



Navigating the obesogenic environment: How psychological sensitivity to the food environment and self-regulatory competence are associated with adolescent unhealthy snacking



F. Marijn Stok^{a,b,*}, Emely De Vet^c, Jane Wardle^d, Maria T. Chu^{d,e}, John De Wit^f, Denise T.D. De Ridder^a

^a Clinical and Health Psychology, Utrecht University, The Netherlands

^b Psychological Assessment and Health Psychology, University of Konstanz, Germany

^c Communication, Philosophy and Technology, Centre for Integrative Development, Wageningen University and Research Centre, The Netherlands

^d Health Behaviour Research Centre, Department of Epidemiology and Public Health, University College London, UK

^e School of Health Sciences, City University London, UK

^f National Centre in HIV Social Research, University of New South Wales, Australia

ARTICLE INFO

Article history:

Received 18 July 2014

Received in revised form 6 October 2014

Accepted 3 December 2014

Available online 10 December 2014

Keywords:

Obesogenic environment

Power of food

Self-regulation

Adolescence

Eating behavior

Snacking

ABSTRACT

Purpose: Living in an obesogenic environment may not affect all adolescents to the same extent, depending on their psychological sensitivity to the food environment and their self-regulatory competence. The purpose of the current study was to examine associations of these two factors with unhealthy snacking among adolescents. We also investigated whether self-regulatory competence could attenuate the negative effects of being sensitive to the food environment.

Methods: A survey was completed by 11,392 European adolescents (10–17 years old). The survey measured psychological sensitivity to the food environment, self-regulatory competence and self-reported unhealthy snack intake.

Results: Higher food environment sensitivity and lower self-regulatory competence were associated with more unhealthy snacking. The two factors also interacted, with self-regulatory competence attenuating the influence of high food environment sensitivity.

Discussion: Adolescents who are sensitive to the food environment reported higher unhealthy snack intake. More frequent use of self-regulation strategies on the other hand was associated with lower unhealthy snack intake. Moreover, self-regulatory competence was found to moderate the influence of psychological sensitivity to the food environment on unhealthy snacking, although the effect size was small. Fostering adolescents' self-regulatory competence can help enable them to better navigate the obesogenic environment.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

About one-third of European school-aged children are now overweight (Wang & Lobstein, 2006). A large body of evidence shows that the omnipresence and easy accessibility of palatable energy-dense foods, often referred to as the *obesogenic environment* (Swinburn, Egger, & Raza, 1999), contributes substantially to this trend (Booth, Pinkston, & Carlos Poston, 2005). Living in the obesogenic environment is especially challenging for adolescents, who are just beginning to learn to handle increased autonomy regarding eating choices (Basset, Chapman, & Beagan, 2008; Stok, De Ridder, Adriaanse, et al., 2010). Additionally, their reward sensitivity is heightened whereas inhibitory control is not yet fully developed (Steinberg, 2007). However, the effects of the obesogenic environment on individuals are not universal, with a proportion of the population remaining slim despite

environmental pressures (Lowe & Butryn, 2009; Wardle & Boniface, 2008). The current study investigates if differences in the extent to which adolescents are sensitive to the obesogenic environment can explain differences in unhealthy snacking, and if self-regulatory competence can attenuate the negative effects of being sensitive to the obesogenic environment on unhealthy snacking.

1.1. The psychological power of food and self-regulatory competence

Studies with adults have shown that individuals differ in their psychological sensitivity to the food environment (Cappelleri, Bushmakin, Gerber, et al., 2009; Lowe, Butryn, Didie, et al., 2009), and that these individual differences are associated with eating-related outcomes. Obese participants reported higher sensitivity than non-obese participants (Lowe et al., 2009), and sensitivity was shown to predict frequency and intensity of chocolate craving and to negatively predict success in abstaining from eating chocolate (Levitsky & Shen, 2008). The obesogenic environment thus affects some individuals

* Corresponding author at: Postbox 80140, 3508 TC Utrecht, The Netherlands.
E-mail address: F.M.Stok@uu.nl (F.M. Stok).

more than others, raising the question of whether adolescents who experience high psychological sensitivity to the food environment would inevitably overeat as long as they are in an obesogenic environment. We believe that this may not necessarily be the case and that there may be factors, such as self-regulatory competence, that can buffer the negative effects of the food environment on eating behavior.

