Dependence Module of the MINI Plus Adapted for Sugar Dependence: Psychometric Properties

Módulo de Dependência do MINI Plus Adaptado para Dependência de Açúcar: Propriedades Psicométricas

Marco Aurélio Camargo da Rosa[*, a], Cristiano Mauro Assis Gomes[a], Neusa Sica da Rocha[b],
Felix Henrique Paim Kessler[b], Sonia Maria Blauth de Slavutzky[b],
Efigênia Ferreira e Ferreira[a] & Flavio Pechansky[b]
[a]Universidade Federal de Minas Gerais, Belo Horizonte, Brasil
& [b]Universidade Federal do Rio Grande do Sul, Porto Alegre, Brasil

Abstract
This study aimed to analyze the factorial structure and the scale of measurement of the items for dependence of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) adapted for sugar consumption in order to verify if the structural characteristics can be applied to sugar dependence. The questionnaire was applied to a sample of 500 subjects in Brazil (67% female; mean age: 38 y.o.; 43% from weight control clinics; 63% with normal BMI). An exploratory factor analysis was performed to determine the factorial structure and unidimensionality; and, a Rasch model analysis, to verify unidimensionality and items distribution. The model with best fit is unidimensional. All items had good fit to the Rasch model with a reliability of .99, infit between .86 and 1.14 and outfit from .71 to 1.20. The items of MINI Plus adapted for sugar dependence presented good psychometric properties, suggesting that the dependence criteria of DSM-IV support the verification of the construct for sugar addiction.
Keywords: Sugar, dependence, questionnaires, validation studies.

Resumo
Analisar a estrutura fatorial e a escala de medida dos critérios de dependência do DSM-IV adaptado para açúcar a fim de verificar se as características estruturais são aplicaveis para dependência de açúcar. O questionário foi aplicado numa amostra de 500 pessoas (67% mulheres; média idade: 38 anos; 43% de clínicas obesidade; 63% IMC normal). A análise fatorial exploratória determinou a estrutura fatorial e unidimensionalidade; a análise de Rasch, a unidimensionalidade e distribuição dos itens. O modelo com melhor ajuste era unidimensional. Todos os itens apresentaram ajustes adequados na análise de Rasch com confiabilidade de 0,99, *infit* entre 0,86 a 1,14 e *outfit* entre 0,71 e 1,20. Os itens de dependência do MINI Plus adaptados para açúcar apresentaram boas propriedades psicométricas, sugerindo que os critérios do DSM-IV contribuem na verificação do constructo dependência de açúcar.
Palavras-chave: Açúcar, dependência, questionários, estudo de validação.

Questionnaires or tests such as the MINI Plus, the CIDI, and the ASSIST are widely used for diagnostic purposes in psychiatry (Humeniuk et al., 2008; D. V. Sheehan et al., 1998; Wittchen, 1994). The MINI Plus is an example of a brief assessment tool, consisting of several modules for the diagnosis of psychiatric disorders and validated in over 30 languages. One of the modules of the MINI Plus (Module L) is specific for the assessment of abuse and dependence of psychoactive substances other than alcohol. It is based on the criteria of the *Diagnostic and Statistical Manual of Mental Disorders– Fourth Edition* (DSM-IV), which are widely used for the development of dependence scales of various psychoactive substances.

According to the DSM-IV (American Psychiatric Association [APA], 2004), dependence on a psychoactive substance is a chronic disorder characterized by the interaction of three or more of the following criteria (label) occurring at any time within a 12-month period: 1- tolerance ('tolerance'); 2- withdrawal or withdrawal relief avoidance ('withdrawal'); 3- use in larger amounts or for longer periods than intended ('larger/longer'); 4- persistent desire or unsuccessful efforts to cut down ('quit/control'); 5- time spent in obtaining the substance ('time spent'); 6- giving up or reducing important activities in

favor of substance use ('activities given up'); and 7-continued substance use despite knowledge of a physical or psychological problems resulting from use ('phys/psych problems'). These diagnostic criteria for dependence reflect the consensus of researchers as to which patterns of behavior or physiological characteristics constitute symptoms of these conditions.

In 2005 our research group adapted the "L" module "Non-alcohol Psychoactive Substance Use Disorders" of the MINI Plus Questionnaire for sugar in order to generate psychiatric diagnosis indicators. The adapted instrument consists of 20 items that address dependence throughout an individual's lifetime as well as current dependence and abuse (APA, 2004; Rosa, Slavutzky, Pechansky, & Kessler, 2008).

The main issue is whether or not sugar dependence exists. Questionnaires addressing addiction to foods and sweets have recently been proposed such as the Yale Food Addiction Scale, based upon DSM-IV substance dependence criteria (Gearhardt, Corbin, & Brownell, 2009); the Questionnaire on Cravings for Sweet or Rich Foods among smokers, adapted from the Alcohol Urge Questionnaire (Toll, Katulak, Williams-Piehota, & O'Malley, 2008); and the Sweet Taste Questionnaire (Kampov-Polevoy, Alterman, Khalitov, & Garbutt, 2006). All these questionnaires were exploratory studies and showed to be adequate reliable and valid measures for evaluate craving or addiction for sweet foods.

Menezes, Nascimento, Gorenstein, Andrade and Zuardi (2000) stress the lack of biological markers or other measurable representations for the vast majority of psychiatric disturbances. In order to verify whether there is sugar dependence, as other psychiatric disorders, it requires to take into account a combination of variables due to this complex process. Thus, such disturbances are evaluated basically through clinical symptoms and syndromes.

