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Full Length Research Paper

An investigation of the relationships among depression, anxiety, flexibility and gastric symptoms

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Brain-gut connection is well established as is depression and anxiety to gastric pathology. Still elusive is clarity on specific cognitive and behavioural states and bowel functioning. Therefore this study investigated the relationships among depression, anxiety, flexibility, and gastric symptoms. 120 student participants completed the four scales used: Beck Depression Inventory (BDI), General Expectancy for Success Scale (GESS), Bowel Health Questionnaire (BHQ), and Luchin water-jar problems. Correlational analysis showed high correlation between BDI and BHQ, especially for young male students. Scores on the Luchin water-jar problems were negatively correlated with the BHQ and the best predictor variable for scores on BHQ was BDI, followed by scores on flexibility (Luchin). Multivariate analysis revealed a significant effect of Sex on the GESS. Univariate analysis showed a significant effect of Age on the same scale. Results suggest that depression, flexibility and gastric symptoms may be associated in nonclinical samples.

Key words: Anxiety, depression, flexibility, gastric symptoms.

INTRODUCTION

Since William Beaumont earliest works in 1833, neuroanatomical connections in the relationship between anxiety and depression to the development and aggravation of gastrointestinal disorders are well documented (Kennedy et al., 2012; O"Malley et al., 2011; Drossman et al., 1988; Mai, 1988; Jorgensen, 1988; Clouse, 1988; Varis, 1987). The limbic structures in the temporal lobe region (amgydalar and hippocampal formation), also called „visceral" brain have been implicated in generating emotional experiences and the modulation of gut related dysfunction (Henke et al., 1991) since changes in these structures produce changes in emotional states and related gut activities (Henke and Ray, 1992). The amgydala"s strategic position permits the reception and integration of highly processed inputs from all sensory systems. It connects the cognitive and emotional-related areas with the gut-related areas of the brain, explaining why emotional states have direct effect on the gut (Clouse, 1988). Aside mediating the subjective sensation of anxiety, the limbic system plays a role in the sensation of visceral discomfort as changes in bowel functioning are associated with high levels of anxiety (Varis, 1987) and intense experiences of emotionally aroused states (Kennedy et al., 2012; Varis, 1987).

Several areas in the amgydalar complex are also important in depressive states. Lesions (Henke and Ray 1992) or chronic stress (McLaughlin et al 2009) in the hippocampus have been associated with helplessness and rigidity similar to depressive symptoms. Likewise, depressed persons exhibit various forms of rigidity. Affective and cognitive states in the depressed are easily triggered and rigidly maintained even in the face of evidence to the contrary. The hippocampus" inherent erasure mechanism which facilitates cognitive flexibility and mediates the process of unlearning learned responses appears impaired under stress; hence the observed rigidity and perseveration (Meiran et al., 2011; Graham et al., 2010; Graham et al., 2010; Cerquieira et al., 2007; Cerquieira et al., 2007). Understandably a Type A behaviour characterized by high stress, excessive drive, and strong sense of time urgency is associated with gut related dysfunction (Moberg et al., 1991). The

synergistic interaction of the amgydala and the hippocampus clarifies the relation of the cognitive, affective, and visceral functions of the human person (LeDoux, 1992).

These studies suggest that rigidity or inflexibility might be related to stress, anxiety, depression, and the onset of gastrointestinal disorders. Though there is little agreement in the definition, meanings, and behavioural expressions and measures of rigidity (Luchin, 1951; Chown, 1959), a definition used with some consensus is the inability to reconstruct an alternative solution to problems (Luchin 1951) or the continued use of a set behavioural strategy when the objective condition demand a change – a form of perseveration (Chown, 1959; Cerquieira et al., 2007).

The link between depression, as the interplay of anxiety and negative cognition, and self concept and how these might be related to the development of gastric pathology are of interest in this paper. Whether or not environmental challenges produce gut pathology depend on the organism‟s ability to cope; and the coping function is reflected in the ability to adjust flexibly to changed environmental conditions (Henke and Ray, 1992). Flexibility arguably involves risk, optimism, and belief in self-efficacy since it is often easier and safer to stick with the known.

