

ADHD and obesity

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DSM-5 criteria for the diagnosis of Attention-Deficit/Hyperactivity Disorder.

A persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, as characterized by (1) and/or (2):

Inattention: Six (or more) of the following symptoms have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic/occupational activities:

Note: The symptoms are not solely a manifestation of oppositional behavior, defiance, hostility, or failure to understand tasks or instructions. For older adolescents and adults (age 17 and older), at least five symptoms are required.

- a. Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or during other activities (e.g., overlooks or misses details, work is inaccurate).
- b. Often has difficulty sustaining attention in tasks or play activities (e.g., has difficulty remaining focused during lectures, conversations, or lengthy reading).
- c. Often does not seem to listen when spoken to directly (e.g., mind seems elsewhere, even in the absence of any obvious distraction).
- d. Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (e.g., starts tasks but quickly loses focus and is easily sidetracked).
- e. Often has difficulty organizing tasks and activities (e.g., difficulty managing sequential tasks; difficulty keeping materials and belongings in order; messy, disorganized work; has poor time management; fails to meet deadlines).
- f. Often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (e.g., schoolwork or homework; for older adolescents and adults, preparing reports, completing forms, reviewing lengthy papers).
- g. Often loses things needed for tasks and activities (e.g., school materials, pencils, books, tools, wallets, keys, paperwork, eyeglasses, mobile telephones).
- h. Is often easily distracted by extraneous stimuli (for older adolescents and adults, may include unrelated thoughts).
- i. Is often forgetful in daily activities (e.g., doing chores, running errands; for older adolescents and adults, returning calls, paying bills, keeping appointments).

Hyperactivity and impulsivity: Six (or more) of the following symptoms have persisted for at least 6 months to a degree that is inconsistent with developmental level and that negatively impacts directly on social and academic/occupational activities:

Note: The symptoms are not solely a manifestation of oppositional behavior, defiance, hostility, or failure to understand tasks or instructions. For older adolescents and adults (age 17 and older), at least five symptoms are required.

- a. Often fidgets with or taps hands or feet or squirms in seat.
- b. Often leaves seat in situations when remaining seated is expected (e.g., leaves his or her place in the classroom, in the office or other workplace, or in other situations that require remaining in place).
- c. Often runs about or climbs in situations where it is inappropriate. (**Note:** In adolescents or adults, may be limited to feeling restless).
- d. Often unable to play or engage in leisure activities quietly.
- e. Is often "on the go", acting as if "driven by a motor" (e.g., is unable to be or uncomfortable being still for extended time, as in restaurants, meetings; may be experienced by others as being restless or difficult to keep up with).
- f. Often talks excessively.
- g. Often blurts out an answer before questions have been completed (e.g., completes people's sentences; cannot wait for turn in conversation).
- h. Often has difficulty waiting his or her turn (e.g., while waiting in line).
- i. Often interrupts or intrudes on others (e.g., butts into conversations, games, or activities; may start using other people's things without asking or receiving permission; for adolescents or adults, may intrude into or take over what others are doing).

B. Several inattentive or hyperactive-impulsive symptoms were present prior to age 12 years.

C. Several inattentive or hyperactive-impulsive symptoms are present in two or more settings (e.g., at home, school or work; with friends or relatives; in other activities).

D. There is clear evidence that the symptoms interfere with, or reduce the quality of, social, academic, or occupational functioning.

The symptoms do not occur exclusively during the course of schizophrenia or another psychotic disorder and are not better explained for by another mental disorder (e.g., mood disorder, anxiety disorder, dissociative disorder, personality disorder, substance intoxication or withdrawal).

Specify whether:

Combined presentation: If both Criterion A1 (inattention) and Criterion A2 (hyperactivity-impulsivity) are met for the past 6 months.

Predominantly inattentive presentation: If Criterion A1 (inattention) is met but Criterion A2 (hyperactivity-impulsivity) is not met for the past 6 months.

Predominantly hyperactive/impulsive presentation: If Criterion A2 (hyperactivity-impulsivity) is met and Criterion A1 (inattention) is not met for the past 6 months.

Specify if

In partial remission: When full criteria were previously met, fewer than the full criteria have been met for the past 6 months, and the symptoms still result in impairment in social, academic, or occupational functioning.

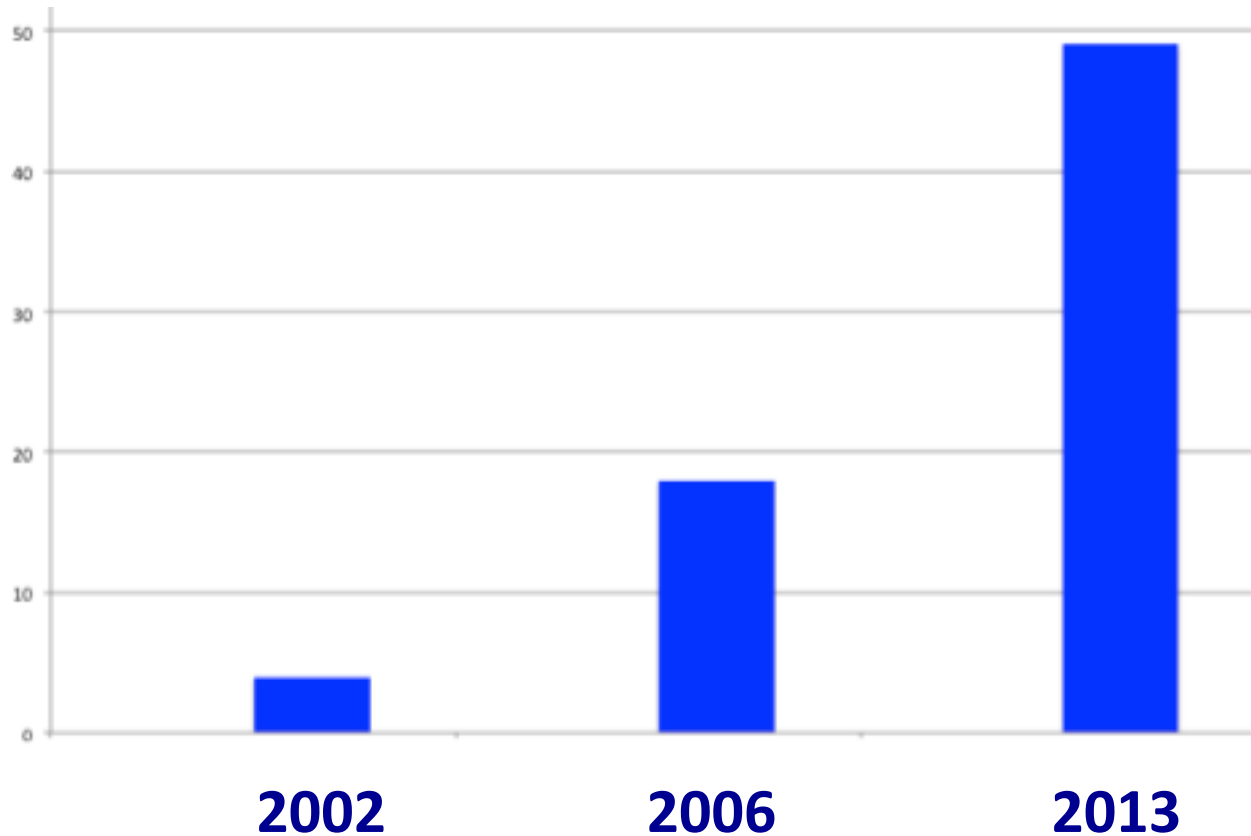
Specify current severity:

