

ORIGINAL ARTICLES

## Constructive thinking, rational intelligence and irritable bowel syndrome

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### Abstract

**AIM:** To evaluate rational and experiential intelligence in irritable bowel syndrome (IBS) sufferers.

**METHODS:** We recruited 100 subjects with IBS as per Rome II criteria (50 consulters and 50 non-consulters) and 100 healthy controls, matched by age, sex and educational level. Cases and controls completed a clinical questionnaire (including symptom characteristics and medical consultation) and the following tests: rational-intelligence (Wechsler Adult Intelligence Scale, 3rd edition); experiential-intelligence (Constructive Thinking Inventory); personality (NEO personality inventory); psychopathology (MMPI-2), anxiety (state-trait anxiety inventory) and life events (social readjustment rating scale). Analysis of variance was used to compare the test results of IBS-sufferers and controls, and a logistic regression model was then constructed and adjusted for age, sex and educational level to evaluate any possible association with IBS.

**RESULTS:** No differences were found between IBS cases and controls in terms of IQ ( $102.0 \pm 10.8$  vs  $102.8 \pm 12.6$ ), but IBS sufferers scored significantly lower in global constructive thinking ( $43.7 \pm 9.4$  vs  $49.6 \pm 9.7$ ). In the logistic regression model, global constructive thinking score was independently linked

to suffering from IBS [OR 0.92 (0.87-0.97)], without significant OR for total IQ.

**CONCLUSION:** IBS subjects do not show lower rational intelligence than controls, but lower experiential intelligence is nevertheless associated with IBS.

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**Key words:** Constructive thinking; Intelligence tests; Intelligence; Irritable bowel syndrome

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### INTRODUCTION

Irritable bowel syndrome (IBS) is a common disease worldwide, with a prevalence in the general population ranging from 2% to 15%, depending on the definition criteria used<sup>[1,2]</sup>. Its pathophysiology is unknown, yet several biological factors have been implicated<sup>[3]</sup>; and aside from these biological factors, psychosocial factors have long been known to be involved in IBS. While anxiety has consistently been associated with IBS<sup>[4]</sup>, to what precise degree it is a cause or consequence remains unresolved<sup>[5]</sup>. Personality traits, and neuroticism in particular, have been linked to IBS, although it is a matter of debate whether they are associated with consultation behavior<sup>[6]</sup> or with the disease itself<sup>[7]</sup>.

Cognition (beliefs, interpretation and expectations) plays a pivotal role in the interaction of subjects with

the environment, and cognitive abilities should drive this interaction on a daily basis and for long-term success. Several items of information suggest that cognitive processes may be important in IBS. Abnormal illness behavior which has been associated with many chronic diseases, including non-consulters' IBS<sup>[8]</sup>, is to a great extent the result of a cognitive process<sup>[9]</sup>, involving appraisal and interpretation, and is likely associated with worry<sup>[10]</sup>. Hypervigilance as to abdominal perceptions may be viewed as a cognitive process<sup>[11,12]</sup>. IBS patients use less effective coping styles<sup>[6,13]</sup>, which are indeed modulated (appraisal of threat, adapting the response to the situation) by the use of cognitive abilities.

Although intelligence is not easy to define<sup>[14]</sup>, it may be construed as the ability to solve problems<sup>[15]</sup>. Problems arising from life may be categorized as abstract problems, which call for an analytical approach and a slow response, and daily life problems, which call for automatic analysis and a quick response. Solving abstract problems is a task performed by rational intelligence and can be measured by IQ<sup>[14]</sup>. IQ has been found to be associated with health<sup>[16]</sup> and longevity<sup>[17]</sup>, likely through an influence on health knowledge and health behavior<sup>[18]</sup>. Attree *et al*<sup>[19]</sup> recently found a lower IQ in IBS subjects *vs* controls. Rational intelligence might enhance one's ability to identify environmental factors precipitating bowel symptoms and change one's lifestyle accordingly.

Solving daily problems is not a rational task but rather relies on cognitive abilities to interpret events efficiently. Epstein proposed the concept of constructive thinking (experiential intelligence), defined as automatic thoughts in daily life to survive at a minimum cost of stress<sup>[20]</sup>. According to his cognitive-experiential theory, constructive thinking operates passively and automatically at a preconscious level, thinking in terms of associations and broad categories, is closely connected with emotions, interpreting experience, and guiding conscious thoughts and behaviour. It can be measured by the Constructive Thinking Inventory (CTI), which is independent of IQ and moderately related to success in life and physical well-being<sup>[21]</sup>. Under the hypothesis of stress-driven changes in brain-gut interaction (IBS as emotional motor system output)<sup>[22]</sup>, it might be hypothesized that the lower a person's constructive thinking, the higher the stress generated by daily life and, by extension, the higher the possibility of suffering from IBS symptoms.