Sugar Dependence Construct

The theoretical construct of sugar dependence has recently been investigated. A number of studies address issues related to the excessive intake of sweets and the possible association to abuse and dependence (Avena, Rada, & Hoebel, 2008; Kampov-Polevoy et al., 2006). Some authors have reported evidence of comorbidity between substance abuse and excessive desire ("craving") or preference for solutions with high concentrations of sucrose (Avena et al., 2008; Janowsky, Pucilowski, & Buyinza, 2003; Kampov-Polevoy et al., 2006; Pelchat, 2002; Spring et al., 2008). Tobacco studies have shown that sugar may attenuate tobacco craving and withdrawal symptoms (Berlin, Vorspan, Warot, Maneglier, & Spreux-Varoquaux, 2005). Kampov-Polevoy (1997) has also found that commonly abused drugs and sweet foods share the ability to increase the extracellular concentration of dopamine in the nucleus accumbens, suggesting that alcohol and sweet substances share the same dopaminergic mechanism with regard to pleasurable effects. Some authors believe the explanation lies in the neurochemical mechanism of reward that modulates certain drug-seeking behavior (Blass, Dobbing, & Springer, 1987; Janowsky et al., 2003; Levine, Kotz, & Gosnell, 2003; Mercer & Holder, 1997; Pelchat, 2002). Food, especially those high in sugar and fat, have been linked to binge eating (Drewnowski, Kurth, Holden-Wiltse, & Saari, 1992; Gendall, Joyce, Sullivan, & Bulik, 1998) as well as overeating among obese individuals (Drewnowski, Kurth, & Rahaim, 1991; Ifland et al., 2009) and depressed individuals (Jeffery et al., 2009). This overconsumption has recently been compared to drug addiction (Lenoir, Serre, Cantin, & Ahmed, 2007; Pelchat, 2002) and is responsible for the increase in the incidence of adverse health conditions (Christensen, 1997; Heaton, 1991; World Health Organization [WHO], 2003).

Dependence criteria	Evidence of dependence	References
('tolerance')	Rats increase their consumption of glucose	(Colantuoni et al., 2002; Colantuoni et al., 2001)
('withdrawal')	Sugar-bingeing rats show signs of withdrawal	(Avena et al., 2008; Colantuoni et al., 2002; Lenoir et al., 2007)
('larger/longer')	Diet interventions for weight loss are frequently followed by weight regain	(Dansinger, Tatsioni, Wong, Chung, & Balk, 2007; Ifland et al., 2009)
('quit/control')	Inability to cut back on certain foods	(Dansinger et al., 2007; Volkow & O'Brien, 2007)
('time spent')	Compulsive food consumption results in fatigue and sleepiness	(Ifland et al., 2009)
('activities given up')	Binge-eaters isolate themselves and miss out on social life	(Ifland et al., 2009)
('phys/psych problems')	Subjects receive medical advice to reverse the consequences or prevent the worsening of the condition, but are unable to follow this advice	(Dale, Mann, McAuley, Williams, & Farmer, 2009; Dale, McAuley et al., 2009; Volkow & O'Brien, 2007)

Figure 1. Evidence of sugar dependence based on DSM-IV Criteria.

Figure 1 presents several authors using the DSM-IV criteria have found evidence that sugar intake can produce a pattern of symptoms that are consistent with DSM-IV descriptions for dependence. These studies showed the presence of tolerance, withdrawal, loss of control, difficult to cut down, physical or psychological problems in animals or humans.

Sugar seems to be well associated with psychoactive substances, but some studies suggest the possibility that it may also be psychoactive. Therefore, it is critical that steps such as convergent validity and the discovery of somatic markers, among others, are part of a research agenda on the construct of sugar addiction. The first step in this study was to investigate the appropriateness of DSM-IV for sugar. According to literature searches conducted in ISI, Pubmed, Psychinfo in the year 2011, using the following MeSH Terms: "Sugars", "Questionnaires", "DSM-IV", no work covers all the criteria of the DSM-IV in a single analysis specifically for sugar. Existing studies do not address all the criteria for DSM-IV dependence or are not specific for sugar.

If sugar really is a psychoactive substance, the structure of the MINI Plus "L" module should work for the diagnosis of sugar dependence. Therefore, it is mandatory that the MINI Plus "L" module applied for sugar would present appropriate psychometric properties.

This article aims to verify some psychometric properties of the MINI Plus "L" module adapted for sugar to verify the validity of dependence criteria of DSM-IV, whose analysis is crucial so that the research agenda of the construct dependence of sugar can proceed. The psychometric properties were analyzed using the factor structure, scale properties, divergent validity, scale reliability, item reliability, and person and factor determinacies.

Method

Subjects and Procedures

A convenience sample of 500 individuals was asked to respond to the MINI Plus "L" module adapted for sugar in a voluntary, anonymous format, with no financial gain (Rosa et al., 2008). Data collection was conducted in two large Brazilian cities (Porto Alegre and Belo Horizonte), with 250 participants in each city. Among these, 100 were recruited from weight-control clinics, referred by physicians (University hospital and self-help groups for weight control), and 150 were recruited by convenience sampling from public and private institutions within the cities. Data collection was designed in such a way that participants reported sugar use ranging from no problem with sugar to strong disturbance related to the use of the substance. Therefore, the data collection was performed in a hospital setting, self-help groups, factories and other non-specific environments.

Inclusion criteria were: ages between 18 and 60 and sufficient cognitive ability to understand and respond to the questionnaire, as determined by the interviewer's clinical judgment. In the two cities, all participants were interviewed by the same interviewer (MR), who was also responsible for explaining the study objectives and clarifying all doubts. The interviewer was trained to follow the guidelines for the administration of the MINI Plus questionnaire (D. V. Sheehan et al., 2001).

