Sense of coherence modifies the association between untreated dental caries and dental pain in low-social status women

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Evidence of the link between sense of coherence (SOC), dental caries and dental pain is scarce. **Objective:** To explore the relationship of SOC and dental caries with dental pain prevalence in low-social status women. **Basic research design:** A cross-sectional study. **Participants:** A convenience sample of 190 women whose children attended a selected school in São João de Meriti, Brazil. **Method:** Socioeconomic, demographic and oral health behaviour data were collected through interviews. SOC was assessed using the Antonovsky scale. Dental caries was evaluated through oral examinations. Multivariate logistic regression models were used to obtain Odds Ratio (OR) and 95% Confidence Intervals (CI). **Main outcome variable:** Dental pain in the past 6 months. **Results:** Dental pain prevalence was 26% (95%CI 20, 33). DMFT and decayed teeth means were 14.3 (SD 7.2) and 2.4 (SD 2.6), respectively. The odds of having dental pain was higher for women with moderate dental caries and low SOC (OR 3.3, 95%CI 1.1, 9.3) and women with high caries and low SOC (OR 4.0, 95%CI 1.7, 9.5) compared with women with low caries and high SOC. **Conclusions:** Dental caries and lower SOC were factors associated with dental pain. SOC appeared to buffer the effect of dental caries on dental pain in women from low-socioeconomic status.

Key words: *sense of coherence, dental caries, dental pain in low-income women, Brazil*

Introduction

Dental pain is a subjective outcome that occurs mainly as a result of dental caries (Pau *et al.*, 2003; Bastos *et al.*, 2008b). Dental pain influences peoples' well-being and quality of life through impairments on social activities, working-related productivity and sleeping problems (Baker *et al.*, 2010; Gururatana *et al.*, 2014).

The distribution of dental pain in the population results from a complex interaction between economic, psychosocial and biological factors that are unequally distributed across social groups (Bastos *et al.*, 2008a;b). Previous studies have investigated demographic and socioeconomic characteristics associated with dental pain. Overall, younger and those from minority ethnic groups, women, and socioeconomically disadvantaged people were more prone to report dental pain (Bastos *et al.*, 2005; 2008a; Okunseri *et al.*, 2005). Whilst dental pain is considered a common problem in the general population, the role of psychosocial factors related to dental pain is poorly understood (Pau *et al.*, 2003).

Psychosocial factors are important predictors of oral conditions, among which the salutogenic model has been highlighted as a key determinant of subjective outcomes (Baker *et al.*, 2010). The salutogenic model considers people's resources and their capacity to solve problems and give meaning to life, despite difficult circumstances and negative life experiences (Antonovsky, 1979; 1987). Salutogenesis focuses on the potential to generate and maintain positive health from those supportive resources that are protective factors. The sense of coherence construct is the cornerstone of Antonovsky's salutogenesis theory. SOC is a series of health resources comprising a global orientation and individual ways of thinking, feeling and acting with self-confidence that leads people to use their available resources.

SOC seems to have an important role in the explanation of oral health outcomes including oral health-related quality of life (Baker *et al.*, 2010; Savolainen *et al.*, 2005) and tooth retention (Bernabé *et al.*, 2012). There is evidence of SOC's moderating effect on subjective health outcomes. SOC buffered the impact of stressful life events, such as family breakdown and financial crisis, on self-reported health in adults (Richardson and Ratner, 2005). In addition, SOC was a mediator of the relationship between resistance resources/deficits and bodily pain among elderly people (Wiesmann *et al.*, 2013).

Previous studies showed that SOC moderates the effect of clinical oral status on oral health related quality of life (Baker *et al.*, 2010; Nammontri *et al.*, 2013; Gururatana *et al.*, 2014). It can be argued that SOC modifies the influence of dental caries on dental pain since SOC enables people to manage tension, mobilise resources to promote effective coping, which in turn may buffer the symptons of the dental clinical status (Antonovsky, 1979). However, no study investigated whether SOC moderates the association between clinical measures and dental pain.

Studies of the psychosocial factors that protect against dental pain are scarce, especially among people from low-socioeconomic status. The aim of the present study was to assess the association of SOC and untreated dental caries with dental pain prevalence in the past six months in low-social status women. In particular, we tested the hypothesis that SOC moderates the relationship between untreated dental caries and dental pain in low-social status women.