Mild: Few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in no more than minor impairment in social or occupational functioning.

Moderate: Symptoms or functional impairment between "mild" and "severe" are present.

Severe: Many symptoms in excess of those required to make the diagnosis, or several symptoms that are particularly severe, are present, or the symptoms result in marked impairment in social or occupational functioning.

Pubmed: “ADHD AND obesity”



“There may be an elevated likelihood of obesity among individuals with ADHD” **DSM-5**

1. ADHD in obesity

First author, year	Sample	Association
Altfas, 2004	215 bariatric adults	YES
Erermis, 2004	60 obese children, 30 comp.	YES
Agranat-Meged, 2005	26 obese boys	YES
Fleming, 2005	75 obese adults	YES
Alfonsson, 2012	187 bariatric adults	YES
Gruss, 2012	116 bariatric adults	YES
Nazar, 2013	155 adults	YES

2. Obesity in ADHD

First author, year	Sample	Association
Holtkamp, 2004	97 ADHD children	YES
Curtin, 2005	98 ADHD children	YES (if stimulant naïve)
Huebel, 2006	39 ADHD boys, 30 comp.	NO
Dubnov-Raz, 2010	275 ADHD children	NO (but no med naïve)
Mueller, 2010	12 ADHD boys, 12 comp.	NO
Gungor 2010	362 ADHD, 390 comp.	YES
Fliers, 2013	372 ADHD, 12 comp.	YES (boys)/NO (young girls)
Pauli-Pott, 2013	207 ADHD, 103 compar.	NO

3. Epidemiological samples

First author, year	Sample	Association
Bandini 2005	19,759 children	NO
Rojo, 2006	35,043 adol	NO
Lam, 2007	1,429 adol	YES
Waring, 2008	62,887 children	YES
Pagoto, 2008	6,735 adults	YES
Drukker, 2009	1,411 children/adol	NO
Chen, 2009	46,707 adol	YES
Fuemmelar, 2010	15, 197 adults	YES
Kim, 2011	66,707 children	YES
De Zwann, 2011	1,633 adults	YES
Koshy, 2011	1074 children	YES
Erhart, 2012	2,863 children	YES
Egmond-Frohlich, 2012	11 159 children-adol	YES/NO
Cortese, 2013	34653 adults	YES/NO
Byrd, 2013	3050 adol	NO

1. ADHD in obesity

First author, year	Sample	Association	SES	Psych comorb	Stimul	Other
Altfas, 2004	215 bariatric adults	YES				
Erermis, 2004	60 obese children, 30 comp.	YES				
Agranat-Meged, 2005	26 obese boys	YES				
Fleming, 2005	75 obese adults	YES				
Alfonsson, 2012	187 bariatric adults	YES				
Gruss, 2012	116 bariatric adults	YES		✓		✓ (sleep)
Nazar, 2013	155 adults	YES		✓		✓ (sleep)

2. Obesity in ADHD

First author, year	Sample	Association	SES	Psych comorb	Stimul	Other
Holtkamp, 2004	97 ADHD children	YES		✓	✓	
Curtin, 2005	98 ADHD children	YES		✓	✓	
		(if stimulant naïve)		✓	✓	
Huebel, 2006	39 ADHD boys, 30 comp.	NO		✓		
Dubnov-Raz, 2010	275 ADHD children	NO (but no med naïve)		✓		
Mueller, 2010	12 ADHD boys, 12 comp.	NO				
Gungor 2010	362 ADHD, 390 comp.	YES				
Fliers, 2013	372 ADHD, 12 comp.	YES (boys)/NO (young girls)		✓		
Pauli-Pott, 2013	207 ADHD, 103 compar.	NO		✓		

3. Epidemiological studies

First author, year	Sample	Association	SES	Psych comorb	Stimul	Other
Bandini 2005	19,759 children	NO				✓ (race)
Rojo, 2006	35,043 adol	NO				NO
Lam, 2007	1,429 adol	YES	✓			✓ (snoring)
Waring, 2008	62,887 children	YES	✓	✓	✓	✓ (race)
Pagoto, 2008	6,735 adults	YES	✓	✓	✓	✓ (smoking)
Drukker, 2009	1,411 children/adol	NO				✓ (race)
Chen, 2009	46,707 adol	YES	✓			✓ (race)
Fuemmelar, 2010	15, 197 adults	YES	✓	✓		✓ (smoking)
Kim, 2011	66,707 children	YES	✓	✓	✓	✓ (race)
De Zwann, 2011	1,633 adults	YES	✓	✓		NO
Koshy, 2011	1074 children	YES	✓			✓ (smoking)
Erhart, 2012	2,863 children	YES	✓	✓	✓	✓ (several)
Egmond-Frohlich, 2012	11 159 children-adol	YES/NO	✓			✓ (smoking)
Cortese, 2013	34653 adults	YES/NO	✓	✓		✓ (race)
Byrd, 2013	3050 adol	NO		✓		