The study received approval from the Institutional Review Board of the Hospital de Clínicas of Porto Alegre (Nº: 04-184). Written informed consent was obtained from all participants prior to their inclusion in the study.

Instrument

The MINI Plus "L" Module adapted for sugar has a total of 20 dichotomous item, eight on sugar dependence throughout the individual's lifetime, eight on current sugar dependence, and four on current sugar abuse (Rosa et al., 2008). In the present study, only the first eight items were analyzed to verify if the construct referring to lifetime sugar dependence is valid (Figure 2).

In the description and discussion of the results issues were treated as criteria, so that in addition to the filter question each item refers to one diagnostic criterion regarding such dependence based on the DSM-IV criteria. Information was also collected regarding age, gender and body-mass index (BMI). This instrument adapted for sugar was tested in Portuguese language.

Statistical Analysis

In order to estimate the structure validity of the adapted MINI Plus "L" module for sugar addiction, the following statistical methods were applied: analyzing the factorial structure using exploratory factor analysis (EFA); determining scale properties using Rasch analysis; determining convergent validity from the statistical difference between normal-weight and obese individuals; and measuring reliability using Cronbach's alpha (Bland & Altman, 1997). Item reliability and person reliability also were determined by Rasch analysis (Linacre, 2002). Statistical analysis was performed using the Statistical Package for Social Sciences (version 15.0 for Windows) for the Mann-Whitney test and descriptive analysis; the MPlus program (version 5.2) for exploratory factor analysis; and the Winsteps program (version 3.64) for Rasch model analysis.

EFA solutions were obtained using the maximum likelihood methods. The solution selected was the one which presented the best Comparative Fit Index (CFI) and Root Mean Square Error of Approximation (RMSEA) and the parsimony principle (Bentler, 1990; Byrne, 2001; Hair, Anderson, Black, & Tatham, 1998; McDonald & Ho, 2002; Ullman, 2001). The criteria of satisfactory adjustment of the model to the data were adopted according to the following index values: CFI equal to or greater than .90 and RMSEA less than or equal to .08 (Linacre, 2002).

DSM-IV Criteria	Questions
Filter question	1- Have you ever had persistent desire for sweets or taken more than once to feel better, or to change your mood? **(craving)**
1	2 - Have you found that you needed to increase the amount of sweets you ate to get the same effect that you did when you first started taking it? **('tolerance')**
2	3 - When you reduced or stopped eating sweets, did you have withdrawal symptoms (aches, shaking, fever, weakness, diarrhea, nausea, sweating, heart pounding, difficulty sleeping, or feeling agitated, anxious, irritable or depressed)? Did you eat something to keep yourself from getting or so that you would feel better? **('withdrawal')**
3	4 - Have you often found that when you ate sweet substances, you ended up taking more than you thought you would? **('larger/longer')**
4	5 - Have you tried to reduce or stop eating sweet substances, but failed? **('quit/control')**
5	6 - On the days that you have eaten sweet substances, did you spend substantial time (>2hours) in trying to get them, eat them or recover from their effects, or thinking about them? **('time spent')**
6	7 - Have you ever reduced your activities (e.g., hobbies, work, daily activities) or have you ever spent less time with your family or friends because of sweet substances? **('activities given up')**
7	8 - Have you continued to eat sweet substances even though them caused you health or mental problems? **('phys/psych problems')**

Figure 2. Dependence questions from the MINI Plus "L" module adapted for sugar.

The factors of the solution selected were then rotated using oblique rotation (Geomin).

In the Rasch model analysis, the infit and outfit parameters and reliability of the scale criteria generated were taken into consideration. Infit is a parameter that must have a value greater than .70 and less than 1.30 to be considered satisfactory, whereas for outfit the value must be greater than .50 and less than 1.50 (Linacre, 2002). Rasch model offers several benefits: Item statistics are independent of the sample from which they were estimated; Examinee scores are independent of test severity; Test analysis doesn't require strict parallel tests for assessing reliability; Item statistics and examinee severity are both reported on the same scale (Hambleton & Swaminathan, 1984). With the aim of conducting divergent validation, we checked the differences of obese and nonobese patients in terms of their scores on the Rasch scale with the Mann-Whitney U nonparametric test, as well as the effect size of this difference.

Results

The average time to complete the questionnaire was 14 minutes. Among the overall sample of 500 individuals, 335 (67%) were female. Ages ranged from 18 to 60, with a mean of 37.6 + 12 (standard-deviation). A total of 63.4% had a BMI between 19 and 25 and 36.6% had a BMI of 30 or more. Nearly 43% were recruited from diet and weight-control centers.

The solution with one factor exhibited adequate patterns of adjustment, with a chi-square value of 53.43 (*df*=20), *P*-value .0001, a CFI value of .98 and an RMSEA value of .06. The latent factor is called "Sugar Dependence" because it is the first clue about this new construct. This factor was able to explain 51.67% of the common variance attributed to the criteria. Cronbach's alpha was .75 and the factor determinacies was .95. All items presented a good factorial loading, with a minimal of .61, which demonstrates a latent variable explanatory capacity of at least 37% of the variance in all items. Items four, five, six, filter question and item two (in that order) were better explained by the factor (Figure 3).

The items four, five, six, filter question and item two were explained by a factor of at least 50% of its variance. The results of the factorial structure indicate that the instrument exhibits satisfactory adjustment to the unidimensional model, which suggests the possibility of Rasch model analysis.

