Body weight status, eating behavior, sensitivity to reward/ punishment, and gender: relationships and interdependencies

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THE O' BRAIN PROJECT
The Interplay of Brain and Behavior in Obesity

Introduction

- Obesity is typically associated with eating behavior (Bellisle et al., 2004), but recent studies also found relationships with personality traits like reward responsiveness (Davis et al., 2008).
- This study's goal was to quantify the individual and joint contribution of eating behavior (dietary restraint, disinhibition of eating, hunger) and obesity-relevant personality traits (self-report reward/ punishment sensitivity) to BMI variance explanation.
- A special focus was on gender-dependent effects.
- Further, the relationship between body mass index (BMI) and eating behavior (especially dietary restraint) seems to be more complex than previously described. We aimed at modeling this relationship.

Methods

QUESTIONNAIRES

TFEQ: Three-Factor Eating Questionnaire (Stunkard and Messick, 1985), measures three dimensions of eating behavior:
1) *CR* (cognitive restraint, intent to control food intake)
2) *DIS* (disinhibition, overeating tendencies)
3) *HUN* (hunger, food intake in response to feelings of hunger)

BIS / BAS Scales: quantifies responsiveness of the behavioral inhibition (*BIS*, measure of sensitivity to punishment) and activation system (*BAS*, measure of sensitivity to reward) (Carver and White, 1994)

SUBJECTS

two cohorts of healthy subjects (age 18-46, BMI 18-47):
(1) TFEQ-only: TFEQ assessed, n=326 (181 men)
(2) TFEQ-plus: subgroup of the former; also BIS/ BAS assessed, n=192 (110 men)

STATISTICS

- multiple regression analyses using SPSS
- separate tests for associations between the *TFEQ* scales and BMI in the TFEQ-only cohort
- separate tests for associations of *BIS* or *BAS* with BMI in the TFEQ-plus cohort
- test for gender interactions
- all significant terms were used to build a comprehensive regression model for BMI including eating behavior and personality traits
- based on previous findings, we tested for a quadratic relationship between BMI and *CR* (moderated by *DIS*)

Results

1. BMI modeling based on eating behavior (TFEQ)

- regressors included in the model (significantly correlating with BMI): CR, DIS, CR^2, CR*DIS, gender, age
- BMI variance explanation: ~ 23%

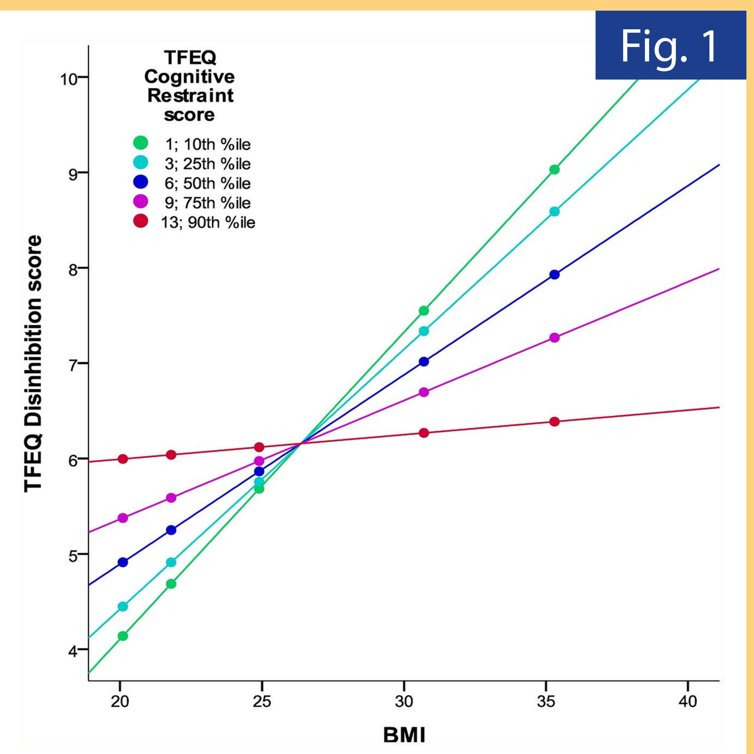


Figure 1: Interaction of *DIS* and *CR* on BMI (TFEQ-only cohort, n=326). *CR* attenuates the effect of *DIS* on BMI.

Partial correlation of BMI*CR = -0.203 ($p<0.0005$; adjusted R^2 change = 0.163). Dots indicate percentiles of BMI (20.1, 21.8, 24.9, 30.7 and 35.3 kg/m²). Colors indicate percentiles of CR (1, 3, 6, 9, 13).

Dietrich & Federbusch et al., 2014, Front. Psychol.