Adult attention-deficit hyperactivity disorder and obesity: epidemiological study

Samuele Cortese, Stephen V. Faraone, Silvia Bernardi, Shuai Wang and Carlos Blanco

Face to face interviews in **34 653 US adults**
from the National Epidemiologic Study on Alcohol and
Related Conditions (NESARC)

Table 8 Logistic regression model in the entire sample (men plus women), the dependent variable is obesity rate (at Wave 2) and the independent variables are the number of hyperactive, impulsive and inattentive symptoms before age 18, any lifetime mood, anxiety and substance use disorders, ethnicity and individual income^a

Predictors (independent variables)	<i>b</i>	s.e.	Adjusted OR	95% CI	<i>P</i> (2-sided)
Number of inattentive symptoms	0.02	0.01	1.02	1.00–1.05	0.036
Number of impulsive symptoms	0.06	0.02	1.06	1.02–1.10	0.001
Number of hyperactive symptoms	−0.02	0.01	0.98	0.95–1.00	0.092
Any mood disorders, lifetime	0.26	0.03	1.30	1.21–1.39	<0.0001
Any anxiety disorders, lifetime	0.20	0.04	1.22	1.13–1.31	<0.0001
Any substance use disorders (other than nicotine dependence), lifetime	−0.08	0.04	0.92	0.86–0.99	0.028
Nicotine dependence, lifetime	−0.06	0.04	0.94	0.87–1.02	0.121

LONGITUDINAL STUDIES

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Obesity in Men With Childhood ADHD: A 33-Year Controlled, Prospective, Follow-up Study

Samuele Cortese, Maria A. Ramos Olazagasti, Rachel G. Klein, F. Xavier Castellanos, Erika Proal and Salvatore Mannuzza
Pediatrics; originally published online May 20, 2013;

Men with childhood ADHD

vs.

those without childhood ADHD:

significantly higher BMI (30.16 ± 6.3 vs. 27.66 ± 3.9 ; $P = .001$)

and obesity rates (41.4% vs 21.6%; $P = .001$)

ORIGINAL ARTICLE

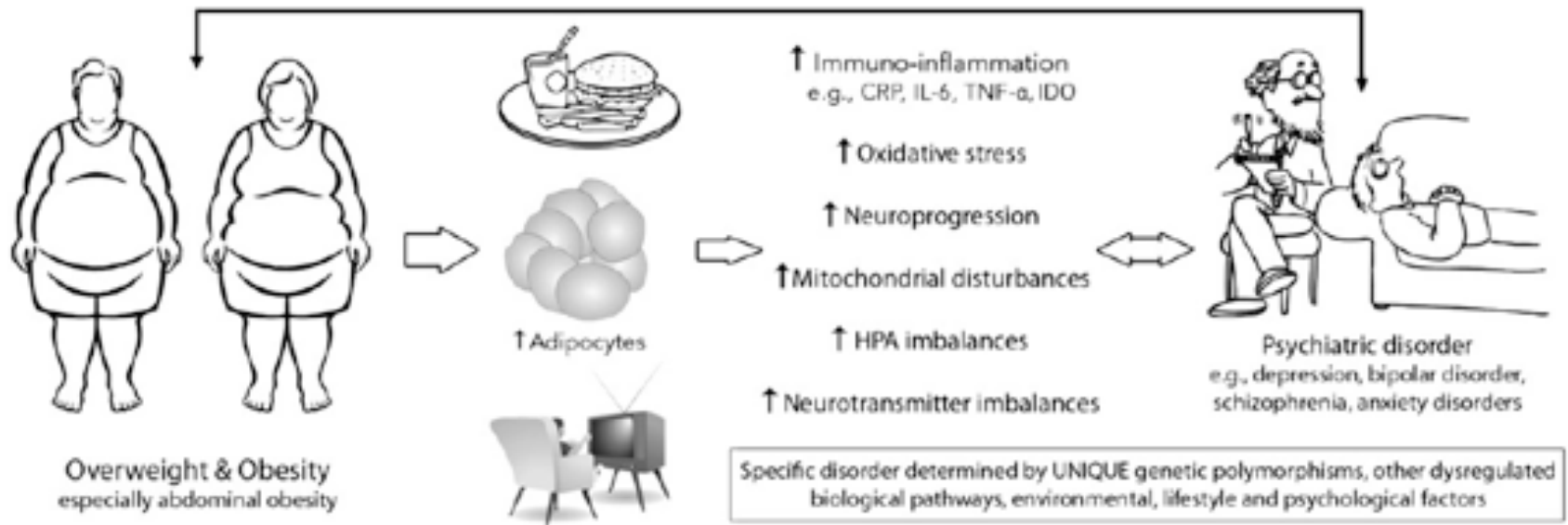
Association between attention-deficit/hyperactivity disorder symptoms and obesity and hypertension in early adulthood: a population-based study

BF Fuemmeler¹, T Østbye^{1,4}, C Yang², FJ McClernon³ and SH Kollins³

15 197 adolescents followed from 1995 to 2009

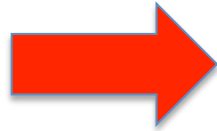
Controlling for demographic variables, physical activity, alcohol use, smoking and depressive symptoms: those with vs. those without three or more HI or IN: significantly higher odds of obesity (OR=.1.50, 95% CI: 1.22-2.83)

