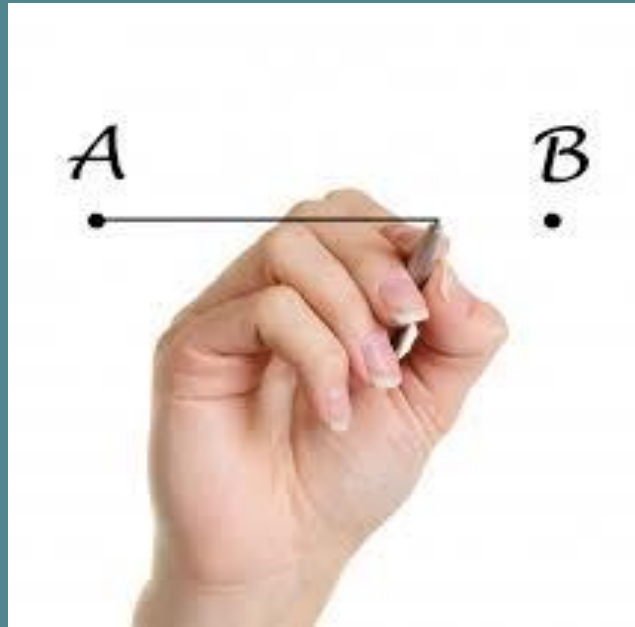


MAKING IT PERSONAL

*USING POPULATION HEALTH DATA AND
INCENTIVES TO DRIVE BEHAVIOR CHANGE*

Chris A. Jones, D.Phil., M.Sc.
Assistant Professor of Surgery and Economics
Director, Global Health Economics Unit
Vermont Center for Clinical and Translational Science

UNDERSTANDING BEHAVIOR



1. Early work
2. Data-driven personalized medicine
3. Reinforcing behavioral change

UNDERSTANDING BEHAVIOR



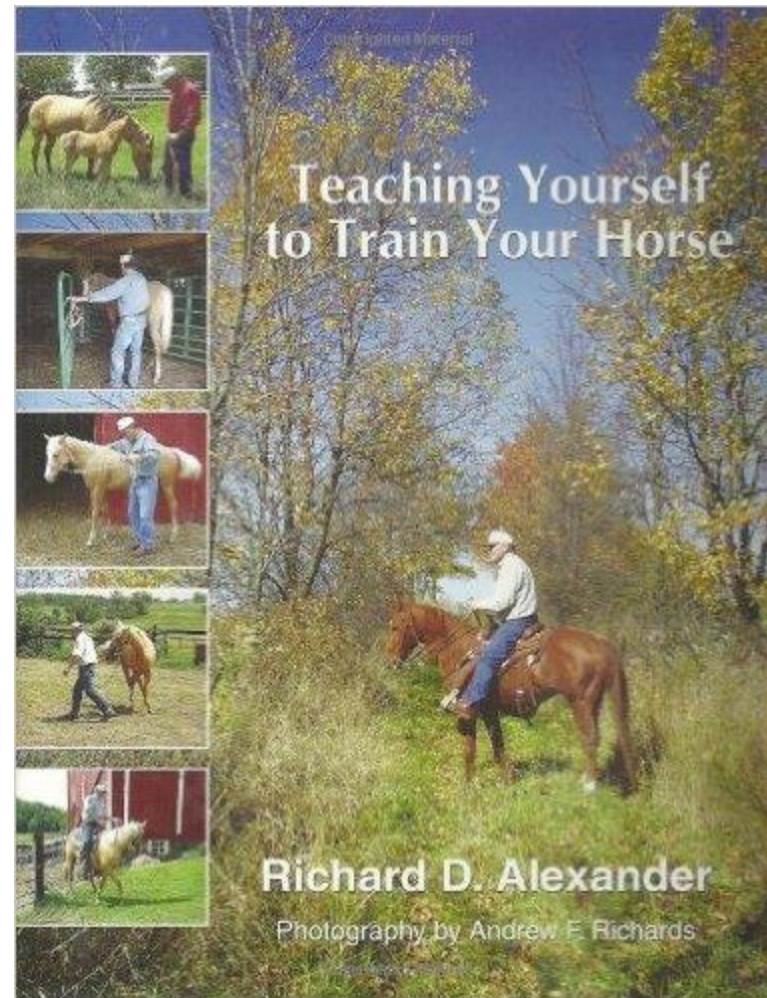
1. Early work
2. Data-driven personalized medicine
3. Reinforcing behavioral change

DISCLOSURES

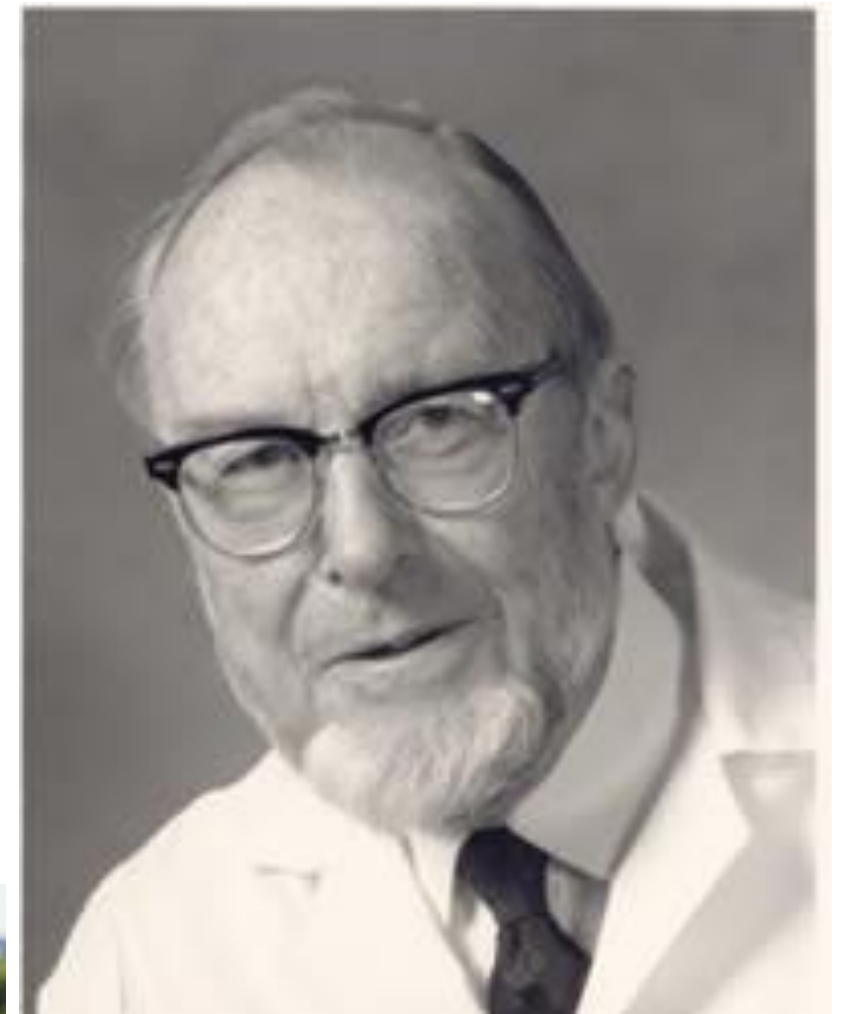
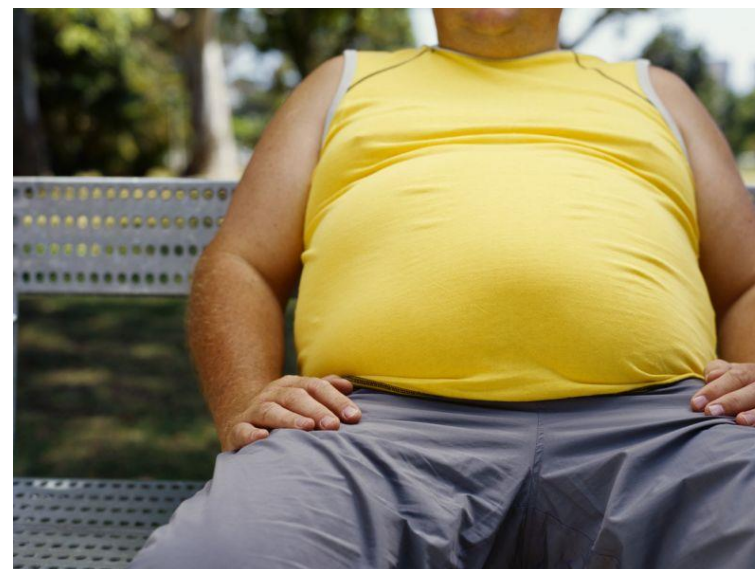
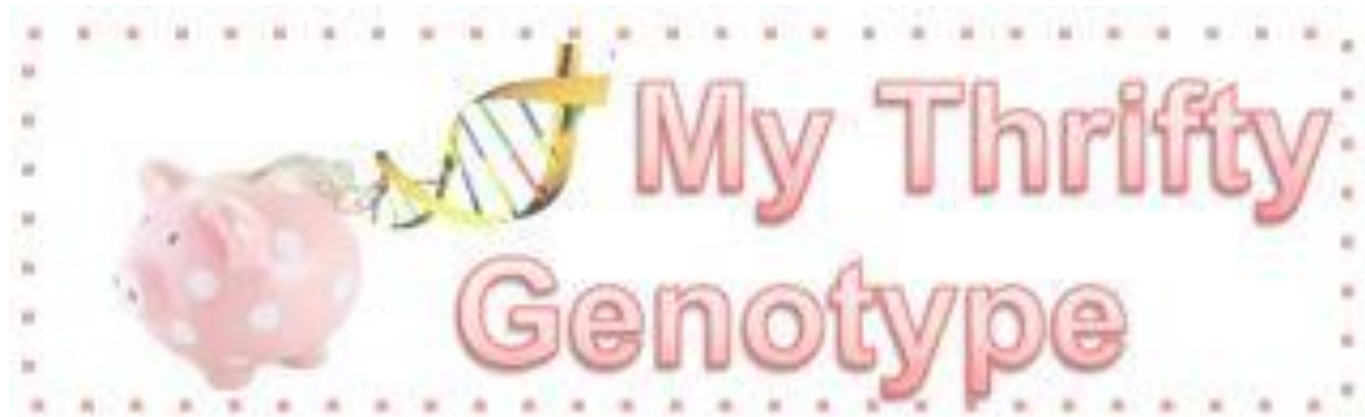
1. Financial (consulting to public companies)
 2. Corporate (ForMyOdds Inc, trUStr LLC)
 3. Reputational (pro-clinical decision support)
 4. Political (fundraising for presidential candidate)
- * Images adapted from Google and other sources



