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…
So, who am I in this scheme and what should I eat to remain in optimal health?

Me?

blood pressure
vascular health
liver health
Muscle health

Oxidative processes
Glucose control

Lipid control
Immune control

Overarching processes

Inflammatory processes

mental health

Joint health

Target areas
Intestinal health
Lung health

Liver health

Cognition

Bone health
personalized nutrition based consumer goals

organs

flexibility processes and sub-processes

nutrients (connected in diets)
The flexible phenotype: the system is a shock absorber ("phenotypic flexibility")

Visceral adiposity → dyslipidemia

systemic inflammation → gut inflammation → IBD

Hepatic inflammation → fibrosis

endothelial inflammation

High cholesterol → LDL elevated

Glucose toxicity → β-cell failure

Muscle metabolic inflexibility

Adipose IR

75 g Glucose

Metabolically healthy

Nakatsuji, Metabolism 2009
Phenotypic Flexibility as biomarker of health

134 biomarkers report on challenge responses in organs

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

**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

**Pancreas**
- Disposition index
- C-peptide
- Insulin
- Glucagon
- HOMA-B

**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

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

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

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

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

Blue = responding
Green = not responding
Back = could not be determined
Personalized (Micro)nutrient Recommendations related to systems flexibility

Liver
Choline, carnitine

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

Pancreas
Leucine, vitK, vitD, Mg

low grade inflammation
vitD, VitE, Mg, ω-3 fatty acid, flavonoids, curcuminoids

Catechins?
We can now quantify the individual processes and optimize these with personalized diets.
Type 2 diabetes subgroups react differently on different diets

**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.
Metabolic flexibility

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

Lipid flexibility

- Gluconeogenesis
- Insulin sensitivity
- Incretin production
- Bile production
- Insulin sensitivity
-Disposition index
- Metabolic flexibility

Carbohydrate flexibility

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

Carnitine, choline

- DHA, EPA, Se, Vit E

Fiber, vitK, Mg

DHA, EPA, Se, Vit E

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

Inflammation challenge

- Oxidative stress
- Nitrosative stress
- Chronic low grade inflammation
- NO formation
Phenotypic flexibility of 50 healthy subjects in a “health space”
So what`s the right diet for me?
From public Health
dietary recommendations are mostly based on epidemiology: associations of the masses
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?

Misleading Information?
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.

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.
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

Doctors
Research
Infant formula producers
Retail
Retail
Health Service Providers

Developers
Hospitals
food industry
Farmers market
Government

Schools & daycare
Education

Ernst Hafen, ETH Zurich
CONSTANT CRAVERS
They want to eat all the time
EMOTIONAL EATERS
People who eat for psychological reasons
DISCIPLINE

...is just choosing between what you want now and what you want most.
Four Behavioural changes phases

- **Initial response**: Initial effort to change behavior
- **Continued response**: Continue effort to establish behavior
- **Maintenance**: Sustained effort to continue newly established behavior
- **Habit**: Self perpetuating pattern of behavior

Rothman (2009) Disentangling behavioural initiation and behavioural maintenance
Each person deserves the right method for the right phase

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<thead>
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**360 DEGREES DIAGNOSIS**

- Metabolic status and flexibility
- Genetics

- Eudaimonic wellbeing
- Life goals
- Worldview
- Religion
- Mindfulness
- Gratefulness

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

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

360
### Example of individual approach based on 360°

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**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