Multiple bidirectional pathways



Lopresti & Drummond, Prog Neuropsychopharmacol Biol Psychiatry 2013

ADHD



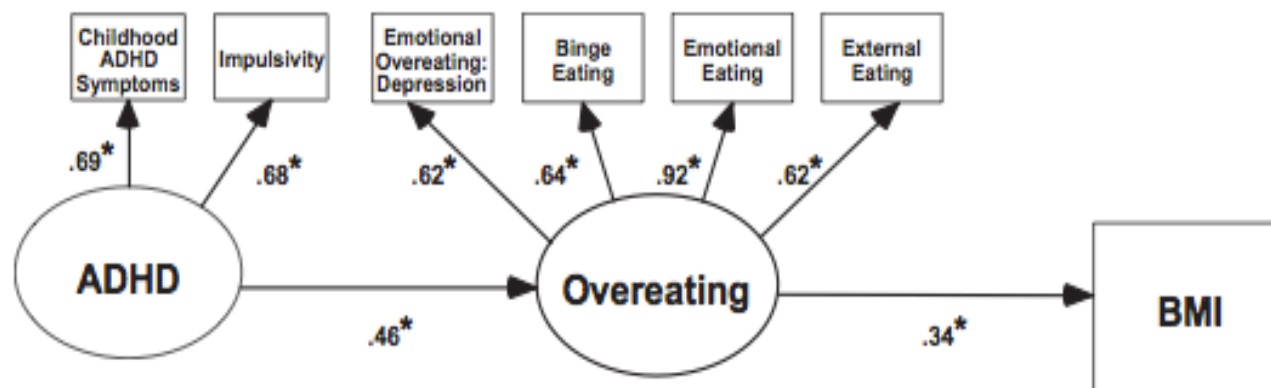
obesity

- **IMPULSIVITY:** deficient inhibitory control and/or delay aversion -> dysregulated eating patterns-> weight gain
- **INATTENTION:** difficulty adhering to a regular eating pattern

Cortese et al., Curr Top Behav Neurosc 2012

Associations among overeating, overweight, and attention deficit/hyperactivity disorder: A structural equation modelling approach

Caroline Davis^{a,b,*}, Robert D. Levitan^b, Megan Smith^a, Stacey Tweed^a, Claire Curtis^a



$^* \leq 0.001$

Fig. 1. SEM model testing correlations among ADHD symptoms, aspects of overeating, and Body Mass Index in a sample of healthy adult women.

Possible role of:

- Inhibitory dysfunction
- Delay aversion
- Deficits in planning and organization

Davis et al., Eat Behav 2006

Influence of attention-deficit/hyperactivity disorder on binge eating behaviors and psychiatric comorbidity profile of obese women

Bruno Palazzo Nazar^{a,b,c,*}, Raphael Suwwan^d, Camilla Moreira de Sousa Pinna^{a,b,c},
 Monica Duchesne^c, Silvia Regina Freitas^c, Joseph Sergeant^e, Paulo Mattos^a

Table 3

BES predicted by Beck depression inventory, K-SADS-IN, K-SADS-HI, BIS-11 and STAI CS in a forced entry regression model.

Variable	R ²	Adjusted R ²	Significance	Standardized B
BDI	.211	.204	**	.460
K-S IN	.294	.282	**	.305
BIS-11	.321	.303	*	.190
STAI CS	.329	.301	<i>N.S.</i>	.107
K-S HI	.331	.301	<i>N.S.</i>	–.565

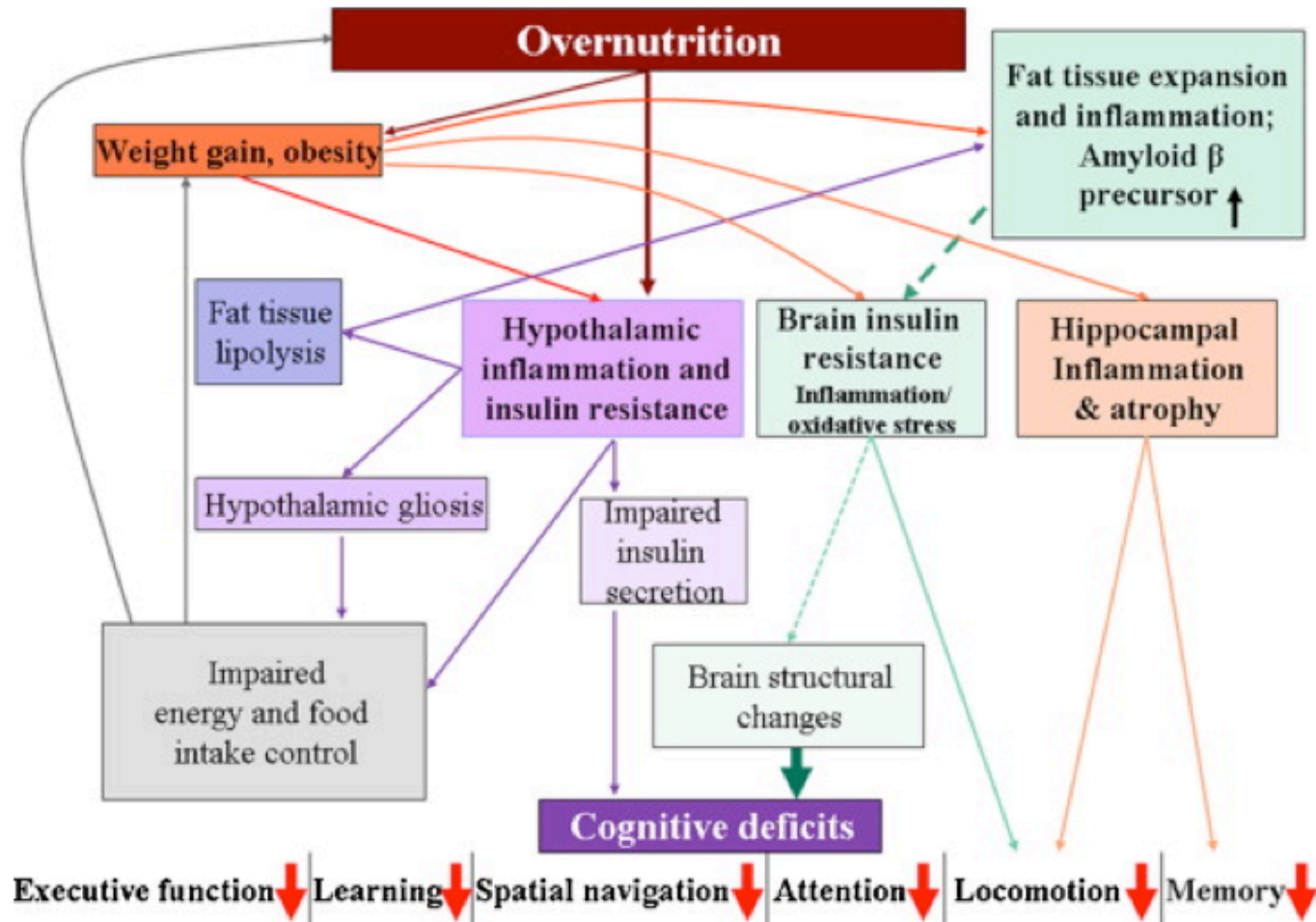
Abbreviations: BDI = Beck Depression Inventory; K-S IN = Kiddie-SADS Inattention Symptoms; BIS-11 = Barratt Impulsiveness Scale 11; STAI CS = Spielberger Trait–State Anxiety Inventory Composite Score; K-S HI = Kiddie-SADS Hyperactivity–Impulsivity Symptoms ** = $p < 0.001$; * = $p < 0.05$; *N.S.* = Non-Significant.