Self-regulatory competence is the ability to resist an immediate temptation in the service of attaining a long-term desired goal (Baumeister & Vohs, 2004; Metcalfe & Mischel, 1999). Adolescents have been shown to know various self-regulation strategies in the food domain (Stok, De Vet, De Ridder, et al., 2012), and higher use of these strategies has been shown to be associated with healthier eating behaviors (De Vet, De Ridder, Stok, et al., 2014). Self-regulatory competence thus has a direct correlation with healthier intake. We propose that self-regulatory competence may have another benefit, namely, that it may also serve as a moderator of the negative impact of being sensitive to the food environment on eating behavior.

1.2. Current study

In the current study, data were used from an international survey conducted within the scope of the TEMPEST project, in which self-regulation of eating in adolescents in nine European countries was investigated. Unhealthy snacking was chosen as outcome variable because adolescents have more autonomy and choice over the snacks they eat than over main meals (Stok et al., 2010) and because snacking is an important contributor to overweight (Duffey & Popkin, 2011; Zizza, Siega-Riz, & Popkin, 2001). Our hypotheses were that higher psychological sensitivity to the food environment would be associated with more unhealthy snacking, that higher self-regulatory competence would be associated with less unhealthy snacking, and that self-regulatory competence would attenuate the impact of food environment sensitivity on unhealthy snacking

2. Methods

2.1. Participants and procedures

A total of 11,392 adolescents aged 10–17 years took part in the survey. Participants' mean age was 13.2 years ($SD = 2.0$) and 50.5% were girls. Data were collected in 121 schools in nine European countries (The Netherlands, Belgium, UK, Germany, Denmark, Finland, Poland, Romania, and Portugal), selected to represent various geographic locations, socio-economic backgrounds, and overweight prevalences. Moreover, within each country, care was taken to select schools from both urban (58.5%) and rural (41.5%) regions and from both lower (47.8%) and higher (52.2%) socio-economic status areas. Data collection complied with the ethical guidelines applicable in each country; in countries where this was required, ethical approval from the relevant institution was obtained. Active or passive consent from adolescents and their parents was also obtained.

2.2. Measures

The questionnaire was originally prepared in English and was translated and back-translated to each country-specific language. The following measures were included in the current analyses:

Socio-demographic and anthropometric measures: Participants reported their age and gender. BMI was calculated from self-reported height and weight. Using age- and gender-specific cutoff points (Cole, Bellizzi, Flegal, et al., 2000), a dichotomous weight status variable (not overweight versus overweight) was computed. *Immigrant status* was assessed by asking participants to indicate the language they usually speak with their parents (Berry, Phinney, Sam, et al.,

2006), from which a dichotomous variable was created (native versus immigrant). *Family socio-economic status* was assessed using the Family Affluence Scale (FAS; Currie, Molcho, Boyce, et al., 2008). Using the protocol described by the developers of the scale, three categories reflecting low, medium and high affluence were computed.

Psychological sensitivity to the food environment was assessed using an abbreviated 11-item version¹ of the Children's Power of Food Scale (C-PFS; unpublished child version of the PFS (Lowe et al., 2009 and Cappelleri et al., 2009), available from lowe@drexel.edu). This scale measures the psychological impact of the food environment. Example items are "I think about food even when I'm not truly hungry" and "I often think about what foods I might eat later in the day." Response options ranged from 1 (strongly disagree) to 5 (strongly agree). The scale had good internal reliability (Cronbach's $\alpha = .86$).