2. BMI modeling based on eating behavior (TFEQ) & sensitivity to reward (BAS) and punishment (BIS)

- regressors included in the model: CR, DIS, CR^2, CR*DIS, BIS, BAS, gender, BIS*gender, BAS*gender, age
- BMI variance explanation: ~27% (women: ~32% , men: ~25%)

Figure 2: Opposing relationships between BMI and *BAS* in women and men (TFEQ-plus cohort, *n*=192). The relationship of *BAS* and BMI is moderated by gender (women: positive association, men: negative association; similar for BIS).
Partial correlation of BMI (age as covariate) with BAS is 0.214 in women (*n*=82) and -0.295 in men (*n*=110). Dashed lines indicate 0.95 confidence interval.

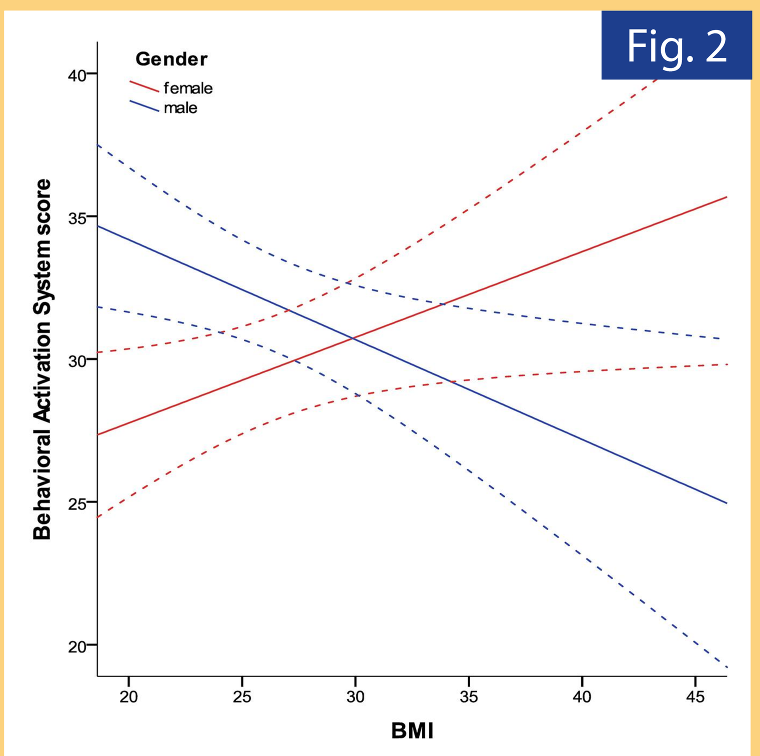
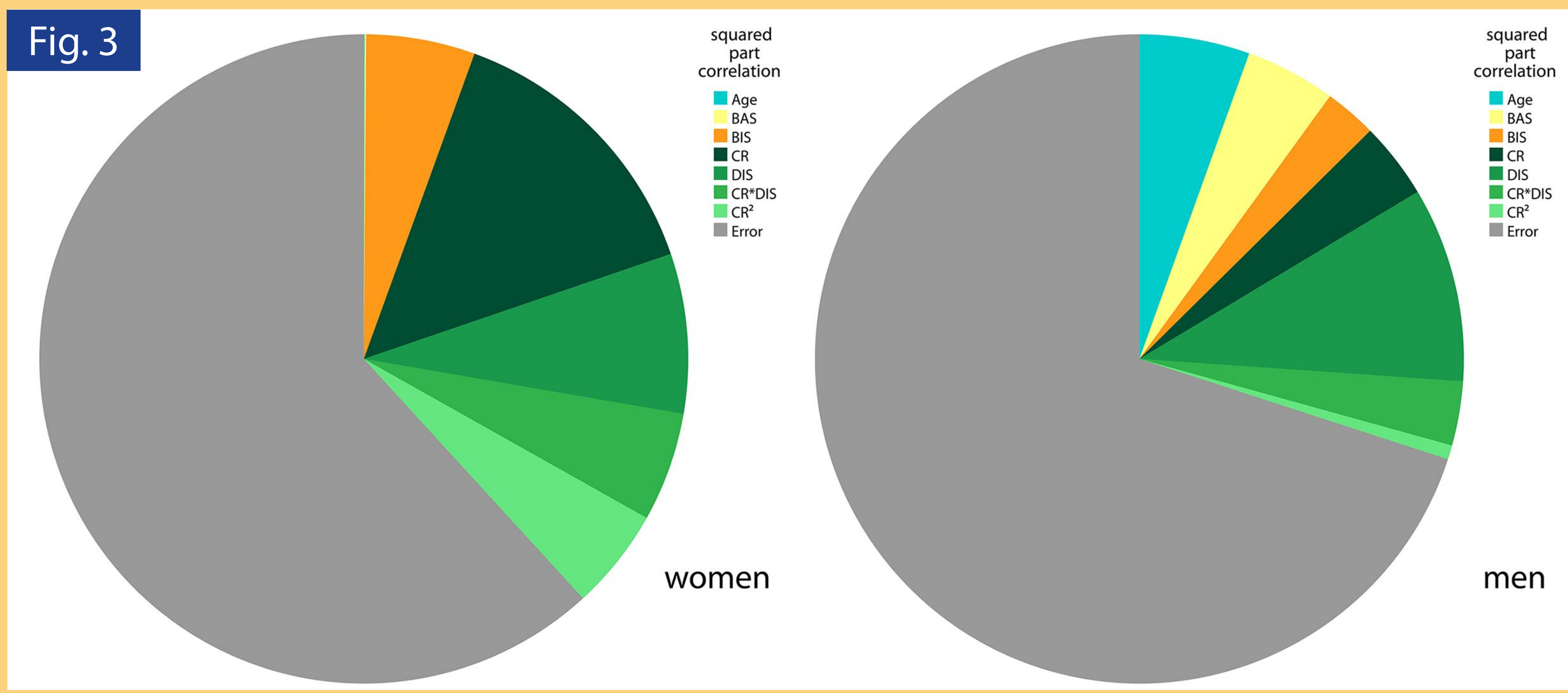


