EDITORIAL

The sound of silence is music to the heart

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The underlying tempo of different types of music may have an effect on heart rate and blood pressure

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In 1918 Hyde and Scalapino described the effects of different types of music on heart rate and blood pressure. They commented, "the minor tones of music increased the pulse rate…and lowered the systolic and diastolic pressures. On the other hand the stirring notes of Toreador's song…increased the systolic and pulse pressure…[and] increased the pulse rate".[1] In 1920 Diserens noted that music also had an effect on respiratory timing: "in general respiratory rhythm follows that of the music".[2] Since then, numerous studies have documented the effects of different types of music on heart rate, blood pressure and respiratory frequency.[3 4] In this issue of *Heart*, Bernardi and colleagues suggest, in contrast to Hyde and Scalapino, that it is not the key in which the music is set, but the underlying tempo that is important in determining the physiological response.[5]

ENTRAINMENT OF RESPIRATION

One of the features of biological oscillators is their ability to synchronise to, or be entrained by, external inputs.[6] While the exact nature of the central respiratory pattern generating system remains open to debate,[7 8] it may broadly be classified as a form of oscillator, and this oscillator may be entrained by a wide range of inputs, including afferent feedback from muscles during rhythmic movement or exercise,[9] by somatic afferent nerve stimulation,[10] vestibular stimulation,[11] or by cardiac afferent inputs.[12] The ability of these "non-respiratory" inputs to alter respiratory timing has largely been ignored in studies of respiratory control.

Auditory inputs have also been shown to produce entrainment of respiratory timing,[3] as well as to entrain spinal motor neurones and to produce faster reaction times.[13]

Bernardi and colleagues[5] studied the effect of different styles and tempos of music on cardiovascular and respiratory control in both musicians and non-musicians. They found that breathing frequency was increased by musical inputs, and that this increase was proportional to the tempo of the music. They describe 1:4 entrainment of breathing to the underlying musical rhythm at slow tempos, and 1:8 entrainment at faster tempos, and while they suggest that at intermediate tempos an integer ratio is not observed, this does not preclude more complex coupling relationships from being present.[6] The correlation between musical tempo and respiratory frequency was greater in musicians than non-musicians, consistent with the earlier observation of Haas and colleagues that musicians showed a greater degree of respiratory entrainment than non-musicians.[3] It is possible that the musician's trained ear effectively resulted in a stronger input signal from the music to the respiratory oscillator than in the non-musician, resulting in the stronger correlation between tempo and respiratory rhythm.

In addition to describing an increase in respiratory frequency, Bernardi and colleagues[5] also noted an increase in heart rate and blood pressure, with the increase again correlated to music tempo. Whether the observed increases in heart rate and blood pressure are the independent consequence of entrainment/stimulation of sympathetic neural oscillators on the brain, or are due to respiratory influences on sympathetic outflow,[14] may be difficult to establish.

WHAT HAPPENS WHEN THE MUSIC STOPS?

Perhaps the most interesting observation in the study by Bernardi and colleagues[5] is not their description of the effects of music on respiratory and cardiovascular function, but rather the consequences of turning the music off. They randomly interspersed a two minute period of silence between the different styles of music they studied, and found that respiratory frequency, heart rate, and blood pressure all decreased to below baseline levels. The authors suggest that the music is associated with a level of arousal, and that relaxation occurs when the music is stopped.

An alternative explanation for the observed decrease during silence is that the entrainment or forcing of the respiratory and sympathetic oscillators by the auditory input resulted in both respiratory frequency and sympathetic outflow being elevated. While the driving input was present, what was observed was the consequence not of the intrinsic state of the oscillators, but rather a product of the intrinsic state combined with a driving input. A consequence of driving the oscillators at increased frequencies may well be a decrease in the intrinsic frequency, and this decrease is what is observed in the period of silence when the music is stopped.

