Psychological and Perceptual Factors Associated With Arrhythmias and Benign Palpitations

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Objective: Little is known about how patients who seek medical help for benign palpitations can be distinguished from those with clinically significant arrhythmias. This study tested whether patients with arrhythmia can be distinguished from those who are aware of sinus rhythm or extrasystoles on the basis of sex, prevalence of anxiety disorders, and heartbeat perception. **Methods:** A consecutive sample of patients referred to a cardiology clinic participated in the study. Patients were diagnosed as having either arrhythmia ($N = 62$), extrasystoles ($N = 75$), or awareness of sinus rhythm ($N = 47$). They were assessed with use of the anxiety disorders and hypochondriasis modules of the Structured Clinical Interview for DSM-IV. Both patients and control subjects ($N = 35$) answered questionnaires measuring anxiety, fear of bodily sensations, and depression and underwent a heartbeat perception test. The present report focuses on patients who had palpitations but no comorbid cardiovascular disease. **Results:** Patients with awareness of sinus rhythm could be distinguished from those with arrhythmia by several variables: female sex, higher prevalence of panic disorder, poor performance on the heartbeat perception test, report of palpitations when doing the test, higher heart rates, lower levels of physical activity, and (as trends) a greater prevalence of panic attacks, fear of bodily sensations, and depression. In contrast, patients with arrhythmias rarely reported palpitations when doing the test but were more likely to perceive their heartbeats accurately than patients with sinus rhythm and control subjects. Performance on the heartbeat perception test was intermediate in patients with extrasystoles; these patients also had an intermediate prevalence of panic disorder and intermediate depression scores. **Conclusions:** Measures of panic disorder and a simple heartbeat perception test could complement medical assessment in the diagnosis of patients who seek medical help for palpitations. The results also have implications for the treatment of patients with benign palpitations. **Key words:** palpitations, arrhythmia, panic attacks, sex differences, heartbeat perception

BDI = Beck Depression Inventory; BSQ = Body Sensations Questionnaire; DSM-IV = *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition; FQ = Fear Questionnaire; SCID = Structured Clinical Interview for DSM-IV Axis I Disorders—Patient Edition; STAI = State-Trait Anxiety Inventory.

INTRODUCTION

The uncomfortable awareness of a beating heart, palpitations, is reported by as many as 16% of patients in general medical settings (1) and is the second most common reason for referral to cardiologists (2). Palpitations are experienced in a variety of ways, including pounding or racing of the heart, missing a beat, flip-flopping in the chest, rapid fluttering of the chest, or pounding in the neck (3).

Benign Palpitations: Search for a Cause

The majority of palpitations are medically benign. Weber and Kapoor (4), who studied 190 consecutive patients with palpitations attending a university medical center in the United States, found that only 43% had palpitations of a cardiac origin. Thus, more than half of the patients reporting palpitations do not have clinically significant arrhythmias. Two forms of benign palpitations can be distinguished: Ectopic beats or extrasystoles are experienced as irregular or missed beats, whereas palpitations associated with the awareness of sinus rhythm are experienced as regular but racing or pounding beats. Ziemetbaum and Josephson (3) concluded in a recent review that patients with such benign palpitations are the most challenging cases. These patients often undergo a variety of unnecessary diagnostic procedures, and, as Ziemetbaum and Josephson (3) suggest, "the physician's fear of missing a treatable condition may lead to the inappropriate use of expensive tests with little diagnostic and therapeutic value." Repeated testing is common, because the reassurance provided by negative findings wears off over time and because patients seem to be unable to remember accurately the results of previous tests when followed up 6 months later (5).

It would be desirable to identify the factors that explain benign palpitations to reduce the likelihood of unnecessary or repeated cardiologic investigations and to obtain indications for treating these symptoms. Previous research suggests that two factors may be associated with benign palpitations, sex and anxiety. First, women seem to be more likely than men to report cardiac symptoms that do not have an organic cause (4, 6–8). Second, there is a high prevalence of panic

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disorder and other psychiatric symptoms among patients with palpitations (and among cardiology patients in general) (9–12). In Weber and Kapoor's study (4), palpitations were associated with anxiety disorders, mainly panic attacks or panic disorder, in 31% of patients. The authors did not report what proportion of patients with a cardiac origin of their palpitations suffered from panic disorder. Barsky et al. (13) found that 19% of 145 consecutive palpitation patients referred for investigative 24-hour electrocardiographic monitoring had a diagnosis of current panic disorder; these patients also had high scores on measures of somatization and hypochondriasis, but it was not possible to determine whether there were any differences on these measures between palpitation patients with and without clinically significant arrhythmias. An unusually high prevalence of panic disorder, 67%, was reported in a retrospective study of 107 patients with supraventricular tachycardia (14). Thus, although there is evidence of substantial overlap between palpitations and panic disorder, prevalence estimates vary widely, probably as a result of widely varying recruitment procedures. Furthermore, whether there are differences in the prevalence of panic disorder between patients with clinically significant arrhythmias and those with benign palpitations remains unclear.