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Methods

This was a cross-sectional study of a sample of women whose children were enrolled at a state-funded school in São João de Meriti, Brazil. São João de Meriti is a medium sized city in the Baixada Fluminense district, Rio de Janeiro state with a population of predominantly low socioeconomic background. The Poverty Index of the city measured by the Brazilian Institute of Geography and Statistics Poverty is 47% (IBGE, 2014).

The inclusion criteria were that the women should have family income under four times the Brazilian minimum wage or schooling less than nine years, have natural teeth and be aged over 25 years. The last criterion was used because SOC is said to remain relatively stable after this age (Antonovsky, 1987).

A sample of 186 participants was estimated based on 18% prevalence of dental pain in the past six months (Bastos *et al.*, 2008a), with 95% power and 5% Type I error probability to detect differences of 10% between groups. The sample size was increased by 20% to allow for possible non-responses, therefore all 220 women whose children were enrolled in the selected school were invited.

0	1	2	3	4	5	6	8	9	10

No pain   Pain as bad as it could be

Figure 1. *Box Scale-11 pain scale*

A self-administered 11-point box scale (BS-11) (Figure 1) was used to assess dental pain in the past six months (Jensen *et al.*, 1987). Women were asked to mark a box in answer to the following question: "Could you mark the box representing the level of dental pain you had during the past 6 months?"

Sense of coherence was measured using the short version of the SOC scale (SOC-13), which consists of 13 items, each scored 1-5, with response options on a five-point Likert scale (Antonovsky, 1987; Bonanato *et al.*, 2009) (See online-only Appendix 1). A SOC score is calculated as the sum of the item codes (possible range from 13 to 65) with high final SOC-13 scores indicating strong SOC. The Brazilian version of SOC-13 has shown adequate psychometric properties. Cronbach's α varied between 0.71 and 0.80 in two studies, and Spearman's correlation for test-retest reliability was 0.76 (Bonanato *et al.*, 2009). The median SOC score in the sample was 48.00, range from 30 to 63. Scores above the median were classified as high SOC and the others as low SOC.

Dental caries was assessed as the decayed component (D) of the DMFT index. The clinical examinations followed the WHO guidelines for oral health surveys (WHO, 2013). Three calibrated dentists using North Carolina periodontal probes and oral plain mirrors (Hu-Friedy®; Chicago, IL, USA) conducted the oral clinical examinations in the school's dental office. The examiners were blind to the aim of the study and the questionnaire data. Levels of dental caries were analysed in three groups: no caries, 1 to 3 decayed teeth and 4 or more decayed teeth, representing low, moderate and high caries levels (Peres *et al.*, 2005).

Demographic and socioeconomic covariates included age, ethnicity, marital status, education level, family income, housing conditions and oral health behaviours. Ethnicity was assessed through self-perceived skin colour as proposed by the Brazilian Institute of Geography and Statistics was recorded using the following options: white, brown, black, yellow or indigenous (Travassos and Williams, 2004). Education level considered the number of approved years of schooling, categorized in groups of 0-4, 5-7 and ≥8 years. Monthly family income was later converted to Brazilian minimum wages (BMW, ≈ U$140) then categorized as 0-1, 2-3 or ≥4 BMWs. Housing conditions were classified according to the presence or absence of a water supply inside the house. Women's oral health behaviours were recorded by tooth brushing frequency (daily and ≥2 times per day) and dental floss use (every day, sometimes, never). The above mentioned co-variates were considered potential confounders on the relationship between dental caries and dental pain. For instance, ethnicity, marital status and social conditions have been related to dental pain and dental caries (Costa *et al.*, 2012; de Pinho *et al.*, 2012).

Before the main study, a pilot study and clinical calibration study selected 20 women from another public school. SOC-13 Cronbach's α was 0.78 and intraclass correlation coefficient based on repeated interviews within 12 days was 0.81. Kappa coefficients for caries assessment were ≥0.79 for intra-examiner and ≥0.79 for inter-examiner reliability.

A formal invitation to participate, including information about the aims and procedures was sent to women aged 25 years or over whose children were enrolled in the school. Two further invitations were sent to those who did not answer the first call. All invited women who agreed to participate signed a written informed consent. The study was approved by the Research Ethics Committee of the National School of Public Health, Oswaldo Cruz Foundation (Protocol no. 49/07).