Accordingly, this study sought primarily to assess whether IBS sufferers might be different to healthy non-IBS sufferers in terms of intelligence (rational and experiential), and, secondarily, whether there might be a link between intelligence and IBS-related medical consultation.

## MATERIALS AND METHODS

### Study design

Case-control study including IBS sufferers and matched healthy subjects.

### Study population

Cases were defined as subjects, both consulters and non-consulters, who met the Rome II IBS criteria. An IBS consulter was defined as any currently symptomatic subject who had consulted a physician due to bowel symptoms and had been diagnosed with IBS after an appropriate work-up. An IBS non-consulter was defined as any subject from the general population with symptoms of IBS who had not consulted a physician in this connection.

Controls were defined as subjects from the general population without recurrent abdominal pain or bowel symptoms, who suffered no relevant chronic diseases and had undergone no relevant abdominal surgery.

### Recruitment, selection and inclusion

IBS consulters were recruited from primary care and secondary-level gastroenterologist offices at the 7th Health Area of Madrid (Spain), which provides medical attention to approximately 515 000 inhabitants. Patients diagnosed with IBS in accordance with the above definition, were invited to participate. Patients were not enrolled at a tertiary-care facility so as to better represent the population of patients with IBS.

IBS non-consulters and healthy controls were recruited from the general population residing in the same geographical area as patients. Members of the public were directly approached at corporate offices, leisure centers or department stores and invited to participate in the study. Relatives of recruited IBS patients and patients or patients' relatives attending medical facilities were excluded. After initial agreement, all subjects were briefly interviewed about any medical conditions (to exclude relevant chronic diseases), recurrent abdominal pain, bowel-related symptoms (to classify them as potential IBS subjects as per Rome II criteria or as subjects free of bowel-related symptoms), and prior medical consultation on account of such symptoms (to classify them as non-consulters): subjects with bowel-related symptoms who failed to meet the Rome II criteria as well as subjects who met the Rome II criteria but reported consulting a physician in this regard were not selected.

All subjects selected-IBS consulters, non-consulters, and controls-completed a clinical questionnaire, which included questions on sociodemographic data, symptoms and medical resource utilization, including number of physician visits due to bowels symptoms in the prior year. This questionnaire was successfully used in a population-based IBS study<sup>[2]</sup>, and enables Rome II criteria as well as consultation behavior in the preceding year to be verified. Inclusion criteria for IBS subjects (patients and non-patients) were age 18-65 years and Rome II criteria checked by the clinical questionnaire. Healthy controls were matched to IBS patients by age ( $\pm 5$  years), sex, and educational level (junior school, high school, and university). Exclusion criteria were history of psychiatric disease requiring treatment; significant visual or hearing deficit; and inability to complete the set of instruments used in the study.

### Instruments

In addition to the clinical questionnaire, the study design included instruments that measured IBS severity, rational intelligence, non-intellectual intelligence, personality traits, psychopathology, and life events. These instruments were respectively.

### Functional bowel disease severity index (FBDSI)

The FBDSI was developed by Drossman *et al*<sup>[23]</sup> and has been shown to correlate with symptoms interference with daily functioning and health related quality of life<sup>[24,25]</sup>. It comprises three variables, namely: current pain [evaluated by a visual analog scale (VAS)]; diagnosis of functional chronic abdominal pain (chronic pain without bowel dysfunction); and the number of medical visits in the preceding 6 mo. Severity was classified as mild (< 37), moderate (37-110) or severe (> 110). Since severity in IBS subjects as rated by the complete index included medical consultation, both the complete FBDSI and current pain assessed by VAS were analyzed.

### Wechsler Adult Intelligence Scale, 3rd edition (WAIS-III)

The WAIS-III was designed as a comprehensive test of cognitive ability for adults. It contains 11 subtests and three additional subtests. Variables obtained are three IQ scores (total IQ, verbal IQ, and performance IQ). It has been adapted and validated for use in the Spanish population, and results were scored using normative values<sup>[26]</sup>. The test was taken in quiet surroundings and all subjects underwent a brief psychological interview beforehand; special care was taken to minimize potential anxiety regarding test performance. Moreover, it was clearly stated at the time of inclusion that test results would in no case be linked to any care change in IBS subjects or to any specific psychological intervention. Subjective scoring of the WAIS-III was done blinded to subjects' study group.

