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Cardiac Anxiety in people with and without Coronary Atherosclerosis

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Abstract

Many studies have shown that cardiac anxiety when occurring in the absence of coronary artery disease is common and quite costly. The Cardiac Anxiety Questionnaire (CAQ) is an 18 item self-report measure that assesses anxiety related to cardiac symptoms. In order to better understand the construct of cardiac anxiety, a factor analysis was conducted on CAQ data from 658 individuals who were self- or physician- referred for electron beam tomographic screening to determine whether clinically significant coronary atherosclerosis was present. A four-factor solution was judged to provide the best fit with the results reflecting the following factor composition: heart focused attention, avoidance of activities that bring on symptoms, worry or fear regarding symptoms, and reassurance-seeking. Factorial invariance across groups was also assessed to determine whether the factor structure of the CAQ was similar in individuals with and without clear evidence of coronary atherosclerosis. The factor structure of the CAQ did not differ between the two groups. However, the group without coronary atherosclerosis had significantly higher mean scores on their attention and worry/fear factors suggesting that people without a diagnosed cardiac condition pay more attention to and worry more about their cardiac related symptoms than those people who have coronary atherosclerosis.

Keywords

Anxiety sensitivity; cardiac; anxiety; confirmatory factor analysis; factorial invariance; configural invariance; metric invariance

Fear of bodily sensations, one component of anxiety sensitivity, has been found to play a central role in panic disorder (Cox, 1996; McNally &Eke, 1996; Reiss and McNally, 1985) and is likely to play a role in its etiology (Schmidt, Lerew, & Jackson, 1997) and persistence over time (Clark, 1988). Fear of anxiety sensations, as measured by the Anxiety Sensitivity Index (ASI; Reiss, Peterson, Gursky, & McNally, 1986), has been shown to reflect specific dimensions referring to somatic, social, and psychological consequences (e.g., Zinbarg, Brown, & Barlow, 1997). Taylor and Cox (1998) found that an expanded measure of anxiety sensitivity, the Anxiety Sensitivity Profile (ASP), included four lower-order factors composed of items that assess bodily sensations pertaining to fears of respiratory, cardiac, cognitive, and gastrointestinal symptoms. Based upon such evidence, researchers are increasingly exploring

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the possibility that a fear of certain bodily sensations may be a psychological risk factor for other types of anxiety pathology (e.g., Eifert, 1992; Zinbarg, Mohlman, & Hong, 1999).

There has been a considerable amount of research examining the relationship between anxiety, usually in the form of panic disorder and chest pain (e.g., Beck, Berisford, Taegtmeyer, & Bennett, 1990; Beitman, Mukerji, Lamberti, Schmid, DeRosear, et al., 1989). This phenomenon is often referred to as non-cardiac chest pain. Many of these studies have focused exclusively on chest pain as a primary symptom, because the potential seriousness of this complaint usually requires that it be medically investigated. As many as 43 percent of individuals undergoing coronary angiography to determine the etiology of their chest pain do not have clinically significant coronary heart disease (CHD; Beitman et al., 1989; Dammen, Arnesen, Ekeberg, Husebye, & Friis, 1999; Katon, Hall, Russo, Cormier, Hollifield, Vitaliano, & Beitman, 1988). Instead, a large proportion of these individuals are believed to be suffering from an anxiety or depressive disorder or may be in the prodromal phase of these conditions (Carter, Servan-Schrieber, & Perlstein, 1997; Katon et al., 1988).