First, structured face-to-face individual interviews were carried out to collect demographic and socioeconomic data, SOC and dental pain prevalence in a private location within the school. The participants were referred to the school's dental office for oral clinical examinations.
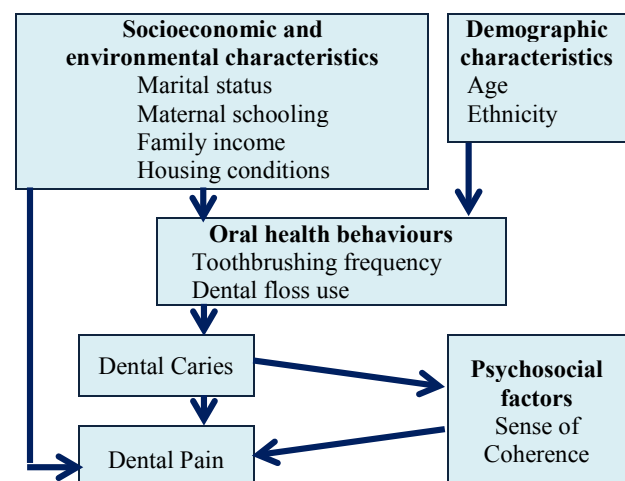

Figure 2. *Hypothesised model of the relationships between dental caries, sense of coherence and dental pain*

The hypothesised explanatory relationships between dental caries, SOC and other variables, and dental pain prevalence are summarized in Figure 2. Socioeconomic characteristics have direct and indirect effects on dental pain (Bastos *et al.*, 2005; Okunseri *et al.*, 2005). Oral health behaviours may be mediated by socioeconomic and demographic characteristics and influence dental caries, which in turn is the main determinant of dental pain (Pau *et al.*, 2003). We hypothesized that SOC moderates the effect of dental caries on dental pain, which means the strength of the association between dental caries and dental pain is dependent on the level of the SOC.

In data analysis, the participants were dichotomised according to the presence (BS-11≥1) or absence (BS-11=0) of dental pain in the last six months. The frequencies of demographic and socioeconomic characteristics as well as oral health behaviours were estimated for the sample and for the two groups. Associations between age, DMFT, number of decayed teeth, severity of dental pain and SOC score were examined by nonparametric Spearman linear correlation coefficients.

The effect modification between SOC and dental caries on dental pain was tested in regression models. First, dental caries was added to the regression model. After that, a dummy/joint effect variable (SOC*dental caries) was added. The regression models with and without the dummy/joint effect variable were compared using the likelihood ratio test. The dummy/joint effect variable when added to the model was significant (P=0.03), suggesting that SOC modifies the relationship between dental caries and dental pain.

The relationship between SOC, dental caries and dental pain prevalence was assessed through bivariate and multivariable logistic regression to Odds Ratio and 95% Confidence Intervals (95%CI). The association between the dummy/joint effect variable SOC and dental caries and dental pain was adjusted for demographic and socioeconomic variables, and for oral health behaviours. Hosmer and Lemeshow (2000) goodness-of-fit test was used to evaluate the models. All analyses were carried out with Predictive Analytics Software 21.0 (PAW Statistics), formerly SPSS.

Results

Of the 220 women invited to participate, 197 agreed but 7 were excluded because of the selection criteria leaving a final sample of 190 women. Quality assurance of data collection consisted of assessing the consistency of SOC scale and dental caries measurements throughout the main study. Following re-examination of 20 participants after 12 days, SOC-13 Cronbach's α was 0.72, the Kappa coefficient for caries presence and ICC for SOC-13 test–retest agreement were 0.85 and 0.84, respectively.

The age of the participants ranged from 26 to 63 years (mean 37.5, SD 7.2), 59% were of Brown ethnicity and 69% were married. Half of the participants had less than eight years of schooling (52%) and only 10% had family income of four BMW or more. Most, 91%, lived in adequate housing conditions. Tooth brushing frequency two or more times per day was over 90% but 46% reported no use of dental floss. Dental pain prevalence in the past six months was 26%. Mean DMFT, decayed and missing teeth in the sample were 14.3, 2.4 and 7.6, respectively (Table 1).

