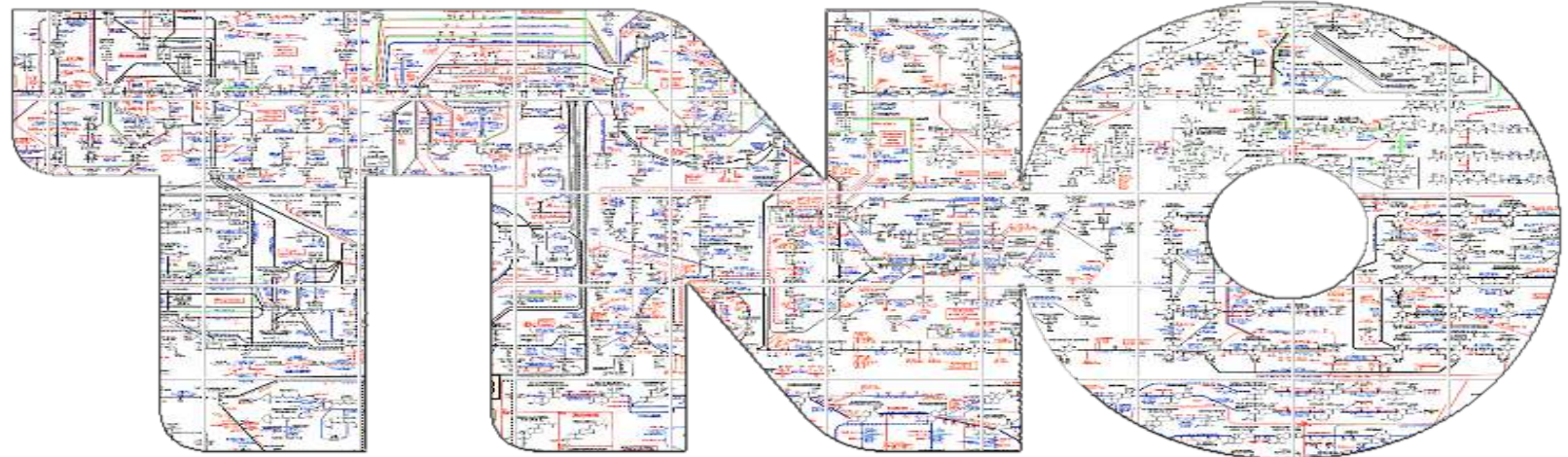# State of the Science and Technology in Personalized Nutrition
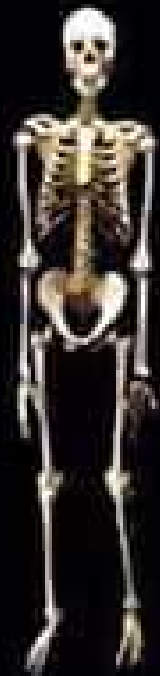
Ben van Ommen

Personalized nutrition – the questions

- Are we different in our nutritional needs?

- What is my optimal nutrition
    - What is my health?
    - What do I know about my health
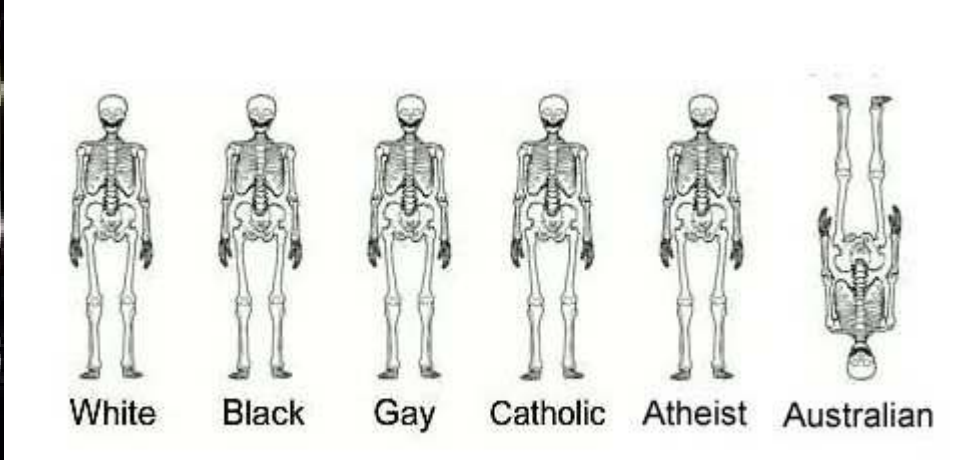
- How can I act upon it?

Different from the inside…

Different from the outside…

Health

External exposome

Air, water, dietary, soil contaminants, occupation, drugs, behaviours, social factors, *etc*.

Cl_n Cl_m

Microbiota

Internal exposome

Epigenome

DNA methylation, miRNA, histone proteins

CH_3

Transcriptome

RNA

Proteome

Proteins

Metabolome

Metabolites

OH

Genome
DNA sequence

Environment | Body

TNO innovation for life

disease areas

Parkinson

Rheumatoid Arthritis

Alzheimer

Multiple Sclerosis

Ulcerative Colitis

Hypertension

CVD

Hyper-cholesterolemia

Type 2 diabetes

obesity

Metabolic syndrome

Sarcopeny

Osteo porosis

allergies

COPD

Inflammatory Bowel Syndrome

Crohns disease

Cognition — mental health

Joint health

Target areas

blood pressure

Oxidative processes

Vit E

Folate **Fe**

Vit D

Immune control

Se

Intestinal health

vascular health

Choline

Glucose control

EPA, DHA, ARA

Vit C

Inflammatory processes

Riboflavin

Overarching processes

liver health

Biotin

metabolic processes

Coenzyme Q

Lipid control

Pantothenic acid

Lung health

Muscle health

Bone health

TNO innovation for life

personalized nutrition based consumer goals

Weight management
cholesterol
Lipid flexibility
Glucose flexibility
blood pressure

organs

muscle
vasculature
adipose
gut
liver
pancreas

flexibility processes and sub-processes

Inflammation control
Satiety
Insulin sensitivity
Fatty acid oxidation
Lipid distribution
Insulin production

nutrients (connected in diets)

