

**The neurobiology of eating behaviour: An
investigation into the construct of food addiction
in young Australian adults**

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There are no conflicts of interest to declare.

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Glossary of terms and abbreviations

ACC	Anterior cingulate cortex
BMI	Body mass index
cm	Centimetres
D2	Dopamine receptor type 2
DA	Dopamine
DLPFC	Dorsolateral prefrontal cortex
DRD2	Dopamine receptor type 2 gene
DSM	Diagnostic and Statistical Manual of Mental Disorders
FA	Food addiction
FAD	Food addicted group
HMRI	Hunter Medical Research Institute
ICC	Intraclass correlation coefficient
JBI	Joanna Briggs Institute
kcal	Kilocalories
kg	Kilograms
kJ	Kilojoules
m	Metres
NAc	Nucleus accumbens
NFA	Non- food addicted group
NSW	New South Wales
PFC	Prefrontal cortex

PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
SD	Standard deviation
STROBE	Strengthening the Reporting of Observational studies in Epidemiology.
Taq-1A	Taq-1A polymorphism of the DRD2 gene
US	United States
VTA	Ventral tegmental area
WHO	World Health Organization
YFAS	Yale Food Addiction Scale

Table of contents

The neurobiology of eating behaviour: An investigation into the construct of food addiction in the Australian population	i
Statement of originality	ii
Copyright permission	iii
Acknowledgement of collaboration	iv
Acknowledgement of authorship	v
Statement of contribution of others	vi
Supervisors	vii
Acknowledgements	viii
Conflict of interest	x
Publications and presentations arising from this thesis	xi
Awards received during candidature	xiii
Glossary of terms and abbreviations	xiv
Table of contents	xvi
Table of tables	xxi
Table of figures	xxiii
Supplementary tables	xxv
Thesis abstract	1
Chapter 1 Introduction	5
1.1 Overview	5
1.2 Obesity	6
1.2.1 Prevalence and classification of obesity	6
1.2.2 Consequences of obesity	6
1.2.3 Aetiology of obesity	7
1.2.4 Implications of the food addiction construct for weight loss approaches ..	7
1.3 Change in the food environment	8
1.3.1 Change in dietary patterns	9
1.4 Control of food intake	9
1.4.1 Homeostatic control of eating	11
1.4.2 Hedonic control of eating	11
1.5 Addiction	13
1.5.1 Neural mechanisms in addiction	14
1.5.2 Dopamine and dopamine receptors	15
1.5.3 Relevance of dopamine to food and obesity	17
1.6 Food addiction	18
1.6.1 History of food addiction	19
1.7 Animal models of addictive-like eating	20
1.8 Diagnosis of addiction in humans	22
1.8.1 The Diagnostic and Statistical Manual of Mental Disorders	22
1.8.2 Addiction in the Diagnostic and Statistical Manual of Mental Disorders ..	23

1.8.3	DSM-IV substance-use disorders.....	23
1.8.3.1	DSM-IV Substance dependence	23
1.8.4	DSM-5: Substance-related and addictive disorders	26
1.8.4.1	DSM-5 substance-use disorder.....	26
1.8.4.2	DSM-5 Non-substance related disorders.....	27
1.9	Food addiction in the context of the DSM	28
1.9.1	Food addiction as DSM-IV substance dependence disorder	29
1.10	Feeding and eating disorders.....	30
1.10.1	Binge eating disorder and food addiction.....	30
1.10.2	Bulimia nervosa, anorexia nervosa and food addiction.....	31
1.11	Neuroimaging in addiction and eating behaviour	32
1.11.1	Functional magnetic resonance imaging in food addiction.....	33
1.12	Genetic overlap between reward, addiction and obesity.....	35
1.13	Characteristics of food associated with food addiction.....	36
1.13.1	Whole foods	37
1.13.2	Macronutrients and micronutrients	37
1.13.3	Food components and additives.....	38
1.13.4	Food properties	38
1.14	Dietary assessment	39
1.14.1	Australian eating survey.....	40
1.15	Food addiction assessment.....	40
1.16	Summary.....	41
1.17	Research aims.....	42
1.17.1	Primary aim	42
1.17.1.1	Thesis hypothesis.....	42
1.17.2	Secondary aims.....	42
1.18	Thesis structure	44
1.18.1	Overview	44
1.18.2	Systematic review of neural responses to visual food cues	46
1.18.3	Systematic review of studies that have used the Yale Food Addiction Scale.....	46
1.18.4	Cross-sectional survey investigating food and dietary profiles associated with food addiction.....	46
1.18.5	Validation study of online self-reported height and weight	47
1.18.6	Longitudinal study investigating the temporal stability of food addiction	47
1.18.7	Pilot fMRI study of the differences in neural responses to visual food cues according to food addiction status	48
Chapter 2	Neural Responses to Visual Food Cues According to Weight Status: A Systematic Review of Functional Magnetic Resonance Imaging Studies	49
2.1	Overview.....	50
2.2	Abstract	50
2.3	Introduction	51
2.4	Methods	53