Table 1. Demographic and socioeconomic characteristics, oral health behaviours and oral clinical data of the participants (N=190)

	n	(%)	mean (SD)
Age			37.5 (7.2)
Ethnicity			
White	44	(23)	
Black	30	(16)	
Yellow	4	(2)	
Brown	112	(59)	
Marital status			
Married/mate	131	(69)	
Single	47	(25)	
Divorced / Widow	12	(6)	
Schooling (years)			
≤4	53	(28)	
5 to 7	43	(23)	
≥8	94	(49)	
Family income			
≤1 times BMW [1]	52	(27)	
2 to 3 times BMW	119	(63)	
≥4 times BMW	19	(10)	
Water supply			
Inside the house	173	(91)	
Outside the house	17	(9)	
Tooth brushing frequency			
≥2 times per day	174	(92)	
1 time per day	16	(8)	
Dental floss use			
Every day	31	(16)	
Sometimes	72	(38)	
Never	87	(46)	
Dental pain	50	(26)	
Number of teeth			20.1 (7.5)
DMFT			14.3 (7.2)
N missing teeth			7.6 (7.4)
N decayed teeth			2.4 (2.6)

[1] BMW, Brazillian Minimum Wage

Significant correlations were observed between the severity of dental pain and SOC scores (*rho*=-0.24, P<0.001); the severity of dental pain and number of decayed teeth (*rho*=0.17, P<0.05); and DMFT and age (*rho*=0.45, P<0.001). SOC scores were not correlated with number of decayed teeth (*rho*=-0.003, P>0.05).

Demographic and socio-economic characteristics, oral health behaviours, SOC and dental caries data compared among the dental pain groups are presented in Table 2. Dental pain prevalence was not associated with demographic, socio-economic, oral health behaviours and housing conditions variables. An unadjusted association with dental pain was observed with SOC (OR=2.0) and with high levels of dental caries (OR=2.8).

The association between the dummy/joint effect variable SOC and dental caries with dental pain was tested using crude and adjusted risk estimates (Table 3). In unadjusted analysis (Model 1), women with moderate levels of caries and low SOC had greater odds of dental pain (OR 2.5) than those with low caries and high SOC. In addition, high caries and low SOC was related to an increased chance of dental pain (OR 2.9) (Model 1).

Table 2. Bivariate analysis of covariates and dental pain

Variable	Category	Dental pain (N=50) %	No pain (N=140) %	Odds Ratio	95%CI	P value
Age	26 to 32 years (ref.)	34	28	1		
	33 to 39 years	34	34	0.81	0.37, 1.80	0.608
	≥40 years	32	39	0.69	0.31, 1.54	0.367
Ethnicity	White (ref.)	18	25	1		
	Brown	60	59	1.42	0.61, 3.31	0.413
	Black	18	15	1.67	0.57, 4.86	0.350
	Yellow	4	1	3.89	0.48, 31.52	0.203
Marital status	Married/mate (ref.)	74	67	1		
	Single	16	28	1.82	0.54, 6.08	0.334
	Divorced / Widow	10	5	0.52	0.22, 1.22	0.133
Schooling (years)	≥8 (ref.)	52	49	1		
	5 to 7	18	24	0.69	0.29, 1.64	0.403
	≤4	30	27	1.03	0.49, 2.18	0.934
Family income	≥4 BMW [†] (ref.)	14	9	1		
	2 to 3 BMW	60	64	0.58	0.21, 1.60	0.292
	≤1 BMW	26	28	0.57	0.19, 1.76	0.329
Water supply	Inside the house (ref.)	90	91	1		
	Outside the house	10	9	1.19	0.40, 3.55	0.762
Toothbrushing frequency	≥ twice per day (ref.)	94	91	1		
	Once per day	6	9	0.62	0.17, 2.29	0.476
Dental floss use	Every day (ref.)	14	17	1		
	Sometimes	40	37	1.32	0.47, 3.24	0.583
	Never	46	45	1.23	0.49, 3.54	0.672
Sense of coherence	High (ref.)	42	59	1		
	Low	58	41	2.01	1.05, 3.87	0.037
Dental caries	Low (ref.)	16	31	1		
	Moderate	50	44	2.22	0.92, 5.37	0.078
	High	34	24	2.75	1.06, 7.13	0.037

[†]BMW (Brazilian Minimum Wage)

Table 3. Association between sense of coherence (SOC) and dental caries with dental pain with a sequential introduction of confounders.