triglycerides
K
folate
B12
choline
carnitine
dairy
fruit
leafy vegetables
Meat fish egg
carbs
Grains &nuts
Mg
protein
fiber
legumes
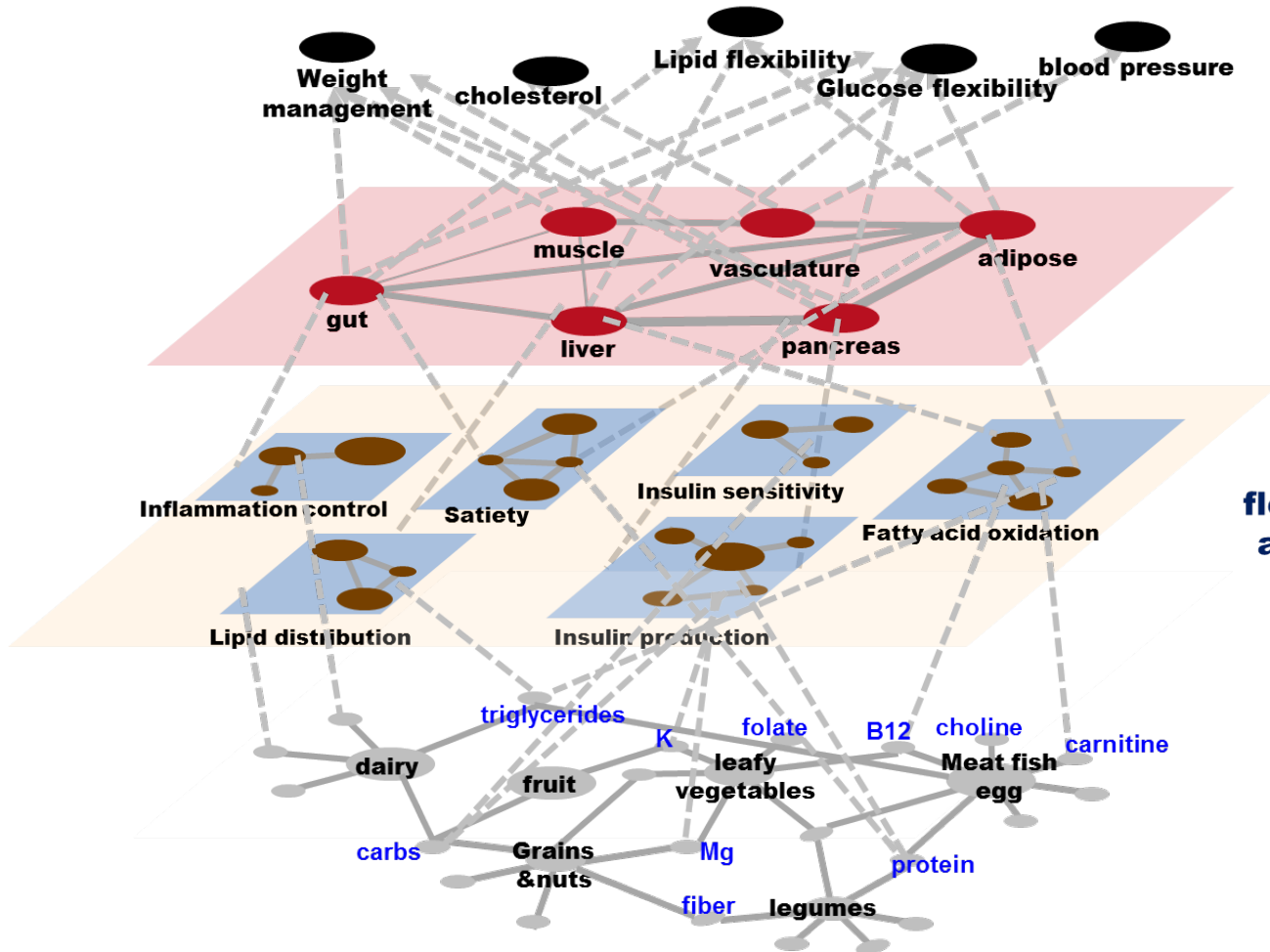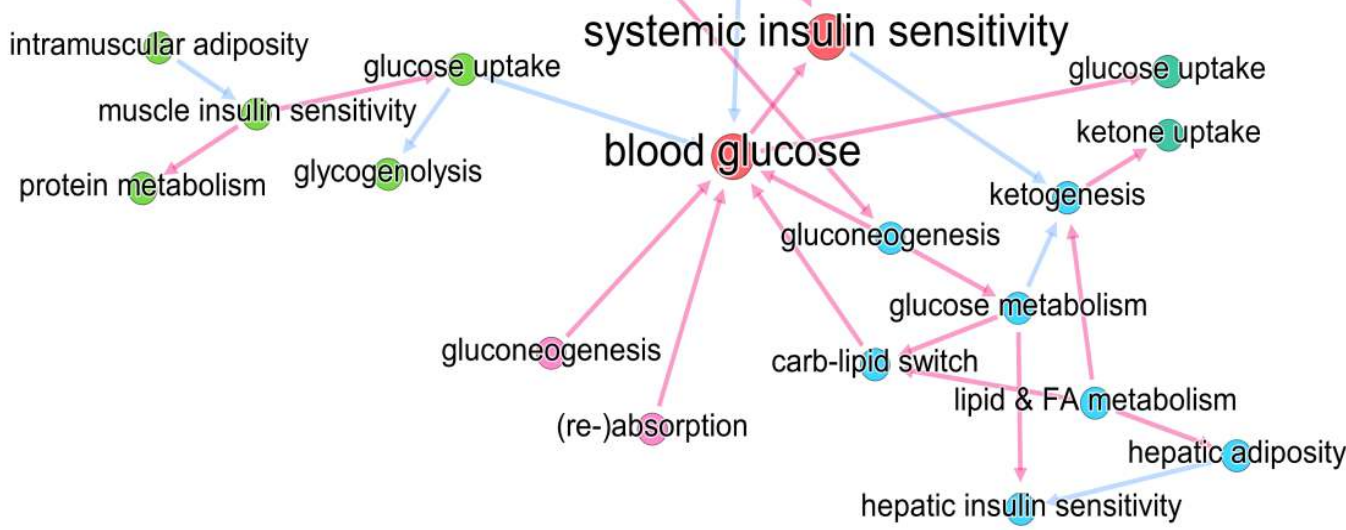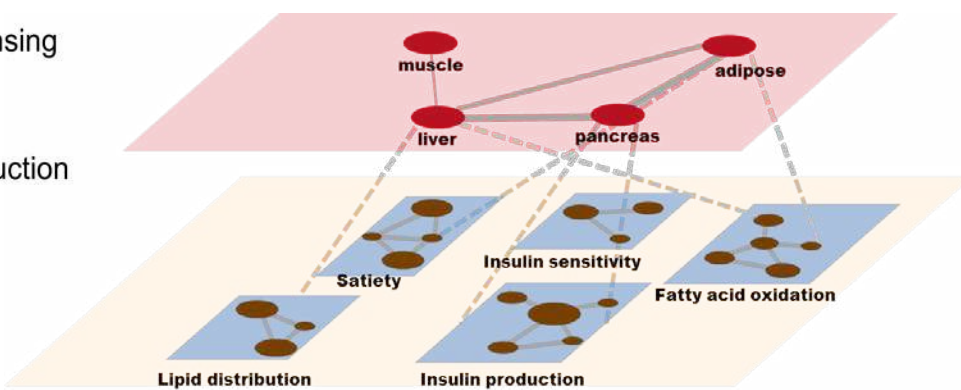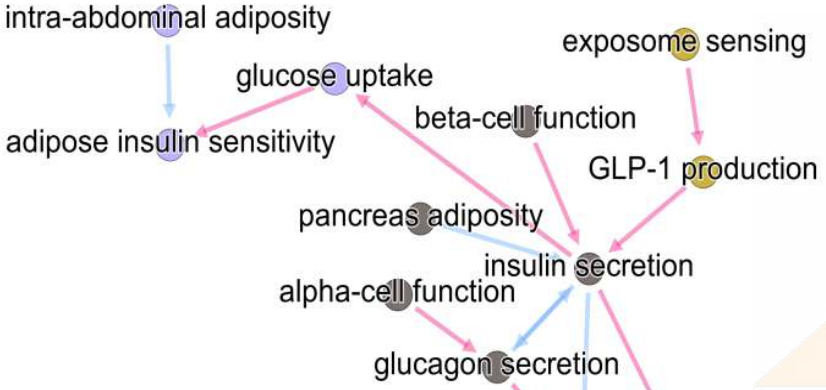
75 g Glucose

