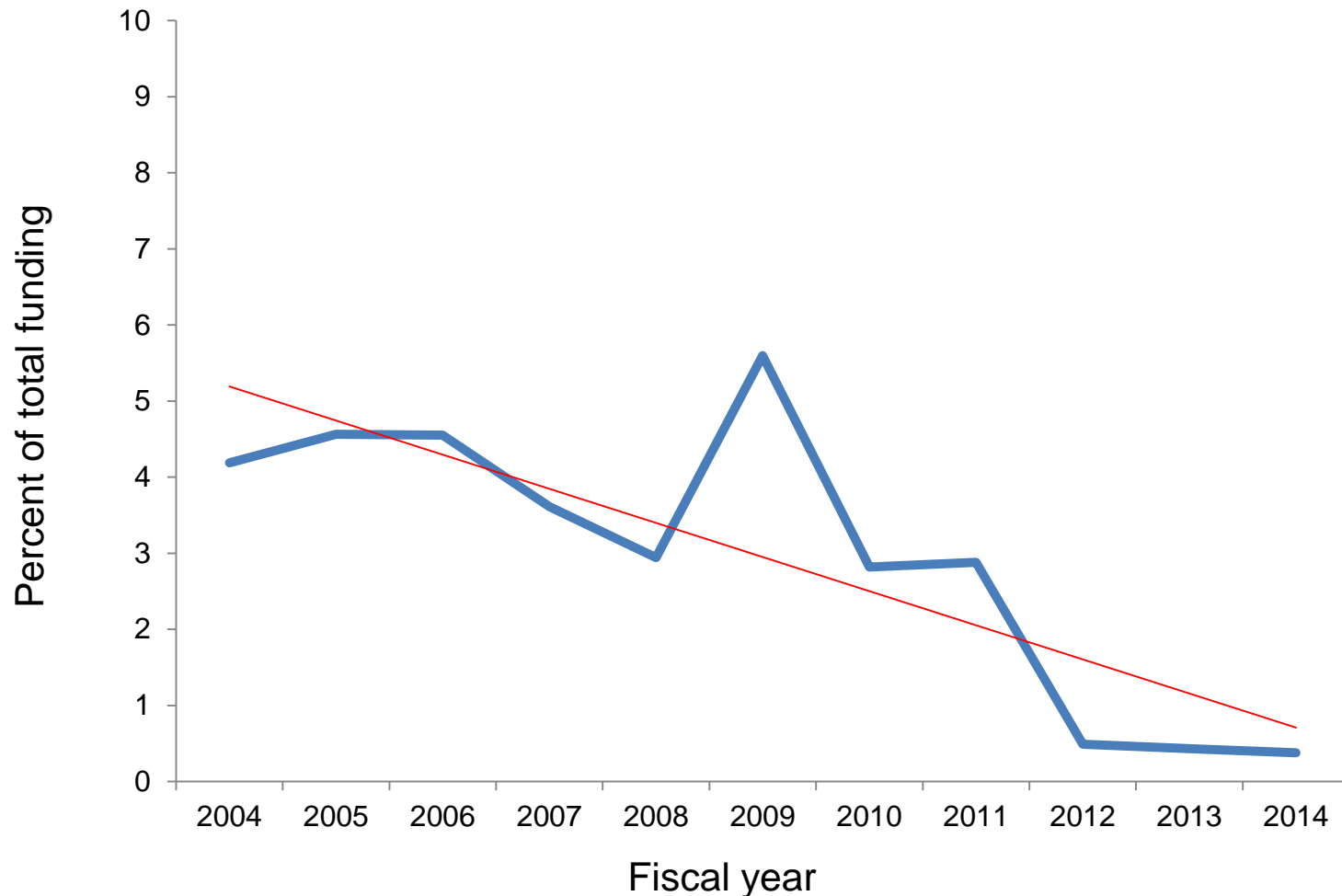


\* Health care expenditure is Group Insurance Commission spending plus MassHealth (Medicaid)

