Neurocognitive interventions for obesity treatment

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Acknowledgements

NIH NIDDK R01DK103554, R01DK094475, R01DK075861, R21DK80266, R21HD074987, K02HL112042, University of Minnesota Obesity Center (NIH NIDDK/5P30-DK050456-14), University of California, San Diego, Academic Senate Award, Department of Pediatrics Faculty Development
Disclosures

- Funding from the Egg Nutrition Board
Percent of adults who lose weight in behavioral weight loss programs
Percent of adults who lost weight and retain weight loss 4 years later.
Percent of children who lost weight who are no longer overweight in adulthood

- No longer overweight
- Non-responders
Why are the results so grim?

- Individual level factors have been mostly overlooked
- Neurocognitive factors represent how the individual interacts with the current environment
STOP OVER EATING
Expectation of reward from food
Actual reward from food cues
Inhibitory mechanisms

Kakoschke, Kemps, Tiggemann, 2015
Actual reward
From food cues

Expectation of reward from food

Inhibitory mechanisms

Kakoschke, Kemps, Tiggemann, 2015
Response to taste in obese compared to healthy weight children

Figure 1. Plots demonstrating main effects of group (upper) and condition (lower) within regions of interest for the sucrose task. Upper: Within the bilateral amygdala and insula, overweight children had an elevated response to sucrose and water. Lower: Within the bilateral amygdala, brain response was elevated for sucrose relative to water across all participants. Error bars represent the standard error for each group. Bars with different letters (A vs B) are significantly different from one another. Hot colors indicate voxels reflecting a greater response to sucrose or water within the regions of interest, all voxels p<0.05. L=left; R=right; P=posterior; OB: obese children; HW: healthy weight children.
Habituation to taste in obese compared to healthy weight children
Expectation of reward from food
Actual reward
From food cues

Inhibitory mechanisms
Actual reward
From food cues

Expectation of reward from food

Inhibitory mechanisms
Inhibitory mechanisms
Reflect inhibition
Circuit inhibition
Descending inhibition
System inhibition
Post-synaptic inhibition
Lateral inhibition

Aron et al, 2007
MacCleod et al, 2003

Motor/Behavioral
Selective Attention
Emotion
Memory

Aron et al, 2007
MacCleod et al, 2003
Motor/Behavioral  Selective Attention  Emotion  Memory
Selective attention processing of food cues

Measure of how rewarding someone finds food
• Motivational value is attributed to food cues through associative conditioning
• Food cues become salient through continual association with a rewarding experience (e.g., eating) through dopaminergic pathways
• Food cues capture attention and drive consumption of that food
• These processes can occur implicitly, without necessary conscious awareness
Caveats re: AB research

- Multiple measures – dot probe, EEG, eye tracking, attention network task
- Multiple variables for assessment
  - Automatic orientation - rapid, involuntary prioritization (bottom-up process)
  - Sustained attention - slower, goal-oriented (top-down process)
- Sated and hungry
AB translates to eating

Kemps, Tiggemann, Elford, 2015
Kemps, Tiggemann, Orr, Grear, 2014
AB in Overweight vs Healthy Weight

• When sated, overweight individuals show impaired orientation biases compared to healthy weight

• Mixed results for sustained attention;
  – One study demonstrated avoidance of food cue
  – One showed approach towards food cue

• When not sated, all individuals, regardless of weight, show preference for food cues

Castellanos et al., 2009; Nijs et al., 2010; Werthmann et al., 2011;
Attention Modification Programs

• AMP Computer programs implicitly train individuals that if salient and neutral stimuli are present, neutral stimulus has a better signal value

• AMP programs have been applied primarily in anxiety disorders and are being applied to appetitive disorders

• Metanlyses in anxiety show moderate effect (d=.61)

MacLeod et al, 2002
Hakamata, Lissek, Bar-Haim, Britton, Fox, Leibenluft, Ernst, Pine, 2011
Attentional bias modification encourages healthy eating☆,☆☆