The results of Rasch analysis to items are shown in Table 1, which details the measure values and criteria adjustments to scale (Item Severity, Infit and Outfit).The items are presented in order of severity, from the hardest to the easiest to comply.
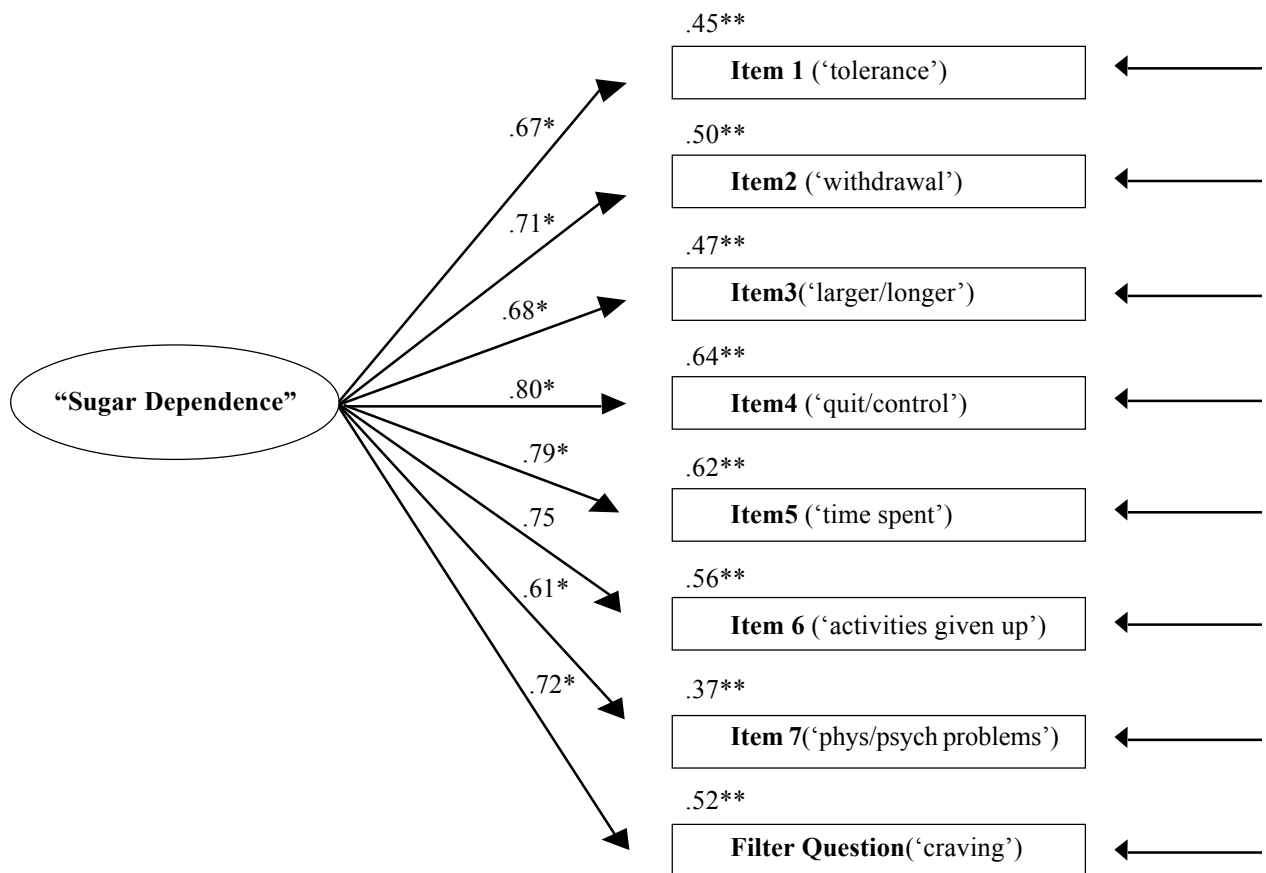
Figure 3. Solution presenting the best adjustment.
Note. * Factor Loadings; **explanatory capacity.

Table 1
IRT Item Severity and Adjust Index of the items from MINI Plus Dependence Module Adapted for Sugar Dependence

Symptoms of dependence	Rasch Analysis (*N*=500)			
	Prevalence	Item Severity (S.E.)	Infit	Outfit
Item 6 ('activities given up')	5.4	3.17 (.26)	1.00	.93
Item 2 ('withdrawal')	17.8	.95 (.15)	1.04	1.07
Item 1 ('tolerance')	21.0	.61 (.14)	1.06	1.06
Item 5 ('time spent')	24.0	.32 (.14)	.89	.71
Item 4 ('quit/control')	25.0	.23 (.13)	.86	.71
Filter question ('craving')	34.6	-.56 (.12)	.98	.94
Item 7 (phys/psych problems)	54.4	-2.03 (.12)	1.14	1.20
Item 3 ('larger/longer')	62.4	-2.69 (.13)	1.02	1.12
Mean		.00 (.15)	1.00	.97
SD		1.70 (.04)	.08	.17

Note. IRT= Item Response Theory; S.E. = standard error. Rasch Model Index Values on an average scale of 50, with a standard deviation of 10. All item presented satisfactory infit (.70 to 1.30) and outfit (.50 to 1.50).

All items proved appropriate for the Rasch scale, with infit values between .86 and 1.14 and outfit values between .71 and 1.20. The item separation reliability was .99 and for the person separation reliability it was .48.