Why Do Many Arrhythmias Remain Unnoticed?

Studies of the general population have shown that ventricular ectopic activity is common in the general population, occurring in 50% to 55% of people younger than 30 years, in 64% to 73% of middle-aged men and women, and in an even higher percentage of people older than 60 years (15). Atrial premature beats are also common (16–18). However, the likelihood that arrhythmias will be noticed is low, even in patients who seek medical help for palpitations. Barsky et al. (19) studied 137 patients with palpitations with 24-hour ambulatory electrocardiographic monitoring and found that 63.5% of patients did not detect any of their arrhythmias. Only 19% detected more than 1% of the cardiac events, and even the most sensitive patients failed to notice the vast majority of their arrhythmias. We need to know why the vast majority of arrhythmias remain unnoticed and why only some people notice them and seek help. Individual differences in the sensitivity of heartbeat perception may play a role.

Research on panic disorder has suggested that an enhanced sensitivity in perceiving one's heartbeat may underlie the frequent reports of palpitations in patients with this disorder (20, 21). Patients with panic disorder with agoraphobia were shown to be more accurate in perceiving their heartbeats than patients with specific phobias or depression and normal control subjects (20–23). Good heartbeat perception predicted maintenance of panic attacks during a 1-year follow-up period (24). Our research has also shown that hypochondriacal patients who were concerned about heart disease were more accurate in perceiving their heartbeats than control subjects and hypochondriacal patients with other concerns (eg, cancer) (25). There is also some indication that patients with social phobia may be as good as patients with panic disorder at perceiving their heartbeats (26). Thus, it seems that an enhanced ability to perceive one's heartbeats may contribute to the sensation of palpitations in patients with anxiety disorders or hypochondriasis. A study of patients referred for ambulatory Holter monitoring suggested that this also applies to patients presenting with palpitations. Barsky et al. (27) found that a significantly greater proportion of such subjects perceived their resting heartbeats more accurately than did control subjects. However, they did not have access to cardiac information and thus were unable to determine whether there were differences in heartbeat perception between diagnostic subgroups of patients with and without arrhythmias.

Aims

The aim of the present study was to investigate in a representative sample of referrals to a cardiac clinic whether there are differences between patients with clinically significant arrhythmias and those with an awareness of extrasystoles or sinus rhythm in any of the factors associated with palpitations described above (ie, sex, prevalence of anxiety disorders, and heartbeat perception).

METHODS

Participants

One hundred ninety-three consecutive patients referred from primary care practices to the cardiology clinic of Northampton General Hospital (Northampton, UK) for evaluation of palpitations were recruited for the study. The clinic provides a specialist cardiologic service for a defined urban and surrounding rural area. Patients underwent clinical assessment (interview, physical examination, and resting electrocardiography) by an experienced cardiologist (D.C.S. or J.B.). Following standard clinical guidelines (3, 28), more detailed investigation by ambulatory and/or exercise electrocardiography was performed in 54% of the patients. On the basis of the cardiologic assessment, patients were classified into three groups (without knowledge of the results of the psychological assessment and heartbeat perception test): those with arrhythmias (eg, atrial fibrillation and paroxysmal supraventricular tachycardia), those with extrasystoles, and those with awareness of sinus rhythm.

Arrhythmias. Palpitation due to clinically significant arrhythmias was diagnosed if there was electrocardiographic confirmation

of arrhythmia at the time of symptoms or if the patient had a history of one of more episodes of rapid palpitations of sudden onset and offset. Sixty-two patients (34%) met this criterion.

Extrasystoles. Palpitation due to extrasystoles was diagnosed if there was electrocardiographic confirmation of atrial or ventricular extrasystoles at the time of symptoms or if the patient had a history typical of extrasystoles and no other arrhythmias. Seventy-five patients (41%) met this criterion.

Awareness of sinus rhythm. Palpitation due to awareness of sinus rhythm was diagnosed if an electrocardiogram recorded at the time of symptoms showed normal sinus rhythm or sinus tachycardia or if the patient had a history of awareness of forceful, regular beating of the heart, at a rate <140 beats/min, not of sudden onset or offset, and without other clinical or electrocardiographic features indicating a possible substrate for tachyarrhythmia (ie, no underlying cardiac disorder). Forty-seven patients (25%) met this criterion.

The remaining nine patients were excluded because they did not attend or complete the cardiologic assessment ($N = 4$), suffered from noncardiac chest pain rather than palpitations ($N = 2$), suffered from neurological conditions rather than palpitations (eg, migraine headaches, $N = 2$), or because palpitations were no longer a symptom ($N = 1$).

Twenty-two percent of patients had a comorbid cardiovascular disease (eg, ischemic heart disease, valvular disease, cardiomyopathy, structural heart disease, or hypertension); that is, they had a cardiovascular abnormality that existed in addition to the palpitations but was not their cause. There was no difference between patient groups in the prevalence of comorbid cardiovascular disease ($\chi^2(2,184) = 1.92$, $p > .38$).

