‘Without music, life would be a mistake.’ Friederich Nietzsche (1844—1900)

‘Everything is music. A painting, a landscape, a book, a journey is worth only if its music can be heard.’ Jacques de Bourbon-Busset (1912—2001)

1. Prelude

These two quotations encapsulate my personal thinking about music. I cannot imagine my life without listening to music most of the time. Being both a surgeon and an amateur musician, I have been, for a long time, intrigued by the potential relations between medicine and music (Fig. 1).

Indeed there have been in history, many famous people who were both musicians and physicians or surgeons [1]. Just in the field of cardio-thoracic medicine, Leopold Joseph Auenbrugger (1722—1809) and René Théophile Hyacinthe Laënnec (1781—1826) provide brilliant examples; both were composers and excellent musicians; the former described chest percussion and the latter invented the stethoscope; both were able to use their musical abilities to implement their medical achievements.

In a recent study, physicians and nurses working in the operating room in three different hospitals were interviewed to evaluate the perception of the influence of music [7]. Most of the participants (93%) reported to listen to music on a regular basis outside the hospital and a majority (63%) on a routine basis in the operating room. Most professionals (63%) considered that music had a positive effect on staff communication and nearly 80% claimed that music made people calmer and/or more efficient.

Allen and Blascovich have studied the autonomic responses and the intellectual performance of surgeons during a standard laboratory psychological stressor [8]. Fifty senior surgeons, who reported to listen to music regularly during surgery, were asked to perform serial arithmetic tasks under three different conditions: silence, investigator-selected music (Pachelbel’s Canon in D) and self-selected music. Autonomic reactivity (as assessed on heart rate, systolic blood pressure and skin conductance) was significantly reduced in the surgeon-selected music condition than in the investigator-selected music condition, which in turn was significantly less than in the no-music control condition. Likewise, speed and accuracy of task performance were significantly better in the surgeon-selected music condition than in the experimenter-selected music condition, which in turn was significantly less than in the no-music control condition.

2. First movement: listening to music during surgery (medical employment of music)

There is a strong evidence that listening to music during and after surgery is beneficial to surgical patients [3—6]. Music has been shown to decrease pain, stress and anxiety and to reduce the needs for analgesic and anesthetic drugs. There are many surgical centers in which music is used as a routine in the operating room as well as in the intensive care unit.

Less attention has been paid to the potential effects of music on the operating room staff. There is nevertheless convincing evidence that music may be beneficial to surgical teams as well.

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The effect of music on surgical performance has been evaluated in a few studies, involving expert surgeons as well as junior surgeons. In the first study, eight internationally
recognized expert surgeons were randomized to perform three simple tasks on a laparoscopic simulator [9]. The tasks were performed under the four following conditions: silence, mental loading (by mental arithmetic tasks), auditory stress (by dicaotic music, a condition in which a different type of music is heard through each ear), and auditory relaxation (listening to classical music by Mozart). End-points of the study were time to complete the task and its accuracy. All experts performed the tasks more accurately while listening to classical music; the effect on time until task completion was more variable. A very similar study was conducted in a large group of junior surgeons without laparoscopic experience [10]. Forty-five novice surgeons were randomly assigned to three groups: silence, listening to activating music (classical pieces known to evoke an activated mental condition, such as Richard Wagner’s “Walkyrie”) and listening to deactivating music (music known to arouse relaxing emotions, such as Mozart’s piano sonatas). The participants were asked to subjectively consider the music as pleasant or unpleasant. The results suggested that the group listening to activating music had the worst performance; however, there was a trend toward improvement when participants considered the music pleasant rather than unpleasant. In a last study, twelve experienced surgeons undertook complex laparoscopic tasks on a simulator under three conditions: silence, noise and music [11]. Speed and accuracy of performance remained unchanged across the three conditions, suggesting that the intense concentration required by a complex task, allows experienced surgeons to effectively ‘block out’ noise as well as music.