Other ADHD-related factors

- **ADHD -> more TV & videogames -> obesity** (Ehart et al., ECAP, 2012)
- **ADHD -> less sport -> obesity** (Kim et al., Prev Med, 2011)

Obesity → ADHD

Inflammation?



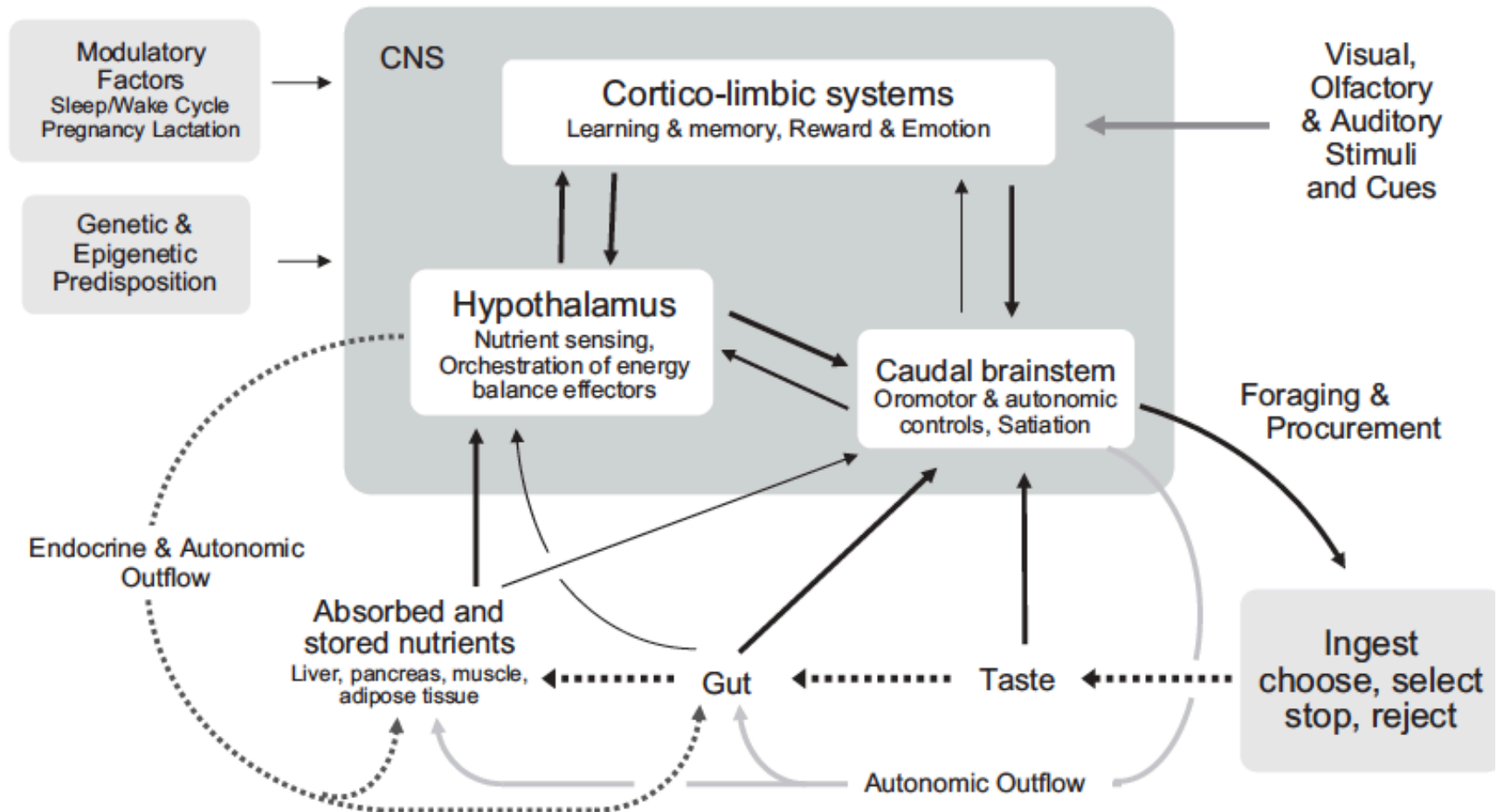
Shefer et al., Neurosc Biobeh Rev 2013

ADHD

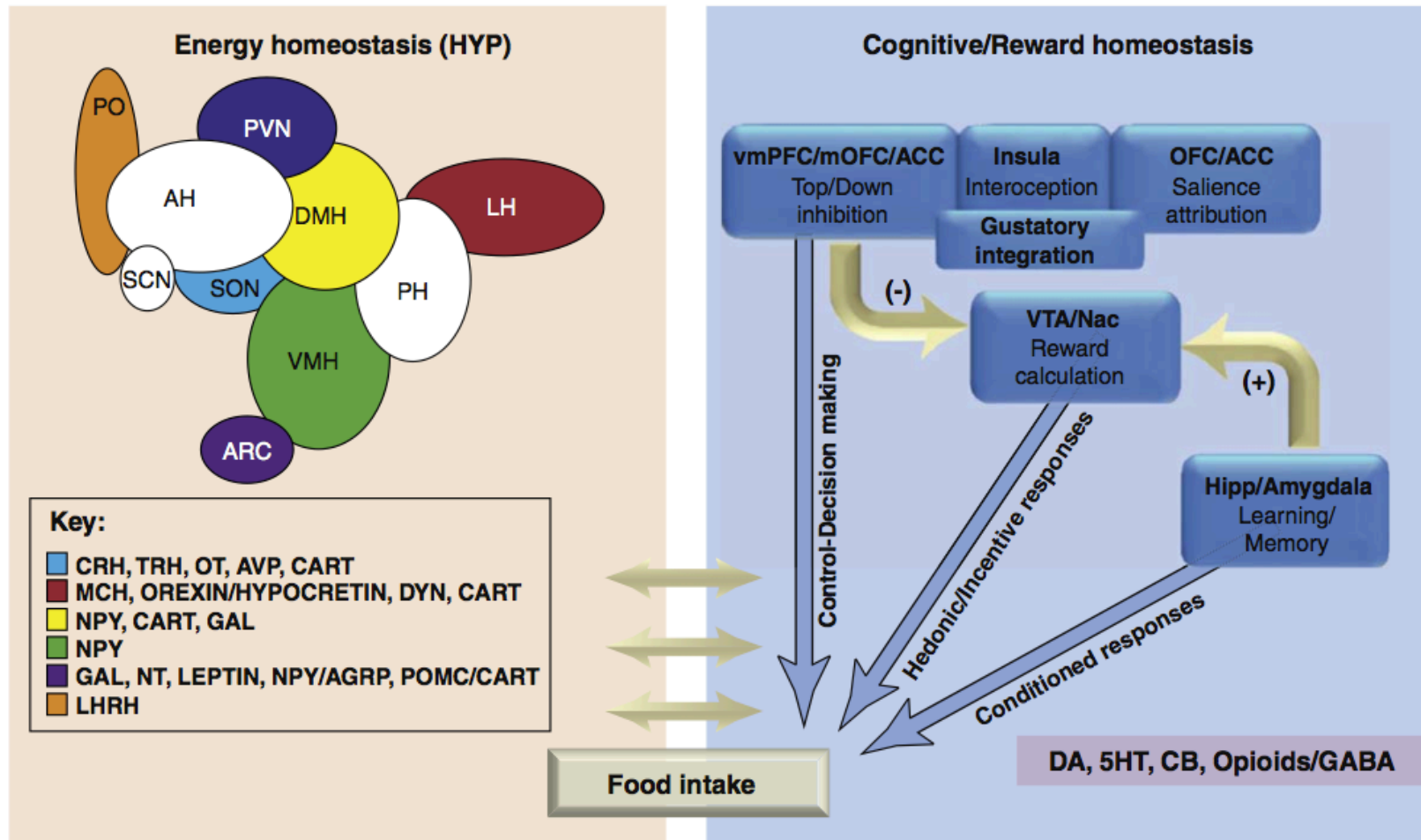


obesity

Neural control of food intake and energy balance



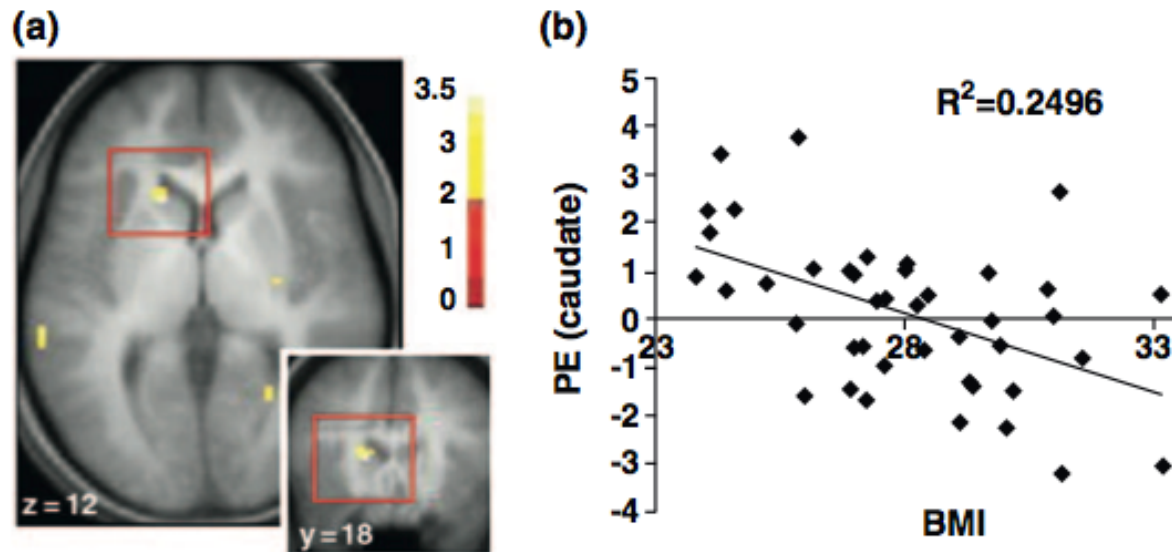
Morrison et al., Nutr Rev 2007



Volkow et al., Trends Cogn Sci 2011

- **INCREASED “WANTING”**

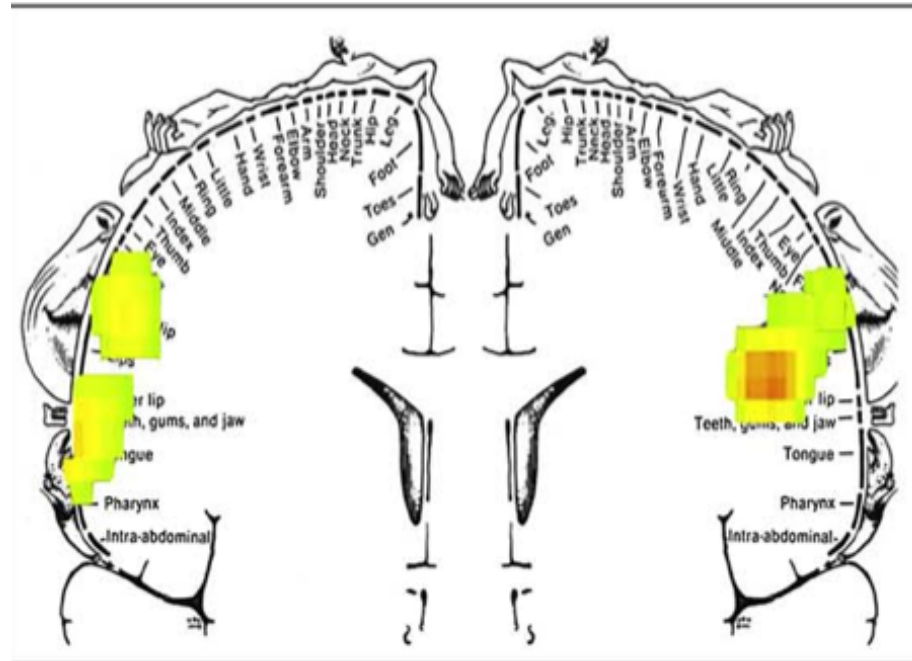
- **DECREASED “LIKING”**



MNI coordinates							
	x	y	z	Number of voxels in cluster	Activation cluster Z	pFDR corrected	Effect size r_s
