Interactions between the Brain and Gut

Tim Moran
Department of Psychiatry and Behavioral Sciences
Johns Hopkins University School of Medicine
Johns Hopkins Global Obesity Prevention Center
Bloomberg School of Public Health
Baltimore, MD
Satiety Signaling

- Feedback arising from recently ingested food that is transmitted to the brain to affect ongoing eating
Sham Feeding – no gastric fill or intestinal nutrient contact
Sham feeding – intestinal nutrient infusions

Greenberg et al., 1990
Satiety Signaling

Feedback from consumed foods leading to meal termination and satiety

• Neural
• Gut peptide
Vagal Sensory Terminations

Intramuscular Array
“Stretch”

Intraganglionic Laminar Endings
“Tension”

Mucosal Terminals
“Nutrient”

Berthoud and Neuhuber, 2000
Vagal sensory response to gastric volume

2 ml GASTRIC SALINE LOAD

VAGAL AFFERENT

5 sec

ANTRAL PRESSURE

5 mm Hg

ANTRAL TENSION

2 gm
Gastric vagal afferents respond to volume not load composition
Satiety Signaling

Gastric response to increasing volume

What does this mean for eating in a meal?

Does changing volume and energy density matter?
Low calories salads reduce overall intake during a meal

Rolls et al., 2004
Low calories salads reduce overall intake during a meal

Rolls et al., 2004
Soups reduce subsequent meal intake beyond their calories

Rolls et al., 1999
Decreasing energy density results in reduced daily intake.

Williams et al., 2013
Gut Peptide Satiety Signaling

- Glucagon
- Amylin
- CCK
- PYY(3-36)
- GLP-1
Glucagon
Amylin
CCK
PYY(3-36)
GLP-1

Feedback
Gut peptides: modes of action

Vagal sensory nerve fibers innervate the gut near endocrine cells in intestinal villi.

Patterson et al., Anat Rec, 2002
Integration of responses to distention and CCK in duodenal vagal afferents
Cholecystokinin (CCK) induced dose related reduction in meal size
Vagal deafferentation blocks CCK satiety and alters meal patterns.
Satiety Signaling

Do different macronutrients affect CCK secretion?

How does that affect hunger and satiety?
Greater CCK secretion in response to a high protein meal

Brennan et al., 2012
Less hunger and greater satiety in response to a high protein meal

HOCHSTENBACH-WAELEN ET AL., 2009