The map constructed from the Rasch model analysis demonstrates the participant dependence level and the relationship between the item and the probability of the item to be responded positively with regard to the dependence level of the participants (Figure 4).
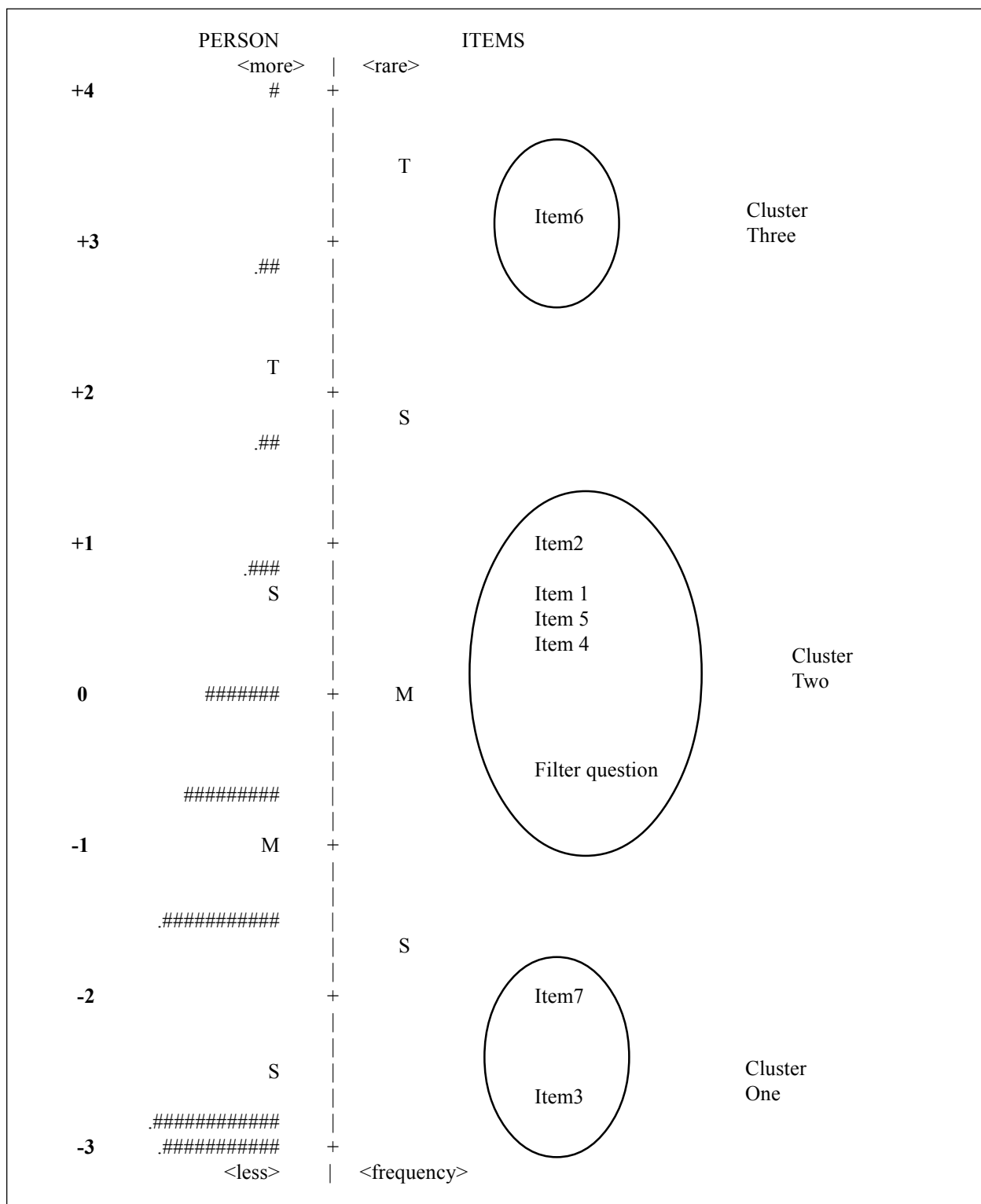
Figure 4. Rasch variable map of 8-item.
Note. Each "#" is 8 person. M, mean; S, 1 *SD* from the mean; T, 2 *SD* from the mean.

At the bottom you can see a large number of participants aligned with the item most likely to be responded, and on top you can see a small number of individuals aligned with the items least likely to be responded. There were gaps between items. This allows for the identification of three clusters of items, corresponding to three ranges probability of participant answers. The clusters are: Cluster one: item three (taking larger amounts) and seven (eating despite having problems). Cluster two: filter question (craving), item four (unable to cut down), five

(time spent using or recovering), one (tolerance) and two (withdrawal). Cluster three: item six (giving up important activities). The easiest item – or the ones with the highest probability of positive answers – are items three (taking larger amounts) and seven (eating despite having problems). Item six (giving up important activities) shows the lowest probability of being positively answered by the majority of respondents.

We verified during divergent validation that obese and nonobese individuals showed statistical differences in the scale. Obese individuals showed a higher score in the scale, with a median in the Rasch measures (standard deviation of the individuals) = -.76, while nonobese individuals had a median = -1.66. The Mann-Whitney U test showed significant differences, with a $U = 20987.00$ ($p<.000$). The effect size of this difference was medium (.53, with a confidence interval between .35 and .72).

Discussion

The research agenda on the construct of sugar addiction has shown significant advances in producing evidence in animals or humans on the presence of DSM-IV. Moreover, these studies analyzed the criteria separately so that we can characterize this as the first step of the agenda. It was thus proposed in this paper that a second step be should considered crucial for the agenda to continue. This step was the joint analysis of the eight questions of the Module "L" of the MINI Plus (a filter question and seven DSM-IV) to determine the construct dependence of sugar (a latent variable).