Important to both depression and anxiety is a person‟s attributional life style. Anxious individuals are more likely to make internal, global and stable attributions for bad outcomes and such attribution style is frequently accompanied by depressed moods (Dowd and Milne, 1985; Abramson and Seligman, 1978) because attributions, as explanations for events, are accompanied by sanctions of credit or blame. A sanction of blame when it results from internal, stable and global attribution for negative events plays a causal role in depression (Abramson and Seligman, 1978; Stanley and Maddux, 1986b).

While the relation of emotional states, such as anxiety and depression, in gut functioning is well established the role of rigidity or flexibility in bowel health is not explored. Therefore questions of interest in this study are twofold: First, if depressed states are often due to the interplay of negative cognition of helplessness and anxiety with low self efficacy (Stanley and Maddux, 1986b), then what is the relationship of depression to lack of flexibility as an adaptive behaviour? Second, if depressed persons are more rigid in behaviour and cognition would rigidity induce greater anxiety states and stress with consequent gut dysfunction given the physiological and functional interconnectedness among cognitive functions, emotions and digestive system?

To conclude that depressed persons with gastrointestinal disorders are less flexible would be premature without experimental validation. The suggested link requires exploration. To present, no study has examined flexibility as it relates to anxiety, depression, and gastric pathology. This study explored these relationships and expects that persons with more depressive or anxiety symptoms would be less flexible and would show more bowel related dysfunction.

MATERIALS AND METHODS

Participants

These consisted of 80 undergraduate students (18 to 23 yrs) of the St. Francis Xavier University (STFX) in Antigonish, Nova Scotia, Canada. 40 postgraduate students, categorized as mature students (24 to 55 years), from the Coady International Institute of the STFX were included in the study. Participants who did not complete all questionnaires were not included in the study analysis. In total, there were 30 male and 50 female young students and 21 male and 19 female mature students.

Four scales were used: The Beck Depression Inventory (BDI), the General Expectancy for Success Scale, (GESS), a Bowel Health Questionnaire (BHQ) and the Luchin water jar problems.

The BDI, a scale used to measure depressive symptoms in normal and clinical population, (Stanley and Maddux 1986b) consists of 21 questions with four alternatives each and range from 0-3, indicating increasing intensity of depressed affect. 63 would be the highest possible score on the BDI.

The GESS is related to anxiety and negative cognition often associated with depression, used to assess participants‟ general self efficacy expectancies about the future, (Corcoran and Fischer 1987) it consists of 30 questions on a five point scale, on which 1 indicates a high improbability of some future event happening and 5 indicates a high probability that the event will occur. Participants rated each item in terms of how it applies to them. Scores range from 30-150 and higher scores reflect an internal control of success.

The BHQ identifies symptoms of bowel dysfunction and distinguishes between patients with functional gastrointestinal symptoms and health controls (Talley et al., 1989). For this study, the scale was modified from a „yes-no‟ type of answer to a four-point scale with 21 questions ranging from „very often‟ (3) to „little or never‟ (0) to make correlation with other scales possible. Highest possible score would be 63.

The Luchin water jar problem was used as a flexibility test. The water jar problem produces Einstellung effects in subjects of varying ages and experiences (Luchin, 1951). The Einstellung effect is the use of the set method (B-A-2C), often referred to as the E method, when a simpler method (A+C, A-C) could be used. The original form consists of five illustrative problems which establish a mental set, and two critical problems. The first of the two critical problems can be solved by either using the set formula (B-A-2C, E method) or a simpler formula (A-C or

Table 1. Means and standard deviations for all participants.

Measures	Groups			
	MALES		FEMALES	
	Young	Mature	Young	Mature
BDI	9.87 (10.82)	7.52 (6.40)	7.92 (4.45)	10.11 (6.23)
GESS	112.87 (12.71)	111.19 (16.36)	106.72 (19.49)	94.95 (17.29)
BHQ	5.17 (5.14)	4.53 (3.84)	5.32 (5.22)	7.42 (5.13)
LUCHIN	1.17 (1.46)	1.09 (1.34)	1.06 (1.32)	0.53 (1.12)

Note: Standard deviations are in the brackets.