Richard D. Alexander (1925-)

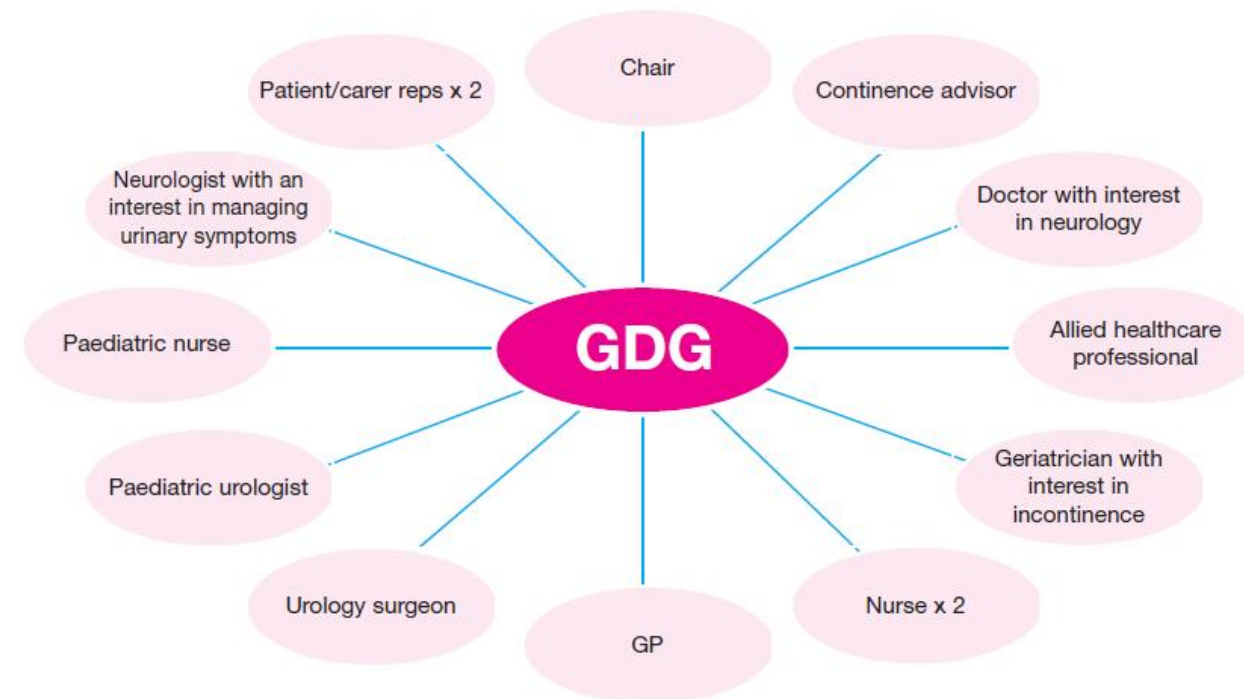


James V. Neel (1915-2000)