→ Irreversible process
↔ Reversible process

β-cell — Pathology
gluc — Risk factor

Metabolically healthy

reversible

%Adiponectin (%)

H WC<85 WC≥85

adipose inflammation

systemic inflammation

gut inflammation

IBD

Visceral adiposity

ectopic lipid overload

%TC (%)

C WC<85 WC≥85

High cholesterol

Hepatic inflammation

fibrosis

endothelial inflammation

DL-C (%)

LDL elevated

dyslipidemia

%TG (%)

P < .05
P < .001

D WC<85 WC≥85

Glucose (mmol/L) WC≥85 WC<85

High glucose

Glucose toxicity

Muscle metabolic inflexibility

Adipose IR

IRI (mU/L) WC≥85 WC<85

systemic Insulin resistance

β-cell failure

irreversible

%SE P = .07

I WC<85 WC≥85

%SE P = .10
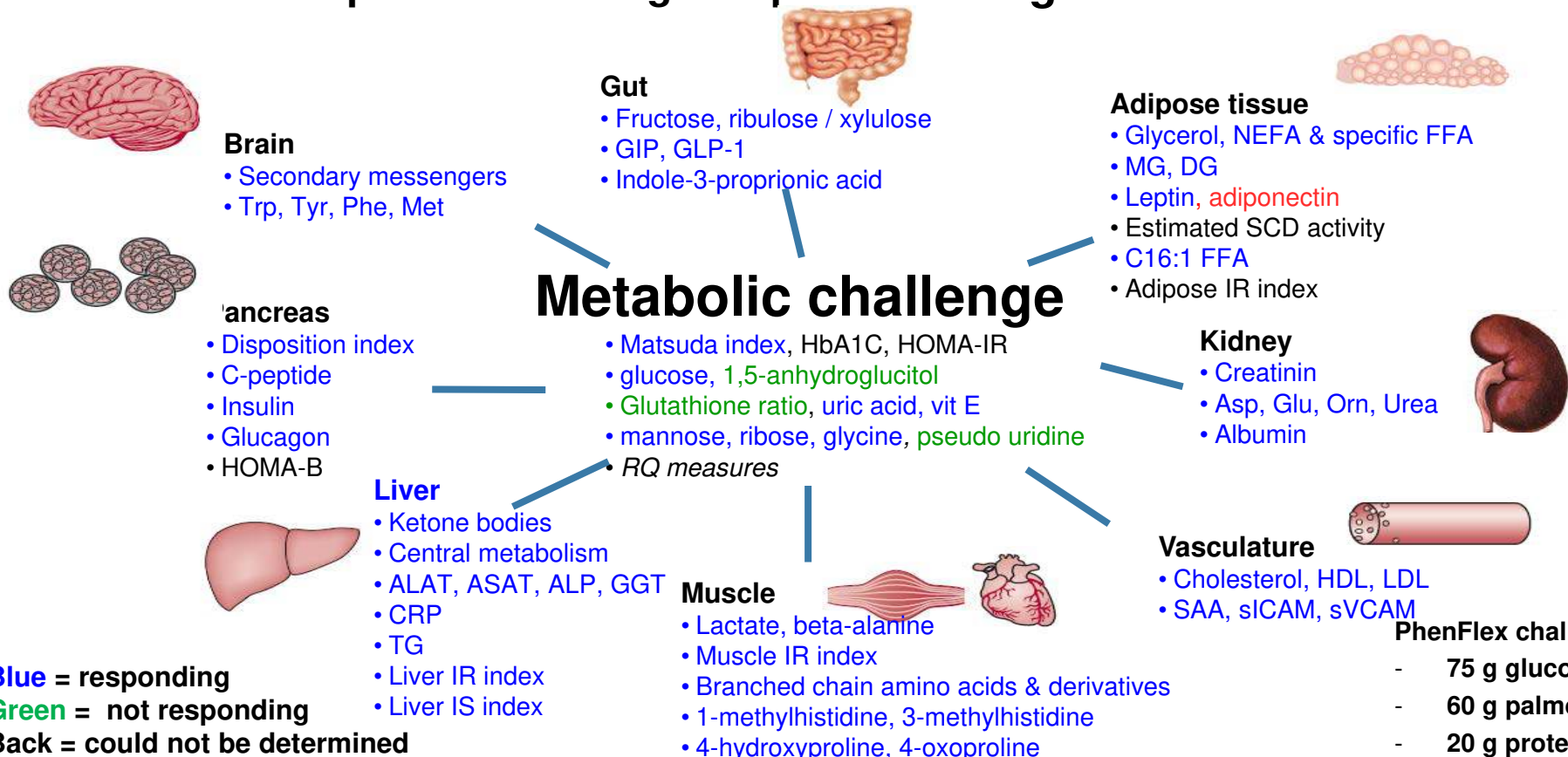
F WC<85 WC≥85

%DE P < .05 P < .01

G WC<85 WC≥85

The flexible phenotype: the system is a shock absorber ("phenotypic flexibility")

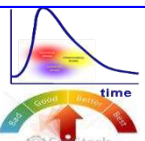Cardiac dysfunction → Heart failure ← Myocardial infactions

Nakatsuji, Metabolism 2009

Phenotypic Flexibility as biomarker of health
134 biomarkers report on challenge responses in organs

Gut
- Fructose, ribulose / xylulose
- GIP, GLP-1
- Indole-3-proprionic acid

Adipose tissue
- Glycerol, NEFA & specific FFA
- MG, DG
- Leptin, adiponectin
- Estimated SCD activity
- C16:1 FFA
- Adipose IR index