### CTI

The CTI is a self-administered test developed by Epstein under the conceptual framework of Cognitive-Experiential Theory<sup>[20]</sup>. Constructive thinking is a set of automatic habitual thoughts used in daily life, and is regarded as a measure of experiential intelligence<sup>[21]</sup>. CTI provides a global measure of constructive thinking, six subscales (Emotional coping, Behavioral coping, Personal superstitious thinking, Categorical thinking, Esoteric thinking, and Naive optimism), and two validity subscales (Defensiveness scale and Validity scale). This test has been adapted and validated for use in the Spanish population, normative values for which are available<sup>[27]</sup>. T-scores were obtained using a computerized scoring software program. Under the rules of the Spanish Manual, tests were deemed invalid when the T-score was above 70 on the defensiveness scale or below 30 on the validity scale.

### NEO personality inventory (NEO-PI)

The NEO-PI is a widely used personality inventory designed to measure personality based on the "big five"

theory. The Spanish version is a validated instrument and normative data are available. T-scores for the five traits (neuroticism, extroversion, openness, agreeableness, and consciousness) were obtained using a computerized scoring software program.

### State-trait anxiety inventory (STAI)

A widely used questionnaire with a validated Spanish version, the STAI is a 40-item self-report measure designed to assess anxiety. Subjects indicate how they generally or right now feel, by rating the frequency of their feelings of anxiety on a 4-point scale ranging from 1 (almost never) to 4 (almost always).

### Minnesota multiphasic personality inventory 2 (MMPI-2)

The MMPI-2 is a widely use inventory for the assessment of psychopathological personality. Normative values for the Spanish population are available. Clinical scales were included (hypochondriasis, depression, hysteria, psychopathic deviate, paranoia, psychasthenia, schizophrenia, hypomania, and social introversion).

### Social readjustment rating scale (SRRS)

The SRRS is a measure of stressful life events developed by Holmes and Rahe in 1967<sup>[28]</sup>, consisting of a 61-item list of significant life events. A validated Spanish version exists, which includes a scale of each item's emotional impact scored from 0 to 100<sup>[29]</sup>. On the 61-item checklist, the participants marked events that they had experienced in the previous year. The number of stressful life events and their total emotional impact in the preceding year were obtained for each subject.

### Statistical analysis

Primary analysis was intended to disclose differences in intelligence (rational and non-intellectual) between IBS subjects (both patients and non-patients) and healthy controls. For this purpose, analysis of variance was used to perform univariate comparisons of WAIS-III and CTI measures, and sociodemographic data, personality traits and life events were also compared between the respective groups. To evaluate to what extent global constructive thinking and IQ variables might be associated with suffering from IBS, a logistic regression model was constructed (model 1), adjusting for age, sex and educational level; a full model was constructed to adjust for variables showing significant differences between IBS and control subjects, excluding those with correlation coefficients of 0.7 or higher with Global CTI score or IQ.

A secondary analysis was performed to evaluate the possible implication of measured factors in medical consultation sought because of IBS symptoms. To this end, IBS consulters and non-consulters were compared, using the same statistical model. To evaluate illness behavior, a multiple regression model was constructed (stepwise forward method), with the number of physician visits in the last year as a dependent variable and global constructive thinking, total IQ, neuroticism, number of life stressful events, clinical scales of MMPI-2

and state and trait anxiety as independent variables. Data are expressed as mean  $\pm$  SD, unless otherwise stated. Statistical analysis was performed using the SPSS version 13 computer software package.

### Composition of case group and calculation of sample size

We chose a ratio of 1:1 for IBS consulters and non-consulters in the case group, which may well represent the entire IBS population in this country (49% of IBS subjects as defined by the Rome II criteria had visited a physician in the previous year)<sup>[30]</sup>.

As there were no experimental data at the time of protocol design (January 2003) for making assumptions in similar settings, a five-point difference in the overall CTI scale was taken as relevant. This five-point estimate was based on the Spanish correction manual, which suggests that T-scores of 45 to 55 be regarded as normal, and 35 to 44 as moderately low. Since the mean T score for the general population could be expected to be 50, the minimum value for inferring a relevant lower score would be 44 (a five-point margin being sufficient to detect relevant differences). Hence, assuming a standard deviation of 10 (since this is a T-score), and with  $\alpha$  and  $\beta$  risks set at 0.05 and 0.1 respectively, 85 subjects would be needed in each group.