2.4.1	Meta-analysis.....	57
2.5	Results.....	58
2.5.1	Healthy weight compared to overweight/obese participants.....	60
2.5.2	Weight change interventions.....	61
2.5.3	Healthy weight participants.....	62
2.5.4	Obese participants.....	63
2.5.5	Results of the ALE Meta-analysis.....	63
2.6	Discussion.....	65
2.7	Conclusion.....	73
2.8	Acknowledgements.....	73
Chapter 3	The prevalence of food addiction as assessed by the Yale Food Addiction Scale: A systematic review.....	74
3.1	Overview.....	75
3.2	Abstract.....	75
3.3	Introduction.....	76
3.4	Methods.....	78
3.5	Results.....	81
3.5.1	Prevalence of FA diagnosis.....	85
3.5.2	Prevalence of FA symptoms.....	90
3.5.3	Relationship of YFAS outcomes with other variables.....	90
3.5.4	Comparison of 'high' vs 'low' FA.....	92
3.6	Discussion.....	93
3.7	Conclusions.....	100
3.8	Acknowledgments.....	100
3.9	Conflicts of Interest.....	100
Chapter 4	Foods and dietary profiles associated with 'food addiction' in young adults.....	101
4.1	Overview.....	102
4.2	Abstract.....	102
4.3	Introduction.....	103
4.4	Materials and Methods.....	106
4.4.1	Food Addiction Survey.....	106
4.4.1.1	Demographic and self-reported anthropometric data.....	107
4.4.1.2	Yale Food Addiction Scale.....	107
4.4.1.3	Dietary Intake via the Australian Eating Survey Food Frequency Questionnaire.....	108
4.4.2	Statistics.....	109
4.5	Results.....	110
4.5.1	Food and nutrient intake according to food addiction diagnosis.....	114
4.5.2	Relationships between symptom scores and food and nutrient intake.....	118
4.6	Discussion.....	122
4.7	Conclusions.....	126
4.8	Acknowledgments.....	127

4.9	Conflicts of Interest	127
Chapter 5	How accurate is Web-based self-reported height, weight and body mass index in young adults?.....	128
5.1	Overview.....	129
5.2	Abstract	129
5.3	Introduction	130
5.4	Methods	132
5.4.1	Participants	132
5.5	Statistics	133
5.6	Results	134
5.7	Discussion	141
5.8	Conclusion.....	143
5.9	Acknowledgements and Conflicts of interest	143
Chapter 6	The stability of ‘food addiction’ as assessed by the Yale Food Addiction Scale in a non-clinical population over 18-months	144
6.1	Overview.....	145
6.2	Abstract	145
6.3	Introduction	146
6.4	Methods	148
6.4.1	Participants	148
6.4.2	Measures.....	149
6.4.3	Procedure	149
6.4.3.1	Original food addiction survey.....	149
6.4.3.2	18-month follow-up food addiction survey.....	150
6.4.4	Data analysis.....	151
6.5	Results	152
6.6	Discussion	156
6.7	Conclusion.....	159
6.8	Conflicts of Interest	160
6.9	Acknowledgements	160
Chapter 7	Neural correlates of food addiction “diagnosis” as assessed by the Yale Food Addiction Scale: An exploratory pilot study in young females.....	161
7.1	Overview.....	162
7.2	Abstract	162
7.3	Introduction	163
7.4	Methods	166
7.4.1	Participants	166
7.5	Measures	167
7.5.1	Demographic survey	167
7.5.2	Yale Food Addiction Scale.....	168
7.5.3	Anthropometrics	168
7.5.4	Appetite, hunger and image ratings survey.....	168