The patient groups differed in age (mean = 44, 48, and 41 years for the arrhythmia, extrasystole, and sinus rhythm groups, respectively; $F(2,183) = 3.37$; $p < .05$). Patients in the extrasystole group were significantly older than those in the sinus rhythm group. A detailed description of the clinical features of the patient groups are available elsewhere (R. A. Mayou, et al., unpublished).

The control group ($N = 35$, 60% women) was recruited from hospital staff who were comparable in age and sex to the patient groups. Control subjects reported that they did not have either an anxiety disorder or palpitations.

Assessment of Anxiety Disorders

Patients were interviewed by trained research nurses using selected sections of the SCID (29) to assess whether they suffered from panic attacks, panic disorder, agoraphobia, hypochondriasis, or social phobia. When interviewing patients about panic attacks, we used the screening questions of the SCID rather than asking them whether they had additional symptoms when having palpitations. Diagnoses were reviewed by the first author, who has extensive experience in diagnosing anxiety disorders with the SCID. Diagnoses were made without knowledge of the results of the cardiologist's assessment.

Psychological Questionnaires

Patients and control subjects completed several questionnaires designed to measure symptoms of anxiety, depression, and fear of bodily sensations.

Depression. Depression was assessed with the 21-item BDI (30). The BDI is a widely used standardized measure with high reliability and validity.

Trait anxiety. Participants answered the 20-item trait version of the STAI (form Y) (31). The STAI is a widely used standardized measure with high reliability and validity.

Fear of bodily sensations. The BSQ (32) is a 17-item measure of fear of bodily sensations with good reliability and validity. It was originally developed for the assessment of patients with panic disorder and agoraphobia but has also been shown to be useful in the assessment of somatoform disorders (33).

Phobic avoidance. Participants answered the FQ, a standardized 15-item measure of phobic avoidance of established reliability and validity (34). The questionnaire assesses three domains of avoidance behavior, agoraphobia, social phobia, and blood-and-injury phobia. The total score was used for the present analysis.

Heartbeat Perception Test

Heartbeat perception was assessed with the mental-tracking paradigm developed by Schandry (35). Subjects were instructed to silently count their heart beats during signaled intervals of 35, 25, and 45 seconds without taking their pulse or using other strategies, such as holding their breath. Testing was conducted in a quiet, lowly lit office on a research ward and was performed by a trained research nurse. To prevent distraction, patients were seated so that they could not see the computer equipment or the nurse when doing the test.

During each trial of the heartbeat perception task, subjects were first presented with a warning stimulus (800 Hz, 65 dB, 100 ms) to prepare them for the trial. The warning stimulus was given 500 ms after an R wave was recorded on the subject's electrocardiogram. The start signal (1000 Hz, 65 dB, 50 ms) was triggered immediately after the third R wave that followed the warning stimulus. The tone signaling the end of the counting period (1000 Hz, 65 dB, 50 ms) was given when the interval of 35, 25, or 45 seconds was up and 300 ms after the last R wave had elapsed. The computer program determined the number of R waves occurring during the counting interval.

After each trial, subjects were asked to rate the confidence with which they had felt their heartbeats on a scale from 0 (totally uncertain) to 10 (totally certain). Before and after the test, subjects rated how anxious they felt at that moment on a scale from 0 (none) to 10 (extreme) and indicated whether they felt no (0), some (1), moderate (2), or extreme (3) heart pounding and heart racing. Because few of the participants endorsed symptoms, they were classified on the basis of whether they reported any heart symptoms before or after the test.

It has been suggested that subjects can achieve spuriously correct answers in the heartbeat perception task if they are able to estimate the time interval correctly and then calculate the number of heartbeats from general knowledge of their heart rate (36). To rule out the possibility that group differences in the heartbeat perception task could be due to differences in the ability to estimate time, participants were asked to estimate the time that elapsed between two tones. The time intervals between these tones were similar to the time intervals between the start and end signals in the heartbeat perception paradigm (23, 56, and 40 seconds). No warning stimulus was given to decrease the similarity of this task with the heartbeat perception task. The time estimation test was given after the heartbeat perception test.

Before and after the time perception test, blood pressure was measured, and mean systolic and diastolic blood pressures were calculated. Patients were also interviewed about the physical activities they regularly engaged in at work, during exercise, and at leisure. The strenuousness of each activity was rated. Individual ratings were summed to create a seven-point global rating of physical activity (20).

Statistical Analysis

Degree of inaccuracy in heartbeat perception was defined as the absolute difference between the actual number of heartbeats (AB) and counted heartbeats (CB), divided by actual heartbeats and multiplied by 100 (to express the result as a percentage error score): $[|AB - CB|/AB] \times 100$.