Thus, cardiac related anxiety (see Eifert, Zvolensky, & Lejuez, 2000 for a conceptual review) may cause a person to be particularly attentive to perceived changes in the chest and heart areas. In fact, compared to patients with heart disease, non-cardiac chest pain patients endorse similar or greater levels of fear, distress, and autonomic sensations than individuals who have coronary calcium present (Carmin, Wiegartz, Hoff, & Kondos, 2003). Non-cardiac chest pain patients also report a greater level of sensitivity to cardiac-related stimuli than CHD patients (Eifert et al., 1996) and note greater levels of cardiac-related distress during biological provocation tests relative to nonclinical controls (Bass, 1990; Beck et al., 1990; although this literature is mixed with at least one study not finding the same response, Eifert, Zvolensky, Sorrell, Hopko, & Lejuez, 1999). Non-cardiac chest pain patients also engage in significantly more cardioprotective avoidance behaviors (Aikens et al., 1999; Eifert et al., 1996) and endorse a significantly greater degree of catastrophic thinking when compared to CHD patients and to nonclinical controls (Eifert et al., 1996).

Cardiac anxiety, in the absence of CHD, can be an expensive problem that can result in repeated unnecessary medical expenditures and reduced quality of life for affected patients. Aikens, in a series of studies, discussed the extensive costs of repeated emergency room visits and laboratory tests for persons who are later found to have no cardiac problems (Aikens, Michael, Levin, & Lowry, 1999; Aikens, Zvolensky, & Eifert, 2001). Other authors (e.g., Eifert, Zvolensky, et al., 2000) have discussed the harmful personal costs of worry due to cardiac related anxiety, as well as the disruptions in life and social functioning that can result from this condition. Finding an effective means to reduce the burden on the health care system, which is required to treat people with cardiac anxiety who have no significant organic cardiac disease, as well as ways to reduce the emotional cost to those experiencing non-cardiac chest pain, are important aims with substantial implications for both the individual patient and the health care system.

In order to more fully understand this phenomenon, Eifert and colleagues (Eifert, Seville, Brown, Anthony, & Barlow, 1992; Eifert, Thompson et al., 2000) developed the Cardiac Anxiety Questionnaire (CAQ), which is a self-report measure that assesses the interpretation of cardiac symptoms and sensations as well as related behaviors. Following an exploratory analysis of 188 individuals, Eifert, Thompson and colleagues (2000) reported that CAQ items could be understood as reflecting three factors: fear about heart sensations, avoidance of activities that could bring on symptoms, and heart-focused attention and monitoring.

This paper examines the factor structure of the CAQ in a population of 658 individuals undergoing electron beam tomography (EBT). EBT is a non-invasive diagnostic method that is sufficiently sensitive to provide a useful assessment of whether coronary atherosclerosis is clinically present. An exploratory factor analysis of the CAQ was first used to determine the number of factors to extract and rotate for interpretation. The resulting factor model was then compared to the model reported by Eifert and colleagues (2000) as well as to other theoretical models. Finally, an assessment of whether the factor structure of the CAQ differed between persons with and without significant coronary artery calcification was conducted in order to provide information on the types of anxiety symptoms or related behaviors that might differentiate persons with and without demonstrable cardiovascular pathology.

Method

Participants

Participants in the present study were part of a larger, ongoing study examining anxiety in individuals who received EBT screening to determine the presence of coronary calcification (see Carmin, Wiegartz, Hoff, & Kondos, 2003 for a complete description). All individuals who came for the EBT testing were included in this study and no exclusion criteria was used in this naturalistic study. All participants completed the CAQ with other demographic materials during their visit for EBT. The University of Illinois at Chicago Institutional Review Board approved the protocol under which these data were collected.

Materials

Electron Beam Tomography (EBT)—EBT is a non-invasive method to detect and quantify coronary artery calcium, a clinical marker for coronary heart disease (see Carmin et al., 2003 for procedural details of EBT). The results of EBT scanning have been validated against angiographic (Agatston, Janowitz, Kaplan, Gasso, Hildner, & Viamonte, 1994; Budoff, Georgiou, Broday, Agatston, Kennedy, et al. 1996) and histological (Mautner, Mautner, Froelich, Feuerstein, Proschan, et al., 1994) methods for evaluating CHD. EBT was found to be as sensitive as established methods in detecting clinically significant coronary atherosclerosis (e.g., Rumberger, Schwartz, Simons, Sheedy, Edwards, & Fitzpatrick, 1994). Thus, EBT is considered to be a useful test for diagnosing coronary artery disease.