Mode	Caries and sense of coherence levels	Estimate (SE)	OR	95%CI	P value
Model 1	Low caries/High SOC (ref.)		1		
	Moderate caries/Low SOC	0.92 (0.38)	2.50	1.18-5.30*	0.016
	High caries/Low SOC	1.05 (0.49)	2.86	1.09-7.46*	0.032
Model 2	Low caries/High SOC (ref.)		1		
	Moderate caries/Low SOC	1.26 (0.55)	3.51	1.20-10.28*	0.021
	High caries/Low SOC	1.33 (0.43)	3.77	1.62-8.77*	0.002
Model 3	Low caries/High SOC (ref.)		1		
	Moderate caries/Low SOC	1.21 (0.56)	3.34	1.12-9.34*	0.030
	High caries/Low SOC	1.38 (0.44)	3.97	1.67-9.46*	0.002

* P<0.05; Model 1, unadjusted; Model 2, adjusted for demographic and socioeconomic factors; Model 3, adjusted for demographic and socioeconomic factors, toothbrushing frequency and dental floss use

The interaction between SOC and dental caries remained associated with dental pain after incremental adjustment for demographic and socioeconomic variables. The odds of dental pain were 3.51 and 3.77 greater in women with moderate caries and low SOC; and with high caries and low SOC than those with low caries and high SOC (Model 2). In the final model (Model 3). After further adjustment for oral health behaviours (Model 3), the dummy/joint ef-fect variable SOC and dental caries remained associated with dental pain. Women with moderate caries and low SOC had 3.3 times the odds of dental pain and those with high caries and low SOC showed 4.0 times the odds for dental pain than those with low caries and high SOC. The Hosmer and Lemeshow test had p-values of 1.00 (Model 1), 0.62 (Model 2), and 0.30 (Model 3), suggesting the models were an acceptable fit to the data.

Discussion

Our data support the hypothesis that SOC moderates the relationship between untreated dental caries and dental pain. Women with moderate and high levels of untreated caries and low SOC were more likely to report dental pain in the previous six months compared to those with low untreated caries and high SOC.

This is the first study to report the association between low SOC and dental pain in adults. Our findings agree with previous research in adolescents showing that SOC was a protective factor for toothache (da Rosa et al., 2015). The evidence on the link between SOC and other oral health measures has been shown. Low SOC predicted higher dental caries index in 12-16 years-old children (Viswanath and Krishna, 2015). In adolescents, lower SOC was the most important psychosocial predictor for poor oral health-related quality of life (Baker et al., 2010). However, the role of SOC on adult's oral health is not consistent. In some studies, strong SOC was related to having more teeth (Bernabé et al., 2010; 2012), fewer decayed teeth (Bernabé et al., 2010) and better oral health related quality of life (Savolainen et al., 2005). However, SOC was not correlated with periodontal disease in a 4-year prospective study (Kanhai et al., 2014).

Salutogenesis is a stress resource orientated concept, which focuses on resources, maintains and improves the movement towards health. It gives the answer as to why people with clinical diseases (e.g. dental caries) despite stressful situations and hardships experience lower levels of symptoms (e.g. perceived dental pain), and distress. SOC reflects a person's view of life and capacity to respond to stressful situations (Lindström and Eriksson, 2005). Individuals scoring high on SOC perceive the world as comprehensible, meaningful, and manageable (Antonovsky, 1979; 1987).

This study shows that SOC can moderate the influence of untreated dental caries on the perception of dental pain. We can hypothesize that women with a strong SOC perceive dental pain as more comprehensible and manageable which agrees with the cognitive and motivational components of SOC (Antonovsky, 1979). Therefore SOC may reflect the women's ability to cope with dental pain. Nevertheless, the theoretical model proposed in this study did not include important psychosocial factors, such as depression and anxiety disorders, that are related to SOC and subjective and clinical health measures. Previous studies show that SOC has a positive influence on subjective measures of health and can predict fewer symptoms and functional impacts (Baker et al., 2010).

A moderating role of SOC and coping resources on the association between physical health and health has been reported (Baker et al., 2010; Eriksson and Linstrom, 2006; Gururatana et al., 2014; Nammontri et al., 2013; Wiesmann et al., 2013). This suggests that psychosocial factors are paramount on the individuals' expectations of physical health and daily life performance, which has been supported with experimental evidence where enhanced SOC increased subjective general and oral health (Nammontri et al., 2013).