Mean error scores were obtained by averaging the results of the three trials. The Kolmogoroff-Smirnov test indicated that these scores were not normally distributed. The histograms showed a bimodal distribution with peaks at 5% and at 100% error. Because of the bimodal distribution, participants' performance was dichotomized into *accurate* vs. *inaccurate* perception. Schandry (37) had originally suggested a maximum difference of 2 between counted and actual beats to define accurate perception. Recent research has shown that a maximum error of 10%, which is roughly equivalent to Schandry's criterion for short trials but allows for slightly more missed beats in the longer trials, is empirically useful (23). In addition, the percentage of participants with *probably accurate perception* (maximum error of 20%) (23) and the percentage of participants who did not perceive any heartbeats were determined.

Because the time estimation task was designed to control for spuriously correct answers in the heartbeat perception test, performance in this test was determined by calculating error scores and the percentage of accurate perceivers in the same way as done for the heartbeat perception test.

Because the presence of cardiovascular disease is likely to influence the results of the heartbeat perception test and the psychological measures, group comparisons (of patients with arrhythmias, extrasystoles, or sinus rhythm and control subjects) were performed separately for patients without comorbid cardiovascular disease and those with cardiovascular disease. This report focuses mainly on patients without comorbid cardiovascular disease. There were very few differences between groups of patients with comorbid conditions.

Group comparisons of dichotomous variables were performed with χ^2 tests. Significant overall group differences or trends were followed up with separate χ^2 tests comparing pairs of groups. Group comparisons for continuous variables were performed with analysis of variance if the distribution was normal and with Kruskal-Wallis tests if the distribution was nonnormal (most psychological variables were skewed to the left). Significant overall group effects were followed up with *t* tests or pairwise Mann-Whitney *U* tests, respectively. Associations between heartbeat perception and continuous measures were tested with Spearman correlations (ρ). Associations with dichotomous variables were tested with the ϕ coefficient.

Logistic regression was used to test how well the variables assessed in the study distinguished between patients with arrhythmia and those who were aware of sinus rhythm and how well patients with an arrhythmia could be distinguished from those with benign palpitations (ie, extrasystoles or sinus rhythm).

All significance levels are two-tailed.

RESULTS

Sex Distribution and Prevalence of Anxiety Disorders

Table 1 presents the sex distribution and prevalence of anxiety disorders in the three groups of patients *without* comorbid cardiovascular disease. There were significant group differences in sex and prevalence of panic disorder. Patients who were aware of sinus rhythm were more likely to be women than patients with arrhythmias (82% vs. 53%, OR = 4.0, $p = .005$) or extrasystoles (82% vs. 63%, OR = 2.6, $p < .05$). Patients with awareness of sinus rhythm (18%, $p < .005$) and extrasystoles (12%, $p < .05$) were more likely to suffer from panic disorder than patients with arrhythmia (0%). Overall, panic disorder without agoraphobia was common among patients with benign palpitations, exceeding prevalence estimates for the general population (38–40). Panic attacks were common in all patient groups, with a trend toward a higher prevalence in the sinus rhythm group than in the arrhythmia group (47% vs. 26%, $p < .05$). Social phobia and hypochondriasis were rare. There were no significant

TABLE 1. Sex Distribution and Prevalence of Anxiety Disorders

Variable	Prevalence (%)			χ^2 Test	*p*	Significant Group Differences[a]
	Arrhythmia (*N* = 45)	Extrasystoles (*N* = 60)	Sinus Rhythm (*N* = 39)			
Female sex	53.3	63.3	82.1	7.77, *df* = 2, *N* = 144	<.05	S > A, E
Panic attacks	25.6	35.6	47.4	4.17, *df* = 2, *N* = 140	=.12	S > A*
Panic disorder	0.0	11.9	18.4	8.00, *df* = 2, *N* = 140	<.05	S, E > A
Without agoraphobia	0.0	10.2	10.5			
With agoraphobia	0.0	1.7	7.9			
Hypochondriasis	0	3.4	0	NS[b]		
Social phobia	2.3	1.7	2.6	NS[b]		

[a] A = arrhythmia group; E = extrasystole group; S = sinus rhythm group.
[b] NS = nonsignificant.
* Group difference significant if tested separately, but results of overall test were nonsignificant.

group differences in sex ratio or prevalence of panic disorder for palpitation patients who had a comorbid cardiovascular disorder.

Psychological Questionnaires

Table 2 shows the results of the psychological questionnaires measuring depression, anxiety, and fear of bodily sensations for patients without comorbid cardiovascular disorders. The sinus rhythm group had higher levels of depression (BDI, $p < .005$) and greater fear of bodily sensations (BSQ, $p < .01$) than control subjects. In contrast, patients with arrhythmias did not differ from control subjects and tended to have lower depression ($p = .06$) and fear of bodily sensations ($p = .08$) than patients with sinus rhythm. Patients with extrasystoles were more depressed than control subjects ($p < .005$) but had less fear of bodily sensations than those with sinus rhythm ($p < .05$). Trait anxiety (STAI) and phobic anxiety (FQ) were not significantly elevated in any of the patient groups.

For palpitation patients with comorbid cardiovascular disorders, only one group difference emerged. Patients with sinus rhythm and extrasystoles tended to have greater fear of body sensations that patients with arrhythmia ($\chi^2(2,20) = 6.01$, $p < .05$).