# Proportion of NIH funding awarded to projects with the terms “genetic” or “genetics” in the title, abstract or terms



# Proportion of NIH funding awarded to projects with the terms “population” or “public” in the title, abstract, or terms



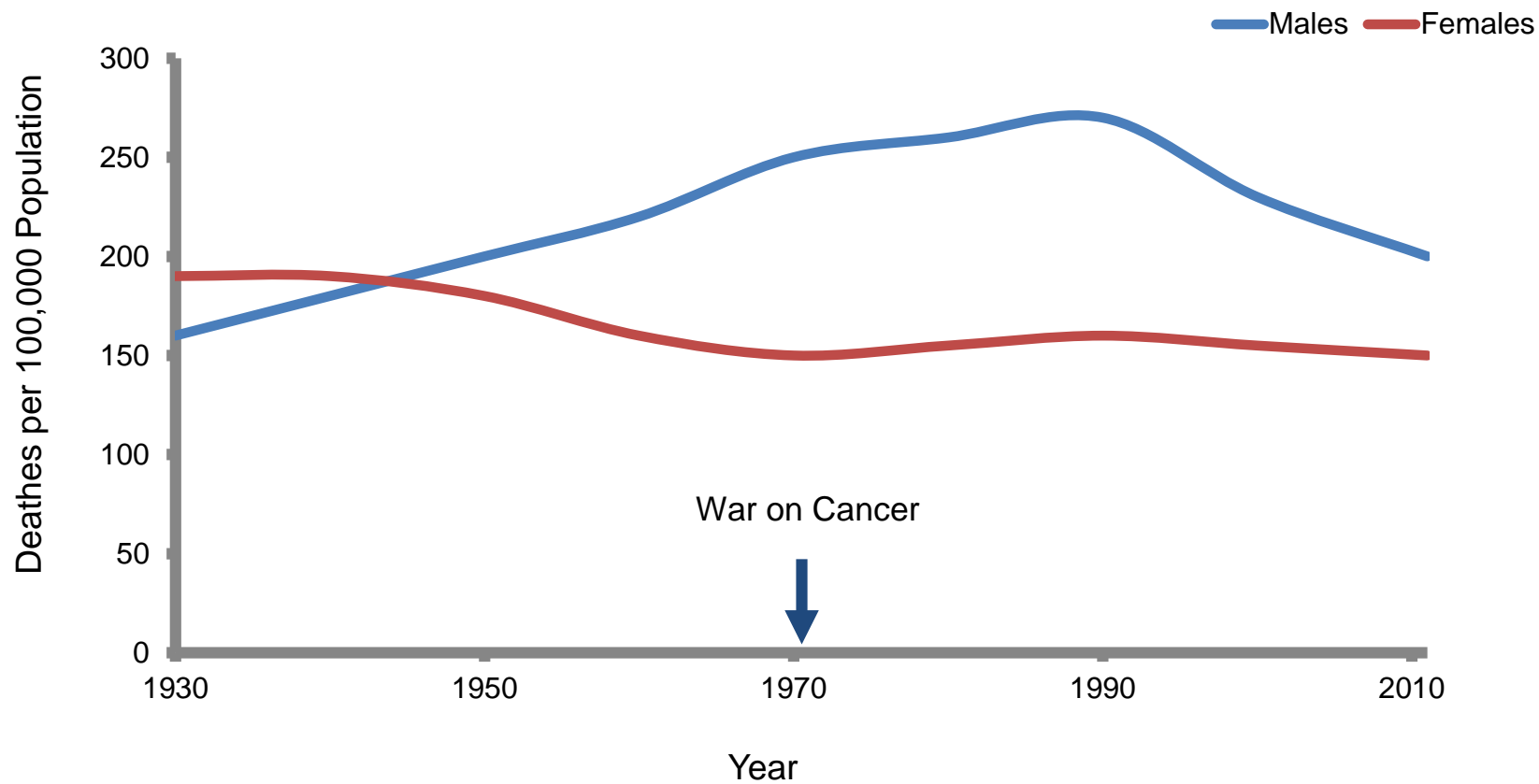
### 3. Hype over hope

“

The time has come in America when the same kind of concentrated effort that split the atom and took man to the moon should be turned toward conquering this dread disease. Let us make a total national commitment to achieve this goal.