The exact mechanism by which music might influence human physiology and particularly reduce stress response remains hypothetical. A recent study may shed some light on this matter [12]. Ten critically-ill patients were randomized into two groups: one group did not receive music whereas the other group received relaxing music (slow movements from the Mozart piano sonatas). In the group listening to classical music, blood pressure was decreased and the need for additional sedation was reduced; in this group, there was a significant increase in serum levels of growth hormone and a concomitant decrease in serum levels of interleukin-6 and stress hormones (epinephrine and dehydroepiandrosterone). These results brought the authors to the following explanation (Fig. 2). Listening to music may influence the hypothalamic–pituitary axis and increase the release of growth hormone by the pituitary gland. The stimulation of the hypothalamic–pituitary axis while listening to music may stem from the transfer effect; it has been reported that listening to music can lead to an increased activation of brain regions that are not directly involved in the process of listening. Some studies have demonstrated that there is an inverse correlation between growth hormone release and interleukin-6 release from peripheral blood mononuclear cells. Interleukin-6 is a potent activator of the adrenocortical and sympathoadrenal axes; a decrease in interleukin-6 production may therefore lead to a decrease in stress hormones release. These data were obtained using Mozart’s music in critically-ill patients. Further studies are necessary to investigate how listening to music influences human physiology in healthy people.

To summarize the first relation between music and surgery, this is a common observation that music influences human physiology. Listening to music reduces the cardiovascular responses to stress, provides relaxation and promotes concentration. There is growing evidence that listening to music improves manual performance and intellectual efficiency. For all these reasons, listening to music during surgery should be beneficial to surgeons and operative room staff members. However, musical experience and sensibility to music may vary considerably between individuals and, therefore, the beneficial effects of listening to music during surgery may vary accordingly.

3. Second movement: playing music and performing surgery (medical explanation of music)

The development of modern techniques such as magnetic resonance imaging (MRI) has made possible to obtain three-dimensional high resolution images of the living brain. Statistical approaches allow precise quantification of different aspects of brain structure (morphometric MRI). The brain of living musicians has been extensively studied and
compared to the brain of non-musicians (Fig. 3). All these studies have clearly established that musicians have structural and functional brain specializations [13—15].

Playing a musical instrument is a complex activity which requires many cognitive skills (e.g., the translation of virtually perceived musical symbols into motor commands with simultaneous auditory monitoring of output). Musical performance involves several brain areas including the motor and sensory cortex in the frontal and parietal lobes, the auditory cortex in the temporal lobe, the anterior portion of the corpus callosum between both hemispheres and the cerebellum; accessory areas are involved as well in the inferior frontal area (music reading), the inferior temporal cortex (pitch) and the superior parietal area (rhythm). Structural and functional modifications have been demonstrated in all these brain regions, when comparing professional musicians with amateur musicians and non-musicians. These specializations are often instrument- or effector-specific and correlate with aspects of the training history supporting the view that they are the result, rather than the cause, of skill acquisition [16]. The changes are correlated with the age at which musical practice has begun and to the intensity of the practice. The musician brain constitutes a model, ’par excellence’, of neuroplasticity. The results obtained in musicians suggest that structural brain differences in adult experts (whether musicians or expert in other areas) are likely due to training-induced brain plasticity [17]. Dysfunctional plasticity in musicians, known as musician’s dystonia, may even lead to deterioration of extensively trained fine motor skills.

Some cerebral modifications noted in musicians may, however, be innate. Some people are born with the ability to identify a sound by its pitch, without any reference; this is known as absolute pitch. Absolute pitch has been linked to one specific structure in the human brain (left planum temporale). It has been demonstrated that the left planum temporale in musicians with absolute pitch is more developed than in musicians without absolute pitch. Discussion is ongoing to determine whether this specific modification is congenital or secondary to some form of functional plasticity which is possible only during a critical period of brain development.