Naomi Kakoschke *, Eva Kemps, Marika Tiggemann

School of Psychology, Flinders University, Adelaide, Australia

• Trained 146 undergraduate women to attend to healthy or unhealthy foods
• AB was trained in the expected direction
• Participants in the attend to healthy foods ate more healthy than unhealthy snacks compared to attend unhealthy foods group
Overweight or obese children (N=24)

1-session AMP

- AMP-Food; 100% training away from food cues to neutral cues
- ACC; 50% training away from food cues to neutral cues; 50% training to food cues from neutral cues
Children high on EAH (>10% Daily caloric needs)
- Consume pizza, carrots and juice dinner
- Fullness measure
- Taste test
- 10 min free access
- % daily caloric needs consumed in the free access session
Attentional bias

Between group F (25)=3.50, p=.073
Eating in the absence of hunger (adjusted for caloric needs)

Between group F (24)=6.48 p=.018
Attention Modification Program Case Series

• An open trial evaluating an attention bias modification program for overweight adults with binge eating
• 14 participants with Binge Eating
• 8 week AMP training
  – 1x/wk in lab; 2x/wk at home

(Boutelle, Monreal, Strong, Amir, under review)
### Observed measurements

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post-treatment</th>
<th>3-month follow-up</th>
<th>Post-treatment (95% CI)</th>
<th>3-month follow-up (95% CI)</th>
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<tbody>
<tr>
<td></td>
<td>Mean (sd)</td>
<td>Mean (sd)</td>
<td>Mean (sd)</td>
<td>Effect</td>
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<td><strong>Binge eating symptoms</strong></td>
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<tr>
<td>Total Binge Episodes *</td>
<td>10.89 (9.62)</td>
<td>3.33 (6.78)</td>
<td>1.88 (3.76)</td>
<td>-1.50** (-1.51 -1.49)</td>
<td>-1.91** (-1.93 -1.90)</td>
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<tr>
<td>Binge Eating Scale</td>
<td>24.33 (8.87)</td>
<td>15.89 (6.19)</td>
<td>17.62 (10.47)</td>
<td>-8.44* (-14.11 -2.77)</td>
<td>-6.35* (-12.25 -0.45)</td>
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<td><strong>Eating Disorder symptoms</strong></td>
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<td>EDE-Q-Global score</td>
<td>3.88 (0.88)</td>
<td>2.98 (1.27)</td>
<td>2.74 (1.12)</td>
<td>-0.90** (-1.39 -0.42)</td>
<td>-1.08** (-1.58 -0.57)</td>
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<tr>
<td><strong>Weight</strong></td>
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<tr>
<td>Body Mass Index (m2/kg)</td>
<td>33.74 (5.25)</td>
<td>32.97 (5.17)</td>
<td>32.15 (4.87)</td>
<td>-0.77* (-1.45 -0.08)</td>
<td>-0.77* (-1.49 -0.06)</td>
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<td><strong>Attention Bias</strong></td>
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<tr>
<td>Dot-probe: Food bias</td>
<td>-23.00 (27.74)</td>
<td>35.06 (62.90)</td>
<td>20.91 (34.30)</td>
<td>58.43* (17.97 98.89)</td>
<td>44.44 2.65 86.23</td>
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<td>Food Stroop difference score</td>
<td>34.00 (38.12)</td>
<td>16.77 (30.36)</td>
<td>35.60 (60.60)</td>
<td>-17.22 (-52.46 18.01)</td>
<td>2.23 -34.31 38.76</td>
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<td><strong>Food cue reactivity</strong></td>
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<td>Power of Food Scale-Food Available</td>
<td>3.78 (1.21)</td>
<td>3.11 (1.20)</td>
<td>2.52 (1.11)</td>
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<td>-1.16** (-1.79 -0.53)</td>
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<td>Power of Food Scale-Food Present</td>
<td>4.33 (0.73)</td>
<td>3.33 (0.95)</td>
<td>3.13 (1.42)</td>
<td>-1.00* (-1.75 -0.25)</td>
<td>-1.16* (-1.94 -0.38)</td>
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<td>Power of Food Scale-Food Tested</td>
<td>3.03 (0.93)</td>
<td>2.56 (0.98)</td>
<td>2.15 (0.74)</td>
<td>-0.57* (-0.92 -0.21)</td>
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<td><strong>Food Cravings</strong></td>
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<td>Preoccupation w/ Food</td>
<td>3.98 (1.57)</td>
<td>3.44 (1.04)</td>
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<td>Loss of Control</td>
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<td>3.74 (0.79)</td>
<td>2.92 (1.06)</td>
<td>-0.72* (-1.25 -0.20)</td>
<td>-1.39** (-1.94 -0.85)</td>
</tr>
<tr>
<td>Emotional Craving</td>
<td>4.44 (1.13)</td>
<td>3.78 (1.08)</td>
<td>3.69 (1.47)</td>
<td>-0.67 (-1.33 0.00)</td>
<td>-0.61 (-1.30 .09)</td>
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<tr>
<td>Positive Expectancy</td>
<td>2.69 (1.09)</td>
<td>2.80 (0.94)</td>
<td>2.43 (0.68)</td>
<td>0.11 (-0.56 0.78)</td>
<td>0.07 (-0.65 0.50)</td>
</tr>
</tbody>
</table>
Weight loss data (lbs) in 8 weeks