Cardiac Anxiety Questionnaire—The CAQ (Eifert, Thompson, et al., 2000) is an 18-item self-report inventory scored on a five-point Likert-type scale, anchored from 0 (never) to 4 (always). Higher scores on this measure indicate greater cardiac anxiety (no reversed scored items). Eifert and colleagues investigated the CAQ in a sample of 188 participants undergoing angiography. They found the CAQ to be composed of three components: fear about heart sensations, avoidance of activities believed to elicit cardiac symptoms, and heart-focused attention and monitoring. They also found the CAQ to have adequate convergent validity with the Anxiety Sensitivity Index (Reiss et al., 1986). The measure has been found to be useful in clinical research with medical patients (Aikens, Michael, Levin, & Lowry, 1999; Zvolensky et al., 2003) and as a cognitive-behavior therapy outcome measure (Eifert, Zvolensky, & Lejuez, 2000).

Statistical Procedures

Mplus software (Muthen and Muthen, 2004) was used in both the exploratory and confirmatory factor analyses. Robust weighted least squares (WLSMV; Flora & Curran, 2004) estimation was used due to the ordinal nature of the CAQ items. Several goodness of fit indices were reported. Fit indices can be broken down into absolute fit (assesses how well the model reproduces the sample matrix in an absolute sense) and incremental fit (assesses the fit of the hypothesized model relative to a baseline model). The most common absolute fit index is the chi-square index. When possible, we used a chi-square difference tests (difference of chi-square values for nested models) to compare between models. Another measure of absolute fit, the root mean square error of approximation (RMSEA) was used. The RMSEA is sensitive to misspecified factor loadings and it provides a penalty for models that are less parsimonious (Browne & Cudeck, 1993). Lower values of the RMSEA indicate better fit. In addition to reporting absolute fit indices, an incremental fit index, the comparative fit index (CFI; Bentler, 1990) was used to assess model fit. The CFI represents the improvement in fit of the hypothesized model to a baseline model. The baseline model is an independence model in which all variables are hypothesized to be uncorrelated. The CFI ranges from 0 to 1, with larger values indicating better fit.

First, exploratory factor analysis was used to determine the number of factors to extract and rotate for interpretation. A common factor analysis with oblique rotation was used in this process. Several complementary methods were used to determine the number of factors to extract and rotate (Cattell, 1966; Longman, Cota, Holden, & Fekken, 1989). The resulting factor model was then compared to the model reported by Eifert and colleagues (2000), as well as other theoretical models, using multiple indicators of fit. The chi-square difference test was used to evaluate whether multiple-factor models fit the data better than a single-factor model.

The second aim of this study was to determine whether the factor structure of the CAQ differed between persons with and without significant coronary artery calcification. To accomplish this aim, the most parsimonious and best fitting model found during the first step of analyses was examined for participants with and without calcifications. In addition, to assess whether the factor structure of the instrument varied between these groups, the factor means of the two groups were also examined to determine any significant differences between the groups (Horn, 1991; Horn & McArdle, 1992; Meredith, 1965).

Results

Demographics and Psychometrics

Six hundred fifty-eight participants completed the study; their mean age was 51.7 (sd=9.6) years. Four hundred thirty-five of the participants were male. The sample was predominantly Caucasian (n=545) and the majority of participant had completed high school (n=641), with 344 persons reporting additional education after high school. Four hundred one of the participants had coronary artery calcium scores considered to be not clinically significant (see Carmin et al., 2003 for additional demographic information).