The main findings of this study showed that the MINI Plus "L" module for sugar has adequate psychometric properties and it exhibited a unidimensional structure where all DSM-IV criteria converge to a single latent variable (presumably understood as the extension of sugar use and dependence). The Cronbach's alpha value indicates that there is sufficient internal consistency among all criteria. Nevertheless, the reliability of person separation of .48 showed a necessity of items that can cover the entire range of the scale in terms of degrees of dependence. All items are relevant for the identification of the latent variable (all items presenting appropriate factor loadings). Infit and outfit values were adequate serving as further evidence that the items are relevant to measure a single latent variable; it was noted that there is a measurable difference in the latent variable between obese and nonobese patients.

Some results presented deserve special attention and will be discussed briefly. The presence of the one-dimensionality of this study agrees with the findings from studies that verified the dimensionality in scales also based on the criteria of the DSM-IV dependence for food addiction (Gearhardt et al., 2009); cocaine and opiates (Wu et al., 2009a); and alcohol and marijuana (Wu et al., 2009b). In these studies all seven items showed adequate factor loads,

ranging between .65 and .97 (Gearhardt et al., 2009; Wu et al., 2009a).

The three items for sugar that showed the highest factor loads (items four, five, six) are those associated with the DSM-IV criteria of "taking larger amounts"; "time spent using or recovering"; and "giving up important activities". In the analysis of factor loads of DSM-IV criteria for other psychoactive substances, it was observed that the item with the highest factor loads were also similar: cocaine (items five, four, three); opioids (items six, four, three); alcohol (items six, five, three); and marijuana (items five, three, six; Volkow & Wise, 2005; Wu et al., 2009b). All these findings show that the most loaded (heavier) items are those related with symptoms indicative of compulsive substance use without physiological dependence. In addition to the low number of questions, the items distribution in the Rasch scale showed that the filter question was not the question most likely to be answered by study participants.

In the analysis of the severity of the items, it is possible to verify that for sugar the degree of severity of the items varied between less severe (item three, "taking larger amounts") and more severe (item six, "giving up important activities"). However, the filter question of the module L of the instrument MINI Plus that is related to craving represented a degree of severity superior to item three. One of the possible reasons for the failure of this question as "filter" may be that sugar does not generate behavior alterations with the same intensity as other psychoactive substances such as marijuana, cocaine or crack, which generated the original instrument. This means that the item did not present favorable sensitivity characteristics to triage individuals with potential symptoms due to sugar consumption. The items most likely to be responded to related to sugar were item three (taking larger amounts) and seven (eating despite having problems). The difficulty in controlling consumption is more easily identified among individuals with restrictions or diet control. According to Ifland (2009) and Volkow and O'Brien (2007), some obese individuals show difficulty in controlling their consumption of nonhealthy substances even while knowing about their negative effects. Volkow and Wise (2005) wrote that ingesting food and drug use involve learned habits and preferences that are characterized by the reinforcing properties of powerful and repetitive rewards. It is possible to verify in the Rasch analysis map that in its lower section, next to the standard deviation minus three, the presence of many individuals below all questions of the instrument could be observed, which calls attention to the fact that these individuals had less than a 50% chance of answering the less severe question of the scale. By observing the performance of the three items for substances such as cocaine, opioids, marijuana and alcohol, one can see that it is one item that presents a level of intermediate severity among the other item. Therefore, item three for sugar, unlike for other substances, would

function better as a filter question for presenting a larger sensitivity than the original filter question adapted for sugar.

Item six ("missed important activities") ascertains such an elevated level of severity that few individuals would respond positively to this item. Since sugar is a common substance, there is usually no discrimination among persons who use it in an abusive format, although subjects with health problems such as obesity or diabetes refrain from using it in the presence of others in order to avoid embarrassment. Literature points toward a relationship between sugar consumption and obesity (Ifland et al., 2009; Volkow & O'Brien, 2007). These same characteristics observed in item 6 for the substance sugar also were observed for alcohol and opioids (Wu et al., 2009a; Wu et al., 2009b).

When comparing the degree of severity variations among the items for the substance sugar, one can observe them to be much greater than the variations in studies with substances such as alcohol, marijuana, cocaine and opioids. These variations may be related to the fact that the population for the sugar study is composed a more heterogeneous sample than samples from other studies. Studies of alcohol, marijuana, cocaine and opioid were conducted with individuals from treatment programs associated with the Clinical Trials Network, i.e., a more homogeneous population.

With regard to diagnostic possibilities, one finding that deserves discussion is the presence of three clusters of items and two gaps observed in the Rasch scale. These gaps suggest the possible existence of a qualitative jump in the history and development of sugar dependence. The first is the formation of the cluster comprised of items three and seven, which suggests that the process of dependence may find its initial aspect in the individual's "loss of control" related to the use of the substance. The present study shows a considerable gap between the first and the second cluster of items, indicating that the historical sequence of events that characterizes dependence could be formulated in jumps. The second cluster presents clearer characteristics of pleasure seeking, but with much more evident traces of loss of control. The second gap between the second and third clusters is even wider than the first. In fact, the third cluster consists of only one item (item six), which already represents a functional inability of the individual due to dependence. This evidence allows for the possibility of future studies of the possible existence of three levels in the history and development of sugar dependence, which presents a relevant contribution to diagnoses in the sense that diagnoses are most commonly based on continuous scales.

An analysis of discriminant validity showed that the obese and nonobese patients exhibited a significant difference when verifying the value of the measure of the Rasch model. The highest value found in obese individuals shows that they are more likely to present the criteria for sugar addiction than nonobese individuals. This finding

may be one possible explanation for the difficulties of behavioral changes in obese individuals and the general failure of treatment for weight loss (Ifland et al., 2009; Volkow & O'Brien, 2007).