No-go > Fixation: Negative Correlations							
Superior frontal gyrus	-21	12	57	73	3.96	0.003 ¹	-0.72***
	21	15	63	3	3.84	0.003	-0.53**
	24	12	54	22	3.73	0.003	-0.79***
	9	33	48	3	3.39	0.005	-0.61***
Middle frontal gyrus	21	15	60	4	3.90	0.002 ¹	-0.66***
VLPFC	-36	42	0	16	3.93	0.008 ¹	-0.56**
Medial PFC	-9	54	-3	12	4.41	0.002 ¹	-0.53**
	6	54	-6	13	3.81	0.006	-0.52**
OFC	-39	33	-9	10	3.56	0.008	-0.45*
	45	33	-6	19	4.30	0.002	-0.52**
	45	42	-9	19	3.32	0.008	-0.39*
No-go > Fixation: Positive Correlation							
Temporal and frontal operculum/Insula	51	9	-6	81	3.99	0.003	0.60***

Batterink et al., Neuroimage, 2010

Processing food palatability



Wang et al., Neuroreport 2002

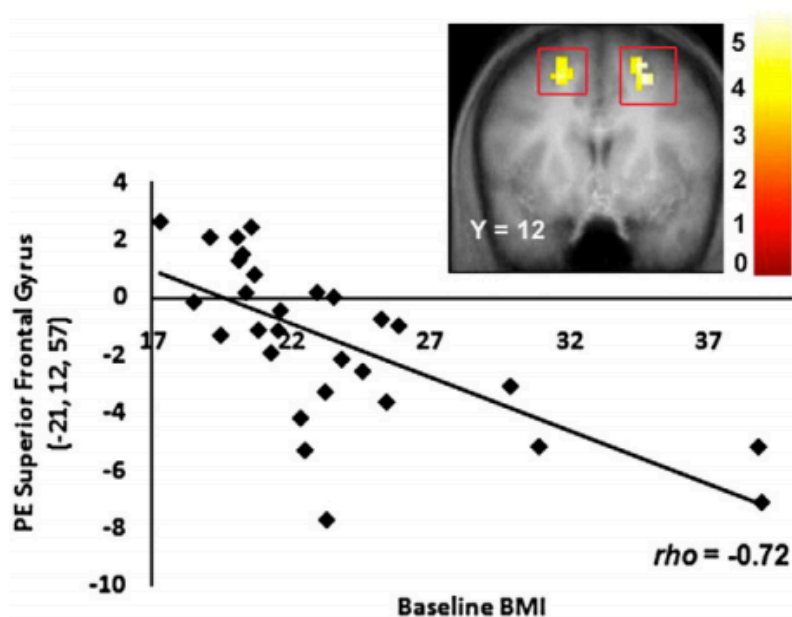