”





Siegel et al. Cancer statistics, 2014. CA Cancer J Clin (2014)

Slide courtesy of Michael Joyner

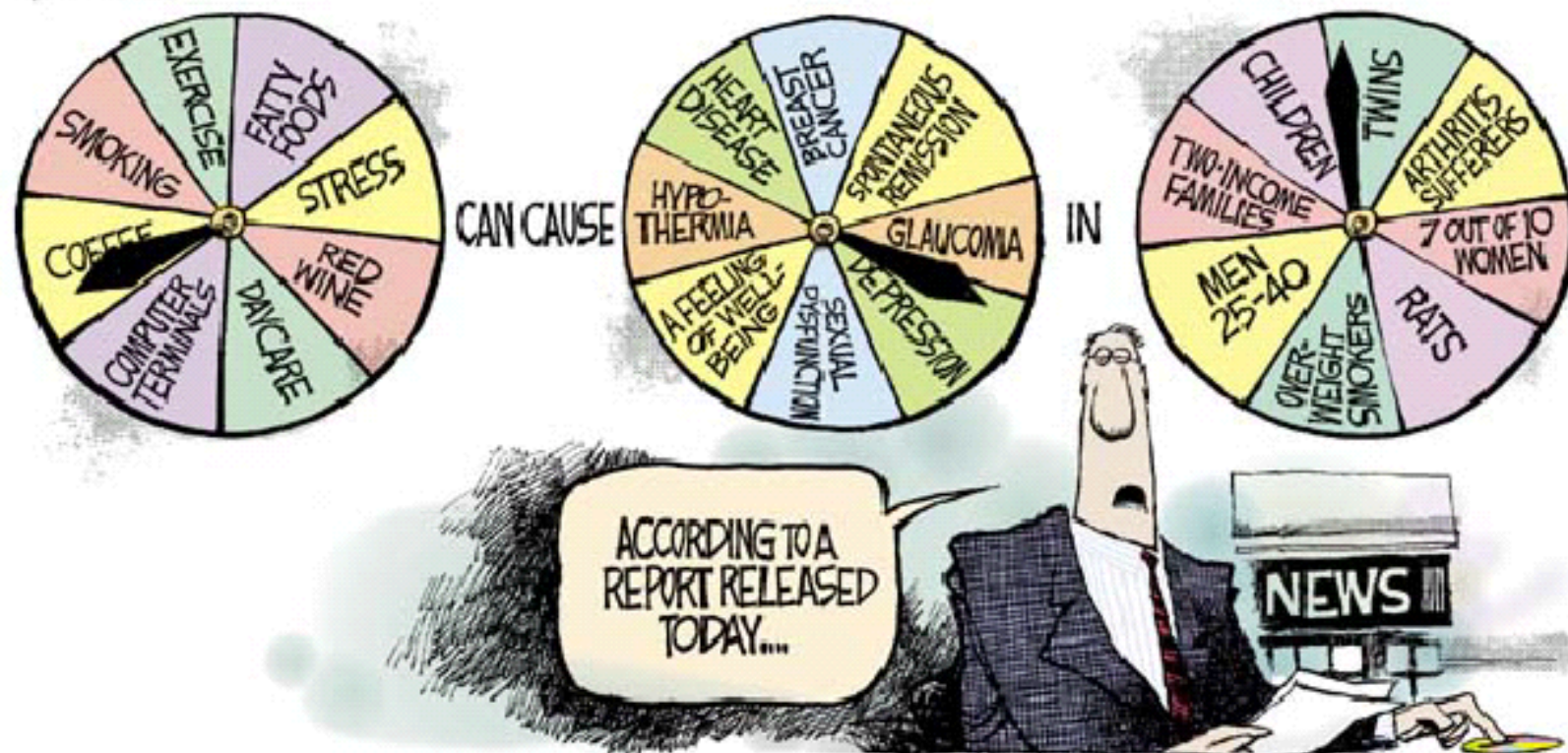
“

Last year, Vice President Biden said that with a new moonshot, America can cure cancer . . . .Let's make America the country that cures cancer once and for all. ”

