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A Tribute to Noise

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Abstract. *A tribute to noise.* Noise is not only the harmful waste of the world of sounds. Some noises have contributed, or continue to contribute, an added value in three fields at least: Internal Medicine, Audiology and Music. Moreover, they are perceived naturally by the ear (Figure 1).

Figure 1. In the early 20th century, the Italian writer Marinetti declared: "The roaring of a motor car is more beautiful than the *Victory of Samothrace*". In his slipstream, the Italian painter and musician Luigi Russolo painted "The dynamism of a motor car", evoking speed and noise. A high-powered racing car is cut into sections by a number of red arrows with different angles, passing through the city and throwing off sparks. The form situated on the right half of the painting enclosed by the first two arrowheads resembles the modern Smart. The shape on the left resembles the profile of a high-speed train. The work dates from 1912-1913. (Museum of Modern Art, Centre Pompidou, Paris).

I. Noise in internal medicine

Hippocrates: direct auscultation[1] (Figure 2a)

The island of Cos, off Minor Asia, was home to the development of the "**clinical**" school of medicine in the fourth and fifth centuries BC. Its principle was defined by Hippocrates and his school, requiring the practitioner to use his five senses to examine his patient and then to use his mind to arrive at a diagnostic conclusion. Of course, these five senses included hearing: listening to the physiological or of the pathological noises produced by the patient. Hippocrates described **succussion**, the sound of a sloshing noise when the patient was shaken by the shoulders, indicating hydropneumothorax. The Hippocratic physician also sounded the chest of the patient by applying his own ear to the thorax, and he listened to the noises of the heart and of the respiratory system. That form of auscultation, which is described as “immediate” or “direct”, was destined to be practised until the 19th century. Even when use of the stethoscope was established among practitioners, many a leading Paris physician still used a towel, which they would lodge between their ear and the patient’s thorax.

Leopold Auenbrügger: percussion[2] (Figure 2b)

This Austrian physician, the son of an innkeeper, watched his father tapping wine barrels to determine how full they were. When he became a physician in Vienna, he applied the same principle to percussion of the thorax. He practised it directly with the tip of his fingers, which allowed him to diagnose pulmonary condensations or pleurisies on the basis of the flat sounds he heard or to identify the presence of air when he heard tympanic resonance. The work describing his observations was not well received by his colleagues until it came to the attention of Corvisart, Napoleon’s physician, who translated it from Latin into French. Corvisart recognised Auenbrügger’s paternity, put the finishing touches to the approach and propagated the method throughout France.

René Hyacinthe Laennec. The stethoscope[3] (Figures 2c,3,4,5)

Unlike Auenbrügger, Laennec had a famous predecessor in the person of Hippocrates, whose works he had read. Laennec was a Breton; he was a fervent Catholic and a Royalist. Should we focus exclusively on this context to explain a sense of modesty that many will consider to be excessive and that made him uncomfortable with direct auscultation on the chest of a woman, especially when she was young and pretty? It is certainly the case that Laennec was looking for another way of listening to the noises of the heart

Figure 2.
2a. Hippocrates (460-377 BC), seated on the left, watches the god of medicine, Asclepius, coming on land on the island of Cos. An inhabitant of the island gives him a slightly warmer welcome (Roman mosaic of the second or third century AD, Cos Museum).
2b. Leopold Auenbrügger (1722-1809).
2c. René Hyacinthe Laennec (1781-1826)

and of the lungs. One day during a walk in Paris, he saw two children playing at what looked like an amusing physics experiment: one of them was rubbing one extremity of a tree trunk several metres long that was lying on the ground, while the other held his ear to the other end, allowing him to hear clearly the corresponding noise.

In July 1817, Laennec had an inspired idea: he took a bundle of paper from a notebook. He tied it up into a roll and then glued it together. It did not take long before this roll was abandoned in favour of a solid wooden cylinder, which was followed by a hollow cylinder: in this instance, an old oboe. He experimented with the tube's length, breadth, thickness and even the inner diameter. He tested several materials before opting for beechwood. The result was the first mono-auricular stethoscope. And indeed, in the early 1818, he christened his device “a stethoscope”. He recorded his observations and his conclusions in the famous *Traité de l’auscultation médiate* (“Treatise on mediate auscultation”), the first edition of which appeared in 1819. As Laennec was an adept of the totally new anatomo-clinical method, he compared the noises perceived at the thoracic level with the lesions observed during autopsies. That is why his instrument was dubbed a stetho**scope** and not (for example) “a stetho**phone**”: listening to the cardio-respiratory noises allowed him to fore**see**, in other words to **see** the lesions in advance...