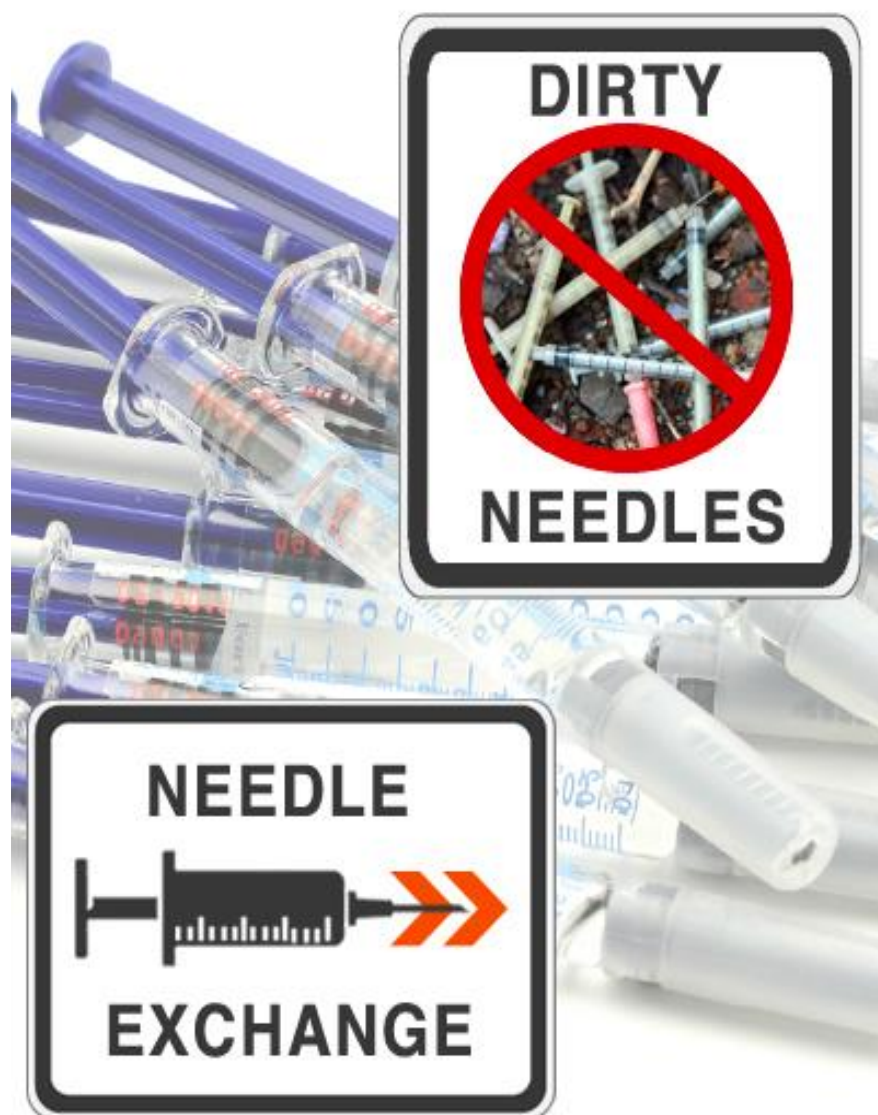




***National Institute for
Health and Clinical Excellence***





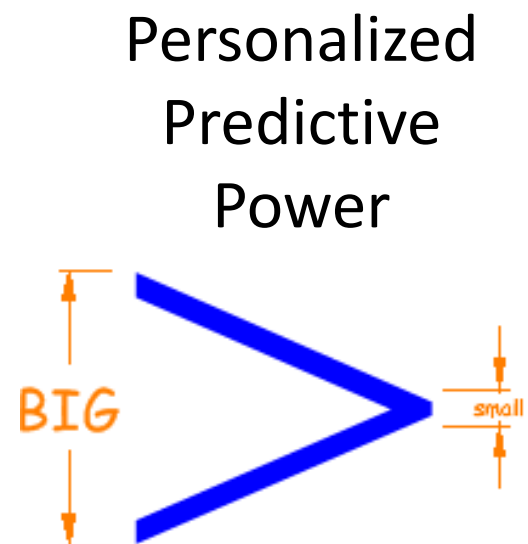
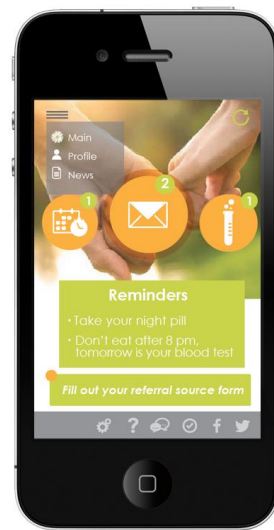




The NEW ENGLAND
JOURNAL of MEDICINE

Blickstein, Jones and Keith (2003). Zygotic splitting rates after single-embryo transfers in in vitro fertilization 348:2366-7.

Point-of-Care Predictive Algorithms



Improved
Clinical
Outcomes

Improved
Cost Savings

Improved
Patient
Satisfaction

Personalized IVF Report



ForMyFertility.co
m



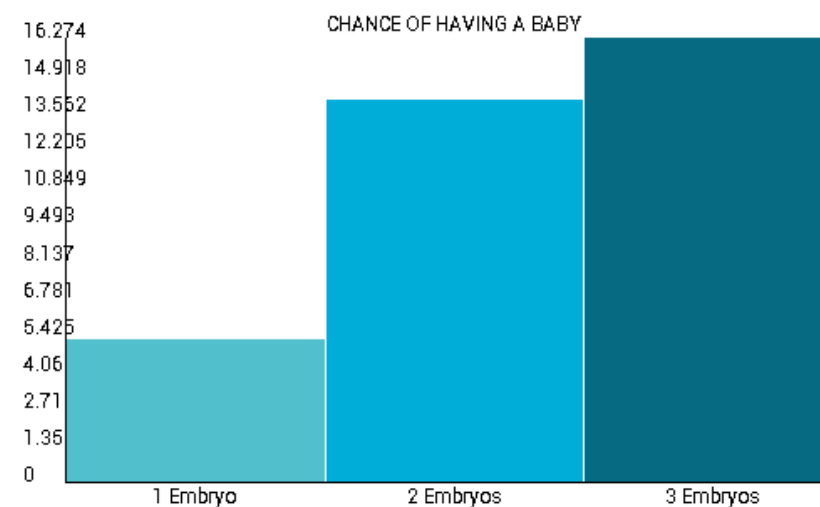
Your Report

home a baby after IVF is **18.7%**. Of all women who succeed in giving birth, **24.8%** are likely to have twins. On average, women who are on their 3rd cycle will have a **15.4%** probability of taking home a baby, and a **22.6%** probability of multiple births.

CHANCE OF HAVING A BABY

A woman's chance of taking home a baby depends in large part on how many good quality embryos are transferred at the time of IVF, her age, duration of infertility and other factors. If a woman like you were to undergo IVF today, the estimated chance of achieving a birth based on the information you provided us would be:

- **5.63%**, if **1 embryo** is transferred
- **15.19%**, if **2 embryo** is transferred
- **17.63%**, if **3 embryos** are transferred



CHANCE OF MULTIPLE BIRTHS

Often women undergoing IVF have multiple births



How It Works

The Functionality 1/4

□ Step 1

IVF Success Test

For My Odds Fertility Questions

To get started, please select an option below.

I am a Clinic/Healthcare Professional

I am an Individual

IVF Success Test Navigation

- Fertility ?'s
- Lifestyle ?'s
- Create Account
- Choose Report
- Additional ?'s

The Functionality 2/4

□ Step 2

IVF Success Test

For My Odds Fertility Questions

What is patient's age at the time of the proposed cycle of treatment?

31 ▼

How many years has the patient been trying to conceive?

1 ▼

Has the patient had a previous live birth?

☐ Yes ☒ No

Has the patient ever had an ectopic pregnancy?

☐ Yes ☒ No

Has the patient ever had a miscarriage?

☒ Yes ☐ No

We assume the patient has experienced at least 1 year of involuntary childlessness following unprotected and regular intercourse, and that she has undergone, is currently undergoing, or is considering undergoing in-vitro fertilization (IVF). Based on this assumption, for the proposed cycle of treatment:

How many eggs are, or do you expect will be, available for fertilization?

3 ▼

How many embryos are, or do you expect will be, available for transfer?

3 ▼

Admin

- Users
- Groups
- Clinics
- Logout

IVF Success Test Navigation

- Fertility ?'s
- Lifestyle ?'s
- Create Account
- Choose Report
- Additional ?'s
- Logout



The Functionality 3/4

□ Step 2 ...cont'd

How many embryos do you anticipate will be transferred on the upcoming cycle?

1

How many IVF treatment cycles has the patient completed to date?

1

Is the patient suffering from endometriosis?

☒ Yes ☐ No

Does the patient smoke?

☐ Yes ☒ No

What medication is the patient currently taking?