# Today's Random Medical News

from the New England Journal of Panic-Inducing Gobbledygook

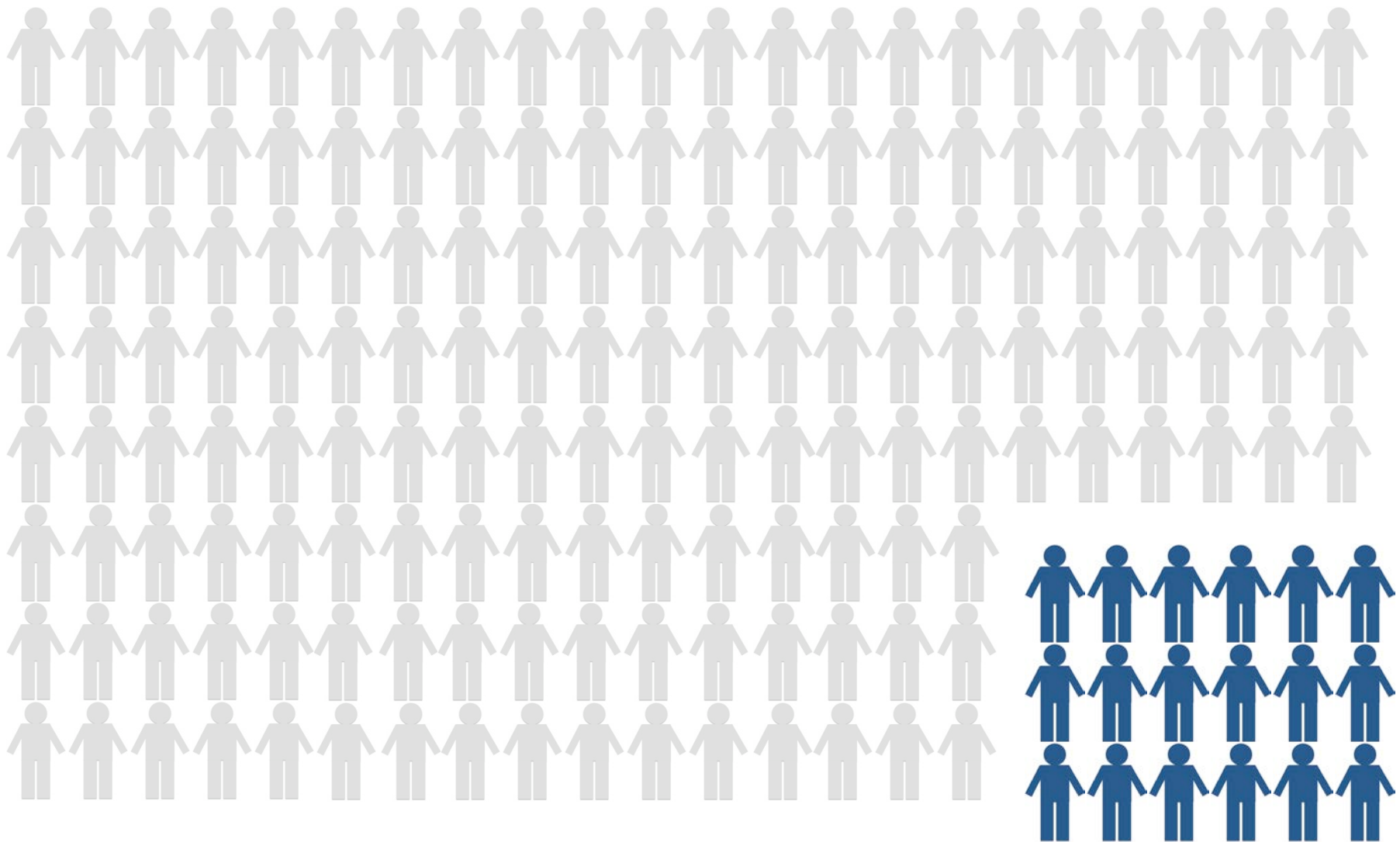