-6.4
-6.8
-7.6
-8.4
-10.6
Generally refers to what is considered “self-control”
• Preventing an unintentional response to stimuli

...especially relevant in the presence of temptation/highly palatable and calorically-dense food
Overweight vs Healthy Weight

• Overweight children had more difficulty with inhibition than healthy weight children, but for food cues only
• Higher BMI was associated with decreased inhibitory control on the stop task over food-related responses in adults
• Obese women (but not men) have difficulty inhibiting food-rewarded, but not money-rewarded, appetitive behavior.

Lokken, Boeka, & Austin, 2009; Houben, Nederkoorn, & Jansen, 2013; Davidson & Martin, 2014
Inhibition Training Interventions

• Laboratory studies:
  • Inhibition of responses to specific stimuli can be trained using stop-task and go/no go task paradigms.
  • Training response inhibition to specific snack food stimuli reduces the subsequent intake, choice and self-served portion size of those foods

Research report

Targeting impulsive processes of eating behavior via the internet. Effects on body weight☆

Harm Veling a,b,*, 1, Guido M. van Koningsbruggen c,1, Henk Aarts a, Wolfgang Stroebe a,d

- Department of Psychology, Utrecht University, The Netherlands
- Behavioural Science Institute, Radboud University Nijmegen, The Netherlands
- Department of Communication Science, VU University Amsterdam, The Netherlands
- Department of Social Psychology, University of Groningen, The Netherlands

- 113 overweight/obese community participants (BMI<35)
- 4 30-minute online trainings over 4 weeks (once a week)
- Randomly assigned to implementation intentions (Diet vs Relax) and Go/No Go (Food vs Control)
Go/No Go Food  100 food pictures 100 filler pictures
Go/No Go Control  200 filler pictures

Implementation Dieting  Participants thought of 5 eating occasions and how they would typically manage that situation. Next, they formulated a plan to think about dieting at a specific opportune time. 
"I will think of dieting when I open the refrigerator"

Implementation Control-Made a plan for 5 occasions to “take it easy” and formulated a plan.
Research report

Training response inhibition to food is associated with weight loss and reduced energy intake

Natalia S. Lawrence a,*, Jamie O'Sullivan a, David Parslow a, Mahmood Javaid a, Rachel C. Adams b, Christopher D. Chambers b, Katarina Kos c, Frederick Verbruggen a