Follistim
Gonal-f
Clomiphene citrate
Antagon

Continue

The Functionality 4/4

□ Step 3 Sample Output (excerpt)

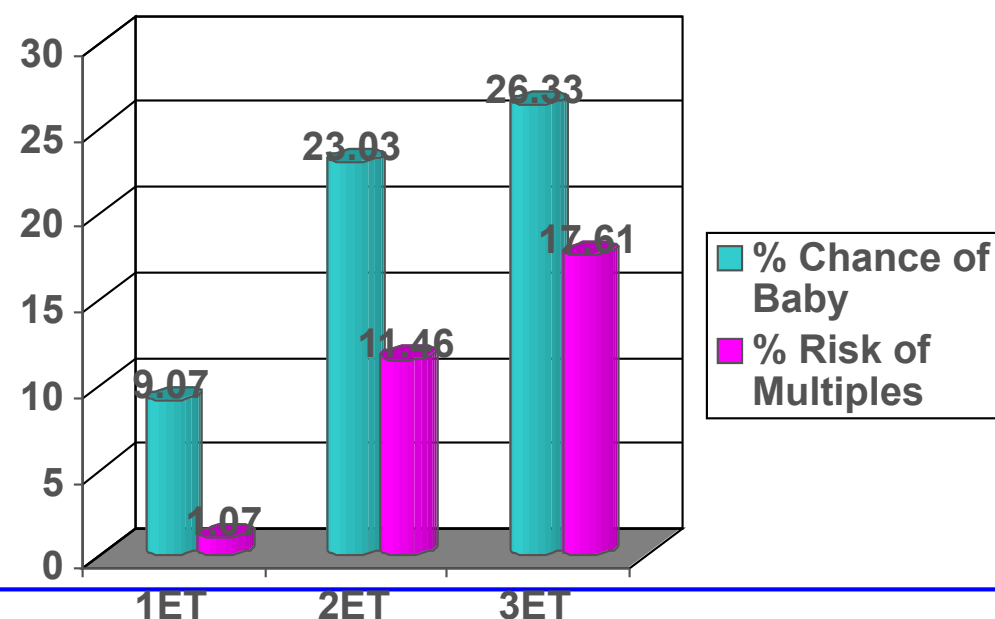
We calculated the probability of the patient taking home a baby following in-vitro fertilization (IVF). The probability of a successful cycle of IVF was calculated based on the assumption that the patient's chances of success are comparable to others in similar circumstances.

For reference, the average probability of taking home a baby after IVF is **18.7%**. Of all women who succeed in giving birth, **24.8%** are likely to have twins. On average, women who are on their 2nd cycle will have a **16.2%** probability of taking home a baby.

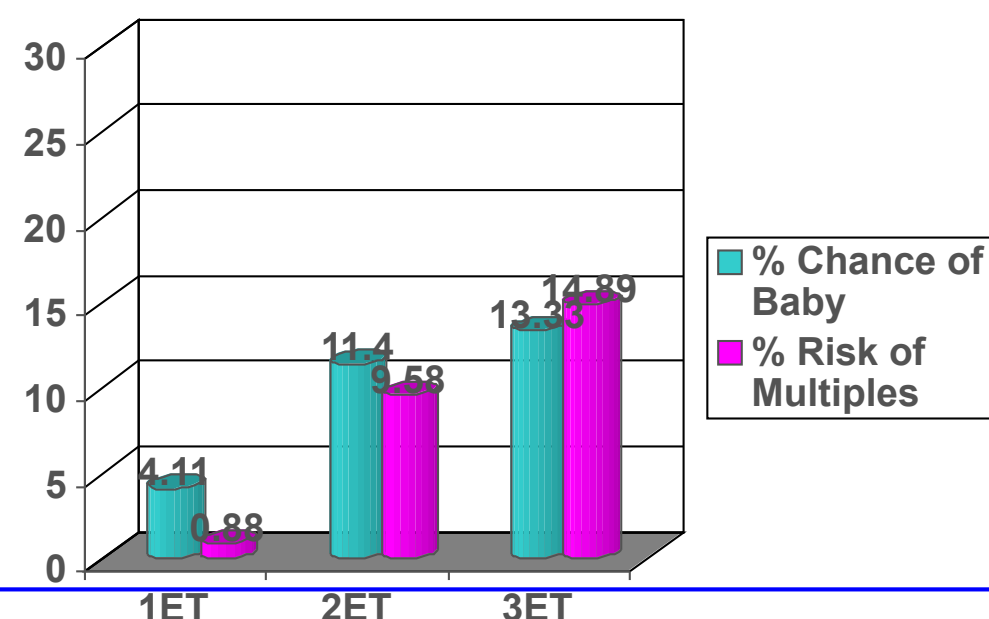
CHANCE OF HAVING A BABY

A woman's chance of taking home a baby depends in large part on how many good quality embryos are transferred (“ET”) at the time of IVF, her age, duration of infertility and other factors. If a woman like you were to undergo IVF today, the estimated chance of achieving a birth based on the information you provided us would be:

Chances Starting Treatment Now



Fast Forward: chances if Treatment Delayed by 5 years



The Confirmation

□ Doctor Verification

- **Agree with treatment algorithm?**
- Recommend a different treatment algorithm?

Real Example: Our Fertility Algorithm

What does this mean in terms of cost savings?

Society is Paying for Downstream Consequences:

✓ Treatments...

✓ Reducing just one ineffective cycle of treatment will save patients \$15,000.

Reducing this risk to just 17% of the annual IVF patients who might otherwise receive sub-optimal care would realize a worldwide cost savings of over \$1 billion per year.

❖ *[15,000 * 50 patients per clinic of average size (equal to 300) * 500 US fertility clinics = \$375 million in savings for the US alone. Another \$375 million in savings for Europe and another \$375 million for ROW].*

✓ Outcomes...

✓ Eliminating risk of twins also means an avg. savings of over \$15,000 that would otherwise be needed in the first 5 years of life, relative to singleton babies. Eliminating this risk to just 10 families per clinic per year would realize cost savings of \$225 million year.

❖ *[10 * 500 * 15,000 = \$75 million in the US, \$75 million in Europe, and \$75 million for ROW]*

Users/Contributors



The Testimonials



Dr. Christopher Jones
Senior Research Associate,
Centre for study of Multiple birth,
Suite 10.15
680 North Lake Shore Drive,
Chicago,
Illinois
60611
USA

21 May 2007

Dear Christopher,

Re: Analysis of HFEA Data

Thank you for taking the time to visit myself and Dr. Christopher Barrett at the HFEA during the Easter break. I am happy to re-affirm the comments previously sent by email.

In the coming weeks the HFEA will take the time to compare the raw data used in your dissertation to the current Register. As you know the HFEA does not have the resources to check the accuracy of the calculations and assumptions, so is unable to vouch for the accuracy of the output. We do however thank you for the work that you are doing, look forward to reading your published work and appreciate you providing a copy of your dissertation as well as the original data set that we gave to you in 1999.

I was very pleased to hear that your presentation to CDC went well and appreciate the contact details which you forwarded.

Yours sincerely,

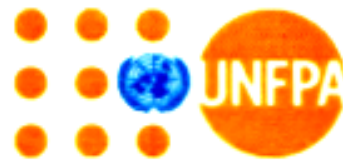
David Tellis

A handwritten signature in dark ink, appearing to read "D Tellis", is positioned above the typed name.

David Tellis
Director of Information Management & Technology

David.Tellis@HFEA.GOV.UK

The Testimonials



February 8, 2011

Dear Dr. Jones,

Thank you for taking the time to present the modeling capabilities of Formyodds.com. We were actually able to use your software for predicting individual chances of taking home a baby following treatments with assisted conception, and can see how this technology can be easily expanded to other disease states for which data are available. We are even more interested in your plans to expand into research, such as research into chronic diseases that plague in both the developed and developing worlds.

Furthermore, it seems that Formyodds.com could assist lesser-trained staff, some of which are in the field, to identify and treat those who are most at need. Formyodds.com could also be useful to other service corps (such as volunteer forces, national armed services, etc.) for predicting individualized chances of disease, and individualized chances of recovery.

In summary, your software service is entirely unique and I believe it will change treatment practice for the better. I have discussed it with Dr. Aleksandar Bodiroza, the head of the Reproductive Health unit for the Arab States at UNFPA and we look forward to collaborating in the months ahead.