7.5.5	Image selection	169
7.5.5.1	Pilot ratings	169
7.5.5.2	Nutrition composition of food images.....	170
7.5.6	Procedures.....	170
7.5.7	Imaging paradigm	174
7.5.8	fMRI data collection.....	174
7.5.9	Pre-processing	175
7.5.10	Data analysis.....	175
7.5.10.1	Demographics, anthropometrics and behavioural data	175
7.5.10.2	Functional MRI data	175
7.6	Results	176
7.6.1	Demographics, anthropometrics and self-reported data	176
7.6.2	Imaging data	181
7.6.2.1	Differences in activation of specific brain areas between groups based on image type and session.....	181
	Junk foods	181
	Healthy foods.....	181
7.6.2.2	Correlation analyses according to food addiction status	184
	Not food addicted	184
	Food addicted	184
7.7	Discussion	188
7.8	Conclusion	192
Chapter 8	Thesis discussion	194
8.1	Overview	194
8.2	Section 1: Synthesis of the current evidence base regarding neural responses to visual food cues and studies using the Yale Food Addiction Scale. 195	
8.2.1	Systematic review of neural responses to visual food cues	195
8.2.2	Systematic review of Yale Food Addiction Scale studies.....	197
8.2.3	Implications for research and clinical practice.....	200
8.2.3.1	Implications for research.....	201
8.2.3.2	Clinical implications	203
8.3	Section 2: A novel investigation into food addiction in young Australian adults	204
8.3.1	Foods associated with food addiction.....	204
8.3.2	The stability of food addiction	205
8.3.3	Differences in neural responsivity to visual food cues according to food addiction status	206
8.3.4	Validation of online self-reported anthropometrics.....	208
8.4	Overall Discussion: Food addiction in Australia	210
8.4.1	Implications for research and clinical practice.....	213
8.4.1.1	Implications for research.....	213
8.4.1.2	Implications for clinical practice	215
8.5	Concluding remarks	217
References	218
Supplementary data		248

Table of tables

Table 1-1: World Health Organization BMI categories.....	6
Table 1-2: Animal models of addictive eating with key supporting references.....	21
Table 1-3: Proposed application of the DSM-IV criteria for substance dependence to food and eating behaviour.....	25
Table 1-4: New DSM-5 substance criteria that were added to the existing DSM-IV criteria outlined for substance dependence	27
Table 1-5: DSM-5 diagnostic criteria for gambling disorder.....	28
Table 3-1: Meta-analysis results of food addiction prevalence by gender, weight status, age, and disordered eating status. Random effects model is reported.	87
Table 4-1: Demographic and anthropometric characteristics of the total sample, non-addicted (NFA) and food addicted (FAD) groups.....	112
Table 4-2: Mean daily nutrient intake and odds ratios for the total sample (n=462), non-addicted (NFA) and food addicted (FAD) groups. Data are presented as <i>mean (standard deviation)</i>	116
Table 4-3: Associations between food addiction symptom scores and mean daily nutrient intake for the total sample.....	120
Table 5-1: Baseline data of adults participating in Web-based food addiction study .	135
Table 5-2: Differences between Web-based self-reported and measured height (cm) and weight (kg) in adults (n=117) grouped by BMI, age, gender.	137
Table 5-3: Differences between Web-based self-reported and measured BMI (kg/m ²) in adults (n=117) grouped by BMI, age, gender.....	140
Table 6-1: Baseline characteristics for participants with complete data sets for both surveys over an 18-month period.....	153
Table 6-2: Kappa and intraclass correlation coefficients with 95% CI between baseline and 18-month measurements of YFAS diagnosis and symptoms (n=69)	155
Table 7-1: Participant characteristics for the total sample, and by YFAS food addiction status.....	177
Table 7-2: Hunger and appetite ratings for the total sample and according to YFAS food addiction status	179

Table 7-3: Table: Image ratings according to YFAS food addiction status..... 180

Table 7-4: Clusters and Corresponding Brain Regions that Displayed Differences in BOLD Activation According to Session (Fasted vs Fed) and Group (FA vs Non-FA), When Viewing Visual Food Cues (Healthy and Junk)..... 182

Table 7-5: Clusters and Corresponding Brain Regions that Displayed Differences in BOLD Activation According to Group (FA vs Non-FA) and Session (Fasted vs Fed), When Viewing Visual Food Cues (Healthy and Junk)..... 183