A+C). This problem tests susceptibility to set. The second critical problem, often called the extinction problem, can only be solved by the simpler formula and tests ability to overcome set (Chown, 1959). The scale was slightly modified for this study. The number of critical problems was increased from two to six, with three problems testing for susceptibility and three others for extinction, to ensure that each participant had a reasonable score for correlation. Scores on critical problems testing for susceptibility to set were used as the test for flexibility since in these problems both the E method and simpler method solve the problem. The use of the simpler method (A+C, A-C) or a creative alternative instead of the E method was considered an exhibition of mental flexibility. Scores range from 0-3. A score of 0 indicated complete set - the E method was used in all three problems. A score of 3, 2, or 1 indicated the number of times participant used a method simpler than the E method in solving the three problems testing for susceptibility to set.

Procedure and data analysis

All participants, except the mature students, were brought to the laboratory where experiment was conducted. Mature students had questionnaire administered in their residence due to schedule conflicts. Before questionnaires were administered, the study was explained to participants, all questions answered and informed consent obtained. Therefore, participation was voluntary without any coercion and participants could cease to continue without any negative consequences. Some students failed to complete the Luchin water jar problems because they found it too “complicated”. 120 students completed all scales and these were used for analysis. 9 incompletes were eliminated and not included in study.

Data were entered and analyzed with SPSS, 15th version. Three approaches were used to analyze data. First, correlations (Pearson) among the different variables were computed. Second, correlational analysis was complemented with a regression analysis. Finally, a multivariate analysis of variance with gender and age groups as independent variables, and score on BDI, GESS, BHQ and Luchin problems as dependent variables was performed.

Ethics statement

The study was approved by the Institutional Review Board of the Department of Psychology at the St. Francis Xavier University, Nova Scotia, Canada.

RESULTS

As expected, there were significant correlations among scores on the flexibility test (Luchin problems), depression (BDI) and the bowel health questionnaire. A negative relation was found between scores on flexibility and bowel health. A high positive correlation was also found between scores on depression and bowel health. A summary of the means and standard deviations for all participants on the four variables is presented in Table 1. Correlations are presented in Table 2.

Males, regardless of age, showed relatively higher correlations between depression scores (BDI) and bowel health than females. For the females, only the young group had a significant positive correlation on depression and bowel health, with no significant correlations for mature females. Unlike mature males whose only significant correlation occurred between depression scores and bowel health, young males showed significant correlations among depression, flexibility and bowel health. The negative correlation between depression and flexibility, and the positive correlation between depression and bowel health suggest that the greater an individual‟s ability for flexibility, the less depressed one is likely to be, and the more depressed is likely to have more symptoms of bowel dysfunction. It is interesting that this trend was found among the young male and not the mature male students. Results are presented in Tables 3 and 4.

To better understand the predictive value of the variables examined in the study, a multiple regression analysis for all subjects with age, sex, BDI, Luchin, GESS as predictors and BHQ score as dependent variable was

Table 2. Correlation matrix for all students on the four variables.

Variable	Measures			
	BDI	**GESS**	**BHQ**	**LUCHIN**
BDI	1.0	-	-	-
GESS	-0.13	1.0	-	-
BHQ	0.54**	0.04	1.0	-
LUCHIN	-0.22*	0.06	-0.27**	1.0

*p<.05, **p<.01, 2tailed, N =120.

Table 3. Correlation matrix for young and mature male students.

Variable	Measures			
	BDI	**GESS**	**BHQ**	**LUCHIN**
BDI	1.0	-	-	-
GESS	-0.01(-0.42)	1.0	-	-
BHQ	0.85**(0.53*)	-0.05(-0.39)	1.0	-
LUCHIN	-0.38*(-0.15)	0.11(0.32)	-0.24(0.16)	1.0

*p<.05, **p<.01, 2 tailed, N for Young Male = 30, N for Mature Male = 21. Correlations for Mature Students are in bracket.