In so far as IQ was concerned, a difference of 10 points was estimated as relevant. Assuming a standard deviation of 15, then, with the same  $\alpha$  and  $\beta$  risk, the sample size would be 56 subjects in each group. Accordingly, a sample of 85 subjects in each group would be enough to enable a mean difference of eight points or higher to be detected. Allowing for the possibility of a 15% data loss, the final sample size was set at 100 subjects per group.

For the secondary analysis, assuming the same relevant differences in mean scores and the same standard deviations, a sample size of 50 per group (consulters and non-consulters) would provide a power of 80% with an  $\alpha$  risk of 0.1.

### Ethics

The study was formally approved by the Institutional Ethics Committee, and prior informed consent was obtained in writing from all participants.

## RESULTS

A total of 73 IBS consulters and 81 IBS non-consulters were recruited. Twenty-three IBS consulters were not included because of psychiatric diagnosis requiring treatment (four patients), not accomplishing Rome II criteria (two patients), incomplete information (one patient) or lack of adequate matching control (16 patients). Thirty-one IBS non-consulters were not included due to not accomplishing Rome II criteria (10 subjects), incomplete information (one subject) or lack of adequate matching control (20 subjects).

The study covered 100 subjects with IBS (50 consulters and 50 non-consulters) and 100 matching healthy controls. Of these, 70 were female in each case. The mean age of

**Table 1 Comparison of intelligence, personality, and life events between controls and IBS subjects**

	Healthy subjects (n = 94)	IBS subjects (n = 94)
Rational intelligence (WAIS-III)		
Total IQ	102.8 $\pm$ 12.6	102.0 $\pm$ 10.8
Verbal IQ	103.4 $\pm$ 11.6	102.6 $\pm$ 10.7
Performance IQ	102.4 $\pm$ 14.2	101.6 $\pm$ 11.6
Experiential intelligence (CTI)		
Global CTI score	49.6 $\pm$ 9.7	43.7 $\pm$ 9.4 <sup>b</sup>
Personality traits (NEO-PI)		
Neuroticism	55.0 $\pm$ 10.6	60.9 $\pm$ 8.7 <sup>b</sup>
Extroversion	44.6 $\pm$ 11.0	45.4 $\pm$ 10.9
Openness	49.6 $\pm$ 12.6	50.6 $\pm$ 12.2
Agreeableness	45.3 $\pm$ 7.9	44.1 $\pm$ 9.0
Conscientiousness	37.8 $\pm$ 9.0	35.9 $\pm$ 8.2
Psychopathology (MMPI-2)		
1-Hypochondriasis	49.6 $\pm$ 9.2	62.2 $\pm$ 12.1 <sup>b</sup>
2-Depression	48.7 $\pm$ 9.6	52.9 $\pm$ 10.9 <sup>a</sup>
3-Hysteria	52.2 $\pm$ 9.6	60.5 $\pm$ 11.5 <sup>b</sup>
4-Psychopathic deviate	49.8 $\pm$ 9.2	54.8 $\pm$ 11.0 <sup>b</sup>
5-Masculinity-femininity	52.2 $\pm$ 10.6	50.3 $\pm$ 10.0
6-Paranoia	48.2 $\pm$ 8.2	52.3 $\pm$ 9.2 <sup>a</sup>
7-Psychasthenia	46.8 $\pm$ 8.7	51.7 $\pm$ 8.3 <sup>b</sup>
8-Schizophrenia	47.0 $\pm$ 8.1	51.5 $\pm$ 10.0 <sup>b</sup>
9-Hypomania	49.1 $\pm$ 9.7	52.3 $\pm$ 10.3 <sup>a</sup>
0-Social introversion	47.4 $\pm$ 8.9	48.6 $\pm$ 8.3
Anxiety (STAI)		
State anxiety	33.4 $\pm$ 8.8	40.5 $\pm$ 11.4 <sup>b</sup>
Trait anxiety	37.1 $\pm$ 9.2	43.7 $\pm$ 10.8 <sup>b</sup>
Stressful life events (SRRS)		
Number in prior 12 mo	8.5 $\pm$ 5.1	9.9 $\pm$ 4.8 <sup>a</sup>
Total emotional impact	445.1 $\pm$ 280.4	521.9 $\pm$ 252.5 <sup>a</sup>

IBS: Irritable bowel syndrome. <sup>a</sup> $P < 0.05$  (ANOVA), <sup>b</sup> $P < 0.001$  (ANOVA) *vs* controls.