Performing surgery is also a complex human activity which involves many cerebral functions. It is interesting to note that playing music and performing surgery have in common several cognitive skills; this includes: great accuracy in motor performance, integration of multimodal sensory and motor information, coordination between eye and hand, spatial visualization, intense concentration, low reaction time, efficient mental rotation. It is therefore reasonable to speculate that musicians and surgeons may have in common some brain specializations and postulate that experience in playing music may help in performing surgery.

In a recent study, 30 novice medical students without laparoscopic experience were asked to perform simple laparoscopic tasks on a simulator [18]. Some students never played a musical instrument; some used to play but were not playing anymore and the remaining was currently playing routinely. The participants, who were currently playing a musical instrument, performed the laparoscopic tasks significantly faster than those who did not. The visuo-spatial abilities used in laparoscopic performance may be enhanced in individuals involved in playing a musical instrument.

These data should be put together with other results which show that learning during sensitive periods of development does not only affect selectively the development of particular skills, but can also influence the brain response to new learning experiences. This so-called meta-plasticity (‘learning to learn’) has been demonstrated in recent studies. Professional pianists showed greater improvement in tactile acuity, following fingertip stimulation [19]. From the surgical point of view, several studies have shown that experience in playing video games is correlated with improved surgical performance on skills simulators and in the operative environment [20—22].

As a summary of the second relation between music and surgery, it can be said that musicians have special brains and that playing music and performing surgery have in common a number of cognitive functions. One could also speculate that surgeons have a special brain and that playing a musical instrument may help them in enhancing their surgical performance. This offers a large field for further research and thought.

4. Third movement: music as a metaphor for surgery

An organizing metaphor has been defined by Burke as follows: ’a device for seeing something in terms of something else; it brings out the thinness of a that, or the thatness of a this’. The intellectual goal of an organizing metaphor is to provide a detailed analysis of both terms of the comparison, but the practical goal is to enlarge our understanding productively.

My purpose is to show that a detailed analysis of music performance may enlarge our vision of surgical practice. Most human activities are based on a tripartite concept made of the performer, the practice and the recipient. In music, the triad includes the musician, the interpretation and the listener; in surgery, it includes the surgeon, the operation and the patient.
4.1. The performer: musician and surgeon

To achieve an optimal performance (musical or surgical), the performer should be an expert. The question then arises to know how to acquire expertise.

For many years, the prevalent accepted theory suggested a single factor, deliberate practice, as the necessary component for acquiring expertise in a given field [23]. Deliberate practice includes all the voluntary activities which are designed specifically to improve performance. The validity of this theory has been established for various activities, including sports, music, chess, mathematics, and even medical diagnosis. Deliberate practice should be started as young as possible and carried out intensively for a long period of time (at least 10 years). Intense deliberate practice leads probably to domain-specific cognitive modifications, an example of neuroplasticity.

The deliberate practice theory has been improved, at least in the musical domain, by the summation theory, as proposed by Detterman and Ruthsatz [24]. In addition to high motivation and intense deliberate practice which remain the leading factors, expert musicians have a general intelligence above the average population and domain-specific skills, known as musical intelligence. Musical intelligence includes a combination of technical and expressive abilities which are mandatory for musical practice. Interestingly, specific tests (such the Gordon’s Test of Music Audiation) have been developed to evaluate musical aptitude and the potential to learn in the musical domain. Expert musicians are bright (high intelligence quotient), exceptionally talented (enhanced domain-specific skills) and highly motivated (intense deliberate practice).

I believe that these data can productively be applied to the education of expert surgeons. In most European countries there is currently a disturbing situation; bright young people are not attracted by medical studies anymore, and bright medical students are not attracted by a surgical career; this situation must be changed and the brightest students should be prompted to become surgeons. The most talented of them should then be selected; it is therefore necessary to design specific tests to evaluate the potential technical and psychological abilities to perform surgery. Once selected, young surgeons must be trained as early as possible, intensively and efficiently (including animal laboratories, simulators and clinical practice).