- 83 overweight/obese community participants
- 4 10-minute online trainings over 2 weeks
- Randomly assigned to active or control
• Active- 9 energy dense foods; 9 healthy foods; 18 nonfood fillers
• High energy dense foods always No Go; healthy foods always Go; nonfood 50% Go/50% No Go
• Control-18 furniture pictures; 18 nonfood fillers
Active group had significantly more weight loss (self-reported and measured)
Active training group had greater reductions in liking and attractiveness of food

But no differences in snacking in the lab
Motor/Behavioral  Selective Attention  Emotion  Memory

Automatic  Extinction
Memory

• Episodic memory
• Information about recent eating experience, such as satiety, is integrated into food choice

• In healthy volunteers, disrupting or facilitating encoding of memories resulted in differential snack intake

• Saturated fats and sugar disrupt hippocampal memory processes in animals

Higgs 2005; 2008
Higgs, Wiliamson, Attwood, 2008
Kanoski, Davidson, 2011
Memory for recent eating intervention

- 51 overweight and obese adults
- Two groups; Memory and Traditional
  - Memory: Self-monitored what ate at last meal right before next meal
  - Traditional: Self-monitored calories after eating
- 12 weeks Guided self-help weight loss
Preliminary results

<table>
<thead>
<tr>
<th>Primary Outcomes</th>
<th>Memory (n=18)</th>
<th>Traditional (n=19)</th>
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</thead>
<tbody>
<tr>
<td>Body weight, kg, mean (SD)</td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>92.4 (18.8)</td>
<td>93.3 (12.9)</td>
</tr>
<tr>
<td>Post Treatment</td>
<td>89.9 (17.4)</td>
<td>90.4 (13.0)</td>
</tr>
</tbody>
</table>

- No significant differences on weight loss, feasibility or acceptability
- Traditional group self-monitored more (66%) than the memory group (49%)
- Memory group had higher scores on Digit Span post-treatment (pre=12.39; post=13.27) than Traditional (pre=13.52; post=13.21)
Episodic Future Thinking

- Episodic future thinking - Vivid episodic simulation of future events
- Prospective imagery improves either the consideration of or the search for the actual value of delayed outcomes during decision making
- EFT shown to reduce delay discounting (ability to delay gratification)
- No significant differences in positive or neutral EFT
- EFT has similar effects on delay discounting in lean and obese women

Benoit et al., 2011; Gellert et al., 2011; Lin, Epstein, 2014; Daniel, Stanton, Epstein, 2013)
EFT and Eating

- 26 overweight and obese women
- Two conditions: EFT or control episodic thinking

![Bar chart showing mean area-under-the-curve (AUC) values for discounting of delayed rewards as a function of size of reward and condition (a), and mean caloric intake (b) as a function of condition. Error bars represent standard errors of the mean.]

Daniel, Stanton, Epstein, 2013
Memory, Obesity, and the Brain

• Obesity and working memory brain related activation using fMRI
  – Healthy cognitively intact middle aged adults (40-60 yrs)
  – Working memory task in scanner
  – Obesity (BMI) was associated with lower task-related activation in the right parietal cortex
  – Evidence that insulin sensitivity mediated the relationship between BMI and differential brain activation during working memory task

(Gonzales, et al., 2010)
Executive function training with game elements for obese children: A novel treatment to enhance self-regulatory abilities for weight-control

Sandra Verbeken a,*, Caroline Braet a, Lien Goossens a, Saskia van der Oord b, c, d

a Department of Developmental, Personality and Social Psychology, Ghent University, H. Dunantlaan 2, 9000 Ghent, Belgium
b Department of Clinical Psychology, Leuven University, Tiesestraat 102 – Box 3720, 3000 Leuven, Belgium
c Department of Developmental Psychology, University of Amsterdam, Amsterdam, The Netherlands
d Cognitive Science Center Amsterdam, University of Amsterdam, Amsterdam, The Netherlands