Table 4. Correlation matrix for young and mature female students.

Variable	Measures			
	BDI	**GESS**	**BHQ**	**LUCHIN**
BDI	1.0	-	-	-
GESS	-0.12 (-0.17)	1.0	-	-
BHQ	0.29* (-0.43)	-0.26 (0.19)	1.0	-
LUCHIN	0.01 (-0.29)	-0.19 (0.18)	-0.26 (0.35)	1.0

*p<.05, **p<.01, 2 tailed, N for Young female = 50, N for Mature female = 19. Correlations for Mature female students are in bracket.

performed. The results showed that the best predictor variable of bowel health is the score on depression, $F(1, 118) = 47.9$, $p<.001$ which was also positively correlated with BHQ (bowel health scores). Flexibility (score on Luchin) was also a significant predictor of bowel health, $F(1, 117) = 4.17$, $p<.05$. This relation is reflected in the negative correlation between bowel health and flexibility.

Finally, multivariate analysis revealed a significant effect of sex on the GESS score, $F(4,113) = 11.13$, $p<.01$; with a mean of 112.18 and 103.48 for males and females respectively. This result showed that males scored higher on the GESS than did females. Univariate analysis revealed a significant effect of age on the GESS scores, $F(1,116) = 4.01$, $p<.05$. Young students scored higher than mature students on the GESS. Results of univariate analysis of variance are presented on Table 5.

DISCUSSION

The negative correlation found between BDI and Luchin suggests that depressed individuals are less likely than non-depressed individuals to be innovative or flexible in changing existing strategies. However, it does not necessarily suggest that depressed individuals are less self-efficacious. Their inability to seek creative alternatives may be a reflection of a decrease in motivation (Varis, 1987) and consistent with other findings of cognitive rigidity in depressed individuals (Meiran et al., 2011; Rickelman and Houfer, 1995).

Cognitive flexibility depends on attitudinal factors (Kennedy et al., 2012), even as measured by the Luchin water jar problems (Luchin and Luchin, 1984; Karnas, 1978; Houston and Cohen, 1975), and possibly individual difference in cognitive styles (Goldsmith and Matherly, 1985). A high level of confidence in self efficacy and low level of hostility toward arithmetic will readily ease the rigidity that obstructs the ability to break mental set for creative alternatives. During the study, most participants made comments reflective of mathematics phobia. Some participants, who had initially consented to participate in

Table 5. Univariate analysis of variance with sex and age as independent variables and BDI, GESS, BHQ, and LUCHIN as dependent variables.

Source of variation	*df*	*p* value
Sex		
BDI	1	0.82
GESS	1	0.01
BHQ	1	0.11
LUCHIN	1	0.19
Age		
BDI	1	0.96
GESS	1	0.05
BHQ	1	0.43
LUCHIN	1	0.25
Sex by Age		
BDI	1	0.11
GESS	1	0.14
BHQ	1	0.18
LUCHIN	1	0.38

study, refused to continue once they encountered the Luchin water jar problems saying “this is too complicated!” A frequent reaction to the Luchin water jar problems, even among the young students, was an exclamation of “math!?” Obviously an attitude of “I cannot do this!” is neither self efficacious nor conducive to flexibility as an adaptive behavior.

A poor performance on the Luchin water jar problems among students could be a reflection of school learned habits involving mechanistic problem-solving strategies that do not encourage creative and careful assessment of each situation (McKelvie, 1990). Students who exhibited the Einstellung effect probably thought „this is how it is supposed to be done‟ and did not bother seeking alternative.