Brain
- Secondary messengers
- Trp, Tyr, Phe, Met

'ancreas
- Disposition index
- C-peptide
- Insulin
- Glucagon
- HOMA-B

Metabolic challenge

- Matsuda index, HbA1C, HOMA-IR
- glucose, 1,5-anhydroglucitol
- Glutathione ratio, uric acid, vit E
- mannose, ribose, glycine, pseudo uridine
- *RQ measures*

Kidney
- Creatinin
- Asp, Glu, Orn, Urea
- Albumin

Liver
- Ketone bodies
- Central metabolism
- ALAT, ASAT, ALP, GGT
- CRP
- TG
- Liver IR index
- Liver IS index

Muscle
- Lactate, beta-alanine
- Muscle IR index
- Branched chain amino acids & derivatives
- 1-methylhistidine, 3-methylhistidine
- 4-hydroxyproline, 4-oxoproline

Vasculature
- Cholesterol, HDL, LDL
- SAA, sICAM, sVCAM

Blue = responding
Green = not responding
Back = could not be determined

PhenFlex challenge:
- 75 g glucose
- 60 g palmoic oil
- 20 g protein

Personalized (Micro)nutrient Recommendations
related to systems flexibility

Liver
Choline, carnitine

Catechins?

low grade inflammation

vitD, VitE, Mg,
ω-3 fatty acid, flavonoids,
curcuminoids

Vasculature
vitC, K, cocoa flavanols,
NO-producing nutrients,
lycopene

Pancreas
Leucine, vitK, vitD, Mg
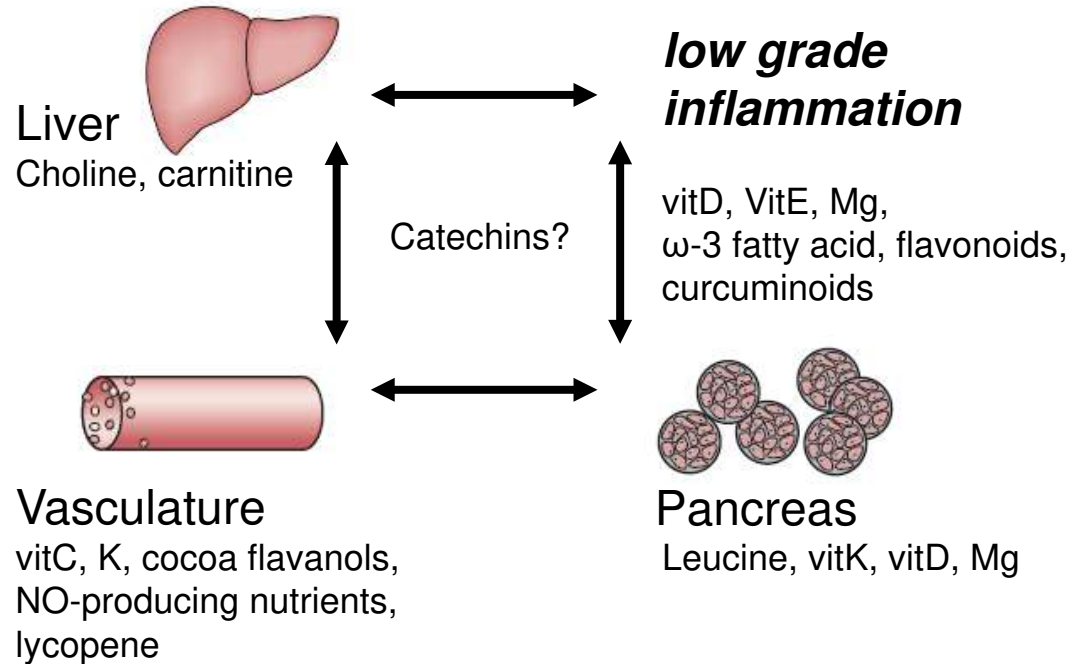
Quercetin, Se, Zn, …

Visceral adiposity

Metabolic health

dyslipi

Stannols, fibre

ectopic overload
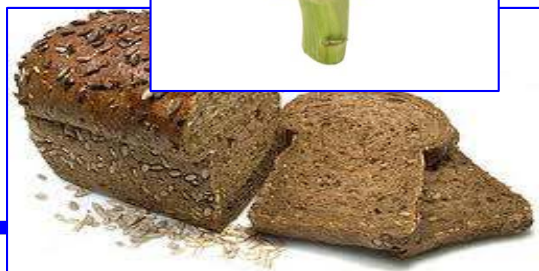
Adipose IR

glycemic index

inf

High

Metabolic challenge

pose

ial
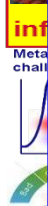
TNO innovation for life

Type 2 diabetes subgroups react differently on different diets

Mediterranean diet improves muscle IS

Low-fat diet improves liver IS

Mediterranean diet improves systemic IS
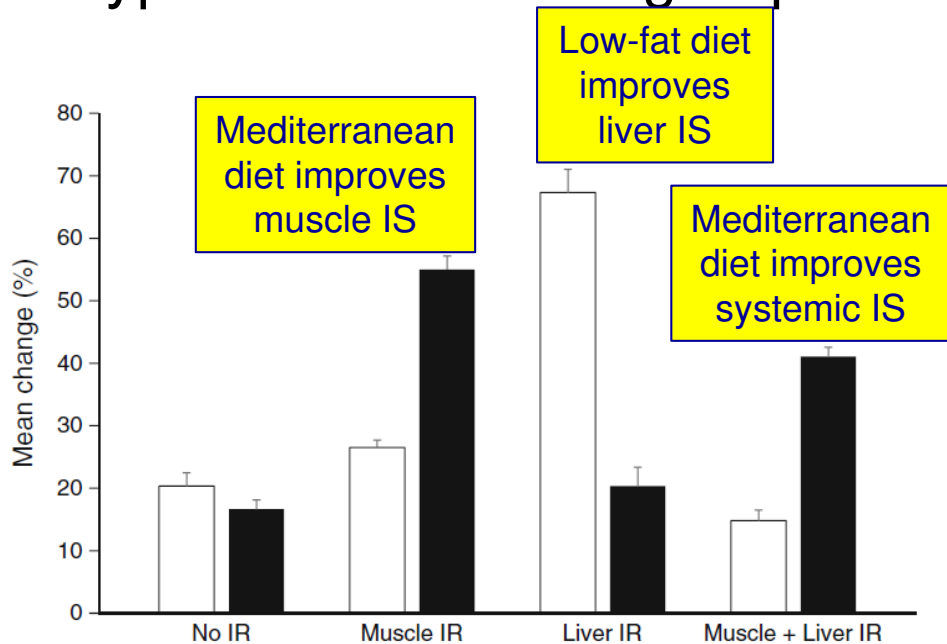
Fig. 1 Mean percentage change in values of disposition index between baseline and after 2 years of follow-up by IR phenotype. *$p<0.05$ between low-fat diet (white bars) and Mediterranean diet (black bars) in each IR subgroup analysed using a univariate model adjusted for age, sex, baseline BMI and change in weight