Eating-related self-regulatory competence was measured using the 24-item Tempest Self-Regulation Questionnaire for Eating (TESQ-E; De Vet et al., 2014). Response options ranged from 1 (never) to 5 (always) and example items are "If I want to have a treat, I take a little bit and put the rest out of sight" and "If I have the urge to eat candy, I find something else to do." One average measure was computed (Cronbach's $\alpha = .93$).²

Unhealthy snack intake was assessed using a single item asking for average daily intake (number of snacks); country-specific examples of unhealthy snacks were provided in the questionnaire (e.g. candy bars, crisps and fried snacks). The answering scale ranged from 0 (none or less than 1 per day) to 5 (more than 4 per day).

2.3. Data analyses

A linear regression analysis was conducted. In Step 1, socio-demographic and anthropometric variables (age, gender, overweight status, immigrant status, and family socio-economic status) were entered. In Step 2, the main effect of food environment sensitivity was assessed, and in Step 3, the main effect of self-regulatory competence was added. Step 4 investigated if there was an interaction between these two variables, which was then further decomposed using simple slopes analysis (Aiken & West, 1991). The effect of food environment sensitivity on unhealthy snacking was examined at two levels of self-regulatory competence, low strategy use ($M - 1SD$) and high strategy use ($M + 1SD$).

To correct for a potential clustering effect at country level, the analysis was re-run using complex sample analysis with the nine countries as strata. The square root of the design effects maximally deviated .007 from 1.00, indicating that the design effect was extremely small. Country effects were thus negligible and because results did not differ between the complex samples analysis and the regular analysis, the latter is reported here.

3. Results

3.1. Sample description

Most participants (74.8%) had a normal weight, while 10.5% was underweight, 12.5% was overweight and 2.1% was obese. Most participants spoke the country's national language with their parents (90.7%). Of the

¹ The eight items that were excluded from the original Children's Power of Food Scale were items 2, 5, 8, 9, 11, 12, 14 and 16.

² The TESQ-E in fact consists of three subscales measuring three different categories of self-regulatory competence. All analyses were also run for each of these three categories separately. Results did not differ between the categories and are therefore reported for the overall measure.

Table 1
regression analyses of unhealthy snacking on socio-demographic and anthropometric variables, psychological sensitivity to the food environment and self-regulatory competence.

	B	β	p
Step 1: $R^2 = .016$, $F(6,9141) = 25.06$, $p < .001$			
Gender (0 = boy, 1 = girl)	-.137	-.048	<.001
Age	.061	.086	<.001
Family affluence dummy 1 (0 = medium/low, 1 = high)	-.230	-.081	<.001
Family affluence dummy 1 (0 = high/low, 1 = medium)	-.176	-.060	<.001
Overweight (0 = not overweight, 1 = overweight)	-.198	-.049	<.001
Immigrant status (0 = native, 1 = immigrant)	.231	.046	<.001
Step 2: $R^2 = .044$, $F(7,9140) = 60.68$, $p < .001$			
Power of food	.324	.169	<.001
Step 3: $R^2 = .152$, $F(8,9139) = 205.59$, $p < .001$			
Self-regulatory competence	-.617	-.346	<.001
Step 4: $R^2 = .153$, $F(9,9138) = 184.08$, $p < .001$			
Interaction: power of food \times self-regulatory competence	-.039	-.031	.001

Note: values shown are the values as obtained in each respective step.

participants, 13.0% came from low affluent families, while 39.3% and 47.8% came from middle and high affluent families, respectively. On average, participants used the self-regulatory strategies sometimes to regularly ($M = 2.39$, $SD = 0.80$), and they reported moderate psychological sensitivity to the food environment ($M = 2.76$, $SD = 0.74$). Participants consumed a daily average of 1.9 unhealthy snacks ($SD = 1.4$).