Factor Analysis of the Cardiac Anxiety Questionnaire

Exploratory factor analysis of the CAQ using robust weighted least squares estimation (WLSMV) indicated that a three or four factor solution should be retained for rotation and interpretation as assessed by inspection of the scree plot of the eigenvalues (eigenvalues of 6.24, 2.72, 1.47, 1.34, 0.97 were obtained for the first five factors). Parallel analysis provides a means for assessing the number of factors to retain for interpretation based on the number of items in the measure analyzed and the sample size from which data are obtained (Longman, et al., 1989). Parallel analysis of these data indicated that four factors should be extracted. Further, items could be grouped into the following four conceptually relevant factors when the solution was promax rotated: (1) heart-focused attention, (2) avoidance of activity that brings on symptoms, (3) worry/fear of heart symptoms, and (4) reassurance-seeking (i.e., from doctors and family members).

A subsequent confirmatory factor analysis was used to compare various factor models to determine which model provided the best fit for the data (see Table 1). The first model tested was a one-factor model. This model required that all the items load on a single factor and thus represents the most parsimonious interpretation of our data—that only one dimension should be used to explain relations among CAQ items. The second model tested was that reported by Eifert, Thompson, and colleagues (2000). It included three factors labeled (1) fear about heart sensations, (2) avoidance of activities believed to elicit cardiac symptoms, and (3) heart-focused attention and monitoring. The final model was the one indicated by the exploratory analysis found in the first step described above.

Overall, Eifert and colleagues' three-factor model and the four-factor model based on the current exploratory factor analysis fit the data significantly better than the one-factor model (chi-square difference = 790.15, df = 12, $p < 0.001$ for 1-factor versus 3-factor; chi-square difference = 934.94, df = 13, $p < 0.001$ for 1-factor versus 4-factor). The four-factor model provided a better fit than the Eifert and colleagues' three-factor model based on RMSEA (.115 for the three-factor and .092 for the four-factor) and CFI (.896 for the three-factor and .932 for the four-factor) estimates. Items in both the 3-factor and the 4-factor models load similarly on the three factors of attention, fear, and avoidance. The four-factor model adds a reassurance-seeking factor. This model yielded factors with a clearer conceptual significance as well. The four-factor model was selected for further investigation in the next series of analyses because of its greater face validity, its slightly better fit, and its compatibility with extant anxiety theory.

The factor structure of the CAQ was next examined in participants with and without significant coronary atherosclerosis. To determine whether the two groups could be differentiated based on their factor structure. We first tested to determine whether the two groups had metric invariance (i.e., that items had the same factor loadings in each group) or configural invariance (i.e., that items loaded on the same factors but not with the same factor loadings in each group; Horn, 1991; Horn & McArdle, 1992; Meredith, 1965). Table 2 lists the loadings, fit statistics, and factor means for each of these two models. The metric invariance model provided a better fit based on RMSEA and CFI values. This finding suggests that the two groups have a similar factor structure and are factorially invariant.

Subsequent to the above factorial invariance analysis, potential differences in the factor means of the two groups were examined. To do this, the factor means for group with significant coronary atherosclerosis group were set to zero, which enables a determination of whether the factor means for the group without coronary atherosclerosis were significantly different from the group with coronary atherosclerosis. The group of participants without coronary atherosclerosis had significantly greater means on the heart-focused attention factor ($p<.05$, $d = 0.15$) and the worry/fear factor ($p<.05$, $d = 0.16$). Although the effect sizes are small, participants without coronary atherosclerosis appeared to pay more attention to their heart-related symptoms and worry more about these symptoms than did people who had significant coronary atherosclerosis. The two groups were not significantly different on reassurance-seeking and avoidance of activities factors.