Sincerely,

A handwritten signature in black ink, appearing to read 'Stakic', is written over the typed name 'Dr. Srdjan Stakic'.

Dr. Srdjan Stakic
Senior Technical Advisor
United Nations Population Fund
605 Third Avenue
New York, New York 10158
United States

ORPHAN DRUG ACT OF 1983

7,000

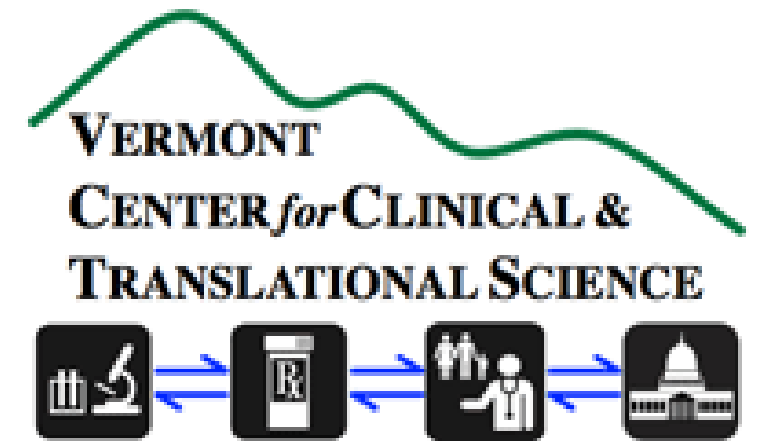
rare diseases,
affecting 20
million people
in the U.S alone





The
UNIVERSITY
of **VERMONT**

DEPARTMENT *of* SURGERY



EXAMPLES: DATA-DRIVEN TOOLS

1. Mammography
2. Aneurysm Repair

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

Ready to Start?

Let's Begin

Tracking data anonymously.

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

Does patient have a family
history of breast or ovarian
cancer?

YES

NO

CANCEL

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

Breast cancer only?

YES

NO

CANCEL

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations Mammography Options

IBIS
MODEL

Gail
MODEL

BOADICEA
MODEL

Claus
MODEL

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

BOADICEA: The Breast and Ovarian Analysis of Disease Incidence and Carrier Estimation Algorithm (BOADICEA) is a computer program that is used to calculate the risks of breast and ovarian cancer in women based on their family history. It is also used to calculate the probability that they are carriers of cancer-associated mutations in the BRCA1 or BRCA2 gene

OK

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations Mammography Options

IBIS
MODEL

Gail
MODEL

BOADICEA
MODEL

Claus
MODEL

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

You said you didn't agree with the previous result. Would you take a moment to tell us why?

Underestimates patient's risk

Overestimates patient's risk

Inappropriate selection of patient risk factors

Not familiar/comfortable with this model

Other (fill out text response)

NEVERMIND

[Click here for more apps!](#)

NEXT SCENARIO : MORE GRANULAR

READY TO START?

HealthCareEvaluations

Mammography Options

Ready to Start?

Let's Begin

Tracking data anonymously.

[Click here for more apps!](#)

FAMILY HISTORY

HealthCareEvaluations

Mammography Options

Does patient have a family
history of breast or ovarian
cancer?

YES

NO

CANCEL

[Click here for more apps!](#)

PATHOLOGICAL RISK FACTORS

HealthCareEvaluations Mammography Options

Any benign pathological risk factors?

YES

NO

CANCEL

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations Mammography Options

**IBIS
MODEL**

**Gail
MODEL**

**BOADICEA
MODEL**

**Claus
MODEL**

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

MAMMOGRAPHY INSIGHT

HealthCareEvaluations

Mammography Options

Please fill in the reason you disagree with our suggestion.

type info here...

SUBMIT

NO THANKS

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations

Mammography Options

Claus: Developed using data from the Cancer and Steroid Hormone Study, a nested population-based case-control study conducted between 1980 and 1982 using breast cancer patients registered in eight Surveillance, Epidemiology, and End Results regions. Only uses family history to estimate risk; incorporating first- and second-degree relatives and age of diagnosis. The Claus lifetime risk tables reflect risks for North American women in the 1980s

OK

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

MAMMOGRAPHY OPTIONS

HealthCareEvaluations Mammography Options

Review the latest research on this topic.

CLICK HERE

To be redirected to a list of the most up to date,
relevant articles and findings on this subject.

CANCEL

Click here for more apps!

MAMMOGRAPHY OPTIONS

HealthCareEvaluations Mammography Options

Review the most recent articles on this subject:

Genetic testing for hereditary breast and ovarian cancer syndrome	READ
Overview of the treatment of newly diagnosed, non-metastatic breast cancer	READ
Breast cancer in men	READ
Clinical features, diagnosis, and staging of newly diagnosed breast cancer	READ
Breast reconstruction: Prosthetic devices	READ
Breast reconstruction: Autologous tissue	READ

[CANCEL](#)

[Click here for more apps!](#)

ENDOVASCULAR VERSUS OPEN ANEURYSM REPAIR

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Patient's age?

54

NEXT

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Was the patient transfered to
this hospital?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Does the patient have a
history of COPD?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Does the patient use
beta-blockers?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Does the patient have
creatinine levels greater than
1.5?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Does the patient have an Iliac
Aneurysm?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

Does the patient have an
ejection fraction greater than
30%?

YES

NO

CANCEL

[Click here for more apps!](#)

SURGERY OPTIONS

HealthCareEvaluations

Surgery Options

OPEN

EVAR

Do you agree with this result?

YES

NO

[Click here for more apps!](#)

SURGERY OPTIONS

OPENEVAR

HealthCareEvaluations

Surgery Options

You said you didn't agree with the previous result. Would you take a moment to tell us why?

Morphology of AAA speaks for open repair

Morphology of AAA speaks for EVAR

Either repair is acceptable but surgeon expertise is open

Either repair is acceptable but surgeon expertise is EVAR

Pt strongly prefers EVAR/OPEN.