Fig. 3. Coronal section showing less activation in the bilateral superior frontal gyrus ($-21, 12, 57$, $Z=3.96$, $pFDR=0.003$) extending into middle frontal gyrus in response to picture of dessert versus baseline fixation as a function of BMI. Although the correlation appears to be driven by 2 outliers, the effect remains significant at the $p=0.05$ level when outliers are excluded.

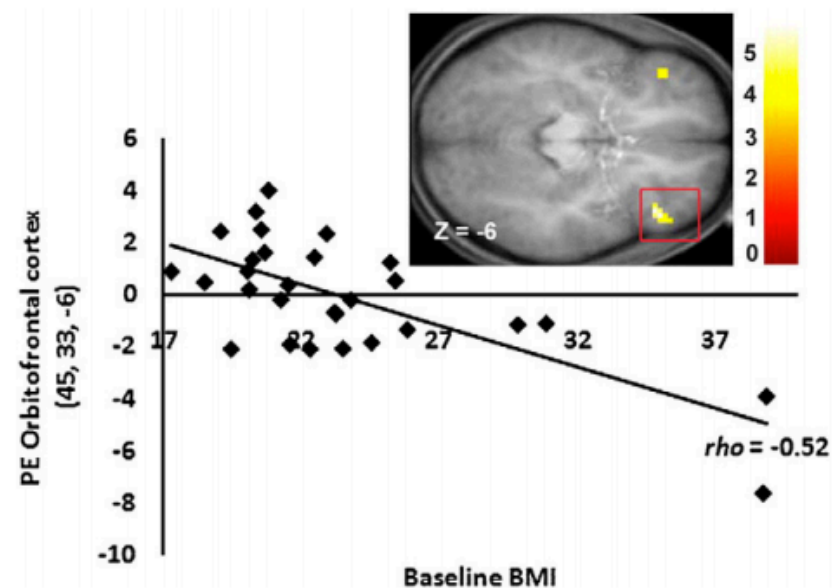


Fig. 5. Axial section of less activation in a region of the OFC ($45, 33, -6$, $Z=4.30$, $pFDR=0.002$) in response to picture of dessert versus baseline fixation as a function of BMI. Again, the effect remains significant at the $p=0.05$ level when the two apparent outliers are excluded.