Furthermore, this evidence can be helpful in developing therapies related to sugar disturbances. Gearhardt et al. (2009) highlights that studies in humans about "food addiction" are still in their initial stages and that future research could help treat a number of disorders associated with the consumption of sweet substances and food. This exploratory study confirms previous research that already posed the hypothesis of the construct of sugar dependence (Avena et al., 2008; Colantuoni et al., 2002; Gearhardt et al., 2009; Ifland et al., 2009).

The present study has limitations which include the following: the diagnosis of eating disorders was not verified in this sample; the nonexistence of a validated instrument to analyze convergent validation; the absence of specific criteria for disturbances related to the use of sugar; the reduced number of questions in the MINI Plus "L" module adapted for sugar and the use of a convenience sample that may not represent the general population.

Based on the results from this study, it can be concluded that the seven DSM-IV criteria are indicators of a unidimensional latent trait called sugar addiction. This is a good sign that the research agenda may continue, resuming the issue addressed in the introduction to this study.

The subsequent stages of this study will include: (a) testing the eight questions on current substance dependence and the four questions on abuse; (b) testing the convergent, discriminant, and incremental validity; (c) administering the adapted instrument to users of alcohol and other drugs to verify cross-dependence; (d) administering the instrument to obese and diabetic individuals since these individuals have restrictions and difficulties in controlling their sugar intake; and (e) add items to better contemplate the dependence gradation on the scale.

References

American Psychiatric Association. (2004). *Diagnostic and statistical manual of mental disorders DSM-IV-TR* (4th ed.). Washington, DC: Author.

Avena, N. M., Rada, P., & Hoebel, B. G. (2008). Evidence for sugar addiction: Behavioral and neurochemical effects of intermittent, excessive sugar intake. *Neuroscience & Biobehavioral Reviews, 32*(1), 20-39.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238-246.

Berlin, I., Vorspan, F., Warot, D., Maneglier, B., & Spreux-Varoquaux, O. (2005). Effect of glucose on tobacco craving. Is it mediated by tryptophan and serotonin? *Psychopharmacology* (Berlin), *178*(1), 27-34.

Bland, J., & Altman, D. (1997). Cronbach's alpha. *British Medical Journal, 314*(7080), 572.

Blass, E. M., Dobbing, J., & Springer, V. (1987). Opioids, sweets and mechanism for positive affect: Broad motivational implications. In J. Dobbing (Ed.), *Sweetness* (pp. 115-126). Berlin, Germany: Springer-Verlag.

Byrne, B. M. (2001). *Structural equation modeling with AMOS: Basic concepts, applications, and programming.* Mahwah, NJ: Lawrence Erlbaum.

Christensen, L. (1997). The effect of carbohydrates on affect. *Nutrition, 13*(6), 503-514.

Colantuoni, C., Rada, P., McCarthy, J., Patten, C., Avena, N. M., Chadeayne, A., et al. (2002). Evidence that intermittent, excessive sugar intake causes endogenous opioid dependence. *Obesity Research, 10*(6), 478-488.

Colantuoni, C., Schwenker, J., McCarthy, J., Rada, P., Ladenheim, B., Cadet, J. L., et al. (2001). Excessive sugar intake alters binding to dopamine and mu-opioid receptors in the brain. *Neuroreport, 12*(16), 3549-3552.

Dale, K. S., Mann, J. I., McAuley, K. A., Williams, S. M., & Farmer, V. L. (2009). Sustainability of lifestyle changes following an intensive lifestyle intervention in insulin resistant adults: Follow-up at 2-years. *Asia Pacific Journal of Clinical Nutrition, 18*(1), 114-120.

Dale, K. S., McAuley, K. A., Taylor, R. W., Williams, S. M., Farmer, V. L., Hansen, P., et al. (2009). Determining optimal approaches for weight maintenance: A randomized control-led trial. *Canadian Medical Association Journal, 180*(10), E39-46.

Dansinger, M. L., Tatsioni, A., Wong, J. B., Chung, M., & Balk, E. M. (2007). Meta-analysis: The effect of dietary counseling for weight loss. *Annals of Internal Medicine, 147*(1), 41-50.

Drewnowski, A., Kurth, C., Holden-Wiltse, J., & Saari, J. (1992). Food preferences in human obesity: Carbohydrates *versus* fats. *Appetite, 18*(3), 207-221.

Drewnowski, A., Kurth, C. L., & Rahaim, J. E. (1991). Taste preferences in human obesity: Environmental and familial factors. *American Journal of Clinical Nutrition, 54*(4), 635-641.

Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2009). Preliminary validation of the Yale Food Addiction Scale. *Appetite, 52*(2), 430-436.

Gendall, K. A., Joyce, P. R., Sullivan, P. F., & Bulik, C. M. (1998). Food cravers: Characteristics of those who binge. *International Journal of Eating Disorders, 23*(4), 353-360.

Hair, J. F., Anderson, R. E., Black, W. C., & Tatham, R. L. (1998). *Multivariate Data Analysis.* Englewood Cliffs, NJ: Prentice Hall.

Hambleton, R. K., & Swaminathan, H. (1984). *Item Response Theory: Principles and Applications.* Boston, MA: Springer.

Heaton, K. W. (1991). Açúcares nas doenças humanas. In Associação Brasileira de Odontologia Preventiva, *Práticas odontológicas centrada em prevenção: Aspectos básicos* (pp. 5-11). São Paulo, SP: Associação Brasileira de Odontologia Preventiva.