Same reason could account for the seemingly contradictory findings among the sexes‟ means on the Luchin, bowel and BDI correlations. That is, on the analysis of variance, while males showed relatively higher mean than females on the Luchin problems, suggesting less susceptibility to set, the males also showed a much higher correlation between the BDI and bowel health questionnaire. These findings are contrary to expectation in the sense that with less susceptibility to set, it would have been expected that males would exhibit less depressive symptoms relative to females. Hypothesis predicted that less depressed individuals would be more likely to be flexible – that is score higher on the Luchin water jar problems. The sex differences in means, however, suggest that flexibility, as measured by the Luchin problems, and depression and bowel symptoms may not necessarily co-exist. The inconsistency could be because males have less arithmetic phobia than females (Ashcraft, 2002; Luchin and Luchin, 1984) and were therefore able to score higher on the Luchin even though they showed higher scores on the BDI and bowel health questionnaire.

Performance on the Luchin problems could also be a reflection of different cognitive styles. Goldsmith and Matherly (1985) replicated and confirmed by Kauffman‟s (1979; cited in Goldsmith and Matherly, 1985) categorization of two possible cognitive styles - assimilators and explorers. Assimilators continued to use the E method even when simpler method could have been used. In contrast explorers showed creativity in solving problems that could be solved using the E method. In confirmation with Kauffman‟s concept,

Goldsmith and Matherly (1985) found assimilators preferred the well established problem solving methods and overlooked simpler possibilities. Explorers sought new methods even when the standard solution was applicable.

The effects of sex and age on the scores on the BDI and bowel questionnaire were interesting. Both young and mature males showed correlations on both instruments, with a higher correlation found among the young males. This finding suggests that young males are more likely than mature males to be depressive and show signs of bowel dysfunction. The finding is interesting because it is contrary to intuitive expectations. One would expect that with age, experience, and possibly greater life concerns, mature individuals would be more likely to have symptoms of bowel dysfunction if not depression. Given that the young males in this study were mostly first year undergraduate students, however, the level of depression and signs of bowel dysfunction found can be understood. Adjustment to new social and academic environment, the

stress of leaving home probably for the first time, and the difficulties involved in coping with university academic requirements may contribute to the experience of depression and changed bowel patterns. Similar reasons could account for the findings among the mature males who were mainly people from Asian and African countries encountering Canada for the first time. Adjustment challenges related to food and climate can induce depression, anxiety, and changes in bowel functioning.

The period within which experiment was conducted may also have influenced participants‟ scores. Much of the data were collected between October and November when quizzes, papers and midterms were in full swing for young students as was thesis completion for the mature students. Although the females were in the same situation, the mature females‟ failure to show any significant correlation between scores on the BDI and bowel questionnaire was most likely due to the small sample size since the young females had a relatively small, but significant, correlation on these variables. The non-significant results on the correlation between the BHQ and GESS for mature females could be due to the small sample size. The definition of „young‟ and „mature‟ may be arbitrary. Future study could look at age as a continuous variable rather than categorical variable.

Participants‟ age could thus be entered with data for analysis.

The significant effect of sex and age on the GESS scores suggests that males, relative to females, have higher internal control of success. Younger individuals, relative to mature individuals, have higher internal control of success. Contrary to expectations there was no correlation between the scores on the GESS and BDI for both groups of participants.

Conclusion

This study is not without limitations. Larger sample size, particularly among older students, and inclusion of „everyday flexibility‟ sort of questions could have further elucidated findings.

A correlational study between the Luchin water jar problems and a personality inventory would be interesting and might demonstrate a link between characteristics of a Type A personality and an assimilator cognitive style as suggested by Moberg et al. (1991) who intimated that individuals with a Type A personality are more likely to develop gut related dysfunctions. Rigidity in everyday life, however, cannot be necessarily equated with Einstellung rigidity. Further research would be enlightening.

Limitations notwithstanding, the significant correlations found among scores on the BHQ, BDI and the Luchin water jar problems seem to confirm the physiological synergistic interaction of affect, cognition and gut functions. The extent and specific pathways via which cognitive rigidity or flexibility plays a role in the development of gastric pathologies is an interesting question that needs further research. Given many variables that could have contributed to the results obtained, the findings of this study can be considered provocative than definitive. Replication and further research is warranted because a better understanding of the relations among the emotions and flexibility in gastric pathology will have numerous clinical, social, and economic implications.

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