- Obese children in a 10-month inpatient treatment program
- 25-sessions of game-like training of inhibition and working memory
- Randomly assigned to EF-training condition or usual care
• EF-training children improved in working memory compared to usual care children
• Compared to usual care children, the children who completed the EF-training were more likely to maintaining their weight-loss at 8 weeks of post-training
Classical Conditioning

Before Conditioning
- Neutral Stimulus → No Response

During Conditioning
- Neutral Stimulus → Unconditioned Stimulus → Unconditioned Response

After Conditioning
- Neutral Stimulus → Conditioned Response
Anticipatory physiological changes

Increased craving

Decreased craving

Food consumption

Snacking on the couch
Do people who overweight learn relationships between food cues and taste of food differently than healthy weight people?

Meyer, Risbrough, Liang, Boutelle, 2014
Do obese people condition differently than lean?

Meyer, Risborough, Liang, Boutelle, in press
EXTINCTION

SAME OLD WAY

SOMETHING NEW
How can we use learning research to develop interventions

![Extinction Graph](image)
What do we know about extinction

- Extinction is not erasure, and the previous learning can return
- Extinction (renewal) is context dependent
  - Environment, emotion, time etc.

Bouton Bolles, 1979; Bouton, King 1983; Bouton, Ricker 1994, Laborda et al 2011
Strengthen extinction learning

- Trial spacing and frequency
- Partial reinforcement
- Multiple exciters

Boutelle & Bouton, 2015; Bouton, 2006; Moody et al, 2006; Sunsay & Bouton, 2004; Bouton, 2004; Woods et al, 2007; Craske et al, 2008; 2014
Bridge extinction between contexts

- Extinction cues
- Remembering extinction experiences
- Inhibition learning?

Collins, Brandon, 2002; Stasiewicz, et al, 2007; Craske, 2008; 2014
Regulation of Cues (ROC)

Targets based on Schachter’s Externality Theory

- Improvement in Appetite Cues
- Decreases in Responsivity to External Cues
Improving appetite cues

Appetite Awareness Training

• Focus is not on forbidding food, but eating less of it
• Monitor and learn about hunger and internal cues to stop eating

Decreasing responsivity to external cues

- **Cue exposure treatment (CET-Food)**
- Repeated non-reinforced exposures to a stimulus to extinguish the individual’s conditioned response, such as a craving, to the stimulus or cue
- **Improvement inhibition**

Boutelle et al, 2011; Frankort et al, 2013
Craving over Time

- **Time:** 20 minutes
- **Craving:**
  - Initial craving at 4.0
  - Decreasing over time

The graph shows a peak in craving at the initial time point, followed by a gradual decrease over 20 minutes.
Treatment development

• First study, evaluated the acceptability and feasibility of 2 treatments

• Appetite Awareness Training (AAT) and CET-Food

• High on EAH (>10% Daily caloric needs)
Children high on EAH (>10% Daily caloric needs)
Consume pizza, carrots and juice dinner
Fullness measure
Taste test
10 min free access
% daily caloric needs consumed in the free access session
Two Novel Treatments to Reduce Overeating in Overweight Children: A Randomized Controlled Trial

Kerri N. Boutelle
University of California, San Diego, and University of Minnesota

Nancy L. Zucker
Duke University

Carol B. Peterson and Sarah A. Rydell
University of Minnesota

Guy Cafri
University of California, San Diego

Lisa Harnack
University of Minnesota
8-week program

36 8-12 yr old children & their parents
## Child outcomes

<table>
<thead>
<tr>
<th>Child Outcomes</th>
<th>Baseline</th>
<th>Post-Treatment</th>
<th>6-month Post-Treatment</th>
<th>12-month Post-Treatment</th>
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<tr>
<td><strong>EAH</strong></td>
<td></td>
<td></td>
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<tr>
<td>Volcravo</td>
<td>20%</td>
<td>10% (^{a,b})</td>
<td>13% (^{a})</td>
<td>15%</td>
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<tr>
<td>CAAT</td>
<td>18%</td>
<td>19%</td>
<td>18%</td>
<td>13%</td>
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<td><strong>EAH (w/ Covariate)</strong></td>
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<td></td>
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<tr>
<td>Volcravo</td>
<td>19%</td>
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<td>.00 (^{a,b})</td>
<td>.00 (^{a})</td>
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<td>.00 (^{a})</td>
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<td>.11 (^{a})</td>
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A bit of confusion......