Table of figures

Figure 1-1: The major regulatory factors in the homeostatic and hedonic eating pathways.	10
Figure 1-2 Areas of the brain that are activated in response to palatable food consumption or food-related cues.	13
Figure 1-3 The dopaminergic pathways in the brain.....	15
Figure 1-4 Positron emission tomography of the brain depicting similar hypofunctioning of the dopamine networks in the brain in cocaine-addicted and obese individuals compared to non-addicted, healthy weight individuals.	18
Figure 1-5 Timeline depicting points of interest in food addiction research.	19
Figure 1-6 Increase in the number of food addiction publications from 1956-2015.	20
Figure 1-7 The haemodynamic response to neuronal activity and activation map of subsequent changes in BOLD response in the brain.....	34
Figure 1-8: Flow diagram of the manuscripts that make up this thesis.....	45
Figure 2-1 Flow diagram of studies included in the review.....	54
Figure 2-2: Axial (z), coronal (y), and sagittal views (x) of decreased activation in studies comparing neural activation to visual food cues from pre- to post- weight loss, as detected by fMRI.	64
Figure 3-1: Flow diagram of studies included in the review.....	83
Figure 3-2: Meta-analysis of Yale Food Addiction Scale Diagnosis for all studies.	88
Figure 3-3: Meta-analysis of Yale Food Addiction Scale Diagnosis for overweight/obese samples.....	89
Figure 3-4: Meta-analysis of Yale Food Addiction Scale Diagnosis for healthy weight samples.....	89
Figure 5-1: Level of agreement between self-reported and measured height (cm).....	138
Figure 5-2: Level of agreement between self-reported and measured weight (kg).....	138
Figure 5-3: Level of agreement between BMI calculated from self-reported and measured data (kg/m ²).	138
Figure 7-1: Flow diagram of the study procedure.	172

Figure 7-2: Schematic of the block design paradigm.	173
Figure 7-3 (a) Brain activation map in the axial plane corresponding to the cluster coordinates (x28, y25, z36) consisting of the primary, secondary and associative visual cortices and cingulate cortex.	185
Figure 7-4 (a) Brain activation map in the axial plane corresponding to the cluster coordinates (x28, y25, z36) consisting of the primary, secondary and associative visual cortices and cingulate cortex.	186
Figure 7-5 (a) Brain activation map in the axial plane corresponding to the cluster coordinates (x51, y83, z35) consisting of the anterior prefrontal cortex, dorsal anterior cingulate cortex and the dorsolateral prefrontal cortex.....	187
Figure 8-1: Summary graphic depicting the variability in study conditions and outcome reporting across studies including the samples recruited, hunger-state, nutrition composition of foods and fMRI outcome reporting.....	197
Figure 8-2: Proportion of reviewed YFAS studies reporting quality criteria in adequate detail.	200

Supplementary tables

Supplementary Table 1: Characteristics of included studies investigating neural responses to visual food cues by weight status	249
Supplementary Table 2: Study quality of included studies investigating neural responses to visual food cues	257
Supplementary Table 3: Outcome measures and results of included studies investigating neural responses to visual food cues by weight status.....	259
Supplementary Table 4: Locations of clusters (MNI) with significant ALE values for studies reporting decreases in activation from pre- to post- weight loss included in the meta-analysis.	270
Supplementary Table 5: Characteristics of included studies using the Yale Food Addiction Scale to assess food addiction.....	271
Supplementary Table 6: Quality assessment of the studies reviewed studies.	277
Supplementary Table 7: Results of included studies using the Yale Food Addiction Scale to assess food addiction.....	278
Supplementary Table 8: Mean daily nutrient intake and odds ratios for the YFAS assessed food addicted group (n=68) according to weight status.....	284
Supplementary Table 9: Cross checking of nutritional composition between original Food-pics database and the Australian Foodworks database	285

Thesis abstract

The concept of “food addiction” generates a considerable amount of interest and debate in both the media and the scientific arenas. Numerous behavioural and neurobiological parallels have been identified between specific eating behaviours and substance dependence, such as drug and alcohol addiction. However, the majority of supporting evidence for the phenomenon is derived from animal models, with limited and inconsistent findings in humans.

This thesis aimed to explore the construct of food addiction in the young Australian adult population in relation to dietary intake profiles and activation of brain reward networks to visual food cues. To investigate this aim, this thesis presents a series of four related studies, which were informed by two systematic reviews.