JIM BORGMAN

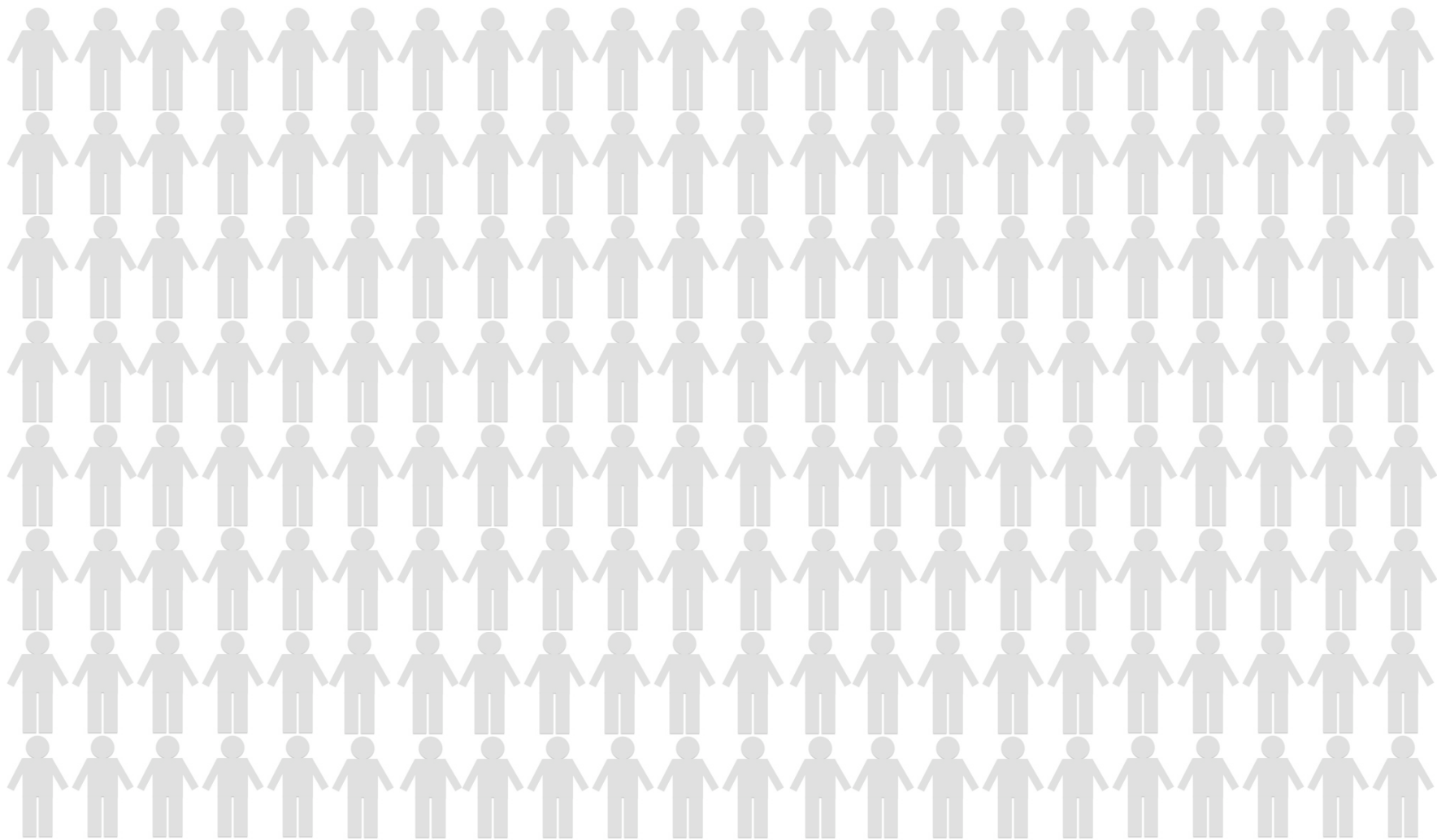


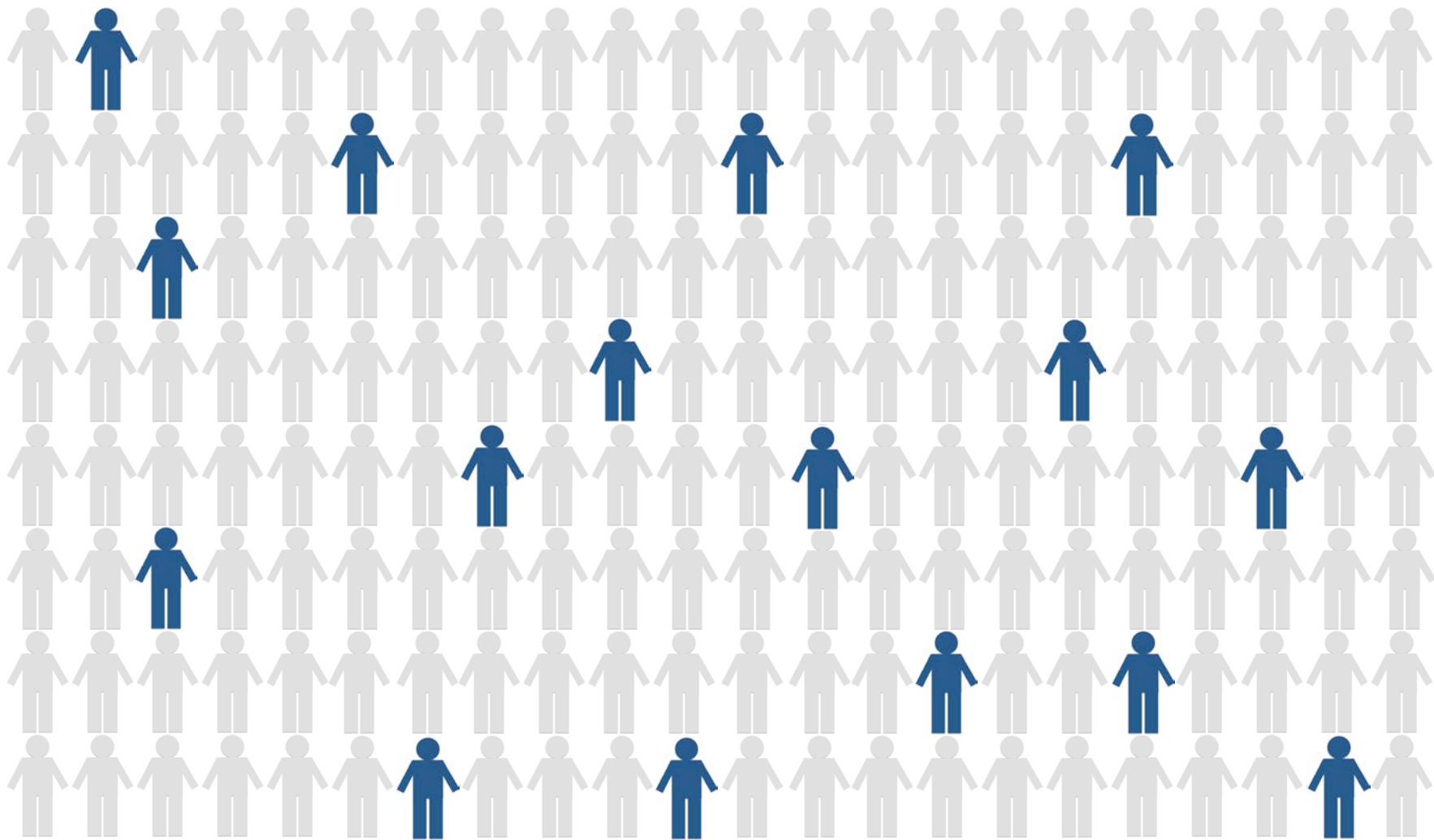
**Figure 3:** New England Journal of Panic-Inducing Gobbledygook.  
Source: Jim Borgman, The Cincinnati Enquirer (27 April 1997, E4).