Women with a weak sense of coherence perceive their world as more chaotic and less manageable and have only limited resources to deal with their oral health, increasing their likelihood to develop dental caries and dental pain. Moreover, women from low socioeconomic status are frequently exposed to high levels of strains of daily life and a strong SOC is crucial to cope with environmental stressors. High SOC represents more resources to facilitate a positive adaptation to these stressors and facilitates the adoption of more favorable oral health behaviours (Antonovsky, 1987).

Contrary to previous studies, dental pain prevalence was not associated with lower socio-economic status (Bastos et al., 2005; 2008a; Okunseri et al., 2005). This can be explained because of our restricted and socioeconomically homogenous sample. The strengths of this study are the use of valid and reliable measures to assess dental pain (BS-11) and SOC. The SOC scale showed good internal reliability and very good temporal consistency suggesting a study with adequate internal validity. BS-11 has been also considered an extremely simple measure to evaluate dental pain (Jensen et al., 1987). Calibrated and trained examiners performed clinical examinations and interviews, avoiding bias of measurement. The use of a nonrandom sample in this study may have influenced the precision of the estimates. Nevertheless, this study could be repeated in populations with different socioeconomic characteristics. The dental pain scale (BS-11) is commonly used in clinical studies to measure pain levels, regardless of the underlying diseases or clinical conditions. In this study, dental pain might resulted from other oral conditions rather than dental caries. Although the prevalence of dental caries is much higher than other oral diseases and dental caries is the main condition associated with dental pain, periodontal conditions, temporomandibular joint dysfunction and oral mucosal lesions are potential causes of dental pain that were not investigated in the present research (Marcenes et al., 2013; Petersen et al., 2005). Untreated decayed teeth (D component of the DMFT) was considered the cause of dental pain. The association between current decayed teeth and dental pain might be overestimated since current missing and filled teeth are also possible clinical conditions that may have caused dental pain in the past six months. The reinforcement of women's SOC may facilitate successful coping with the inherent stressors of human life and contribute to reduce the impact of oral diseases in dental pain. Future studies are needed to identify social, economic and cultural resources that facilitate the management of adverse situations and oral conditions for low income women. The identification and enhancement of these resources through oral health promotion practices can improve oral health and reduce the impact of these conditions on dental pain and well-being.

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Appendix 1 The 13-item Sense of Coherence Questionnaire

Here is a series of questions relating to various aspects of your lives. Each question has seven possible answers. Please mark the number, which expresses your answer, with number 1 and 7 being the extreme answers. If the words under 1 are right for you, circle 1: if the words under 7 are right for you, circle 7. If you feel differently, circle the number which best expresses your feeling. Please give only one answer to each question.

1. Do you have feeling that you don't really care about what goes on around you?

1	2	3	4	5	6	7
very seldom						very often or never

2. Has it happened in the past that you were surprised by the behaviour of people whom you thought you knew well?

1	2	3	4	5	6	7
never happened						always happened

3. Has it happened that people whom you counted on disappointed you?

1	2	3	4	5	6	7
never happened						always happened

4. Until now your life has had:

1	2	3	4	5	6	7
no clear goals or purpose at all						very clear goals and purpose

5. Do you have the feeling that you're being treated unfairly?

1	2	3	4	5	6	7
very often						very seldom or never

6. Do you have the feeling that you are in an unfamiliar situation and don't know what to do?

1	2	3	4	5	6	7
very often						very seldom or never

7. Doing the thing you do every day is:

1	2	3	4	5	6	7
a source of deep pleasure and satisfaction						a source of pain and boredom

8. Do you have very mixed-up feelings and ideas?

1	2	3	4	5	6	7
very often						very seldom or never

9. Does it happen that you have feelings inside you would rather not feel?

1	2	3	4	5	6	7
very often						very seldom or never

10. Many people – even those with a strong character – sometimes feel like sad sacks (losers) in certain situations. How often have you felt this way in the past?

1	2	3	4	5	6	7
never						very often

11. When something happened, have you generally found that:

1	2	3	4	5	6	7
you overestimated or underestimated its importance						you saw things in the right proportion

12. How often do you have the feeling that there's little meaning in the things you do in your daily life?

1	2	3	4	5	6	7
very often						very seldom or never

13. How often do you have feelings that you're not sure you can keep under control?

1	2	3	4	5	6	7
very often						very seldom or never