IBS subjects was  $37.2 \pm 12.6$  years, and there were no differences vis-à-vis healthy controls ( $37.2 \pm 13.1$ ). Both groups reported 18 subjects with junior school, 23 with high school, and 59 with university education. Controls and IBS subjects were similar in terms of: marital status (single 50 and 53, and married 43 and 40, respectively); work status (student 10 and 9, gainfully employed 85 and 84, retired or unemployed 7 and 7, respectively); and family monthly income (€ 2684  $\pm$  1469 and € 2354  $\pm$  2272, respectively).

### IBS features

Among IBS sufferers, 31 were classified as per the Rome II criteria as diarrhea-predominant, 26 as constipation-predominant, and 43 as alternating. With respect to severity of IBS, 55 subjects were classified as mild, 37 as moderate, and eight as severe, with a mean FDSI score of  $47.0 \pm 49.4$ , and a mean current VAS pain of  $29.2 \pm 24.7$ . Seventy-seven subjects reported IBS symptoms of more than 2 years duration.

### Intelligence, personality, psychopathology, anxiety and life events in IBS subjects

Comparison of intelligence, personality, and life events between controls and IBS subjects were shown in Table 1. Six subjects (four controls, one IBS consulter, and one IBS non-consulter) produced invalid CTI scores, so that they and their matched counterparts were excluded from the analysis. IBS subjects registered similar IQ test results



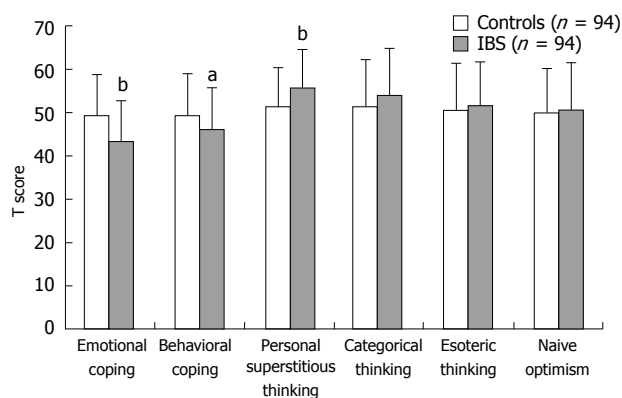


Figure 1 Subscales of constructive thinking in IBS and controls. <sup>a</sup> $P < 0.05$ , <sup>b</sup> $P < 0.01$  vs controls.

Table 2 Regression models to evaluate the association of Global CTI and IQ with suffering IBS

	Model 1	Full model
Global CTI score	0.93 (0.90-0.97) <sup>d</sup>	0.92 (0.87-0.97) <sup>b</sup>
Total IQ	0.99 (0.96-1.03)	0.99 (0.97-1.04)
Stressful life events (SRRS)		1.05 (0.97-1.15)
State anxiety		1.05 (0.99-1.10)
1-Hypochondriasis		1.19 (1.11-1.27) <sup>d</sup>
2-Depression		0.95 (0.90-1.00)
3-Hysteria		0.96 (0.90-1.02)
4-Psychopathic deviate		1.02 (0.96-1.08)
6-Paranoia		1.04 (0.99-1.10)
7-Psychasthenia		1.01 (0.93-1.09)
8-Schizophrenia		0.93 (0.85-1.01)
9-Hypomania		1.02 (0.97-1.07)

Adjusted by age, sex and educational level. <sup>b</sup> $P < 0.01$  (ANOVA); <sup>d</sup> $P < 0.001$  (ANOVA). Hosmer and Lemeshow goodness-of-fit test for the full model:  $P = 0.16$ . CTI: Constructive Thinking Inventory.

to the controls, without differences in total, verbal and performance IQ. However, IBS subjects scored lower in global constructive thinking and higher in neuroticism, and reported more stressful life events in the prior year than did controls. The detailed CTI subscale scores obtained by healthy controls and IBS subjects are shown in Figure 1.

Global CTI score was correlated to neuroticism ( $r = 0.71$ ) and trait anxiety ( $r = 0.71$ ), so these last variables were not included in the model. Table 2 shows the results of the logistic regression model. When neuroticism and trait anxiety were included, scale 1 of MMPI-2 (hypochondriasis) [OR 1.19 (1.11-1.27)] and global CTI score [OR 0.93 (0.87-0.99)] remained independently related, at the same magnitude, to suffering from IBS, without significant OR for any other variable.