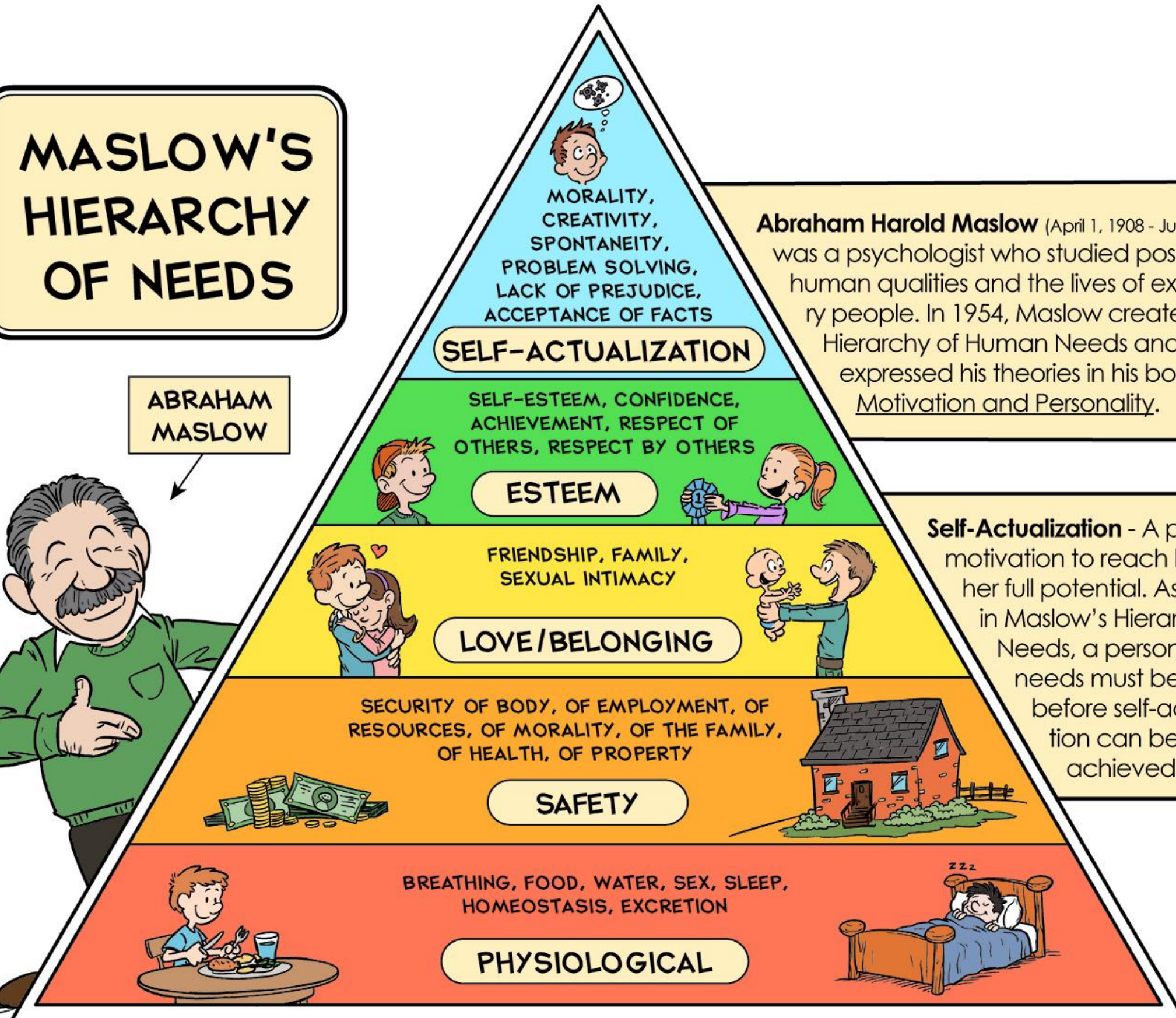
Other (fill out text response)

NEVERMIND

[Click here for more apps!](#)

MASLOW'S HIERARCHY OF NEEDS

ABRAHAM MASLOW



Abraham Harold Maslow (April 1, 1908 - June 8, 1970) was a psychologist who studied positive human qualities and the lives of exemplary people. In 1954, Maslow created the Hierarchy of Human Needs and expressed his theories in his book, Motivation and Personality.

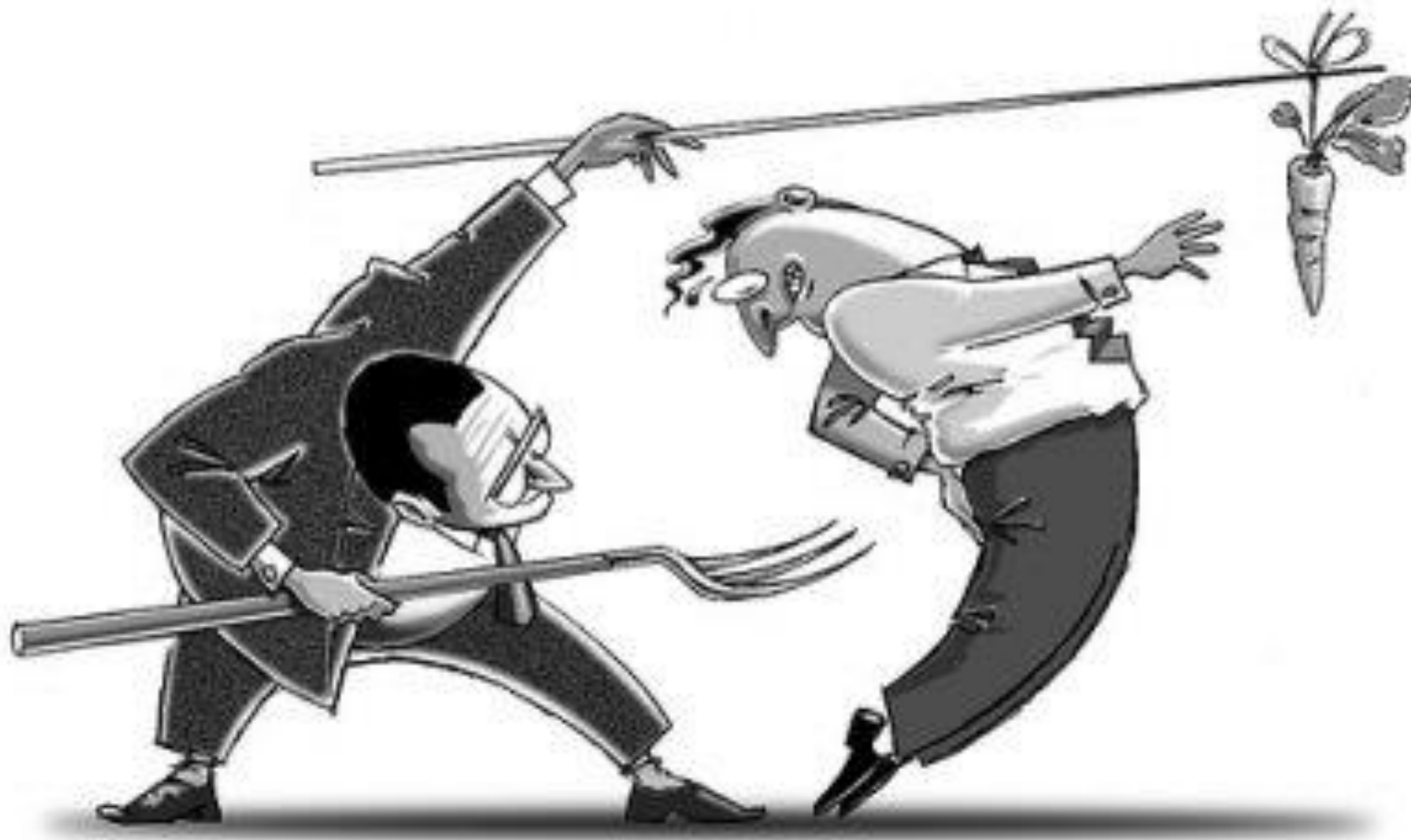
Self-Actualization - A person's motivation to reach his or her full potential. As shown in Maslow's Hierarchy of Needs, a person's basic needs must be met before self-actualization can be achieved.

MOTIVATING HEALTHY CHANGE

Incentives are great for short-term, simple
change:

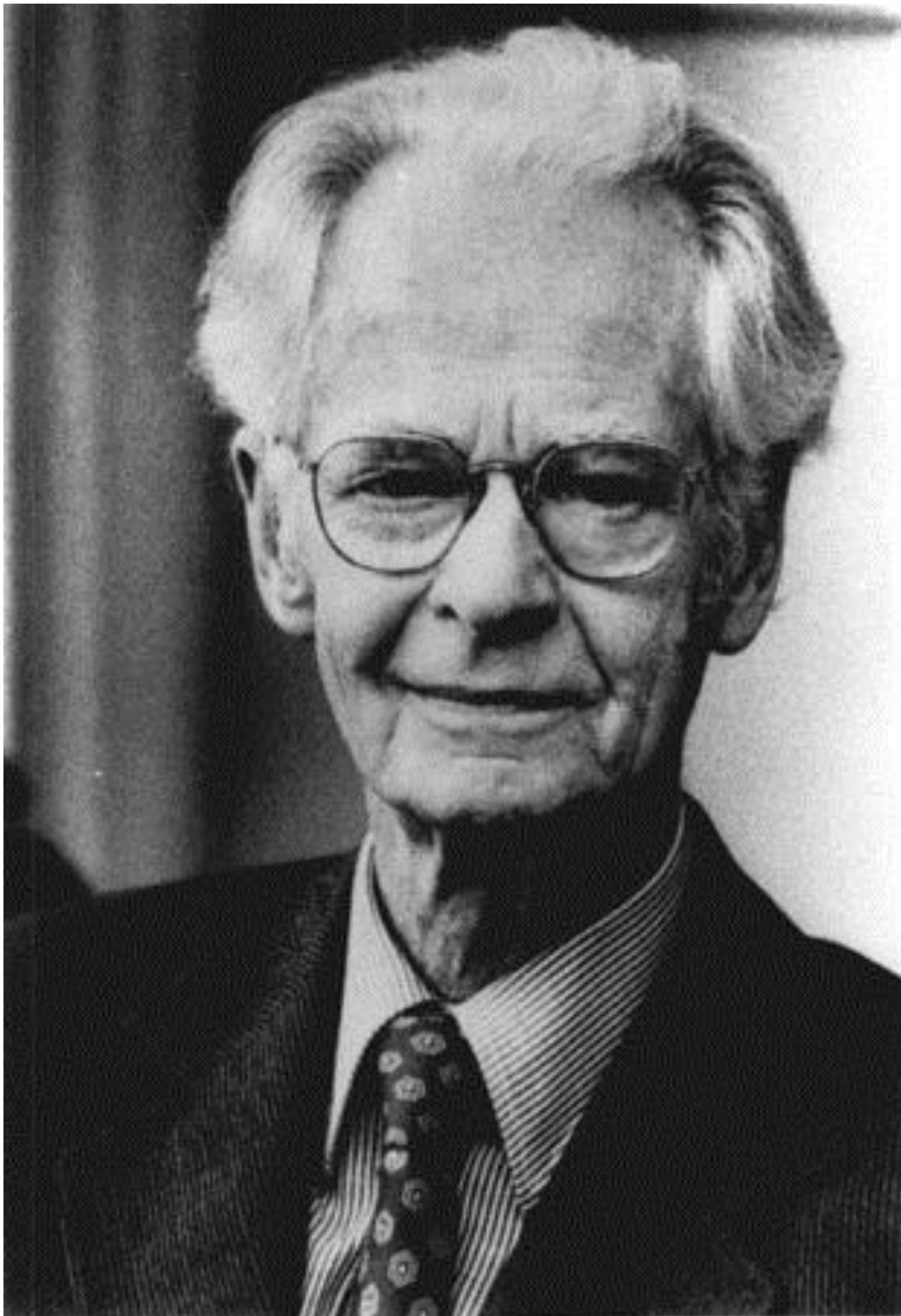
<https://www.youtube.com/watch?v=iRb94IbL13>

8



<http://empoweringthematuremind.com/austin-votes-sticks-vs-carrots-w-zero-step-ordinance/>

Burrhus. F. Skinner (1904- 1990)



[https://www.youtube.com/watch
?v=vGazyH6fQQ4](https://www.youtube.com/watch?v=vGazyH6fQQ4)

Journal of Personality and Social Psychology, 1973, 28, 129-137.

Undermining Children's Intrinsic Interest with Extrinsic Reward: A Test of the "Overjustification" Hypothesis

Mark R. Lepper and David Greene
Stanford University

Richard E. Nisbett
University of Michigan

A field experiment was conducted with children to test the "overjustification" hypothesis suggested by self-perception theory—the proposition that a person's intrinsic interest



is were exposed to one of three conditions: expected-award condition, subjects engaged in the activity in order to obtain an expected reward; no-award condition, subjects engaged in the activity without the reward until after they had completed the activity; and in the no-award condition, subjects did not receive the reward. The results showed that subjects in the expected-award condition showed less subsequent intrinsic interest than subjects in either of the

in an activity may be decreased by inducing him to engage in that activity as an explicit means to some extrinsic goal. Children showing intrinsic interest in a target activity

actions were intrinsically motivated. In a self-perception analysis, this outcome is simply the result of a self-directed inference process. In the low-justification conditions, the subject infers from his behavior and the lack of apparent external pressure that he must have wished to act as he did; while in the high-justification conditions, the subject infers that his behavior was determined by the external pressures in the situation.

Besides its application to many classic dissonance paradigms, self-perception theory has a number of heuristic

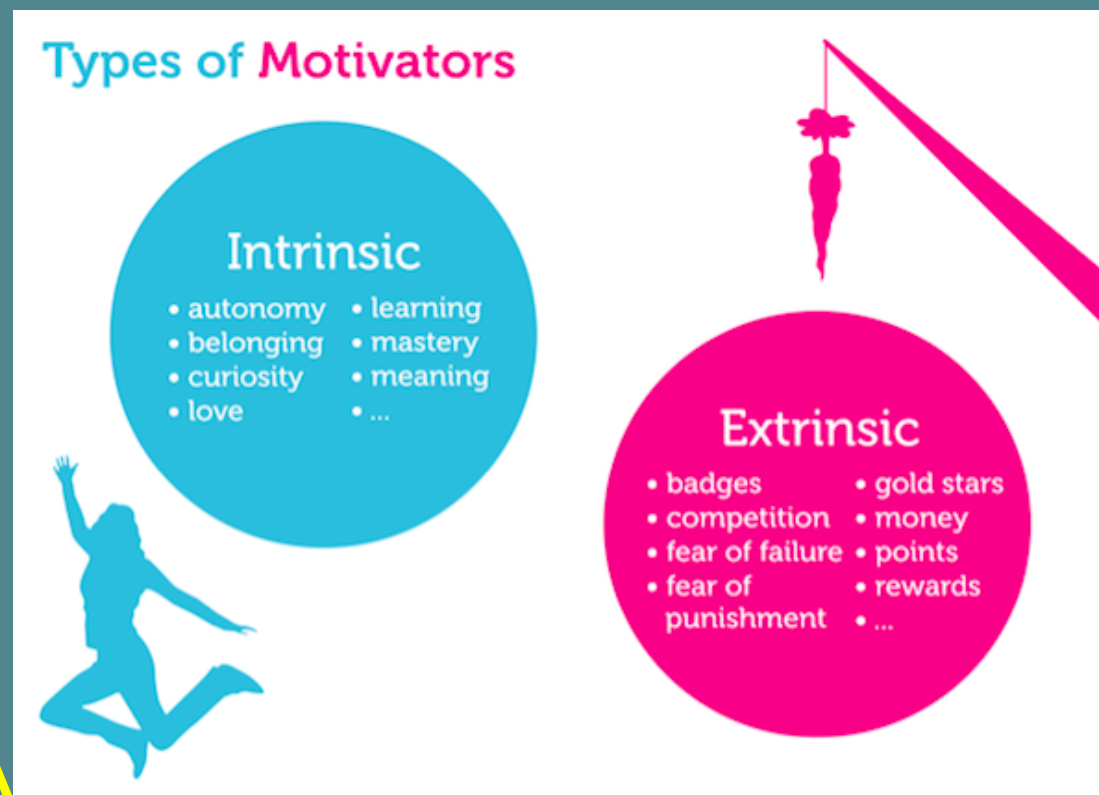
3 Groups of Kids
Promised Good Drawing Award
Unexpected Good Drawing Award
No Award

...eks to ...
...to discern the causes of events and explain the behavior of others of central concern to social psychology (e.g., Brunswik, 1934; Heider, 1958) only in the past few years have psychologists themselves with the process by which one understands his own actions and the actions of others (e.g., Asch, 1951; 1967, 1972; Jones & Davis, 1965; Jones, Kanouse, Kelley, Nisbett, Valins, & Weiner, 1972; Kelley, 1967). Recently, theoretical analyses of the process of self-perception or self-attribution by Bem (1965, 1967) and by Kelley (1967) have suggested that processes of self-perception have a common ground with those of other-perception.

