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Research report

A pilot study evaluating a one-session attention modification training to decrease overeating in obese children [☆]



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ABSTRACT

There are a number of neurocognitive and behavioral mechanisms that contribute to overeating and obesity, including an attentional bias to food cues. Attention modification programs, which implicitly train attention away from specific cues, have been used in anxiety and substance abuse, and could logically be applied to food cues. The purpose of this study was to evaluate the initial efficacy of a single session attention modification training for food cues (AMP) on overeating in overweight and obese children. Twenty-four obese children who eat in the absence of hunger participated in two visits and were assigned to an attention modification program (AMP) or attentional control program (ACC). The AMP program trained attention away 100% of the time from food words to neutral words. The ACC program trained attention 50% of the time to neutral and 50% of the time to food. Outcome measures included the eating in the absence of hunger free access session, and measures of craving, liking and salivation. Results revealed significant treatment effects for EAH percent and EAH kcal (group by time interactions $p < .05$). Children in the ACC condition showed a significant increase over time in the number of calories consumed in the free access session (within group $t = 3.09$, $p = .009$) as well as the percent of daily caloric needs consumed in free access (within group $t = 3.37$, $p = .006$), whereas children in the AMP group demonstrated slight decreases in these variables (within group $t = -0.75$ and -0.63 , respectively). There was a trend suggesting a beneficial effect of AMP as compared to ACC for attentional bias (group by time interaction $p = .073$). Changes in craving, liking and saliva were not significantly different between groups ($ps = .178-.527$). This is the first study to demonstrate that an AMP program can influence eating in obese children. Larger studies are needed to replicate and extend these results.

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Introduction

Recent data suggest that 31% of children in the United States are overweight or obese (Ogden, Carroll, Kit, & Flegal, 2012), which translates to 4–5 million children in the United States. Overweight and obese children are at an increased risk for many negative health complications in childhood and adulthood, including orthopedic and endocrine conditions, cardiovascular disease, cancer and all-cause mortality (Biro & Wien, 2010; Franks et al., 2010; Lobstein, Baur, Uauy, & TaskForce, 2004; Reilly & Kelly, 2011). Additionally, these children are at risk for psychosocial consequences

in childhood and adolescence, including poor self-esteem, teasing and verbal abuse (Puhl & Latner, 2007; Wardle & Cooke, 2005) and isolation from social networks (Strauss & Pollack, 2003). Healthcare and hospital costs are higher for overweight and obese children compared to those who are healthy weight (Estabrooks & Shetterly, 2007; Hampl, Carroll, Simon, & Sharma, 2007; Wang & Dietz, 2002) and the number of hospitalizations among children who are obese nearly doubled from 1999 to 2005 (Trasande, Liu, Fryer, & Weitzman, 2009).

There are a number of neurocognitive and behavioral mechanisms that contribute to overeating, or eating past nutritional needs, which can lead to obesity. These processes which are involved in mobilizing behavior to obtain and eat food include attention to food cues (Nijs & Franken, 2012), learned relationships between the seeing the food cue and the taste (classical and operant conditioning) (Martin-Soelch, Linthicum, & Ernst, 2007; Rozin & Zellner, 1985), cognitions about the food (Higgs, 2008),

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activation of neural circuits in the brain associated with reward (Berridge, 1996, 2009; Wise, 2006), and decreased inhibitory mechanisms (Hofmann, Friese, & Roefs, 2009; Volkow, Wang, Fowler, & Telang, 2008). Responsiveness to food and the general processing of reward and pleasure is considered to be mediated by dopamine in the mesocorticolimbic system (Kelley & Berridge, 2002). Dysregulated dopamine-based reward circuitry has been implicated in overeating and obesity (Volkow, Wang, Fowler, Tomasi, & Baler, 2012). The incentive sensitization theory, which has recently been applied to obesity, proposes that attentional biases for food cues result from repeated pairings of food cues with food intake (Berridge, 2009). Over time through associative conditioning, dopamine based reward circuitry becomes hyper-sensitized to stimuli associated with food, resulting in biased attentional processing toward food related cues (e.g. the sight or smell of highly palatable foods). Food cues become “attention grabbing” in vulnerable individuals, and trigger a motivational state of “wanting” that increases the likelihood of behavioral approach and consumption. Given the ubiquity of food cues in today’s environment, an attentional bias to food cues may play a critical role in the development and maintenance of overeating and obesity, and could be considered an index of individual differences in saliency and reward to food.