### IBS consulters vs non-consulters

Two subjects (one IBS consulter and one IBS non-consulter) produced invalid CTI scores and were thus excluded from the analysis. There were no significant differences between IBS consulters and non-consulters in terms of age, sex, educational level, marital status, work status and family monthly income. Furthermore, IBS features (distribution of subtypes, evolution of

Table 3 Comparison of intelligence, personality, and life events between IBS consulters and non-consulters

	IBS non-consulters ( $n = 49$ )	IBS consulters ( $n = 49$ )
Rational intelligence (WAIS-III)		
Total IQ	103.8 $\pm$ 11.2	99.3 $\pm$ 10.5 <sup>a</sup>
Verbal IQ	104.4 $\pm$ 11.0	100.1 $\pm$ 10.4 <sup>a</sup>
Performance IQ	103.0 $\pm$ 11.7	99.1 $\pm$ 11.6
Experiential intelligence (CTI)		
Global CTI score	46.6 $\pm$ 9.2	41.1 $\pm$ 9.0 <sup>d</sup>
Personality traits (NEO-PI)		
Neuroticism	59.7 $\pm$ 7.5	62.1 $\pm$ 9.6
Extroversion	46.6 $\pm$ 11.5	43.3 $\pm$ 10.2
Openness	52.5 $\pm$ 11.0	48.6 $\pm$ 13.0
Agreeableness	45.5 $\pm$ 8.4	42.7 $\pm$ 9.2
Conscientiousness	35.9 $\pm$ 7.4	35.7 $\pm$ 8.9
Psychopathology (MMPI-2)		
1-Hypochondriasis	60.1 $\pm$ 12.0	64.6 $\pm$ 11.8
2-Depression	50.4 $\pm$ 9.8	55.8 $\pm$ 11.2 <sup>a</sup>
3-Hysteria	58.6 $\pm$ 12.3	62.7 $\pm$ 10.5
4-Psychopathic deviate	52.5 $\pm$ 9.7	57.3 $\pm$ 11.9 <sup>a</sup>
5-Masculinity-femininity	49.2 $\pm$ 11.2	50.9 $\pm$ 8.4
6-Paranoia	51.4 $\pm$ 9.5	53.1 $\pm$ 8.8
7-Psychasthenia	49.8 $\pm$ 8.4	54.1 $\pm$ 8.0 <sup>a</sup>
8-Schizophrenia	50.5 $\pm$ 9.3	52.9 $\pm$ 10.4
9-Hypomania	51.7 $\pm$ 9.1	52.6 $\pm$ 11.3
0-Social Introversion	47.9 $\pm$ 8.5	49.4 $\pm$ 8.0
Anxiety (STAI)		
State anxiety	37.2 $\pm$ 10.0	43.6 $\pm$ 11.6 <sup>a</sup>
Trait anxiety	41.4 $\pm$ 9.5	45.8 $\pm$ 11.4 <sup>a</sup>
Stressful life events (SRRS)		
Number in prior 12 mo	10.3 $\pm$ 5.3	9.5 $\pm$ 4.4
Total emotional impact	539.2 $\pm$ 274.4	500.8 $\pm$ 233.3

<sup>a</sup> $P < 0.05$  (ANOVA), <sup>b</sup> $P < 0.001$  (ANOVA) vs non-consulters.

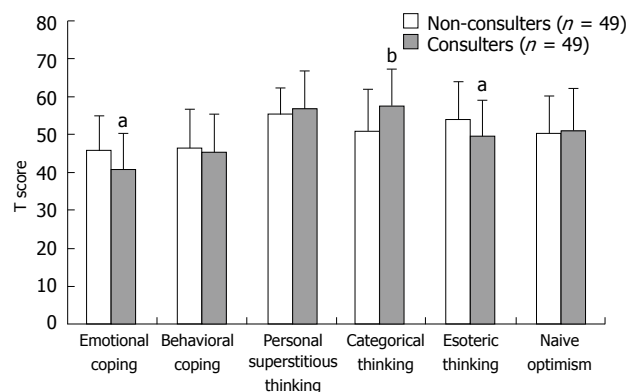


Figure 2 Subscales of constructive thinking in IBS consulters and non-consulters. <sup>a</sup> $P < 0.05$ , <sup>b</sup> $P < 0.01$  vs non-consulters.

bowel symptoms) were similar in both groups, except for severity, with differences between consulters and non-consulters in FDSI scores (70.8  $\pm$  57.8 vs 23.5  $\pm$  21.7;  $P < 0.001$ ) and current pain on VAS (34.4  $\pm$  25.5 vs 23.5  $\pm$  21.7;  $P < 0.05$ ). IBS consulters displayed lower total and verbal IQ and lower global constructive thinking than did IBS non-consulters, without differences in personality traits and stressful life events in the preceding year (Table 3). CTI subscale scores obtained by IBS consulters and non-consulters are shown in detail in Figure 2.