When an individual observes another person engaging in

activity itself. In short, a person induced to undertake an inherently desirable activity as a means to some ulterior end should cease to see the activity as an end in itself.

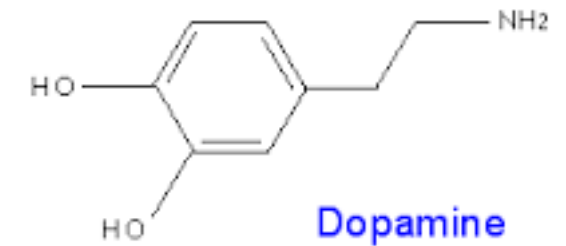
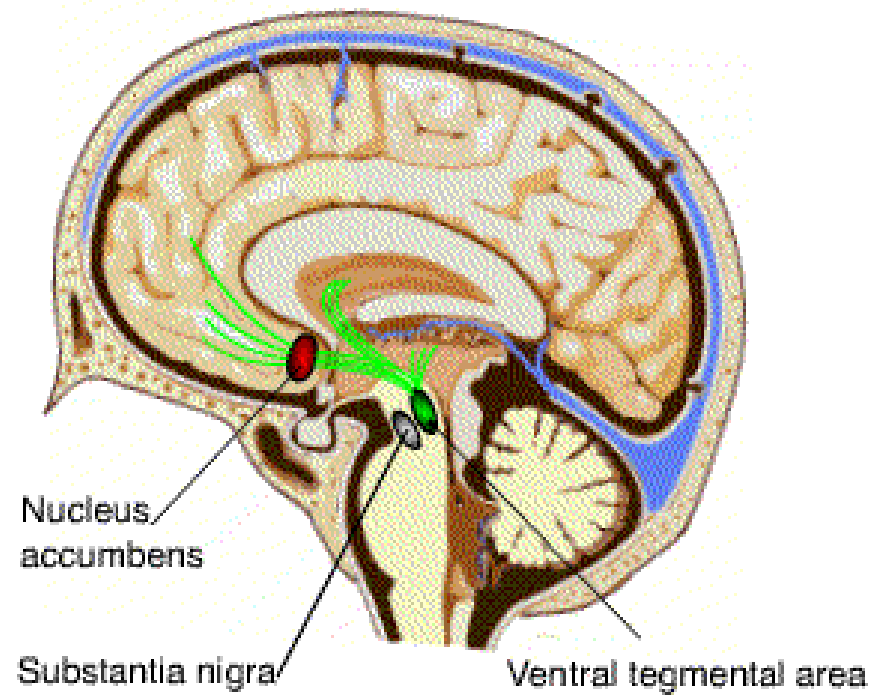
While the existence of such an overjustification effect has been postulated by a number of authors (DeCharms, 1968; Deci, 1971; Kruglanski, Friedman, & Zeevi, 1971; Lepper, 1973; Nisbett & Valins, 1971), this proposition



REWARDS ≠ RECOGNITION
≠ INCENTIVES ≠

Rewards and recognition are given when you've done something,
incentives are given *so that you do* something

Pleasure Reward Pathway



MESOLIMBIC DOPAMINERGIC SYSTEM



trUStr rewards

A fitness-rewarding
smartphone app



Premise:
Rewards can
be
personalized



<http://stockproject1.deviantart.com/art/Pocket-Watch-3663976-182511090>

Found on www.etsy.com

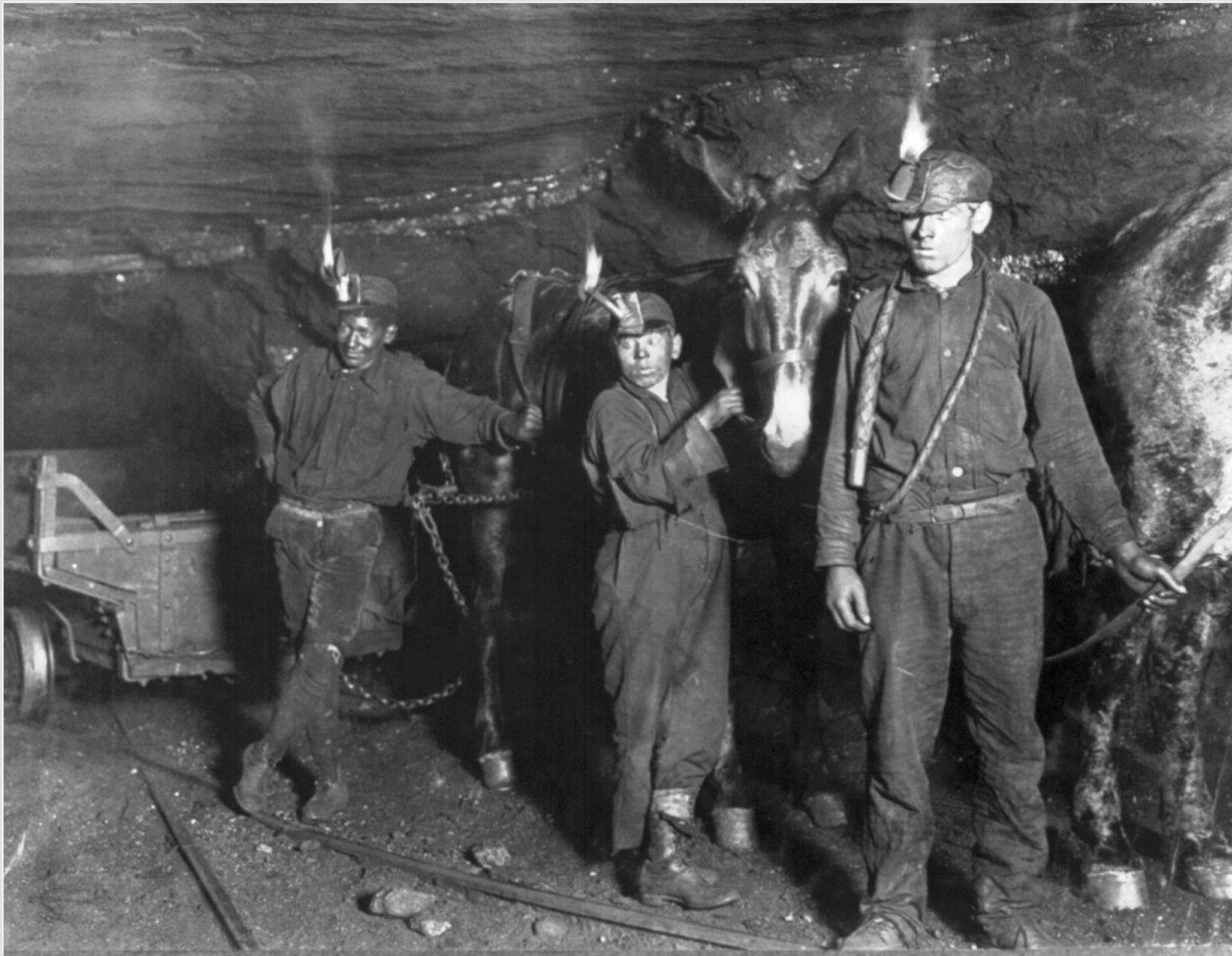




www.iphone.com

www.iphone5cases.com





Coal mining, West Virginia (1908):

https://en.wikipedia.org/wiki/History_of_coal_mining_in_the_United_States



Downloaded 25 Aug 2015--<http://siliconangle.com/blog/2012/04/04/your-guide-to-choosing-a-business-intelligence-tool/data-mining-big-data/>



Logging

www.fs.fed.us



Life Logging



1,369 1,368 1,367 1,366

<http://mashable.com/2014/03/20/lifeloggging-experiment/>

Thank You

Department of Surgery
Department of Economics
Global Health Economics Unit
Computational Story Lab
University of Vermont