T2D subgroup glucose respose to Oral Glucose Tolerance Test

T2D (diagnosed)

T2D (non-diagnosed)

IGT & IFG

IGT (muscle)

IFG (liver)

healthy

Blanco-Rojo, Diabetologia, Oct 2015
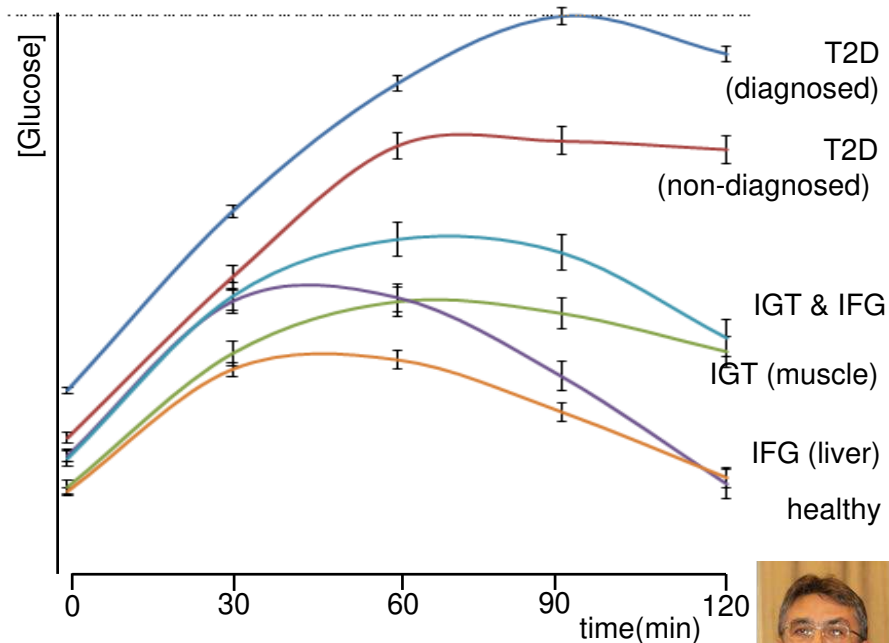
José Lopez-Miranda

- Adipose insulin sensitivity
- Adipokine production
- Lipoprotein production
- Muscle insulin sensitivity
- Ketogenesis
- beta-oxidation
- Lipolysis

Metabolic challenge

time
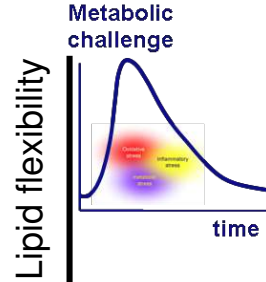
Lipid flexibility

Carnitine, choline

Metabolic challenge

time

- gluconeogenesis
- insulin sensitivity
- incretin production
- bile production
- insulin sensitivity
- Disposition index
- Metabolic flexibility
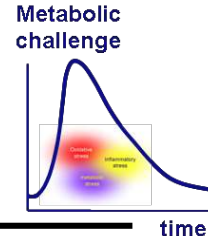
Carbohydrate flexibility

- Gut mediated inflammation
- Oxidative stress
- Nitrosative stress
- Chronic low grade inflammation
- NO formation

Inflammation challenge

time
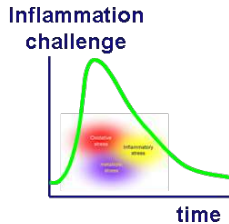
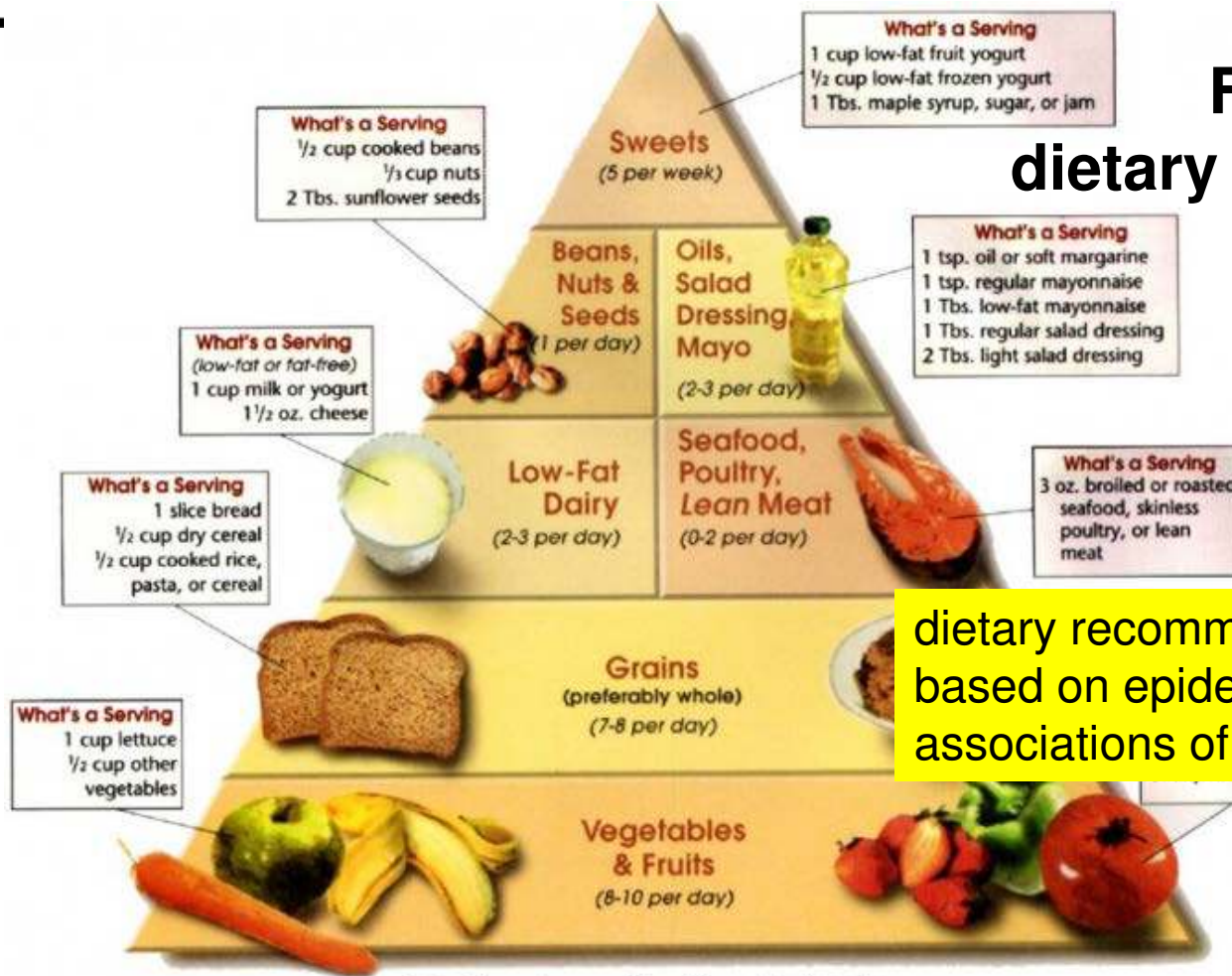Inflammatory stress