Heartbeat Perception Test

Table 3 presents the results of the heartbeat perception test for subjects without comorbid cardiovascular disorders. Patients with arrhythmia were more likely to be accurate in perceiving their heartbeats than patients with sinus rhythm (32% vs. 8%, OR = 5.4, $p < .01$) and control subjects (32% vs. 11%, OR = 3.6, $p < .05$). However, they were also *less* likely to report heart racing or pounding when doing the test than sinus rhythm patients (9% vs. 35%, OR = 5.4, $p < .005$). Patients in the sinus rhythm group performed as poorly as patients in the control group but were more likely to report palpitations when doing the test (35% vs. 0%, $p < .005$) and were more anxious than control subjects before the test ($p < .05$). Patients in the sinus rhythm group also tended to be more likely to report palpitations than patients with extrasystoles (35% vs. 19%, OR = 2.3, $p = .077$). The extrasystole group's performance on the heartbeat perception test was intermediate and did not differ significantly from that of the arrhythmia (18% vs. 32%, OR = 2.1, $p = .11$), sinus rhythm, or control group. Patients in the extrasystole group reported greater anxiety before the test ($p < .05$) and tended to be more likely to report palpitations than control subjects (19% vs. 0%, $p = .052$).

There were no significant group differences in heartbeat perception for patients with comorbid cardiovascular disease, although the pattern of results was very similar, with the largest proportion of accurate perception in arrhythmia patients and no accurate perceivers in the sinus rhythm group.

There were no significant group differences in confidence of heartbeat perception or the percentage of participants who did not perceive any heartbeats. Among palpitation patients, arrhythmia patients had the highest correlations between accuracy of heartbeat perception and confidence ratings ($\rho = 0.69$, $p < .001$). (Participants who could not perceive any heartbeats were excluded from this analysis to avoid artificial inflation of this correlation.) Accuracy and confidence were not correlated in the extrasystole and sinus rhythm groups ($\rho = 0.22$ and 0.11, respectively). A positive correlation was found in the control group ($\rho = 0.52$, $p < .01$).

TABLE 2. Results of Psychological Questionnaires[a]

Measure	Arrhythmia		Extrasystoles		Sinus Rhythm		Control		Kruskal-Wallis χ^2 or ANOVA[b]	Significant Group Differences[c]
	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median	Mean (SD)	Median		
Depression (BDI)	6.5 (7.2)	5	6.8 (5.6)	6	9.9 (9.0)	7.5	3.8 (3.9)	3	$\chi^2(3,173) = 12.59$ $p < .01$	S, E > C S > A*
Trait anxiety (STAI)	36.7 (10.0)		38.0 (10.4)		40.3 (11.8)		34.9 (8.0)		NS	
Fear of body sensations (BSQ)	1.8 (0.6)	1.6	1.7 (0.7)	1.5	2.0 (0.7)	1.8	1.6 (0.5)	1.4	$\chi^2(3,172) = 8.52$, $p < .05$	S > C, E, A
Phobic avoidance (FQ)	16.6 (13.3)	16	15.8 (13.9)	13	20.2 (15.7)	17	13.3 (10.2)	12	NS	

[a] Median is given if distribution was nonnormal.
[b] ANOVA = analysis of variance; NS = nonsignificant.
[c] A = arrhythmia group; C = control group; E = extrasystole group; S = sinus rhythm group.
* $p < .10$.

TABLE 3. Results of Heartbeat Perception Test and Relevant Background Variables[a]

Measure	Arrhythmia		Extrasystole		Sinus Rhythm		Control		χ^2 Test, ANOVA, or Kruskal-Wallis Test[b]	Significant Group Differences[c]
	Mean (SD) or %	Median	Mean (SD) or %	Median	Mean (SD) or %	Median	Mean (SD) or %	Median		
Accurate heartbeat perception	31.8%		18.3%		8.1%		11.4%		$\chi^2(3,176) = 9.10$, $p < .05$	A > S, C
Heart symptoms when doing test (%)	9.1%		19.0%		35.1%		0%		$\chi^2(3,156) = 13.52$, $p < .005$	S > A, C, E* E > C*
Anxiety										
Before test	1.0 (1.7)	0	1.2 (1.7)	0	1.8 (2.7)	0	0.3 (0.8)	0	$\chi^2(3,158) = 6.29$, $p < .10$	S, E > C**
After test	0.8 (1.5)	0	0.8 (1.4)	0	1.4 (2.5)	0	0.2 (0.4)	0	NS	
No perception	22.7%		21.7%		10.8%		22.9%		NS	
Confidence in perceiving heartbeats	4.8 (3.3)	5	4.8 (3.9)	4.8	4.7 (3.1)	5	3.7 (2.8)	4.3	NS	
Accurate time estimation	4.5%		3.3%		0%		17.1%		$\chi^2(3,177) = 11.65$, $p < .01$	C > S, E, A*
Confidence in estimating time	5.9 (1.9)		6.3 (2.5)		5.8 (2.2)		5.5 (1.6)		NS	
Heart rate (beats/min)	69.6 (10.5)		72.1 (11.4)		76.9 (15.1)		68.9 (9.1)		$F(3,173)$ $p < .05$	S > A, E, C
Blood pressure (mm Hg)										
Systolic	120.4 (15.3)		121.8 (14.0)		118.3 (14.5)		118.4 (18.4)		NS	
Diastolic	75.7 (9.3)		76.8 (9.7)		76.6 (9.8)		75.2 (10.8)		NS	
Physical activity	2.5 (1.2)	2.0	2.2 (1.3)	2.0	1.6 (0.9)	1.5	2.0 (0.9)	2	$\chi^2(3,177) = 11.66$, $p < .01$	S < A, E
Body mass index (kg/m^2)	24.2 (4.6)	23.5	24.3 (3.6)	24.3	24.5 (4.4)	24.5	25.9 (6.1)	23.9	NS	
Age (years)	39.8 (14.3)		45.8 (11.7)		39.4 (12.8)		42.3 (11.2)		$F(3,175) = 2.85$, $p < .05$	E > A, S