Discussion

In this study of people undergoing electron beam tomography screening for CHD, support was found for the three-factor model of the CAQ originally described by Eifert, Thompson, and colleagues (2001). However, a newly derived four-factor model provided a better fit for the data from the current sample of 658 participants and the resulting factors also seemed to have greater face validity. Furthermore, parallel analysis, which takes into account sample size in determining the number of factors, also supported the four-factor solution for these data. One explanation for the difference between the two models might be the sample sizes of the two studies. The present study included six hundred fifty-eight people, whereas Eifert, Thompson, and colleagues' study (2000) involved data from one hundred eighteen people. Thus, the larger sample size may have provided more power to detect this fourth factor. The four factors can be described as attention to cardiac symptoms (heart-focused attention or HFA), avoidance of activities that might bring on these symptoms (avoidance), worry and fear of having these symptoms (worry), and seeking reassurance when having these symptoms (reassurance-seeking). The results of this study also suggest that regardless of whether or not CHD was present, subjects had the same four-factor structure on this measure of cardiac anxiety underscoring the stability of the 4-factor solution across groups.

Further comparisons of participants based on the presence or absence of CHD showed that individuals who did not have evidence of coronary artery calcification had higher mean scores on the two factors related to heart focused attention and worry. This finding may appear counterintuitive but is consistent with what could be expected from individuals who are overly focused on health related concerns. Similarly, the degree of coronary artery calcification did not affect how participants responded to items pertaining to avoidance of activities that would induce symptoms, nor was it related to how often participants sought reassurance from healthcare professionals or family members. Furthermore, these findings are consistent with models of anxiety that state that people who are hypervigilent to and have a negative (i.e., anxious) affective response to physical symptoms are more likely to make incorrect judgments about what those symptoms mean (e.g., Clark, 1988; Cox, 1996; Eifert, 1992; Eifert, Hodson, Tracey, Seville, & Gunawardane, 1996; Rapee, & Medoro, 1994). There is thus a greater chance of making a cognitive or interpretive error when one is excessively focused on either potential health related problems or the potential for catastrophic outcomes.

These results suggest that efficacious cognitive behavioral interventions for people with heart related fears might include exposing them to their threatening physical symptoms (i.e., interoceptive exposure) coupled with cognitive strategies to reevaluate their beliefs about the meaning of these symptoms. The desired outcome would be a reduction in the allocation of attentional resources to the presence of symptoms and diminished fear and anxiety related to the physical symptoms due to a more realistic appraisal of core beliefs regarding these symptoms. Kisely, Campbell, and Skerritt (2005) reviewed the limited treatment outcome literature on treatment for cardiac related anxiety and found some initial support for cognitive behavioral interventions. Furthermore, recent developments in the area of health related anxiety (Asmundson, Taylor, & Cox, 2000; Salkovskis & Warwick, 2000; Taylor & Asmundson, 2004) provide support for the use of cognitive behavior therapy, as described above, for treating hypochondriasis (i.e., health anxiety) and health related fears and avoidance. These strategies complement existing cognitive-behavioral therapies for treating cardiac related anxiety (e.g., Esler, Barlow, Woolard, Nicholson, Nash, & Erogul, 2003; Mayou, Bryant, Sanders, Bass, Klimes, & Forfar, 1997). A further extrapolation of these results suggests that by providing education about symptoms and helping patients to differentiate between anxiety and cardiac symptoms, medical professionals may decrease the overuse of the healthcare system that is typical of individuals experiencing cardiac related fears in the absence of CHD.

A limitation of this study is the naturalistic nature of our sample. Information is not known on how or why these individuals came to be screened for coronary atherosclerosis. Some participants were self-referred while others were physician referred. This sample may be more or less prone to anxiety than the population of people with cardiac symptoms. Thus, the factor structure of this measure may not be generalized past people undergoing CBT screening.

Of note, statistically significant differences with small effect sizes related to the factors of attention and worry were found in this study. However, it is quite likely that the group of people with coronary atherosclerosis is composed of two types of people: those who have an excessive amount of cardiac related anxiety and those that have a normal level of fear or concern. Thus, the people with both significant coronary atherosclerosis and high levels of anxiety may have CAQ profiles that overlap with those persons who do not have significant coronary atherosclerosis but still have high levels of anxiety. Research has shown that many people suffer excessive amounts of anxiety following major medical procedures or illness. Further research on cardiac anxiety and on the usefulness of the CAQ in its assessment may help to distinguish these groups and support specific treatments for them as well.