4.2. The practice: interpretation and operation

It is intriguing to note that, at least in the English language, the same words are used to describe both practices: a musical ‘performance’ is produced in a ‘theatre’ and a surgical procedure is ‘performed’ in an ‘operating theatre’. However, the metaphor can be carried out much further than this simple semantic analogy.

Most of the qualities developed by musicians during performance, can be applied metaphorically to surgical practice:

Concentration. Intense concentration is a basic requirement for both musical performance and difficult surgical procedures.

Strictness. A strict respect of the musical score is obviously mandatory. Similarly, the steps of a surgical procedure must be followed strictly to provide a satisfactory outcome.

Anticipation. A musician is reading the score many bars in advance of what he or she is playing. A surgeon should also prepare subsequent surgical steps well in advance.

Improvisation. Improvisation is the essence of jazz music. Even in classical music, there is place for some improvisation called rubato; this makes the expressive differences in interpretation between several performers. Improvisation in surgery is necessary to take care of any unexpected operative event.

Virtuosity. Musical virtuosity includes several elements such as style, elegance, rhythm, spontaneity, rapidity or risk-taking. The same words can be used to define surgical virtuosity which makes a surgical operation safer and quicker.

Ability to listen. A mandatory quality for a musician is the ability to listen to other musicians. In a surgical team, the surgeon should also be able to listen to the ideas and concerns of all the other team members.

Capacity to create harmony. Harmony is the essence of musical performance. This a common experience that an efficient surgical team is constituted by a group of several people, physicians and nurses, working in harmony.

I am convinced from personal experience, that developing those qualities inherent to musical practice and adapting them to surgery could improve surgical performance.

4.3. The recipient: listener and patient

The recipient, third element of the operative triad, is the actual finality.

The finality of music is to arouse in the listener emotions of all kinds. According to the external circumstances and the music itself, these emotions could provide pleasure, refreshment, consolation or fulfillment and, finally, restore harmony and well-being [25]. As previously discussed, recent studies begin to elucidate the physiologic mechanisms by which listening to music may influence human physiology and psychology.

The finality of surgery is, apparently, simple; it is to restore normal anatomy or physiology. This is, actually, the finality of surgical ‘science’, which is disease-centered and based on procedures, techniques and evidence-based protocols. This is forgetting the humanistic dimension of medicine (and surgery) which is medical humanism, often called medical ‘art’ [26]. Humanism in medicine can be defined as those aspects of patient care which, in addition to restoring good health, include meeting patient’s needs for harmony and well-being. It is centered on the patient as a whole, not only on the disease. The finality of medical humanism is therefore pretty much similar to that of music.

The core qualities of medical humanism are empathy and compassion.

During the last century, medical science has obviously been privileged and medical humanism devalued in favor of techniques and procedures. However, it is increasingly
recognized that an appropriate balance should be restored and maintained between medical science and medical humanism. Consequently, humanism should be an important component in the curriculum of medical and surgical studies.

Arts (such as literature, poetry, painting or photography) are commonly used to teach humanities. Music is used as well. Music may even be the best suited art to teach humanism and to evaluate humanistic qualities in students and residents [27]. Music teaches how to listen, an essential step in the learning of empathy and compassion. Music is a universal language that everybody can use and understand. Music is probably the most emotive art and the most powerful in arousing human emotions. For all these reasons, many educationalists think that music is the best suited art to teach emotionally-based subjects such as humanities and ethics.

To summarize, the organizing metaphor involving musical performance and surgical practice may be very productive and enlarge our vision of surgery. It may help in selecting and training young surgeons, in improving surgical efficiency and, most importantly, in restoring the patient as the center of surgical practice.

5. Coda

As quoted as preamble to this address, Friederich Nietzsche stated that 'without music, life would be a mistake'. My purpose has been to show that the relations between music and surgery are multiple, intimate, diversified and fruitful.

At the risk of overdoing the metaphor, I would like to paraphrase Nietzsche and suggest that 'without music, surgery may be a mistake'.

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References