Hunger?

Craving?
Regulation of Cues
An Intervention Based on Schachter’s Externality Theory for Overweight Children: The Regulation of Cues Pilot

Kerri N. Boutelle,1,2 PhD, Nancy Zucker,3 PhD, Carol B. Peterson,4 PhD, Sarah Rydell,5 MPH, Jordan Carlson,6 PhD, and Lisa J. Harnack,5 PhD

1Department of Pediatrics, 2Department of Psychiatry, University of California, 3Department of Psychiatry, Duke University, 4Department of Psychiatry and 5Division of Epidemiology, University of Minnesota and 6Department of Family and Preventive Medicine, University of California
ROC intervention

• 14 visits over 4 months
• Group based treatment program
• Includes both discussion and experiential exercises
• Includes coping skills, tricky hunger
44 8-12 yr old children & their parents

4-month program

ROC

Control
### Observed means of child outcomes at each time point and intervention effects (n = 44)

<table>
<thead>
<tr>
<th>Observed mean (SD)</th>
<th>Group by time interaction p value</th>
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<tbody>
<tr>
<td></td>
<td>Baseline</td>
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<tr>
<td>Obesity</td>
<td></td>
</tr>
<tr>
<td>BMI</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>BMI z-score</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Percent overweight</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>EAH task²</td>
<td></td>
</tr>
<tr>
<td>Percent of daily calories consumed during free access</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Diet</td>
<td></td>
</tr>
<tr>
<td>Kcal per day</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>EAH scale (parent report of child)</td>
<td></td>
</tr>
<tr>
<td>External eating</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Negative affect eating</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Fatigue/boredom eating</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>CEBQ scale (parent report of child)</td>
<td></td>
</tr>
<tr>
<td>Food responsiveness</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
<tr>
<td>Satiety responsiveness</td>
<td>Intervention</td>
</tr>
<tr>
<td></td>
<td>Control</td>
</tr>
</tbody>
</table>

EAH = eating in the absence of hunger; CEBQ = Child eating behaviour questionnaire

²Adjusted for percent of daily calories consumed at ad libitum dinner
<table>
<thead>
<tr>
<th>Observed means of child outcomes at each time point and intervention effects (n = 44)</th>
<th>Observed mean (SD)</th>
<th>Group by time interaction p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
<td>Post-treatment</td>
</tr>
<tr>
<td>Obesity</td>
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</tr>
<tr>
<td>BMI</td>
<td>Intervention</td>
<td>28.0 (5.0)</td>
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<tr>
<td></td>
<td>Control</td>
<td>26.5 (4.5)</td>
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<tr>
<td>BMI z-score</td>
<td>Intervention</td>
<td>2.13 (0.40)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>2.06 (0.40)</td>
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<tr>
<td>Percent overweight</td>
<td>Intervention</td>
<td>63.32 (26.43)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>58.48 (25.31)</td>
</tr>
<tr>
<td>EAH task*</td>
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<td></td>
</tr>
<tr>
<td>Percent of daily calories consumed during free access</td>
<td>Intervention</td>
<td>15.8 (5.0)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>18.2 (8.0)</td>
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<tr>
<td>Diet</td>
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<td>Kcal per day</td>
<td>Intervention</td>
<td>2067 (704)</td>
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<td></td>
<td>Control</td>
<td>1972 (434)</td>
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<tr>
<td>EAH scale (parent report of child)</td>
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<td>External eating</td>
<td>Intervention</td>
<td>15.29 (1.62)</td>
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<td>Control</td>
<td>14.71 (2.47)</td>
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<td>Negative affect eating</td>
<td>Intervention</td>
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<td>Control</td>
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<td>Intervention</td>
<td>10.61 (2.12)</td>
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<td></td>
<td>Control</td>
<td>11.20 (3.51)</td>
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<tr>
<td>CEBQ scale (parent report of child)</td>
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<td></td>
</tr>
<tr>
<td>Food responsiveness</td>
<td>Intervention</td>
<td>3.94 (0.58)</td>
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<tr>
<td></td>
<td>Control</td>
<td>3.81 (0.73)</td>
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<tr>
<td>Satiety responsiveness</td>
<td>Intervention</td>
<td>2.06 (0.53)</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>1.95 (0.63)</td>
</tr>
</tbody>
</table>