In the logistic regression model, adjusted for age, sex and educational level, no variable was independently

**Table 4** Results of stepwise multiple linear regressions to predict number of physician visits among IBS consulters

Dimension	Variables entered in the model	Standardized coefficient ( $\beta$ )	Model
Step 1	1-Current pain (VAS)	-0.38 <sup>b</sup>	$r^2 = 0.13^d$
Step 2	1-Current pain (VAS) 2-Age	-0.39 <sup>b</sup> -0.33 <sup>a</sup>	$r^2 = 0.22^d$

<sup>a</sup> $P < 0.05$ , <sup>b</sup> $P < 0.01$ ; <sup>d</sup> $P < 0.001$ .

associated with IBS-related health care seeking. Among those who had sought health care, the number of physician visits correlated with age ( $r = 0.31$ ;  $P < 0.05$ ), current pain ( $r = 0.38$ ;  $P < 0.01$ ) and hypochondriasis ( $r = 0.29$ ;  $P < 0.05$ ). The number of physician visits among IBS consulters was predicted by current pain, evaluated by VAS, and age in the stepwise multiple linear regression model (Table 4).

## DISCUSSION

The main finding of our study is that experiential rather than rational intelligence is associated with IBS *per se*, supporting the role of cognitive factors, specifically through generation of stress from daily life events.

Our results reject the hypothesis of IBS subjects having a lower rational intelligence. Attree *et al.*<sup>[19]</sup> recently reported that IBS subjects had a full and verbal IQ slightly lower than controls and a deficit in verbal *vs* performance IQ. Differences in our results may be due to differences in the study sample. We studied a convenience sample of subjects with IBS covering the whole spectrum of the disease, without interest in psychological management or prior psychiatric diagnosis, while Attree *et al.*<sup>[19]</sup> included a group of IBS subjects who had previously expressed an interest in participating in research at a school of psychology. Indeed, our finding that consulters displayed a slightly lower full and verbal IQ than non-consulters points to this explanation. Although a subtle cognitive impairment in some IBS patients cannot be ruled out, this would not seem to be true of the majority of IBS subjects.

Our results support the hypothesis of a lower level of constructive thinking among IBS subjects. The main CTI measure is defined as the ability to adapt the way of thinking to different situations (flexibility in thinking), while one of the main scales (emotional coping) is primarily described as the ability to appraise situations as a challenge rather than a threat. The relationship between physical symptoms and constructive thinking seems to be mediated by stress, mostly self-produced, through the generation of negative emotions<sup>[31]</sup>. Moreover, in a common stressful situation such as pregnancy, constructive thinking was shown to impact both on cognitive appraisal of stress (reducing the need for coping and adjustment) and on active coping responses, once the situation has been perceived as stressful<sup>[32]</sup>. Low constructive thinking suggests that subjects with IBS have a higher probability of experiencing daily life events

that are not intrinsically stressful, as being stressful, due to cognitive appraisal.

Stress is thought to play a pre-eminent role in generating and sustaining IBS symptoms. Over 50% of IBS subjects-consulters<sup>[33]</sup> and non-consulters alike<sup>[34]</sup> report that stressful events precipitate or worsen their symptoms. While some previous studies have observed that IBS subjects experience a slightly greater number of stressful life events than do controls or patients with other digestive disease<sup>[35,36]</sup>, other studies have observed no differences in this regard<sup>[6,37]</sup>. In a prospective study, Levy *et al.*<sup>[38]</sup> failed to find differences between IBS subjects and controls in the number of positive or negative daily events, but self-reported daily stress was higher among IBS subjects. Hence, daily events are perceived as being more stressful by IBS subjects, and indeed, a recent Japanese study showed that IBS subjects scored higher on a perceived stress scale<sup>[39]</sup>.

Emotional distress plays a role in IBS and may also impact on daily stress. The association between low constructive thinking and IBS does not seem to be explained by emotional distress, as an association in multivariate analysis persisted even when adjusting for emotional distress measures, like MMPI clinical scales. Although we excluded subjects with a psychiatric diagnosis requiring treatment, our sample of IBS subjects still suffer higher emotional distress than control subjects, to a level similar to that reported by Drossman *et al.*<sup>[6]</sup>.