In general, data suggests that an attentional bias to food cues exists in adults with obesity, but like other fields, there are some mixed results. In two studies with normal weight college students, attentional bias for pictorial food cues was associated with eating in response to food cues (external eating) (Brignell, Griffiths, Bradley, & Mogg, 2009; Hou et al., 2011). In two visual search experiments, detection times were faster when targets were food rather than non-food items, and the detection for food items were negatively correlated with BMI (Nummenmaa, Hietanen, Calvo, & Hyona, 2011). Using an eye tracking paradigm and a pictorial dot probe, obese and normal weight individuals had increased gaze during for food compared to non-food images in the fasted state (Castellanos et al., 2009). When fed, obese individuals had increased attention to food images, while normal weight individuals had similar gaze duration for food and non-food images. A visual probe task showed a bias in initial orientation to food cues in overweight participants compared to lean participants, but did not show a bias in maintained attention to food cues (Nijs, Muris, Euser, & Franken, 2010). Some studies have failed to find this relationship. Using a Stroop task, no differences were seen in interference in color-naming food words between obese and healthy weight adults (Phelan et al., 2011). One study using eye movement during a visual probe task with food pictures showed that overweight participants showed an approach-avoidance pattern of attention toward high-fat food pictures (Werthmann et al., 2011). However, more recent studies suggest that attentional biases for food cues could be more idiosyncratic than considered beforehand, and vary based on internal perceptions, including chocolate craving and self-permission to eat (Werthmann, Roefs, Nederkoorn, & Jansen, 2013).

Less is known about attentional biases for food cues in youth. In one study, overweight and normal weight children completed a Stroop task containing food-related words, negative emotional words, and control words in an effort to assess information processing biases for food-relevant stimuli. Results revealed the obese children were slower in naming the color of food words than the color of control words compared to their normal weight counterparts, suggesting an interference of food cues on attention to the task (Braet & Crombez, 2003). However, in a later study with 87 adolescents (45 overweight and 42 normal weight) no relationship was found between overweight status and interference for food words in an imbedded food word task (Soetens & Braet, 2007). In a prospective study with 35 adolescent girls ranging from lean to

obese using an attention network task involving food and neutral stimuli, results showed that BMI correlated positively with attentional bias to appetizing food stimuli but not neutral stimuli (Yokum, Ng, & Stice, 2011). Taken as a whole, this emerging body of research suggests that attentional biases to food cues are associated with obesity, increased eating and increased BMI, however more studies are needed to draw more firm conclusions. Recent studies show that internal factors play a role in attentional bias, and the idiosyncratic nature of attentional biases to food cues has yet to be fully explored.

To modify attentional biases, researchers have developed programs that automatically divert attentional resources away from salient stimuli by implicitly training individuals that if a salient and neutral stimuli are present, the neutral stimulus has better signal value (MacLeod, Rutherford, Campbell, Ebsworthy, & Holker, 2002). Attention modification programs (AMP) improve an individual’s ability to disengage attention from cues and have been related to changes in activation of the prefrontal cortex to emotional stimuli, implying better top down control of attention as a result of attention training (Browning, Holmes, Murphy, Goodwin, & Harmer, 2010). AMP programs have been applied primarily in anxiety disorders (Amir, Beard, Burns, & Bomyea, 2009; Amir, Beard, Taylor, et al., 2009; Eldar et al., 2012; Heeren, Reese, McNally, & Philippot, 2012; Schmidt, Richey, Buckner, & Timpano, 2009). Although data on attentional biases in anxiety disorders is also mixed, with some studies failing to find expected groups differences between AMP and control conditions (Boettcher, Berger, & Renneberg, 2012; Boettcher et al., 2013; Neubauer et al., 2013), meta-analyses show that AMP programs have statistically large and reliable effects in changing attentional bias in anxiety (Beard, Sawyer, & Hofmann, 2012; Hakamata et al., 2010; Hallion & Ruscio, 2011). A smaller but growing body of literature suggests that AMP programs may be useful in appetitive disorders (e.g. alcohol and cigarettes; (Attwood, O’Sullivan, Leonards, Mackintosh, & Munafo, 2008; Schoenmakers et al., 2010), although findings have also been mixed (Field & Cox, 2008; McHugh, Murray, Hearon, Calkins, & Otto, 2010). Thus, a recent review highlighted the need for increased research on the efficacy of AMP for appetitive disorders (Beard et al., 2012). To date no published study has evaluated an AMP program to train attention away from food cues in overweight and obese individuals.