EAH = eating in the absence of hunger; CEBQ = Child eating behaviour questionnaire

*Adjusted for percent of daily calories consumed at ad libitum dinner
Thoughts?

• Clinically, what could have influenced outcome?
• Who would be most likely to have the highest cue-reactivity?

Adults with binge eating
Targeting Internal and External Cues to Reduce Binge Eating: A Pilot Study

Kerri N. Boutelle, PhD
Carol B. Peterson, Ph.D.
Jordan Carlson, Ph.D.
Kristie Bergmann, M.A.
Stephanie Knatz, Ph.D.

Under review
Adult ROC

- 28 overweight binge eaters
- 4 month ROC program with 3 month follow-up
Acceptability

86% Liked the program (a lot/loved it)

90% felt they were more in control of eating (agree/strongly agree)

90% would recommend it to a friend
## Results on outcomes of interest

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Post treatment</th>
<th>3-month follow up</th>
<th>Change from baseline to post treatment</th>
<th>Change over all 3 time points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BMI</strong></td>
<td>38.74</td>
<td>38.01</td>
<td>37.87</td>
<td>-0.73 (-1.24, -0.23)</td>
<td>-0.44 (-0.71, -0.17)</td>
</tr>
<tr>
<td></td>
<td>(10.20)</td>
<td>(10.04)</td>
<td>(10.09)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Loss of control</strong></td>
<td>15.00</td>
<td>9.39</td>
<td>11.11</td>
<td>-5.61 (-9.10, -2.11)</td>
<td>-1.89 (-3.53, -0.25)</td>
</tr>
<tr>
<td>episodes/month</td>
<td>(13.53)</td>
<td>(13.46)</td>
<td>(13.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overeating</strong></td>
<td>12.36</td>
<td>6.86</td>
<td>8.86</td>
<td>-5.50 &lt;.001</td>
<td>-1.61 &lt;.001</td>
</tr>
<tr>
<td>days/month</td>
<td>(7.94)</td>
<td>(6.80)</td>
<td>(7.82)</td>
<td>(-8.30, -2.70)</td>
<td>(-3.05, -0.17)</td>
</tr>
<tr>
<td><strong>EAH–External</strong></td>
<td>13.75</td>
<td>11.89</td>
<td>12.36</td>
<td>-1.86 (.001</td>
<td>-0.73 (.004</td>
</tr>
<tr>
<td><strong>Power of food</strong></td>
<td>(2.68)</td>
<td>(2.47)</td>
<td>(3.01)</td>
<td>(-2.83, -0.89)</td>
<td>(-1.22, -0.25)</td>
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<tr>
<td><strong>Scale</strong></td>
<td>76.32</td>
<td>68.68</td>
<td>67.82</td>
<td>-7.68 (.002</td>
<td>-4.28 &lt;.001</td>
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<tr>
<td></td>
<td>(13.05)</td>
<td>(17.23)</td>
<td>(14.87)</td>
<td>(-12.29, -3.07)</td>
<td>(-6.30, -2.27)</td>
</tr>
<tr>
<td><strong>Food</strong></td>
<td>3.77</td>
<td>3.36</td>
<td>3.44</td>
<td>-0.41 &lt;.001</td>
<td>-0.16 &lt;.001</td>
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<tr>
<td></td>
<td>(0.76)</td>
<td>(0.83)</td>
<td>(0.75)</td>
<td>(-0.59, -0.22)</td>
<td>(-0.25, -0.08)</td>
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<tr>
<td><strong>Responsiveness</strong></td>
<td>2.27</td>
<td>2.49</td>
<td>2.39</td>
<td>0.21 (.004</td>
<td>0.06 (.125</td>
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<td></td>
<td>(0.64)</td>
<td>(0.61)</td>
<td>(0.62)</td>
<td>(0.07, 0.35)</td>
<td>(-0.02, 0.14)</td>
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</table>
Results on outcomes of interest