3.2. Power of food, self-regulation, and unhealthy snacking

In Step 1, all anthropometric and socio-demographic variables were weakly or moderately correlated with unhealthy snacking (see Table 1): boys, older adolescents, those from low-affluent families, normal-weight adolescents,³ and immigrant adolescents consumed more unhealthy snacks than girls, younger adolescents, those from high- or medium-affluent families, overweight adolescents, and native adolescents. In Step 2, there was a positive association between psychological sensitivity to the food environment and snack consumption that was of moderate strength, while Step 3 demonstrated a strong negative correlation between self-regulatory competence and snack consumption. Step 4 demonstrated that there was also a significant interaction between food environment sensitivity and self-regulatory competence, although the effect was small. A simple slopes analysis indicated that while the association between food environment sensitivity and unhealthy snacking was significant for adolescents both high and low in self-regulatory strategy use, it was stronger for those with lower self-regulatory competence ($B = .234$, $t = 13.28$, $p < .001$) than for those with higher self-regulatory competence ($B = .156$, $t = 8.18$, $p < .001$).

4. Discussion

In today's society, unhealthy food is everywhere. It has recently been suggested that some individuals may be more psychologically sensitive to this obesogenic environment than others (Lowe & Butryn, 2009; Wardle & Boniface, 2008). The current study investigated the association of food environment sensitivity with unhealthy snack intake in adolescents and provided a first indication that adolescents who are more sensitive to the food environment may consume more unhealthy snacks. Self-regulatory competence was negatively related to unhealthy snack consumption. The results further suggested that self-regulatory competence can function as a buffer for adolescents with high food environment sensitivity: adolescents who reported high food environment

sensitivity ate somewhat fewer unhealthy snacks if they made more frequent use of self-regulation strategies.

4.1. The protective function of self-regulatory competence

It is unlikely that the obesogenic environment will change substantially in the near future, raising the question whether people who are psychologically sensitive to the food-replete environment will unavoidably overeat. The current findings suggest that the answer to this question may be *no*. Adolescents may have self-regulation strategies at their disposal, which may help them navigate the temptations of the obesogenic environment: self-regulatory competence had a direct negative association with unhealthy snack consumption and attenuated the impact of food environment sensitivity on unhealthy snacking, although this was a small effect.

Interestingly, a previous study in a comparable sample of participants, which was also part of the TEMPEST project, showed that the association of the actual availability and accessibility of unhealthy foods with adolescents' unhealthy eating was similarly moderated by self-regulatory competence (De Vet, De Wit, Luszczynska, et al., 2013). It is important to note that adolescents' self-regulatory competence can be trained (Duckworth, Grant, Loew, et al., 2011; Gawrilow, Gollwitzer, & Oettingen, 2011; Muraven, Baumeister, & Tice, 1999). Current findings suggest that fostering self-regulatory competence can be doubly beneficial: frequent use of self-regulation strategies may both lead to lower unhealthy snack intake directly as well as attenuate the negative effects of food environment sensitivity on unhealthy snacking.

4.2. Limitations, implications, and conclusions

The current study had a cross-sectional design, and all variables were assessed with self-report measures. The findings should thus be replicated in studies with longitudinal or experimental designs and using objective measures. Furthermore, whereas the direct associations of both food environment sensitivity and self-regulatory competence with unhealthy snacking were of medium effect size, the interaction effect had a very small effect size and implications should be viewed in light of this limitation.

This study indicates that psychological sensitivity to the food environment varies across adolescents and is associated with eating more unhealthy snacks. Self-regulatory competence, on the other hand, is associated with eating fewer unhealthy snacks. Furthermore, the association of food environment sensitivity with unhealthy snacking is moderated by self-regulatory competence, with more use of self-regulatory strategies attenuating the effect of food environment sensitivity, although these results should be interpreted in light of the small effect. The development of healthy eating habits during adolescence is important (Dietz, 1998; Reilly, Methven, McDowell, et al., 2003; Wang & Lobstein, 2006), and these results point to a role for self-regulatory competence both as a direct influence on food choices and, to a lesser extent, as a protective buffer against a high psychological sensitivity to the food environment. One implication of these results is that development of self-regulatory competence could be an important strategy to support healthy dietary choices in adolescents.