Additionally there may not be a theoretical basis for evaluating differences in cardiac-related anxiety between those with coronary artery calcification and those without such calcification. Taxometric approaches are more frequently applied to the study of anxiety sensitivity and future work may be to apply these approaches to the study of the CAQ.

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Table 1

Confirmatory factor analysis.

Item	One Factor Model	Eifert et al. 2000 3 factor solution			4 factor solution			
	cardiac anxiety	fear	avoidance	attention	attention	avoidance	worry	reassurance-seeking
1. I pay attention to my heart beat	0.41			0.62	0.88			
2. I avoid physical exertion	0.85		0.78			0.92		
3. My racing heart wakes me up at night	0.52			0.76			0.57	
4. Chest pain/discomfort wakes me up at night	0.50			0.79			0.68	
5. I take it easy as much as possible	0.64		0.71			0.78		
6. I check my pulse	0.21			0.42	0.72			
7. I avoid exercise or other physical work	0.83		0.75			0.92		
8. I can feel my heart in my chest	0.44			0.68	0.45			
9. I avoid activities that make my heart beat faster	0.75		0.74			0.75		
10. If tests come out normal, I still worry about my heart	0.43	0.53					0.32	
11. I feel safe being around a hospital, physician or other medical facility	0.10	0.66						0.35
12. I avoid activities that make me sweat	0.73		0.72			0.83		
13. I worry that doctors do not believe my chest pain/discomfort is real When I have chest discomfort or I feel my heart is beating fast:	0.53	0.35					0.36	
14....I worry that I may have a heart attack	0.70	0.70					0.71	
15....I have difficulty concentrating on anything else	0.80	0.61					0.87	
16....I get frightened	0.82	0.72					0.90	
17....I like to be checked out by a doctor	0.48	0.74						0.76
18....I tell my family or friends	0.46	0.72						0.63
Model Fit								
Chi-Square	1268.819		478.637				333.879	
df	45		57				58	
Chi-Square Difference (df) from 1 factor model	NA		790.146 (12)				934.94 (13)	
Root mean square error of approximation (RMSEA)	0.221		0.115				0.092	
Comparative Fit Index (CFI)	0.697		0.896				0.932	

Correlations for the four factor model are: attention with avoidance (r=.22), worry (r=.59), and reassurance (r=.36); avoidance with worry (r=.46), and reassurance (r=.16); and worry with reassurance (r=.64).

Table 2

across the groups

	4 factor Metric Invariant (both groups have same loadings)			4 Configural invariant (loadings allowed to vary for each group)							
	avoidance	**worry**	**reassurance-seeking**	**attention CAC**	**attention No CAC**	**avoidance CAC**	**avoidance No CAC**	**worry CAC**	**worry No CAC**	**reassurance-seeking CAC**	**reassurance-seeking No CAC**
				0.87	0.70						
	0.89					0.90	0.94				
		0.62						0.63	0.60		
		0.56						0.55	0.57		
	0.71					0.72	0.69				
				0.53	0.36						
	0.85					0.83	1.15				
				0.62	0.74						
	0.85					0.86	0.81				
		0.47						0.47	0.46		
			0.22							0.29	0.18
	0.82					0.81	0.89				
		0.64						0.62	0.68		
		0.75						0.74	0.78		
		0.91						0.92	0.77		
		0.92						0.91	0.89		
			0.75							0.73	0.79
			0.86							0.87	0.85
	858.014						916.206				
	326						308				
	0.077						0.084				
	0.972						0.968				
AC .19*	CAC =0 No CAC .04	CAC =0 No CAC .19*	CAC =0 No CAC−.09	CAC =0	No CAC .24*	CAC =0	No CAC .01	CAC =0	No CAC .22*	CAC =0	No CAC −.1

ups. CAC = Clinically significant Coronary Atherosclerosis; No CAC = Not Clinically Significant Atherosclerosis; RMSEA= Root mean square error of