Figure 3: BMI variance explained by final regression model in men and women. Depicted are squared part correlations of all variables of the final BMI model (TFEQ-plus cohort, *n*=192).



3. Quadratic interaction of BMI and DIS on CR

model of interdependencies between restrained eating, overeating, and weight status

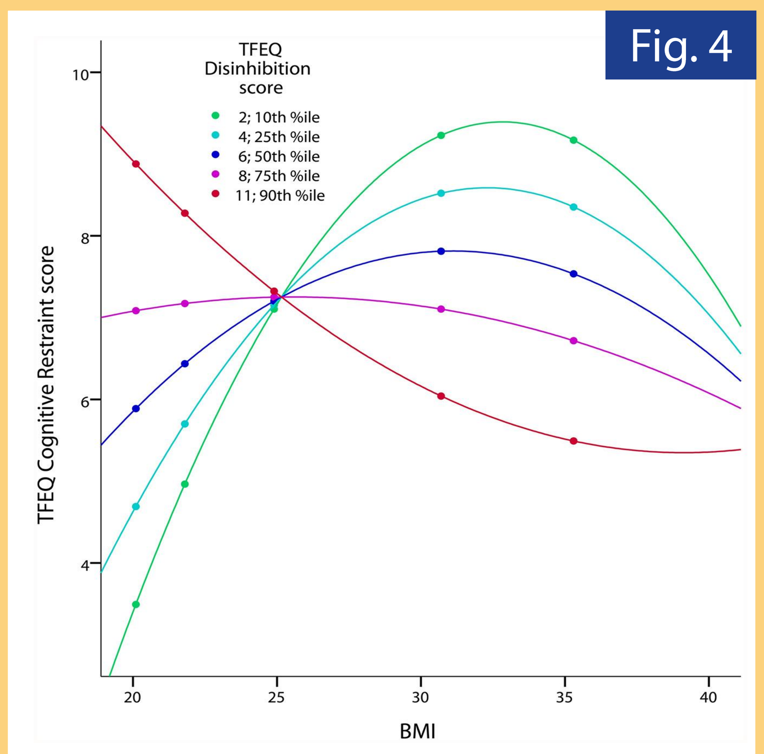


Figure 4: Inverted U-shaped relationship between BMI and *CR* moderated by *DIS* (TFEQ-only cohort, *n*=326). The curvilinear relationship is well pronounced for low levels of *DIS*, but there is no strong curvilinear relationship for high levels of *DIS*.

Partial correlation of BMI²*DIS = 0.185 ($p<0.001$; adjusted R^2 change of 0.083). Dots indicate percentiles of BMI (20.1, 21.8, 24.9, 30.7 and 35.3 kg/m²). Colors indicate percentiles of *CR* (2, 4, 6, 8, 10).

Discussion

Just two measures of eating behavior - the individual level of overeating tendencies together with the level of conscious efforts to restrict food intake - explained already 23% of BMI variance. Exploring the apparent non-linear relationship between *CR* and BMI revealed an inverted U-shaped association moderated by the level of *DIS*. In other words, the curvilinear relationship between BMI and *CR* was well pronounced for low levels of *DIS*, whereas there was no strong quadratic relationship with higher levels of DIS. We concluded that dietary restraint is low in normal weight individuals with a low level of *DIS* as food restriction is not necessary. With higher BMI dietary restraint becomes necessary as losing weight or avoiding further weight gain are supposedly more frequent. Obese individuals, as the model indicates, might not be able to raise sufficient self-control resources to restrain eating. With heightened overeating tendencies (higher level of *DIS*), normal weight individuals presumably increase conscious efforts to restrict food intake in order to maintain weight. Overweight and obese individuals, on the other hand, do not adequately adapt their eating behavior. Eating seems to be dominated by an uncontrolled eating style. The reverse relationships between *BAS* and BMI in men (negative association) and women (positive association) might be due to gender related differences regarding the value of palatable food, with heightened motivation for hedonic food particularly in women (Cepeda-Benito et al., 2003). Gender differences regarding the relationship between BMI and *BIS* might result from differences in emotional eating, with hedonic eating serving as a way to compensate negative emotionality especially in women (van Strien et al., 2013).

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