There are a wide range of inputs that produce significant changes in respiratory timing, heart rate, and blood pressure, from music, meditation, yoga mantra through to exercise. The importance of these inputs for regulation of the cardiovascular and respiratory systems has received relatively little attention, but perhaps we should be paying more attention to the physiology of what happens when these inputs are present, and when they are suddenly removed.

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Conflicts of interest: none

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IMAGES IN CARDIOLOGY

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Infective endarteritis on an aortic dissection flap

A 59 year old man presented to the emergency department with sudden weakness of his lower limbs associated with altered sensation. His history included coronary artery bypass grafting and St Jude aortic valve replacement, hypertension, and atrial fibrillation.

On admission the patient had resistant hypertension despite treatment with multiple intravenous agents, bilateral lower limb weakness, and decreased pin prick sensation with absent proprioception and reflexes. The lower limbs were cool and pale with absent distal pulses consistent with bilateral ischaemia.

A computed tomographic scan revealed type 1 aortic dissection arising distal to the prosthetic aortic valve extending to the common iliac arteries and the patient underwent successful surgery with implantation of a Dacron aorto-bifemoral graft.

His postoperative course was complicated by acute renal failure, coagulopathy, and sepsis. Blood cultures grew sensitive enterococcus. Transoesophageal echocardiogram (TOE) demonstrated aortic dissection and a normal prosthetic aortic valve. In addition there was an echogenic mass (see panels) at the entry tear of the ascending aortic dissection consistent with a vegetation.

After four weeks of intravenous antibiotics a repeat TOE showed resolution of the vegetation. He was discharged after a further two weeks of treatment.

Three months later he successfully underwent elective aortic root replacement using a 24 mm human allograft. Reimplantation of the previous vein graft to the allograft was also performed as well as an additional aortocoronary grafting.

Four months after cardiothoracic surgery the patient leads a moderately independent life.

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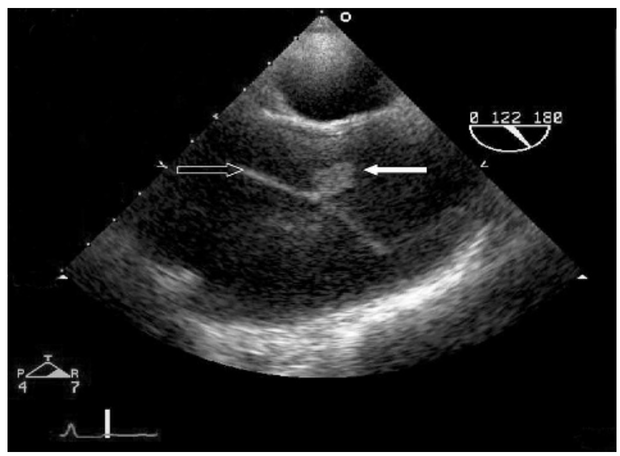
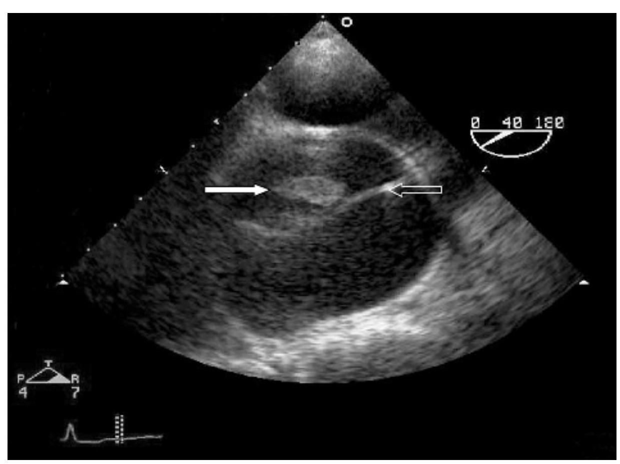


Transoesophageal echocardiography (TOE) showing an echogenic mass (solid arrow) consistent with a vegetation at the aortic dissection entry site (open arrow).



TOE showing the same echogenic mass (solid arrow) at the aortic dissection flap (open arrow).