Considering the plethora of food cues in the environment, and the importance of training children to address responsivity to food cues in their natural environment, it would be valuable to begin to develop interventions to address these neurocognitive processes, including attentional bias. To address this gap, this project tested a one-session attention modification program to examine its effect in reducing responses to food cues in overweight and obese children. We hypothesized that children in the AMP condition, relative to the control condition, would show a decrease in attention bias, eat less and would report decreased cravings, liking of foods and salivation following the AMP program.

Methods

Participants

We recruited overweight and obese 8–12 year old children from listserves, primary care clinics, and from other advertisements in the community in San Diego, CA. Inclusion criteria included child BMI% > 85th, consent from parents, assent from child, and committing to attend both visits. Because we wanted to look at overeating in our laboratory, we only included children who ate a minimum of 5% of their daily caloric needs in the free access EAH paradigm (see ‘Measures’ section). Exclusion criteria included:

(1) psychiatric disorder diagnoses, (2) diagnoses of a serious physical disease for which physician supervision of diet and exercise prescription were needed, (3) medications that would influence weight and eating, and (4) presence of another eating disorder (bulimia nervosa).

Procedure

All participants attended an initial screening for the study, and those who met inclusion criteria completed a baseline assessment (T1) that included an EAH paradigm, a survey and saliva measurement when presented with foods. Participants returned for a second visit (T2) and were randomly assigned to the AMP or ACC program, completed the AMP or ACC program in our clinic, then completed a survey, an EAH assessment, and a saliva measurement. Participants received \$20 in gift cards for time and effort.

Attention modification program–Food

We developed the attention modification program (AMP–Food) based on the program used by [Najmi and Amir \(2010\)](#). AMP–Food consisted of 12 word pairs consisting of matched food words (i.e. cake) and neutral words (i.e. pencil). Words were matched on length and readability. We chose food words rather than pictures as words have been shown to yield stronger training effects compared to picture stimuli ([Hakamata et al., 2010](#)). In the AMP–Food condition, participants were presented with 288 trials that consisted of balanced combinations of a probe type (“E” or “F”) and position of probe on the screen (top of bottom). At the beginning of each trial, children were asked to focus their attention on a fixation cross, which appeared in the center of the screen for 500 ms. The fixation cross then disappeared and a word pair was presented vertically for 500 ms, following which a letter probe appeared in the location of the neutral word. The probe appeared on the screen until the participant identified the probe type. A 500 ms interval of a blank screen was presented before the onset of the next trial. We did not give any specific instructions to the participants to direct attention away from the food words. The position of the neutral word on the screen indicated the position of the subsequent probe, which acted as a contingency reinforcement such that the probe always appeared in the position of the neutral word (training attention away from food cues and toward neutral cues). Participants were instructed to respond to the probe as quickly and as accurately as possible by pressing either the left mouse button (“E”) or right mouse (“F”) button to identify the letter.

Attention control condition

In the attention control condition (ACC), training was identical to the AMP arm except that the probe appeared with equal frequency in the position of the food word and neutral word (training attention to food and neutral words equally).

Measures

Eating in the absence of hunger (EAH) free access paradigm

The assessment measure of EAH was initially described by Birch and colleagues ([Birch & Fisher, 2000](#); [Fisher & Birch, 2002](#)) and has been used in intervention studies targeting overeating ([Boutelle et al., 2011](#)). Each child came into the clinic fed and self-reported post-meal satiety was assessed using a cartoon representation of three levels of fullness ([Faith et al., 2006](#)) along with two questions regarding the child’s level of hunger and fullness via a 1–5 scale with 1 being “not at all hungry/full” and 5 being “extremely hungry/full.” If the child was not at 1 or a 2 on the hunger scale, they were given the choice or a combination of pretzels, raisins, apple slices and carrots until they reported fullness. Next, each child tasted and rated palatability of small samples of 11 sweet and

savory snack foods (popcorn, Cheez-its, Cheetos, potato chips, pretzels, Skittles, Hershey bars, chocolate chip cookies, Fig Newtons, jelly beans, M&M’s) and rated them on a Likert scale on how much they liked the food. Following the rating of foods, the child was told that the coordinator had work in the adjacent room, and the child was left alone in a room with containers holding generous pre-weighed portions of the snack foods as well as toys and games. The child was told that s/he could eat whatever they wanted and/or play with games or books while waiting. After 10 min, the coordinator returned to the room and ended the free access session. The amounts of remaining food items were measured. The total calories consumed by each child was calculated from the amount consumed data, and this total was divided by child’s estimated daily calorie needs to derive the percent of calorie needs consumed during the free access period (EAH%). Daily calorie needs were estimated using age-specific formulas for calculating estimates energy requirements according to weight, age, height, and physical activity level ([National Academy of Sciences, Institute of Medicine, Food and Nutrition Board, 2005](#)). A physical activity level of low active was used for all children in this study to be conservative.