Humeniuk, R., Ali, R., Babor, T. F., Farrell, M., Formigoni, M. L., Jittiwutikarn, J., et al. (2008). Validation of the Alcohol, Smoking And Substance Involvement Screening Test (ASSIST). *Addiction, 103*(6), 1039-1047.

Ifland, J. R., Preuss, H. G., Marcus, M. T., Rourke, K. M., Taylor, W. C., Burau, K., et al. (2009). Refined food addiction: A classic substance use disorder. *Medical Hypotheses, 72*(5), 518-526.

Janowsky, D. S., Pucilowski, O., & Buyinza, M. (2003). Preference for higher sucrose concentrations in cocaine abusing-dependent patients. *Journal of Psychiatric Research, 37*(1), 35-41.

Jeffery, R. W., Linde, J. A., Simon, G. E., Ludman, E. J., Rohde, P., Ichikawa, L. E., et al. (2009). Reported food choices in older women in relation to body mass index and depressive symptoms. *Appetite, 52*(1), 238-240.

Kampov-Polevoy, A. B., Alterman, A., Khalitov, E., & Garbutt, J. C. (2006). Sweet preference predicts mood altering effect of and impaired control over eating sweet foods. *Eating Behaviors, 7*(3), 181-187.

Kampov-Polevoy, A., Garbutt, J. C., & Janowsky, D. (1997). Evidence of preference for a high-concentration sucrose solution in alcoholic men. *American Journal of Psychiatry, 154*(2), 269-270.

Lenoir, M., Serre, F., Cantin, L., & Ahmed, S. H. (2007). Intense sweetness surpasses cocaine reward. *PLoS ONE, 2*(1), e698.

Levine, A. S., Kotz, C. M., & Gosnell, B. A. (2003). Sugars: Hedonic aspects, neuroregulation, and energy balance. *American Journal of Clinical Nutrition, 78*(4), 834S-842S.

Linacre, J. M. (2002). What do infit and outfit, mean-square and standardized mean? *Rasch Measurement Transaction, 16*(2), 878-878.

McDonald, R. P., & Ho, M. H. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods, 7*(1), 64-82.

Menezes, P. R., Nascimento, A. F., Gorenstein, C., Andrade, L. H. S. G., & Zuardi, A. W. (2000). Validade e confiabilidade das escalas de avaliação em Psiquiatria. In C. Gorenstein, L. H. S. G. Andrade, & A. W. Zuardi (Eds.), *Escalas de avaliação clínica em Psiquiatria e Psicofarmacologia* (pp. 23-28). São Paulo, SP: Lemos.

Mercer, M. E., & Holder, M. D. (1997). Food cravings, endogenous opioid peptides, and food intake: A review. *Appetite, 29*(3), 325-352.

Pelchat, M. L. (2002). Of human bondage: Food craving, obsession, compulsion, and addiction. *Physiology & Behavior, 76*(3), 347-352.

Rosa, M. A., Slavutzky, S. M., Pechansky, F., & Kessler, F. (2008). Processo de desenvolvimento de um questionário para avaliação de abuso e dependência de açúcar [Development of a questionnaire to evaluate sugar abuse and dependence]. *Cadernos de Saude Publica, 24*(8), 1869-1876.

Sheehan, D. V., Janavs, J., Baker, R., Harmett-Sheehan, K., Knapp, E., Sheehan, M., et al. (2001). *MINI Plus - Mini International Neuropsychiatric Interview. Brazilian version 5.0.0. DSM IV.*

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., et al. (1998). The Mini-International Neuropsychiatric Interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry, 59*(Suppl. 20), 22-33.

Spring, B., Schneider, K., Smith, M., Kendzor, D., Appelhans, B., Hedeker, D., et al. (2008). Abuse potential of carbohydrates for overweight carbohydrate cravers. *Psychopharmacology* (Berlin), *197*(4), 637-647.

Toll, B. A., Katulak, N. A., Williams-Piehota, P., & O'Malley, S. (2008). Validation of a Scale for the Assessment of Food Cravings among Smokers. *Appetite, 50*(1), 25-32.

Ullman, J. B. (2001). Structural equation modeling. In B. G. Tabachnick & S. Fidell (Eds.), *Using Multivariate Statistics* (Vol. 4, pp. 653-771). San Francisco, CA: Allyn & Bacon.

Volkow, N. D., & O'Brien, C. P. (2007). Issues for DSM-V: Should obesity be included as a brain disorder? *American Journal of Psychiatry, 164*(5), 708-710.

Volkow, N. D., & Wise, R. A. (2005). How can drug addiction help us understand obesity? *Nature Neuroscience, 8*(5), 555-560.

World Health Organization. (2003). *Diet, nutrition and the prevention of chronic diseases* (Who Technical Report Series No. 916). Geneva, Switzerland: Author.

Wittchen, H. U. (1994). Reliability and validity studies of the WHO-Composite International Diagnostic Interview (CIDI): A critical review. *Journal of Psychiatric Research, 28*(1), 57-84.

Wu, L. T., Pan, J. J., Blazer, D. G., Tai, B., Brooner, R. K., Stitzer, M. L., et al. (2009a). The construct and measurement equivalence of cocaine and opioid dependences: A National Drug Abuse Treatment Clinical Trials Network (CTN) study. *Drug and Alcohol Dependence, 103*(3), 114-123.

Wu, L. T., Pan, J. J., Blazer, D. G., Tai, B., Stitzer, M. L., Brooner, R. K., et al. (2009b). An item response theory modeling of alcohol and marijuana dependences: A National Drug Abuse Treatment Clinical Trials Network study. *Journal of Studies on Alcohol and Drugs, 70*(3), 414-425.