Two systematic reviews of the literature were conducted to evaluate current evidence with respect to (i) neural responses to visual food cues, as assessed by functional magnetic resonance imaging (fMRI), and (ii) studies that have used the Yale Food Addiction Scale (YFAS), a tool specifically designed to evaluate addictive-like eating behaviours in adults. The first of these reviews identified that obese individuals displayed increased reward-related neural activation to visual food cues compared to individuals of a normal body weight. This review also highlighted that standardisation of study conditions and outcome reporting is imperative in studies of this nature, in order to facilitate more direct comparisons across studies.

The second review found the weighted mean prevalence of food addiction to be 19.9% across published studies using the YFAS to 2014, and that food addiction prevalence was higher in population samples of females, overweight/obese individuals and individuals with clinically diagnosed disordered eating. This review identified a number of key gaps in the YFAS evidence base, including the paucity of studies investigating specific foods and neural correlates associated with YFAS assessed food addiction, as well as community-based studies evaluating the food addiction construct

at multiple time points. The limitations identified in these reviews were addressed in the subsequent thesis studies.

An online cross-sectional survey was conducted to explore the foods associated with YFAS assessed food addiction in young adults. The survey included demographics, anthropometrics, YFAS and the Australian Eating Survey (AES), a validated dietary intake assessment tool. A total of 462 predominantly female, normal weight participants completed the survey, with 14.7% (n= 68) classified as food addicted. Higher YFAS symptom scores were associated with having a higher percentage energy intake (%E) from energy-dense, nutrient-poor foods, including confectionary, take-away foods and baked sweet products such as cakes and pastries. Higher symptom scores were also associated with a lower %E from nutrient-dense core foods, including whole-grain products and breakfast cereals. This was the first study to characterise the foods associated with YFAS assessed food addiction, and requires replication in a nationally representative population sample.

A validation study was conducted to evaluate the accuracy of online self-reported anthropometrics in young adults, given that weight and body mass index (BMI) could be associated with food addiction. In order to conduct online food addiction surveys, this was important to establish. Young adults reported their current height and weight as part of an online survey, and had the same data objectively measured. Measured and self-reported data were strongly positively correlated and had fairly good agreement. Self-reported height was overestimated, while self-reported weight and calculated BMI were underestimated. However, these discrepancies were small (<1%) and changed the BMI classification of three participants only (2.6%). Online self-reported height and weight can be a valid method of collecting anthropometric data. Further research is needed in the context of intervention studies.

A longitudinal study was conducted to determine the stability of YFAS scores in a community-based population of young adults. Sixty-nine participants who completed the original cross-sectional food addiction survey, also completed a shortened version of the survey 18-months later. YFAS diagnosis was found to have moderate agreement between the two time points, while symptom scores had good agreement. Intraclass

correlation coefficients were interpreted as moderate for both the diagnosis and symptom scores. The YFAS scoring outputs were relatively stable over time in a community based population sample of young adults, and the YFAS was considered a suitable tool to track food addiction over time.

A pilot study was conducted to explore the potential differences in neural activation patterns in response to visual food cues, according to YFAS food addiction diagnosis. An evidence-informed fMRI methodology, based on the review in Chapter 2, was developed. The paradigm included a structural scan and task-related fMRI acquisition while viewing images of energy-dense foods, as well as fruit and vegetables. The methodology was piloted using six food addicted and six not food addicted young females, as per the YFAS food addiction diagnosis. Significant differences in neural activation were identified based on food addiction status in areas associated with encoding the reward value of foods, decision making, memory and visual processing. However, when analysed by group, associations with neural activation in these areas were only significant in the not food addicted group. As anticipated, it is likely that the pilot study lacked adequate power to detect any further differences in reward-related activity between the groups. The methodology was shown to be feasible and should be applied to a larger, more representative population sample, to increase statistical power to detect a difference between groups in future studies.

This body of work has built capacity between dietetics, imaging and psychology, and has a number of implications for future research and clinical practice. For clinicians, the YFAS may be considered for use as a screening tool to identify individuals displaying addictive-like eating behaviours, who may require additional support and the involvement of a multidisciplinary team (e.g. dietitians and psychologists) to optimise treatment outcomes. For research, this thesis has the potential to inform the development and testing of new behavioural treatment approaches to specifically target addictive-like eating behaviours. This may include the incorporation of addiction therapy principles into existing models of nutrition counselling and weight loss advice. Importantly, this body of work provides a foundation on which future

studies can be developed. This includes the replication of the studies using larger, more population representative samples.