Role of funding sources

Funding for this study was provided by the European Commission FP7 Research Program (Health-F2-2008-223488). The European Commission had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Contributors

MS, EdV, JdW, and DdR designed the study and wrote the protocol. MS conducted the statistical analyses and wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

³ The fact that normal-weight adolescents consumed more unhealthy snacks than overweight adolescents was somewhat surprising. One possible explanation may be that overweight adolescents restrict their intake in order to prevent further weight gain or to lose excess weight.

Conflict of interest

All authors declare that they have no conflicts of interest.

Acknowledgments

The authors thank Michael Lowe for his valuable contribution to an earlier version of this manuscript. The authors acknowledge all members of the TEMPEST consortium.

References

- Aiken, L.S., & West, S.G. (1991). *Multiple regression: Testing and interpreting interactions*. Newbury Park, California: Sage.
- Basset, R., Chapman, G.E., & Beagan, B.L. (2008). Autonomy and control: The co-construction of adolescent food choice. *Appetite*, 50, 325–332, <http://dx.doi.org/10.1016/j.appet.2007.08.009>.
- Baumeister, R.F., & Vohs, K.D. (2004). *Handbook of self-regulation: Research, theory, and applications*. New York: Guilford.
- Berry, J. W., Phinney, J. S., Sam, D. L., & Vedder, P. (2006). Immigrant youth: Acculturation, identity, and adaptation. *Applied Psychology*, 55, 303–332, <http://dx.doi.org/10.1111/j.1464-0597.2006.00256.x>.
- Booth, K.M., Pinkston, M.M., & Carlos Poston, W.S. (2005). Obesity and the built environment. *Journal of the American Dietetic Association*, 105, 110–117, <http://dx.doi.org/10.1016/j.jada.2005.02.045>.
- Cappelleri, J. C., Bushmakin, A. G., Gerber, R. A., Leidy, N. K., Sexton, C. C., Karlsson, J., et al. (2009). Evaluating the Power of Food Scale in obese subjects and a general sample of individuals: Development and measurement properties. *International Journal of Obesity*, 33, 913–922, <http://dx.doi.org/10.1038/ijo.2009.107>.
- Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal*, 320, 1240–1243, <http://dx.doi.org/10.1136/bmj.320.7244.1240>.
- Currie, C., Molcho, M., Boyce, W., Holstein, B., Torsheim, T., & Richter, M. (2008). Researching health inequalities in adolescents: The development of the Health Behaviour in School-Aged Children (HBSC) Family Affluence Scale. *Social Science & Medicine*, 66, 1429–1436, <http://dx.doi.org/10.1016/j.socscimed.2007.11.024>.
- De Vet, E., De Ridder, D., Stok, M., Brunso, K., Baban, A., & Gaspar, T. (2014). Assessing self-regulation strategies: Development and validation of the tempest self-regulation questionnaire for eating (TESQ-E) in adolescents. *International Journal of Behavioral Nutrition and Physical Activity*, 11, 106, <http://dx.doi.org/10.1186/s12966-014-0106-z>.
- De Vet, E., De Wit, J. B., Luszczynska, A., Stok, F. M., Gaspar, T., Pratt, M., et al. (2013). Access to excess: How do adolescents deal with unhealthy foods in their environment? *European Journal of Public Health*, 23, 752–756, <http://dx.doi.org/10.1093/eurpub/cks185>.
- Dietz, W.H. (1998). Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics*, 101, 518–525.