Fiber, vitK, Mg

DHA, EPA, Se, Vit E

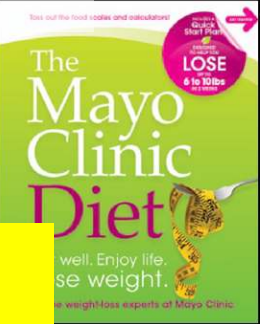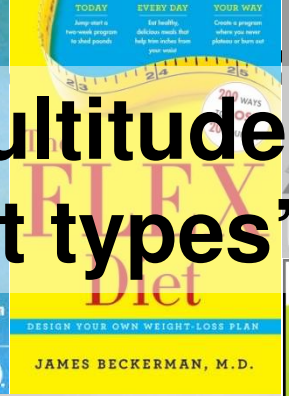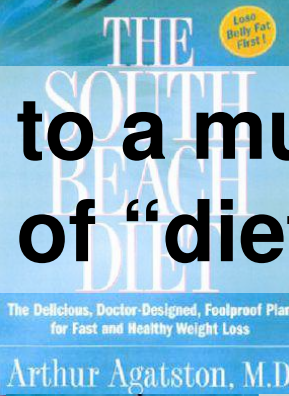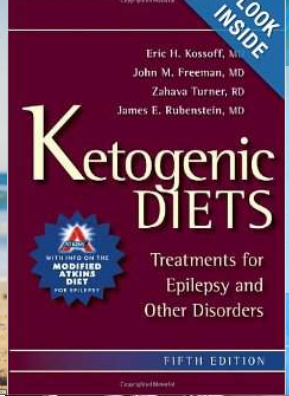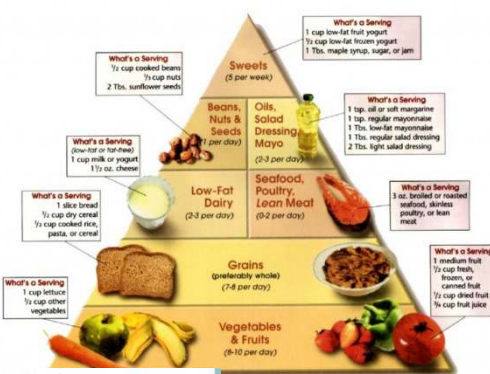Phenotypic flexibility of 50 healthy subjects in a "health space"
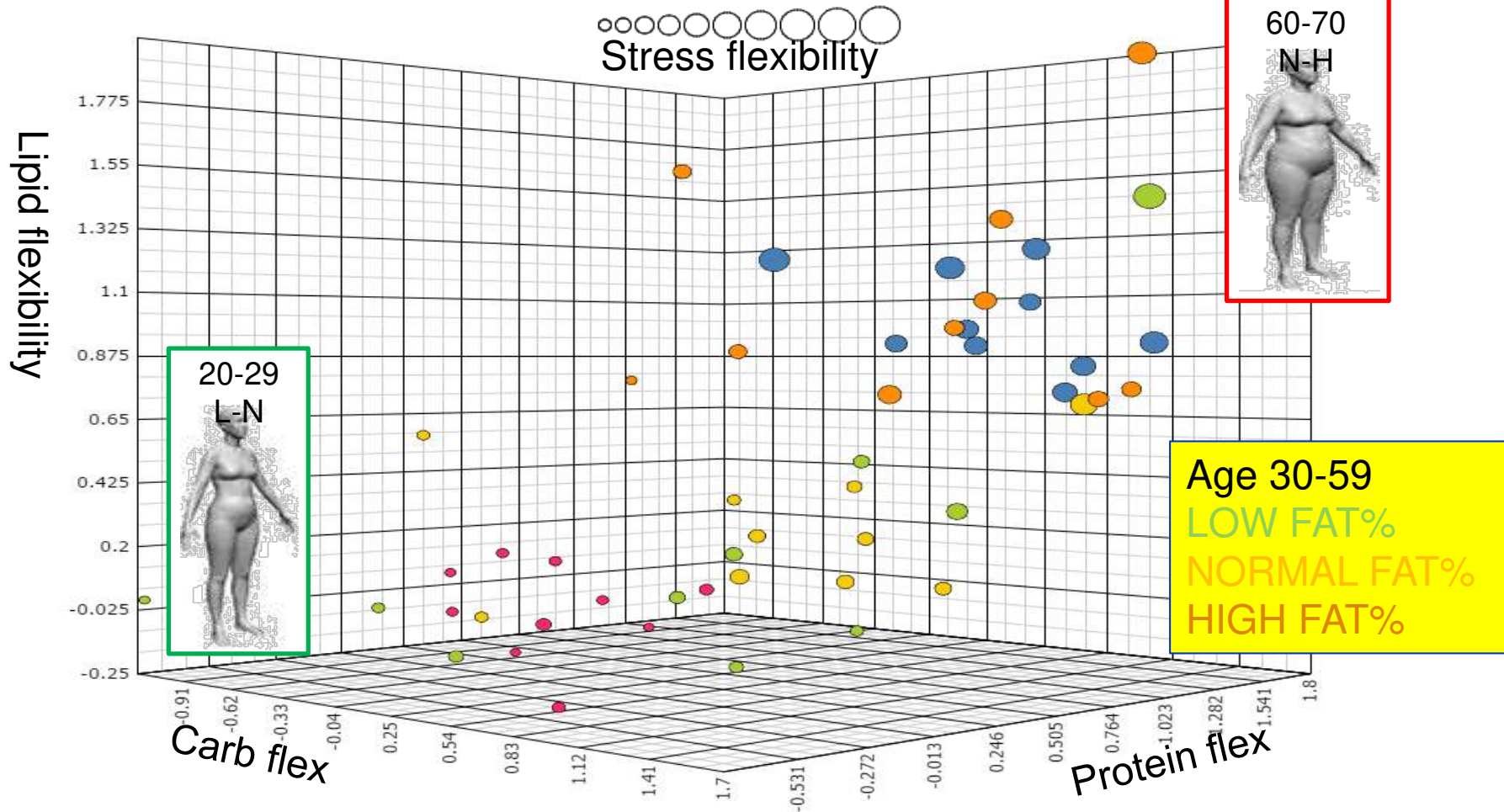
So what`s the right diet for me?