Constructive thinking correlated to neuroticism; a correlation has been previously reported with the CTI emotional coping subscale, which has been deemed to represent the cognitive component of neuroticism<sup>[21]</sup>. Neuroticism is a broad concept that includes cognitive, affective, and behavioral traits<sup>[40]</sup>. Most<sup>[5,41-44]</sup>, although not all<sup>[36]</sup> studies have reported an association between neuroticism and IBS. However, constructive thinking seems to account for the relationship between neuroticism and IBS, suggesting the relevance of cognitive factors in IBS.

Several studies have shown that IBS is associated with less effective strategies to cope with stress<sup>[45,46]</sup>, specifically with symptoms. Thus, the difference between constructive thinking and coping response merits some comment. Constructive thinking would be mostly implicated in the automatic and holistic cognitive appraisal of any event, prior to the occurrence of emotion, and operates at a preconscious level in a way in which a person is unaware<sup>[47]</sup>. Coping is usually defined as cognitive and behavioural efforts to manage a troubled person-environment relationship; it is the reaction to a conscious appraisal of the situation<sup>[48]</sup>. Thus, interpretational activity may occur outside awareness and may be the non-conscious trigger of an emotional response<sup>[49]</sup>. Such a process is likely involved in the activation of the anterior cingulate cortex during subliminal and supraliminal stimulation<sup>[50]</sup>. Moreover, hypnotherapy is effective in IBS and, although the underlying mechanism is unknown<sup>[51]</sup>, it might be hypothesized that it operates partly through a change in preconscious appraisal of internal events<sup>[52,53]</sup>.

Another interesting finding is the association between constructive thinking and IBS-related medical consultation. In the 1980s and 1990s, psychological factors were regarded as predictors of health care sought by IBS subjects<sup>[6,54]</sup>, but recent population-based studies suggest that such factors are not quite so important<sup>[7,39,55]</sup>. Our results are closer to these latter studies, inasmuch as severity of symptoms is seen as the leading factor accounting for medical consultation, without any role for psychological factors. Nevertheless, univariate analysis showed a lower level of constructive thinking in those who had sought health care compared to those who did not; consulters displayed lower emotional coping and higher categorical thinking scores than non-consulters, a finding that points to appraisal of events (i.e. symptoms) as a threat and a more rigid mindset inclined to simplistic solutions as the main differences in thinking between those seeking care and non-consulters. However, constructive thinking does not seem to have a significant role in illness behavior, in view of the lack of correlation with the number of physician visits.

The main limitation of our study lies in the fact that subjects were not extracted from the general population strictly at random. We opted for a semi-random approach owing to the difficulties posed by recruiting our target population in a purely random fashion. There were four requirements for inclusion, namely: presence of bowel symptoms as per Rome II or, alternatively, absence of such symptoms; absence of any psychiatric diagnosis requiring treatment; consent to undergo in-depth evaluation, including a 2-h WAIS-III interview and a number of self-administered questionnaires; and, the need to be matched by age, sex and educational level. The direct-invitation approach allowed for a brief 5-min conversation to assess these criteria, and subjects were recruited in different environments (work and leisure centers) unrelated to medical facilities. Indeed, results from control subjects support this approach, since test profiles proved quite similar to data expected from the general population (mean T-scores of around  $50 \pm 10$ ; IQ around  $100 \pm 15$ ). In the case of IBS non-consulters, the data were comparable to the results of Mearin *et al*<sup>[2]</sup> based on a random Spanish-population sample. Thus, the results in no way suggest that there was any selection bias.

## COMMENTS

### Background

Irritable bowel syndrome (IBS) has been related to psychological distress and consequences of the stress driven emotional outputs. Cognitive abilities drive the interaction of the subject with the environment, which is the basis for stress, and may participate in abnormal illness behaviour, hypervigilance, and less effective coping abilities. One study suggested a lower intelligence in IBS patients.

### Research frontiers

This study is the first to comprehensively evaluate intelligence (rational and experiential intelligence) in an adequate sample of cases and controls.

### Innovations and breakthroughs

The potential role of intelligence in the pathophysiology of IBS is tested. This arm (cognition ability) of the subject-environment interaction has not been formally tested.

### Applications

This study provides support for the role of experiential intelligence in IBS.

Moreover, experiential intelligence may be improved with psychological therapies.

### Peer review

The authors exposed patients and controls to eight different psychological tests in an effort to identify correlations/associations for IBS and psychological phenotypes. The article is well written and the contents are credible.

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