- Duckworth, A. L., Grant, H., Loew, B., Oettingen, G., & Gollwitzer, P. M. (2011). Self-regulations strategies improve self-discipline in adolescents: Benefits of mental contrasting and implementation intentions. *Educational Psychology*, 31, 17–26, <http://dx.doi.org/10.1080/01443410.2010.506003>.
- Duffey, K.J., & Popkin, B.M. (2011). Energy density, portion size, and eating occasions: Contributions to increased energy intake in the United States, 1977–2006. *PLoS Medicine*, 8, e1001050, <http://dx.doi.org/10.1371/journal.pmed.1001050>.
- Gawrilow, C., Gollwitzer, P.M., & Oettingen, G. (2011). If-then plans benefit delay of gratification performance in children with and without ADHD. *Cognitive Therapy and Research*, 35, 442–445, <http://dx.doi.org/10.1007/s10608.010.9309>.
- Levitsky, D.A., & Shen, X. (2008). Food power scale predicts dessert eating, but not meal eating or portion size effect. *Appetite*, 51, 381, <http://dx.doi.org/10.1016/j.appet.2008.04.147>.
- Lowe, M.R., & Butryn, M.L. (2009). Hedonic hunger: A new dimension of appetite? *Physiology & Behavior*, 91, 432–439, <http://dx.doi.org/10.1016/j.physbeh.2007.04.006>.
- Lowe, M. R., Butryn, M. L., Didie, E. R., Annunziato, R. A., Thomas, J. G., Crerand, C. E., et al. (2009). The Power of Food Scale: A new measure of the psychological influence of the food environment. *Appetite*, 53, 114–118, <http://dx.doi.org/10.1016/j.appet.2009.05.016>.
- Metcalfe, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review*, 106(1), 3–19, <http://dx.doi.org/10.1037/0033-295X.106.1.3>.
- Muraven, M., Baumeister, R.F., & Tice, D.M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *Journal of Social Psychology*, 139, 446–457, <http://dx.doi.org/10.1080/00224549909598404>.
- Reilly, J. J., Methven, E., McDowell, Z. C., Hacking, B., Alexander, D., Stewart, L., et al. (2003). Health consequences of obesity. *Archives of Disease in Childhood*, 88, 748–752, <http://dx.doi.org/10.1136/adc.88.9.748>.
- Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science*, 16, 55–59, <http://dx.doi.org/10.1111/j.1467-8721.2007.00475.x>.
- Stok, F. M., De Ridder, D. T. D., Adriaanse, M. A., & De Wit, J. B. F. (2010). Looking cool or attaining self-rule: Different motives for autonomy and their effects on unhealthy snack purchase. *Appetite*, 54, 607–610, <http://dx.doi.org/10.1016/j.appet.2010.02.017>.
- Stok, F. M., de Vet, E., de Ridder, D. T., & de Wit, J. B. F. (2012). "I should remember I don't want to become fat": Adolescents' views on self-regulatory strategies for healthy eating. *Journal of Adolescence*, 35, 67–75, <http://dx.doi.org/10.1016/j.adolescence.2011.06.004>.
- Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Preventive Medicine*, 29, 563–570, <http://dx.doi.org/10.1006/pmed.1999.0585>.
- Wang, Y., & Lobstein, T. (2006). Worldwide trends in childhood overweight and obesity. *International Journal of Pediatric Obesity*, 1, 11–25, <http://dx.doi.org/10.1080/17477160600586747>.
- Wardle, J., & Boniface, D. (2008). Changes in the distributions of body mass index and waist circumference in English adults, 1993/1994 to 2002/2003. *International Journal of Obesity*, 32, 527–532, <http://dx.doi.org/10.1038/sj.ijo.0803740>.
- Zizza, C., Siega-Riz, A.M., & Popkin, B.M. (2001). Significant increase in young adults' snacking between 1977–1978 and 1994–1996 represents a cause for concern! *Preventive Medicine*, 32, 303–310, <http://dx.doi.org/10.1006/pmed.2000.0817>.