Batterink et al., Neuroimage, 2010

COMMON GENETIC FACTORS

RAPID PUBLICATION

AMERICAN JOURNAL OF
medical genetics 
Neuropsychiatric Genetics

Common Obesity Risk Alleles in Childhood Attention-Deficit/Hyperactivity Disorder

Özgür Albayrak,^{1*} Carolin Pütter,² Anna-Lena Volckmar,¹ Sven Cichon,^{3,4} Per Hoffmann,^{4,5}
Markus M. Nöthen,^{4,5} Karl-Heinz Jöckel,^{2,6} Stefan Schreiber,⁷ H-Erich Wichmann,⁸ Stephen V. Faraone,⁹
Benjamin M. Neale,^{10,11} Beate Herpertz-Dahlmann,¹² Gerd Lehmkuhl,¹³ Judith Sinzig,^{13,14}
Tobias J. Renner,¹⁵ Marcel Romanos,^{15,16} Andreas Warnke,¹⁵ Klaus-Peter Lesch,¹⁷ Andreas Reif,¹⁷
Benno G. Schimmelmann,¹⁸ André Scherag,² Johannes Hebebrand,¹ Anke Hinney¹ and Psychiatric GWAS
Consortium: ADHD Subgroup

rs206936 in the **NUDT3 gene** (nudix; nucleoside diphosphate
linked moiety X-type motif 3)

GPRC5B gene (Gprotein-coupled Receptor, metabotropic
glutamate receptor family)

DEBATE

Open Access

Attention-deficit/hyperactivity disorder and impairment in executive functions: a barrier to weight loss in individuals with obesity?

Samuele Cortese^{1,2,7*}, Erika Comencini¹, Brenda Vincenzi³, Mario Speranza^{4,5} and Marco Angriman⁶

Weight Loss Following a Clinic-Based Weight Loss Program Among Adults with Attention Deficit/Hyperactivity Disorder Symptoms

Sherry L. Pagoto, Ph.D.¹, Carol Curtin, MSW², Linda G. Bandini, Ph.D.^{2,3}, Sarah E. Anderson, Ph.D.⁴, Kristin L. Schneider, Ph.D.¹, Jamie S. Bodenlos, Ph.D.⁵, and Yunsheng Ma, Ph.D.¹

ADHD+ vs. ADHD-

More previous weight loss attempts ($p=0.01$) and lost less weight ($p=0.02$)

**Significantly higher levels of emotional eating ($p=0.002$)
greater difficulty with weight control skills ($p=0.01$)**

Original Article

The Hyperactivity/Inattention Subscale of the Strengths and Difficulties Questionnaire Predicts Short- and Long-Term Weight Loss in Overweight Children and Adolescents Treated as Outpatients

Andreas van Egmond-Froehlich^a Monika Bullinger^b Reinhard W. Holl^c
Ulrike Hoffmeister^c Reinhard Mann^d Cornelia Goldapp^d
Joachim Westenhoefer^e Ulrike Ravens-Sieberer^f Martina de Zwaan^g

349 outpatient children with obesity

1-year: follow-up:

Higher baseline HI scores predicted less weight loss

ORIGINAL ARTICLE

Treatment of refractory obesity in severely obese adults following management of newly diagnosed attention deficit hyperactivity disorder

242 obese weight loss refractory obese individuals

78 (32%): ADHD

Weight loss in treated subjects: 15.05 kg (10.35%)

Weight gain in non-ADHD: 3.26 kg (7.03%) (P<0.001)

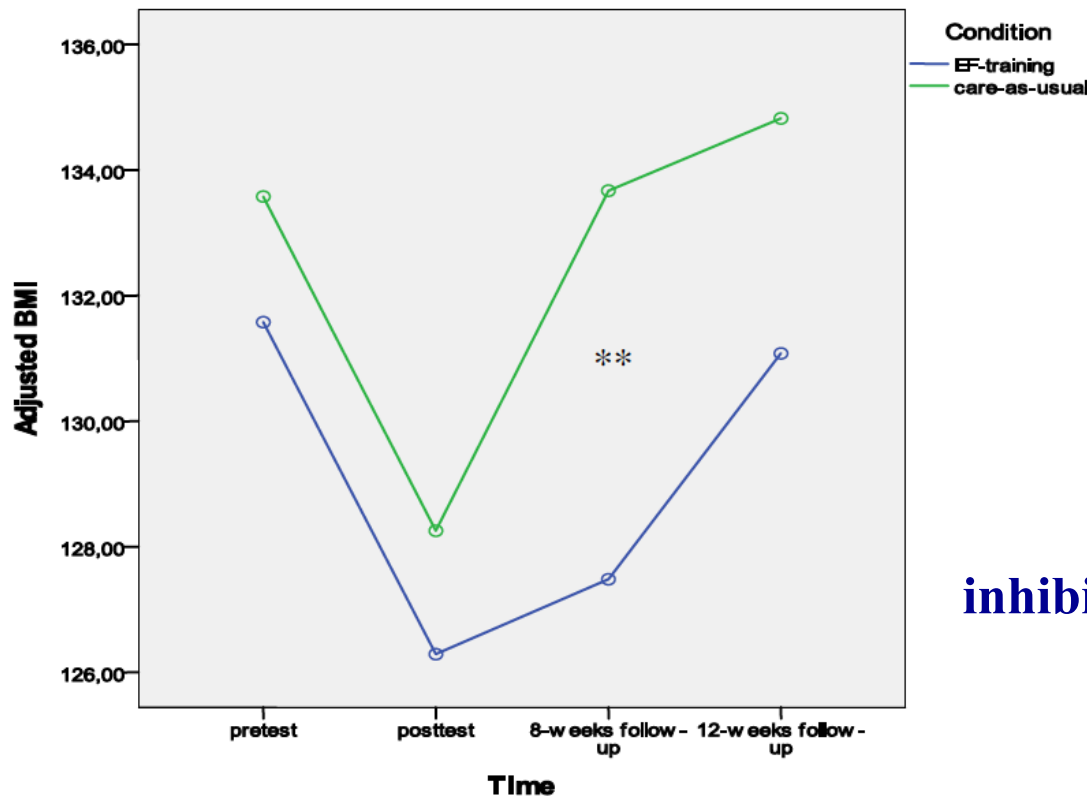
“appetite suppression vanished within 2 months”

“Amphetamines for obesity discontinued in the late 1970s, weight loss results were not longlasting”

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}



**25-session
training of
inhibition and working memory**

Note: Adjusted BMI: BMI adjusted for age and gender; ** $p \leq .01$