[a] Median is given if distribution was nonnormal.
[b] ANOVA = analysis of variance; NS = nonsignificant.
[c] A = arrhythmia group; C = control group; E = extrasystole group; S = sinus rhythm group.
* $p < .10$; ** significant if tested separately, but results of overall test were nonsignificant.

The time estimation task showed a different pattern of results (Table 3). Control subjects were more likely to estimate time intervals accurately than patients with sinus rhythm ($p < .01$), extrasystoles ($p < .05$), and, as a trend, arrhythmia ($p = .065$). Very few patients were accurate. There was no association between accurate time estimation and accurate heartbeat perception ($\phi = 0.08$, $p > .31$). Only three participants (two patients with extrasystoles and one control subjects) were accurate in both tasks.

Table 3 also shows findings for other variables that may influence performance on the heartbeat perception test, such as heart rate, blood pressure, age, physical activity, and body mass index. The sinus rhythm group had higher heart rates and lower levels of physical activity than the other patient groups (for all, $p < .05$). However, the group differences in these variables do not explain the superior performance of arrhythmia patients on the heartbeat perception test, because heart rate and physical activity were not correlated with performance in any of the patient groups or in the total group of palpitations patients (for all, $\rho < 0.17$ and $p > .24$). In control subjects, there was a trend for a correlation between heart rate and good performance on the heartbeat perception test ($\rho = 0.31$, $p = .07$). Patients in the extrasystole group were older than subjects in the other patient groups. Again, this group difference does not explain the superior performance of the arrhythmia group on the heartbeat perception test. Age was negatively correlated with performance on the heartbeat perception test in sinus rhythm patients only ($\rho = -0.36$, $p < .05$).

In additional analyses, we tested whether previously reported associations with heartbeat perception

could be replicated in the present sample of palpitation patients. Heartbeat perception was associated with sex ($\phi = 0.27$, $p = .001$). Men were more likely to be accurate perceivers than women.

Palpitation patients with panic disorder did not differ from those without panic disorder in the percentage of accurate perceivers (ie, maximum error of 10% of heartbeats), but a significantly higher proportion of them (22.2% vs. 5.0%) were probably accurate perceivers (ie, had an error score between 10% and 20%), resulting in a significant group difference when this category was included in the analysis ($\chi^2(2,179) = 7.71$, $p < .05$). The same result was found when we compared all palpitation patients with any form of anxiety disorder (panic disorder, hypochondriasis, or social phobia) to those without any anxiety disorder (37.5% vs. 5.3% probably accurate perception, $\chi^2(2,179) = 12.71$, $p < .005$).

Logistic Regression

The first logistic regression analysis tested how well the variables included in this study could distinguish patients with arrhythmia from patients with awareness of sinus rhythm. The following predictor variables were chosen because they had shown significant differences between these groups: sex, panic disorder, accurate heartbeat perception, heart symptoms when doing the test, heart rate, and physical activity. On the basis of these variables, 80% of the patients were correctly classified (84% of sinus rhythm and 75% of arrhythmia patients). The following four variables showed unique contributions to the prediction: physical activity (*Wald* = 8.93, $r = 0.25$, $p < .005$), sex (*Wald* = 4.38, $r = 0.15$, $p < .05$), palpitations during the heartbeat perception test (*Wald* = 4.23, $r = 0.14$, $p < .05$), and performance on the heartbeat perception test (*Wald* = 4.01, $r = 0.14$, $p < .05$).

Furthermore, we tested how well patients with arrhythmias could be distinguished from patients with benign palpitations (extrasystoles or sinus rhythm). The only variables that distinguished both groups with benign palpitations from arrhythmia patients were panic disorder and accurate heartbeat perception. These variables classified 70% of the patients correctly (33% of the arrhythmia patients and 86% of the other patients). Only good heartbeat perception showed a unique contribution to the prediction (*Wald* = 4.49, $r = 0.12$, $p < .05$).