From public Health dietary recommendations

What's a Serving
1 cup low-fat fruit yogurt
½ cup low-fat frozen yogurt
1 Tbs. maple syrup, sugar, or jam

What's a Serving
½ cup cooked beans
⅓ cup nuts
2 Tbs. sunflower seeds

Sweets
(5 per week)

Beans, Nuts & Seeds
(1 per day)

Oils, Salad Dressing, Mayo
(2-3 per day)

What's a Serving
1 tsp. oil or soft margarine
1 tsp. regular mayonnaise
1 Tbs. low-fat mayonnaise
1 Tbs. regular salad dressing
2 Tbs. light salad dressing

What's a Serving
(low-fat or fat-free)
1 cup milk or yogurt
1½ oz. cheese

Low-Fat Dairy
(2-3 per day)

Seafood, Poultry, Lean Meat
(0-2 per day)

What's a Serving
3 oz. broiled or roasted seafood, skinless poultry, or lean meat

What's a Serving
1 slice bread
½ cup dry cereal
½ cup cooked rice, pasta, or cereal

Grains
(preferably whole)
(7-8 per day)

dietary recommendations are mostly based on epidemiology:
associations of the masses

What's a Serving
1 cup lettuce
½ cup other vegetables

Vegetables & Fruits
(8-10 per day)

Note: Choose lower-salt foods from all categories.

to a multitude of "diet types"
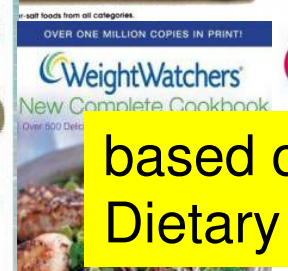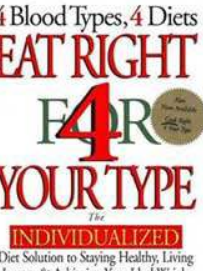
based on a mix of science, fiction and commerce…
Dietary choices are based on the "choice of the book"

Information overflow?

DO NOT ENTER
ENTRANCE ONLY
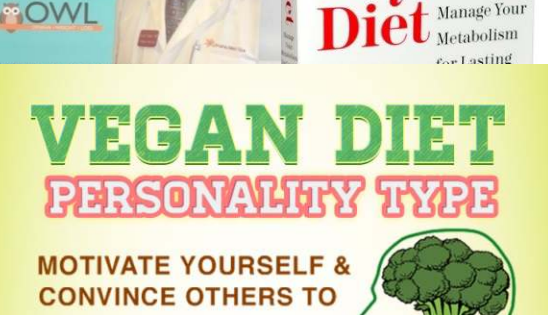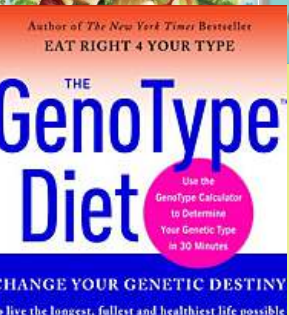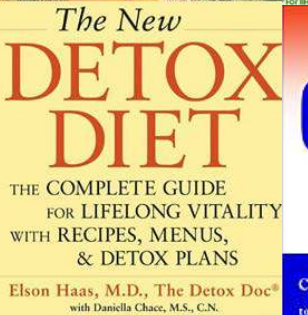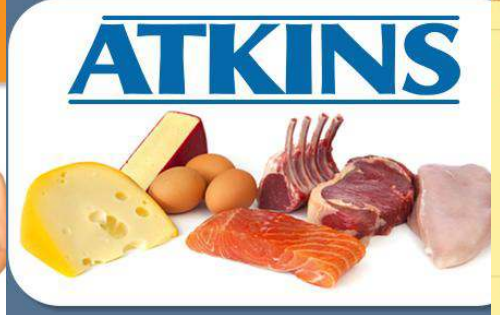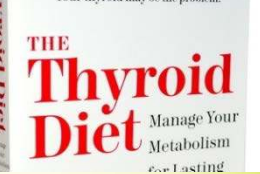
Misleading Information?

The Personal Health Record, Reimagined - Gliimpse Launches Their Health Data Aggregation Platform

Medicine X 2015: "When Personal Become...

Empowering individuals to collect, personalize, securely share and donate their personal health profiles, Gliimpse begins accepting new users today.

Report: Apple Acquires Personal Health Data Start-Up Gliimpse

BY PC MAG ME TEAM   AUG. 24, 2016, 6 P.M.

Gliimpse aims to give users a greater sense of 'ownership around their health.'

1 shares
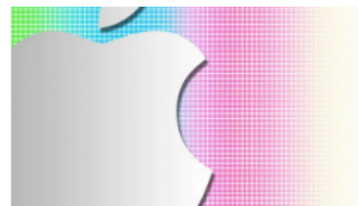
Apple is making moves in the health sector.

According to *Fast Company*, Cupertino has acquired Gliimpse, a Silicon Valley-based personal health data start-up. The acquisition reportedly went down earlier this year, but is just coming to light now.

o Owns

our

Personal Data?

The real value of MY health data: how can this data work for me?

Health Data Cooperative as legal entity that valorizes my own health data.

COOPERATIVE
Citizen-owned
Citizen-controlled

MyDataOurHealth

Developers

Doctors

Schools & daycare

Hospitals

Research

food industry

Infant formula producers

Education

Retail

Farmers market

Government

Health Service Providers

Ernst Hafen, ETH Zurich
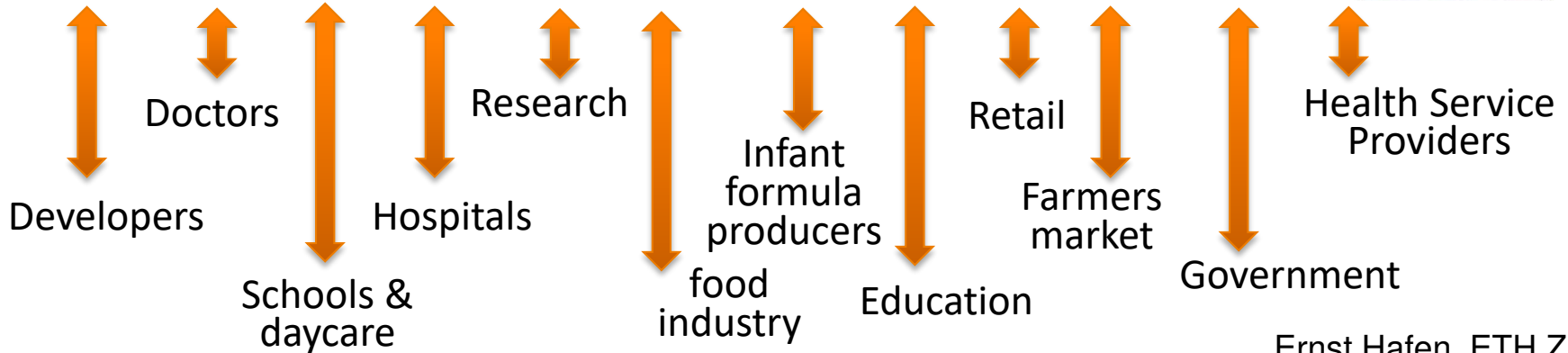
CONSTANT CRAVERS