<table>
<thead>
<tr>
<th>Observed Mean (SD)</th>
<th>Change from baseline to post treatment B (95% CI)</th>
<th>p</th>
<th>Change over all 3 time points B (95% CI)</th>
<th>p</th>
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<td>Power of food Scale</td>
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<td>3.44 (0.75)</td>
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<td>Food Responsiveness</td>
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## Results on outcomes of interest

<table>
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<tr>
<th>Outcome</th>
<th>Baseline Mean (SD)</th>
<th>Post treatment Mean (SD)</th>
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<td>.004</td>
<td>0.06 (-0.02, 0.14)</td>
<td>.125</td>
</tr>
</tbody>
</table>
What changes did you notice in your eating behavior because of ROC?

More aware of how often I eat, more aware of feeling stuffed

Eliminated binge eating completely. Almost eliminated overeating at meals.

I feel I have a lot of resources to make decisions instead of being helpless

I am noticing the biological factors. I am starting to notice hunger @ lunch or dinner sometimes vs oh its time to eat.
iROC study

• Revised our methods
  – 4 foods per session, one at a time
  – Each food twice 5 min, hold, smell, small taste
  – Post-exposure processing
  – Children identify 32 foods
    • Single....same foods each week
    • Multiple....different foods each week
iROC study

- Two studies evaluating methods based on Pavlovian Extinction Theory to improve CET-Food with overweight and obese children

**Study 1**
- Number of exposures (8 vs. 16)
- Single vs. multiple food

**Study 2**
- Context (single vs. multiple)
- Enhanced partial reinforcement
Extinction

Inhibition
KEEP CALM AND STAY TUNED
Summary

• Neurocognitive interventions have potential to change or improve obesity treatments

• Research shows potential for interventions targeting attention, inhibition, memory and extinction

• Could be stand alone treatment(s), or could be combined with behavioral weight loss for children
Benefits

• Address overeating impulses at an implicit level, reducing the need for dietary restraint

• Doesn’t require top down modulation

• Relatively inexpensive
Thank You
• Episodic future thinking (EFT) vs. Control Episodic Thinking (CET)
  – Imagine possible positive future events
  – Imagine a recently experienced event
• EFT reduces delay discounting
• EFT also reduces immediate calorie intake
• Focus on a positive future leads to better decisions today
Daniel et al. 2013, Lin and Epstein 2014
Memory, Obesity, and the Brain

- Obesity and working memory brain related activation using fMRI (Gonzales, et al., 2010)
  - Healthy cognitively intact middle aged adults (40-60 yrs)
  - Working memory task
  - Obesity (BMI) was associated with lower task-related activation in the right parietal cortex
  - Evidence that insulin sensitivity mediated the relationship between BMI and differential brain activation during working memory task
• **Affect**
  Thinking about a positive future helps delay gratification

• **Vividness**
  Imagining future plans makes them seem more possible

• **Detailed Planning**
  Imagining the future helps to identify and avoid problems that could arise in plan implementation