DISCUSSION

This study replicated and extended previous findings on correlates of palpitations in a consecutive sample of patients referred to a specialist cardiology service. The recruitment method ensured the representativeness of the sample and thus overcame the limitations of highly selected populations in other studies. In addition, this is the first study to report psychological differences between patients with clinically significant arrhythmias and those with benign palpitations.

Panic Attacks

Consistent with earlier studies, patients with palpitations reported a high prevalence of current panic attacks of 26% to 47%, which substantially exceeds the lifetime prevalence (using similar criteria) of 7.3% reported for the general population (38). The prevalence of panic disorder without agoraphobia in the present sample of patients with benign palpitations (10%) was also much higher than the annual prevalence of 0.9% to 2.2% found in the general population in several countries (40) and the 0.8% point prevalence reported for the United Kingdom (39). This finding is in line with results of previous studies (4, 13), although the overall prevalence of panic disorder in the present sample was somewhat lower than in American studies. This difference may reflect different referral practices. For example, primary care practitioners in the United Kingdom may be more inclined to diagnose anxiety disorders without detailed specialist investigations. Also, self-referrals to cardiologists are not possible in the British National Health Service.

For patients with arrhythmias who did not have comorbid cardiovascular disorders, we found a low prevalence (0%) of panic disorder (although 26% had infrequent panic attacks). This is in contrast to the very high 67% reported by Lessmeier et al. (14) for patients with paroxysmal supraventricular tachycardia. Besides differences in referral practices, this may reflect differences in the assessment of panic disorder. In the present study, we used the SCID to assess the presence of panic attacks as defined in DSM-IV rather than asking the patient what other symptoms accompanied their palpitations; Lessmeier et al. (14) retrospectively reviewed the symptoms that accompanied the paroxysmal supraventricular tachycardia.

The present study also replicated earlier findings of a relationship between good heartbeat perception and panic disorder. Although Barsky et al. (13) did not find that palpitation patients with and without panic disorder could be distinguished on the basis of mean error when counting their heartbeats, a recent reanalysis of their data in combination with those of other studies indicated a significant difference between patients with and without panic disorder in terms of the pro-

portion of accurate, probably accurate, and nonaccurate perceivers (23). The present results are nearly identical to those of the meta-analysis of previous studies. Furthermore, we replicated previous findings showing that good heartbeat perception is associated with male sex (41), supporting the validity of the findings on heartbeat perception in the present sample.

Perceptual and Psychological Factors That Distinguish Subgroups of Palpitation Patients

The present study identified four variables that may help predict whether patients presenting with palpitations report symptoms because they have clinically significant arrhythmias or because they are aware of sinus rhythm.

First, patients in the sinus rhythm group were more likely to be women than those with arrhythmia. This finding is in line with previous findings that women are overrepresented in groups of patients with noncardiac chest pain (6–8) and palpitations of noncardiac origin (4).

Second, the sinus rhythm group tended to have elevated levels of psychiatric symptoms (panic disorder, depression, and fear of bodily sensations) compared with the arrhythmia group. The prevalence of panic attacks was elevated in patients with arrhythmia, but these patients did not suffer from panic disorder and were similar to control subjects on measures of anxiety and depression.

Third, patients with awareness of sinus rhythm were distinguished from patients in the other groups because they exercised less and had higher heart rates. Besides sex differences, this finding may reflect effects of physical deconditioning, which may contribute to the likelihood of experiencing palpitations. The logistic regression analysis suggested that the contribution of low physical activity to the prediction of group differences was independent of sex differences.

Fourth, the groups showed very different patterns in performance on and self-reports in the heartbeat perception test. Arrhythmia patients performed better on this test than did sinus rhythm patients and control subjects. Their superior performance could not be explained by differences in their ability to estimate time intervals or by differences in heart rate or physical activity. The high correlation between performance and confidence ratings in this group supports the validity of their superior performance, in that arrhythmia patients who did not perceive their heartbeats accurately were aware of their inaccurate reports. There are two possible explanations for the association between arrhythmias and good heartbeat perception. First, episodic arrhythmias might be associated with unmissable sensations that enable the patient to learn to discriminate their normal heartbeats from other sensations. Second, good heartbeat perception may make the patient aware of arrhythmias that remain unnoticed by those who do not seek treatment. The poor ability of most individuals to perceive their heartbeats may be one reason why the majority of ectopic beats remain unnoticed in the general population (15). Because arrhythmia patients do not seem to be particularly worried about bodily sensations, good heartbeat perception may be one factor contributing to their decision to seek treatment.