Unless.

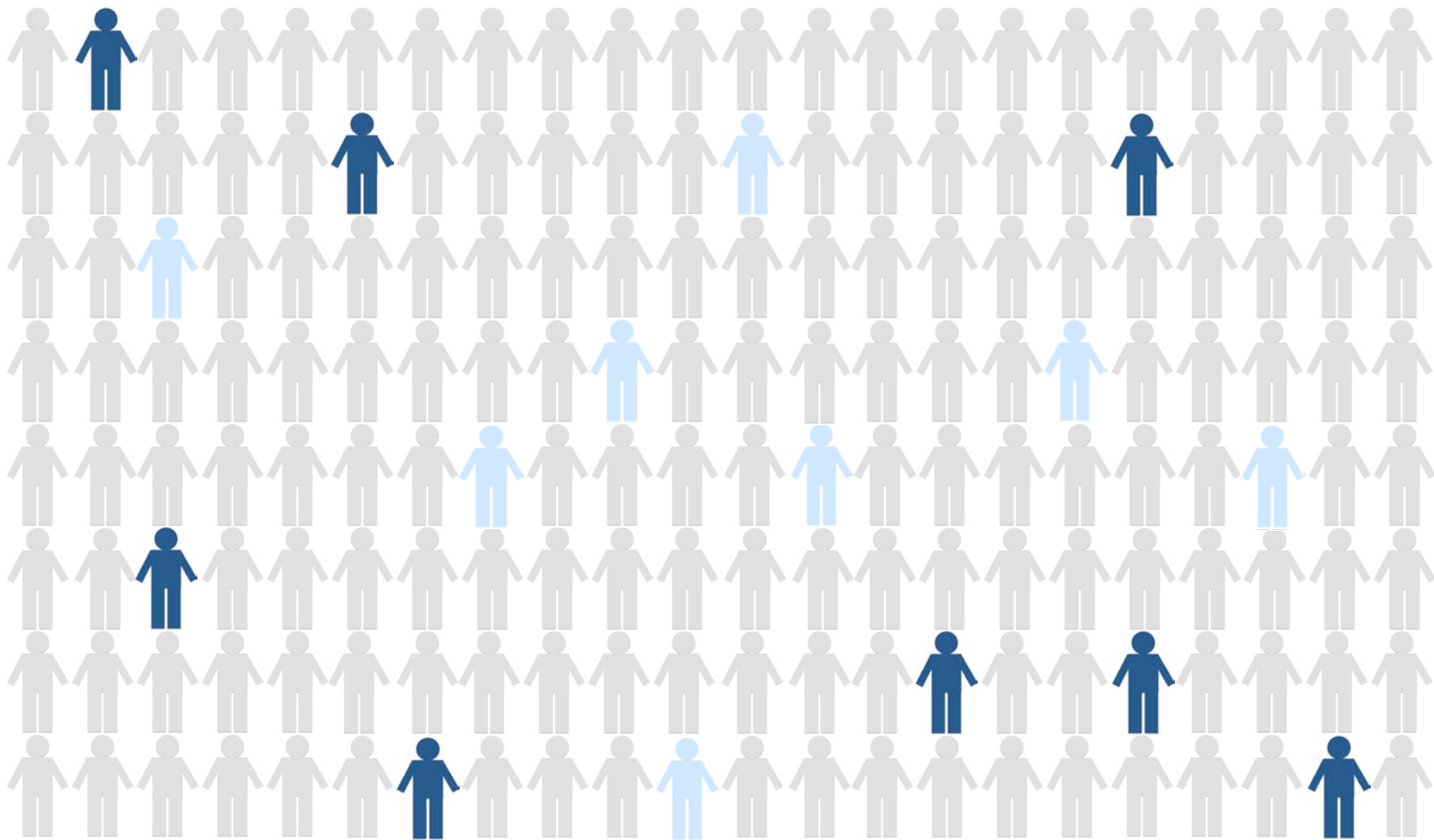












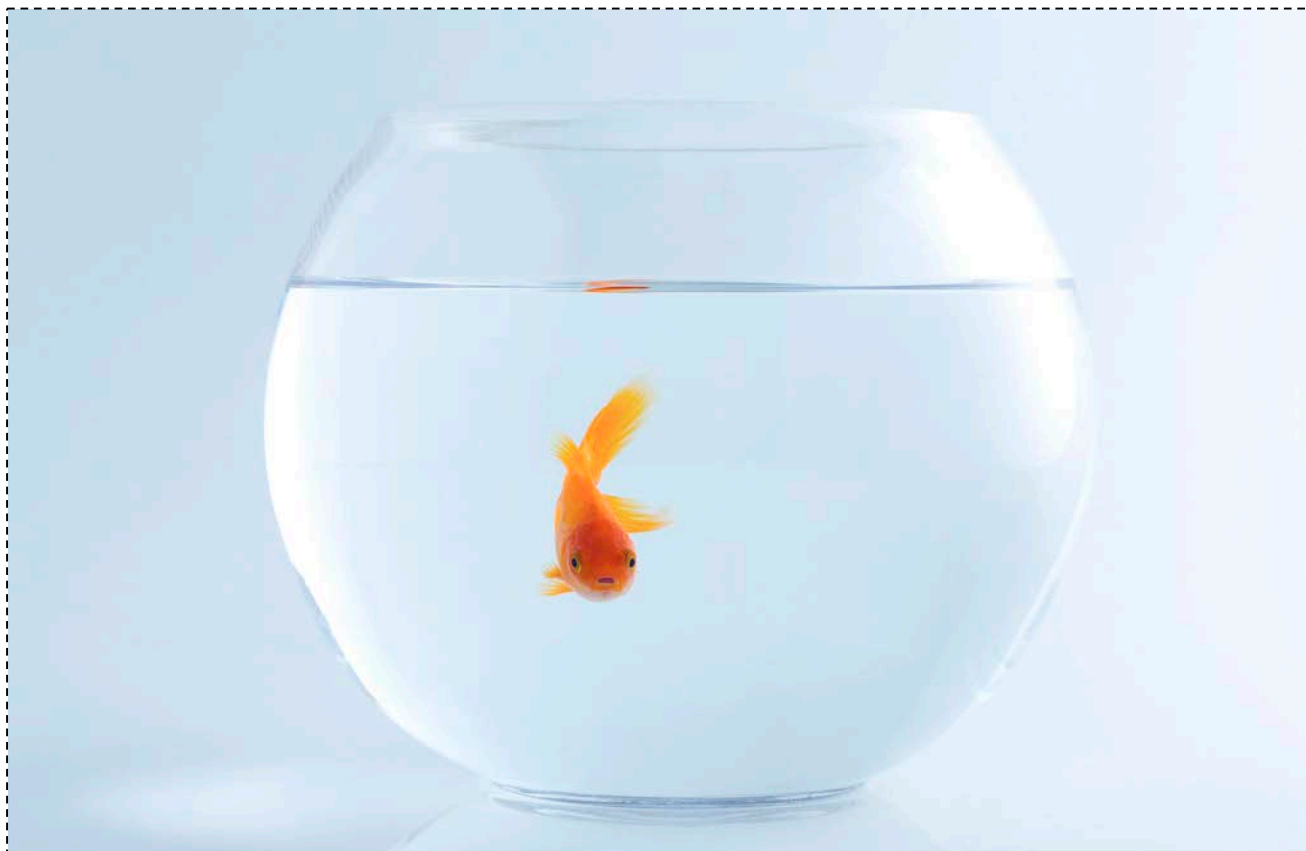
“

I know this is a formidable technical task, one that may not be accomplished before the end of this century. Yet, current technology has attained a level of sophistication where it is reasonable for us to begin this effort. It will take years, probably decades, of effort on many fronts. There will be failures and setbacks just as there will be successes and breakthroughs. And as we proceed we must remain constant ....but isn't it worth every investment necessary....We know it is! ”



*C. Barretti*

*"My loyal opposition wasn't loyal enough."*



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