They want to eat all the time

FEASTERS

Once they start, they can't stop

EMOTIONAL EATERS

People who eat for psychological reasons

Four Behavioural changes phases

MOTIVATION
is what gets you started
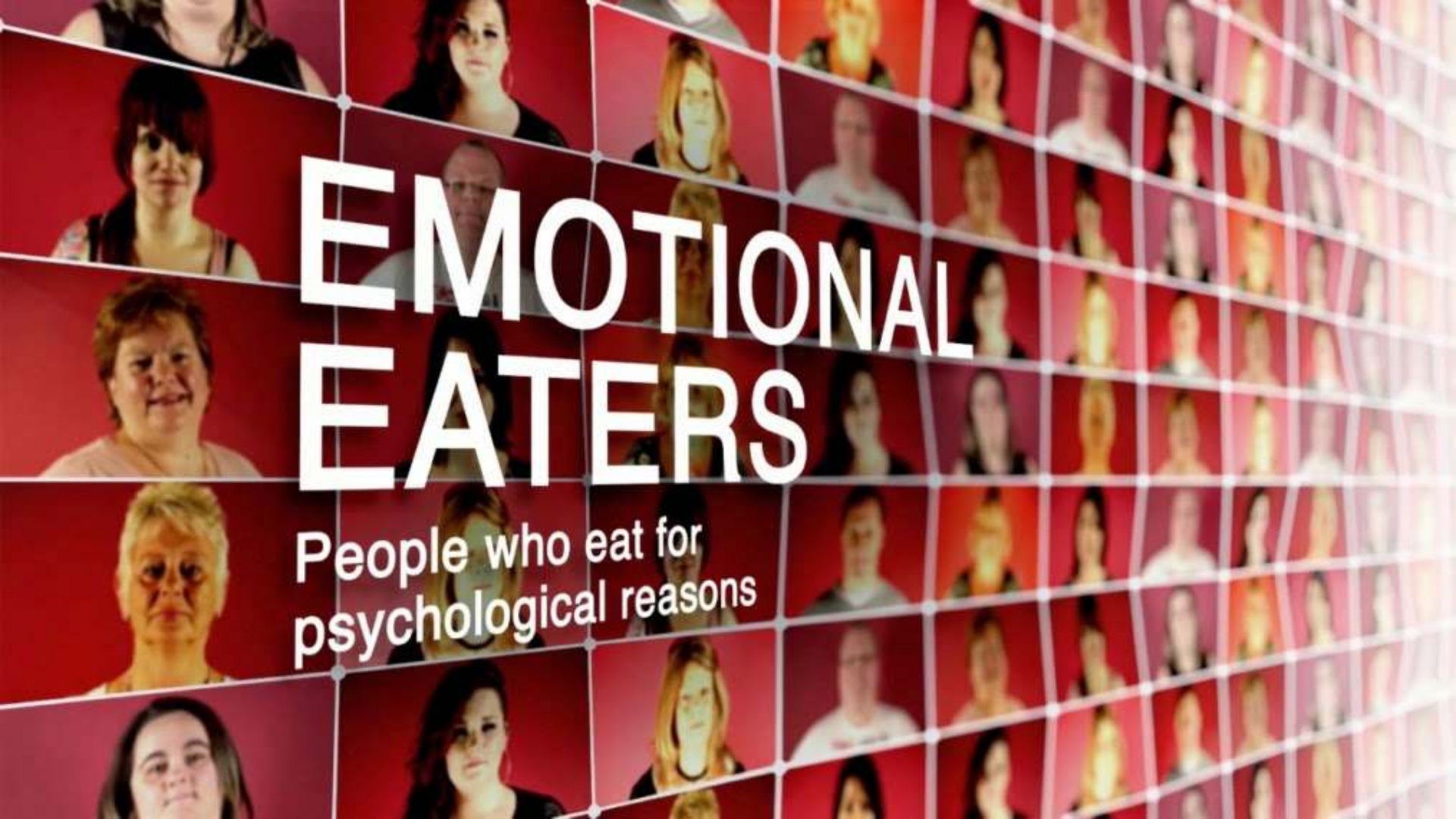
HABIT
is what keeps you going

Jim Ryan

www.BreathOfOptimism.com

Initial response	**Continued response**	**maintenance**	**habit**
Initial effort to change behavior	Continue effort to establish behavior	Sustained effort to continue newly established behavior	Self pertetuating pattern of behavior

CHANGE IS
HARD AT THE BEGINNING
MESSY IN THE MIDDLE
GORGEOUS AT THE END

Rothman (2009) Disentangling
behavioural initiation and behavioural maintenance

Each person deserves the right method for the right phase

Behavior Change Technique (93 different techniues)	Initial response	Continued response	Maintenance	Habit
Prompt practice				
Stress management				
General communication skills training				
Environmental restructuring				
Model/demonstrate the behavior				
Goal setting (outcome)				
Relapse prevention/coping planning				
Facilitate social comparison				
Goal setting (behavior)				
Action planning				
Provide feedback on performance				
Barrier identification/problem solving				
Provide instruction				
Teach to use prompts/cues				
Provide normative information about others' behavior				
Plan social support/social change				

360 DEGREES DIAGNOSIS

360

Spiritual
- Eudaimonic wellbeing
- Life goals
- Worldview
- Religion
- Mindfullness
- Gratefullness

Bio
- Metabolic status and flexibility
- Nutrition intake
- Genetics

Psycho
- Dietary preferences
- Nutrition intake
- Stress resilience
- Personality type
- Coping styles

Social
- Peer pressure
- Food /sports availability
- Family habits
- Work environment
- Health literacy

Example of individual approach based on 360°

Behavior Change Technique	Initial response	Continued response	Maintenance	Habit
Prompt practice				
Stress management				■
General communication skills training				
Environmental restructuring			■	
Model/demonstrate the behavior				
Goal setting (outcome)	■			
Relapse prevention/coping planning				
Facilitate social comparison				
Goal setting (behavior)				
Action planning	■			
Provide feedback on performance				
Barrier identification/problem solving				
Provide instruction				
Teach to use prompts/cues			■	
Provide normative information about others' behavior				■
Plan social support/social change				

Personalized selection of behavioural change sequences

Bottomline

› The technology is there to come

› The science is good enough to introduce

› The data ownership is an issue

› "Personalized" will change society but society also needs to change

› Food services will replace food products