Liking of EAH foods

During the EAH, children completed a questionnaire on how much they liked each of the 11 foods (popcorn, Cheez-its, Cheetos, potato chips, pretzels, Skittles, Hershey bars, chocolate chip cookies, Fig Newtons, jelly beans, M&M’s) on a Likert scale ranging from 1 to 5, with 1 = “disgusting” 5 = “delicious.” An average of liking scores on the 11 EAH foods is presented.

Craving

Children completed a questionnaire on how much they craved the 11 snack foods in the EAH paradigm (popcorn, Cheez-its, Cheetos, potato chips, pretzels, Skittles, Hershey bars, chocolate chip cookies, Fig Newtons, jelly beans, M&M’s) on a Likert scale of 1–5, with 1 being “I don’t want it at all” and 5 being “I need to eat it now” before and after the AMP/ACC training on T2. An average of craving scores on the 11 EAH foods is presented.

Saliva

Salivary flow was measured using the Strongin–Hinsie Peck method ([Peck, 1959](#)). Children were trained to place three pre-weighed cotton dental rolls (cylindrical, 10 mm diameter, 38 mm length, Richmond wrapped cotton rolls) in their mouth under the tongue and on both the left and right sides of mouth between the check and lower gum before and after the AMP/ACC training on T2. Immediately after the collection period, the subject removed the dental rolls and sealed them in a plastic bag. Salivation volume was determined by subtracting pre from post weighing of the dental rolls.

Attentional bias

Consistent with previous research, we used a modified dot probe paradigm to assess attention bias at pre- and post-training ([Najmi & Amir, 2010](#)). Participants were presented with 48 trials comprised from six food/neutral word pairs matched for length and readability. The assessment consisted of equal number of trials for probe type (“E” or “F”), location of probe (top or bottom), and location of food word (top or bottom). Stimulus presentation durations were identical to the AMP/ACC programs. Different word sets were used in the pre-AMP/ACC and the post-AMP/ACC assessments, and none of the assessment words were used in the AMP/ACC training programs. Response latencies were recorded from the onset of the probe (“E” or “F”) to the button press. We then computed a food bias score by subtracting the response latency for probes following food related words from the response latency

for probes that followed neutral words. Larger positive bias scores indicated an attentional bias toward food related words, while larger negative bias scores indicate an attentional bias away from food related words.

Anthropometry

Child height was measured using a standard stadiometer in duplicate. Children's weight was measured in duplicate on a calibrated slide scale without jackets, outerwear or shoes. The average of the two values was used for analysis. Children's heights and weights were translated to BMI and BMI-for-age percentile scores using the CDC growth charts (Kuczmarski et al., 2000).

Results

Overview of data analysis

The current study tested the hypothesis that individuals in the AMP group would demonstrate faster attention disengagement from food-relevant information after the program, relative to the ACC group. Additionally, we predicted that the AMP group would decrease their overeating in the EAH paradigm, and would decrease their craving and liking of the foods more than children enrolled in the ACC group. Finally, as an exploratory aim, we looked at the effect of attentional training on salivary response, a cephalic phase response for eating (Powley & Berthoud, 1985).

Preliminary analyses

For the attentional bias data, we removed incorrect response latencies from each participant's scores. A mean response latency was calculated for each participant for probes replacing food related cues and response latency for neutral words before and after training. Consistent with previous research, incorrect responses were removed from analysis (7.36% of trials). Trials with extreme values (<200 ms or >6000 ms) were also removed (1.47% of trials).