We had also expected an association between awareness of sinus rhythm and heartbeat perception. Previous results from patients with panic disorder and hypochondriasis (20, 22, 25) and from palpitation patients referred for ambulatory electrocardiographic monitoring (27) suggested that perception of sinus rhythm would be associated not only with anxiety but also with an enhanced ability to perceive one's heartbeats. However, this was clearly not the case, because patients in the sinus rhythm group performed as poorly as control subjects. In addition, they were not able to evaluate whether their reports were accurate (as reflected by the lack of correlation between performance and confidence ratings). Interestingly, they were more likely to report heart racing or pounding when doing the test than control subjects or arrhythmia patients. This suggests that complaints of palpitations in this group either reflect misperceptions of other bodily functions as cardiac sensations or are a result of shifts in attentional focus; ie, patients who are usually unable to perceive their resting heartbeats may perceive even moderate heart rates as fast and sudden if external or internal conditions facilitate perception (eg, lying down or caffeine consumption).

Findings for patients with extrasystoles were intermediate between those for patients in the sinus rhythm and arrhythmia groups. A significant proportion of patients with extrasystoles experienced panic disorder or panic attacks, and they were more depressed than control subjects. The performance of the extrasystole group on the heartbeat perception test was intermediate between that of the arrhythmia ($p = .11$) and sinus rhythm groups. The majority were not able to perceive their heartbeats accurately but were more likely than control subjects to report anxiety or (as a trend) palpitations when doing the test.

Clinical Implications

The results of this study have implications for the diagnosis and clinical management of patients presenting with palpitations. Several psychological and

perceptual variables distinguished patients with arrhythmias from those with awareness of sinus rhythm, and a substantial proportion of patients (80%) could be correctly classified on the basis of these variables. Female sex, low levels of physical activity, palpitations when trying to feel one's heartbeats, and poor performance on the heartbeat perception test were the most important predictors of sinus rhythm. Because these variables are easy to assess, they might provide useful information for the diagnosis of patients whose presenting complaint is racing heartbeats. It may be possible to incorporate a simpler version of the heartbeat perception test into the clinical assessment (eg, the patient could count heartbeats while a nurse counts the pulse). If a patient reports heart symptoms when doing the test but is unable to feel heartbeats accurately, this would provide positive diagnostic information in that the symptoms reflect misinterpretations of other sensations as heartbeats or misconceptions about the speed of normal heartbeats. Similarly, low levels of physical activity would point to a role of deconditioning in the palpitations, which would also provide positive diagnostic information. Obviously, these variables should be interpreted in conjunction with the characteristics of the palpitations and other important medical information (28) to prevent misdiagnosis of psychological causes of palpitations when an arrhythmia is present (14, 28).

Patients with extrasystoles were more difficult to distinguish from patients with arrhythmia, and prevalence of panic disorder was the only variable that showed a significant group difference. It might be possible to incorporate a simplified or possibly a self-report version of the appropriate SCID module into the clinical assessment to identify patients in whom panic disorder is a cause of their complaints. In addition, patients in the extrasystole group were only half as likely as those in the arrhythmia group (18% vs. 32%) to perceive their heartbeat accurately, although this difference was not statistically significant ($p = .11$), probably because of the size of the sample.

Previous research has shown that the routine practice of reassuring patients with benign palpitations that the results of diagnostic tests were negative is not effective in the long term (5). The feedback is not remembered well, and patients tend to request additional tests a few months later. Thus, knowledge of negative test results does not seem to change patients' perception that their heart function is abnormal. Additional intervention may be required to achieve this goal. Results of the present study suggest that poor performance on the heartbeat perception test combined with the subjective experience of heart symptoms when focusing on one's heartbeats was among the most important variables distinguishing patients with benign palpitations from those with clinically significant arrhythmias. Patients who show this pattern might benefit from education about palpitations, about the conditions that facilitate heartbeat perception, about the relationship between symptoms and heartbeat perception, and possibly training in discriminating heartbeats from other sensations. Such education may have direct effects on the perception of normal cardiac activity and may also reduce the frequency of panic attacks and the patients' fear of bodily sensations. Some patients may require additional intervention to correct misinterpretations of bodily sensations, such as those developed for treatment of panic disorder (42). In a recent controlled trial (R. A. Mayou et al., unpublished), a short-term intervention that included information about the cause of palpitations, discussion about the patient's beliefs about the symptoms, and advice on coping with symptoms, was shown to be effective in reducing symptoms and improving mood.

The present study also showed differences in psychological adjustment between subgroups of patients with palpitations that have not been previously reported and seem to have implications for clinical management. Whereas arrhythmia patients generally did not report psychological problems, a large proportion of the sinus rhythm group reported elevated anxiety and depressive symptoms. Indeed, panic attacks may be the main reason why many of these patients sought treatment for their palpitations. Prospective studies from both the United Kingdom (43) and United States (5, 44) have shown that psychiatric morbidity predicts poor outcome in patients with palpitations. In general, however, the patients were not referred for psychiatric or psychological treatment (44). Untreated psychological problems may thus maintain the complaint of palpitations in a significant subgroup of patients with benign palpitations. Referral for psychological treatment may be indicated for patients who are aware of sinus rhythm or extrasystoles and suffer from panic disorder and other psychological symptoms, and this may help improve the poor prognosis of these patients.

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