Analysis

Between-group differences were assessed for participant gender and ethnicity (non-Hispanic White or other) using Chi-squared tests and for participant age, BMI, and baseline outcome scores using *t*-tests. Two-way ANOVAs (time by treatment) were used to investigate treatment effects over time, and follow-up paired *t*-tests were used to investigate within-group changes over time. Previous research suggests that attention bias at baseline is a moderator of response to attention training (Amir, Taylor, & Donohue, 2011). To test the hypothesis that participants with higher baseline attentional bias scores would perform more favorably in AMP than ACC, as compared to participants with lower baseline attentional bias scores (moderation), EAH percent and EAH kcal change scores were regressed on baseline attentional bias, condition, and the interaction between attentional bias and condition. Follow-up within-group linear regression models were used to investigate the relation of baseline attention bias scores to EAH percent and EAH kcal change scores in each condition. Outliers were identified based on a Cook's distance > 4/*N* for the main study outcomes which were EAH percent and EAH kcal. Outliers were then excluded from analyses of EAH percent and EAH kcal but included in analyses of other outcomes. A *p* value of 0.05 was used to interpret significance of results. SPSS version 21 was used for the analyses.

Results

Twenty-nine participants completed the study. Two participants had missing data on attentional bias; these participants were retained in the analyses of other outcomes. Three participants had extreme Cook's *d* values on EAH and were excluded from the EAH analyses. Participants were an average of 11 years old (SD = 1.2), 46% were girls, 54% were White non-Hispanic, and mean BMI was 26.6 (SD = 4.2) (see Table 1). These characteristics did not differ significantly between groups. Between-group differences on outcome scores at baseline were not significant; attention bias ($t(25) = -1.76$; $p = .101$), EAH percent ($t(24) = -1.38$; $p = .180$), EAH kcal ($t(24) = -1.05$; $p = .303$), craving ($t(27) = -0.55$; $p = .585$), liking ($t(27) = 0.41$; $p = .688$), and saliva ($t(27) = 0.80$; $p = .429$).

Table 2 presents between- and within-group changes in outcome scores over time. There were significant experimental effects for EAH percent and EAH kcal (group by time interaction $p < .05$). Within-group *t*-tests revealed that the EAH percent and EAH kcal showed a trend toward increase in the ACC group and did not change in the AMP group. There was a trend for significance for an experimental effect for attention bias (group by time interaction $p < .1$), and within group *t*-tests suggested that attention bias decreased slightly from baseline to post-treatment in the AMP group and increased in the ACC group. Changes in cravings, liking, and saliva were not significantly different between groups.

The moderator analyses suggested that baseline attentional bias did not moderate between-group change in EAH percent (interaction $\beta = 2.18$; $t = 1.46$; $p = .159$) and EAH kcal (interaction $\beta = 2.49$; $t = 1.71$; $p = .103$) over time.

Discussion

To our knowledge, this is the first paper to evaluate the effects of an attention modification training program (AMP) on overeating in overweight and obese children. This pilot study suggests that after one session of AMP training, children in the AMP condition maintained their level of overeating in the laboratory paradigm, while children in the ACC group increased how much they ate (see Table 2). Additionally, there was a marginal significant difference between the AMP and ACC group on attentional bias scores. There were no significant differences on changes in cravings, liking or salivation between groups. In summary, implicitly training attention away from food cues seems to have an effect on overeating immediately following a single session AMP training in this sample.

Results suggest that attentional bias toward food tended to increase in the ACC group from pretest to posttest, as compared to the AMP group, in which no pretest–posttest change was observed. Children in the AMP condition essentially ate an average of 16 calories less and decreased their attentional bias by 37 ms following the training, while children in the ACC group ate an average of 65 calories more and increased their attentional bias by 162 ms more following the training. We originally hypothesized that the

Table 1
Participant demographic characteristics.^a

	Total	ACC	AMP
<i>N</i>	29	15	14
Mean (SD) age	10.83 (1.28)	11.29 (1.20)	10.40 (1.24)
% Girls	44.8	35.7	53.3
% White non-Hispanic	55.2	64.3	46.7
Mean (SD) BMI	26.04 (4.08)	26.40 (4.48)	25.70 (3.78)
Mean (SD) BMI percentile	96.38 (2.80)	96.29 (2.92)	96.47 (2.77)

^a No significant between-group differences.

Table 2
Treatment effects across multiple outcomes (N = 29).

	Group	n	Observed M (SD)		Main effects F (df); p		Group by time interaction		Within-group change over time ^b	
			Baseline ^a	Post-treatment	Treatment main effect	Time main effect	F (df)	p	t (df)	p
Attentional bias ^c	ACC	14	-73.4 (241.6)	89.1 (273.5)	0.20 (25); .656	1.37 (25); .252	3.50 (25)	.073	1.88 (13)	.083
	AMP	13	54.3 (172.2)	16.9 (109.6)					-0.62 (12)	.546
EAH percent	ACC	13	9.6 (3.6)	12.2 (2.4)	0.48 (24); .494	1.72 (24); .202	6.48 (24)	.018	3.37 (12)	.006
	AMP	13	12.6 (6.9)	11.8 (6.1)					-0.75 (12)	.466
EAH kcal	ACC	13	246.9 (104.1)	312.0 (79.3)	0.06 (24); .815	2.22 (24); .150	6.02 (24)	.022	3.09 (12)	.009
	AMP	13	297.7 (139.1)	281.8 (140.6)					-0.63 (12)	.542
Cravings	ACC	14	2.62 (0.94)	3.29 (1.07)	0.26 (27); .616	1.51 (27); .230	1.88 (27)	.182	-	-
	AMP	15	2.82 (1.07)	2.79 (1.05)						
Liking	ACC	14	3.74 (0.60)	3.64 (0.69)	0.77 (27); .388	0.02 (27); .890	1.93 (27)	.176	-	-
	AMP	15	3.90 (0.69)	3.52 (1.06)						
Saliva	ACC	14	2.18 (1.28)	2.20 (1.65)	0.61 (27); .443	0.04 (27); .845	0.01 (27)	.926	-	-
	AMP	15	1.86 (0.83)	1.92 (0.76)						

^a No significant between-group differences at baseline.

^b Only calculated if group by time interaction p value was <.1.

^c Positive bias scores reflect higher biases for food cues, while negative bias scores reflect higher biases for neutral cues.

AMP training would lead to significant decreases in attentional bias, which would lead to decreases in overeating. However, the increase in attentional bias and eating following the ACC program was unexpected. The within groups analyses suggested that the majority of changes were seen in the ACC group, with very small nonsignificant changes in the AMP group. Taken as a whole, these results can potentially be understood by considering the differences in the training conditions. The AMP program trained attention 100% away from food words, while the ACC program trained attention 50% away from the food words and 50% toward the food words. Repeated training of attention toward food words in the ACC condition could have triggered incentive salience, and increased attentional bias to foods and wanting of food, which led to increased eating. In hindsight, inclusion of an arm that trained 100% toward food cues would have helped us dissect this hypothesis. Our results also showed that attentional bias was not a moderator of between-group change in eating (EAH% and EAH kcal) in this sample, which may have been affected by the small sample size. Attentional bias research in the anxiety disorders literature suggests that higher levels of baseline attention bias are associated with more favorable response in AMP (Amir et al., 2011). Replication and further research with larger samples sizes is needed to confirm these results.

It is interesting that changes from pretest to posttest on craving, liking or salivation did not differ between the AMP and ACC group, although the directionality of the changes in cravings and liking were in the expected direction. This could suggest that changing bias does not influence cravings, liking or salivation, or more likely it is due to a number of design factors, including length of training (288 trials), types of training (words), or the small sample size. Much larger sample sizes, replication and manipulation of key variables (types of training (words or pictures), number of training visits, length of training), are needed to verify and extend these results.

Although the effects in this study seem small, these results if replicated could have clinical significance over time. The changes in the eating in the absence of hunger paradigm may seem small, however, an increase in caloric intake by 65 kcals/day (such as that in the ACC group) could result in weight gain of up to 8 lbs per year. Additionally, this type of attentional bias modification program may have clinical utility if administered in longer protocols over multiple sessions (Amir, Beard, Burns, et al., 2009; Amir, Beard, Taylor, et al., 2009; Eldar et al., 2012; Heeren et al., 2012; Schmidt et al., 2009) and the assessment of longer protocols on eating and children's BMI should be evaluated.

As in all studies, this study has both strengths and weaknesses that need to be noted. The strengths include the randomized assignment, the use of a strong control group (ACC), the assessment of eating using a laboratory paradigm, and multiple measures that relate to overeating. The weaknesses include the small pilot sample size, the lack of follow-up data, and the lack of information on children's eating in natural circumstances.

This is the first study to evaluate the initial efficacy of an attention modification training program on attentional bias and children's overeating. Although further studies are needed to replicate and extend these results, AMP programs target an individual level mechanism that could be used to address food cue sensitivity. Neurocognitive interventions have the potential to impact overeating in an environment full of calorically dense food cues, by making food cues less salient. Future studies should replicate this study with larger samples, and should evaluate longer programs with multiple attentional training sessions on attentional bias, overeating and children's BMI. Furthermore, studies with larger samples should evaluate moderators of response, and whether changes in attentional bias mediate responding to these programs.

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