The bi-auricular model was built after Laennec’s death, in 1851.

Laennec and the auscultation of the noises from the ENT cavities

Even though history has left few traces of his work in this respect, it should be pointed out that in addition to his interest in the heart and the lungs, Laennec also investigated the movements of air and liquids in other organs. In 1837, a posthumous edition of his treatise tells us that Laennec also used his stethoscope to study the auricular and sinus cavities. He applied his stethoscope to the mastoid apophysis, the frontal prominences and the root of the nose, to the upper dental arch and to the cheekbone. He heard the passage of air into the mastoid and in the various sinuses during a Valsalva-type manoeuvre. In this way, he monitored the patency of the Eustachian tube by listening for the sound of the passage of air

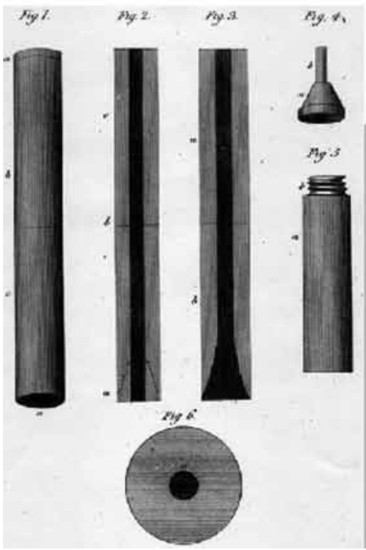
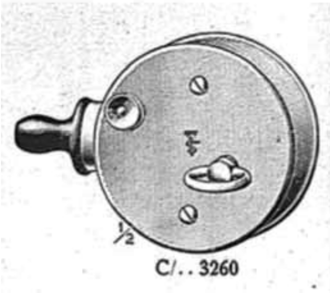


Figure 3. Different stages in the development of the stethoscope. A plate from the treatise on “mediate auscultation” (1819): a full cylinder, a hollowed cylinder with a flared opening. On the last model, you see, unscrewed and upside down, the conical shape of the widened end, intended to rest on the thorax. So the stethoscope had to be assembled first before use.

Figure 4. The stethoscope has been assembled and is ready for use. The upper part will rest on the thorax; the ear fits over the lower part of the instrument.

Figure 5. A posthumous portrait of Laennec showing him using the Hippocratic approach of direct auscultation at the Necker Hospital but holding his stethoscope in his hand! Take note of the top hat, morning coat and cane laid on the chair held by a nun. The picture also shows two medical students, one of whom is taking notes. This painting by Theobald Chartran is in the Sorbonne and dates from about 1889.



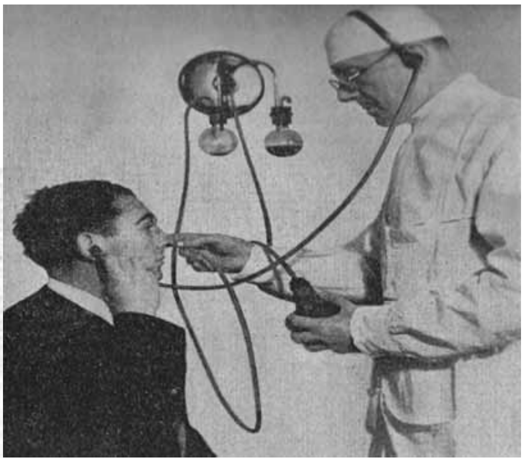


Figure 6. Barany noisemaker, adult model.

Figure 7. Georges Portmann sounding the patency of the Eustachian tube with "the tubular telephone".

and, in cases involving catarrh, identified the presence of mucus in the Eustachian tube and in the sinuso-nasal ducts on the basis of humid rales.

One particularly striking comment was: *Auscultation will be a reliable way of identifying the obliteration of the Eustachian tube*. He anticipated "the tubular telephone" that was to interest Escat about 100 years later in the 1930s.

II. Noise in Otology and in Audiology

1. Robert Barany's noisemaker[4] (Figure 6)

• Identifying profound unilateral deafness

Robert Barany described his noisemaker for the first time in 1908. Originally, the device was developed to identify profound unilateral deafness. In 1903, Barany accepted the position of assistant at the Otological clinic directed by Adam Politzer at the University of Vienna, and it was while working there that he came up with the idea for his device. It included a clock mechanism for winding it up and it produced a sort of buzzing, purring noise. The intensity could be controlled using a polished metallic button situated on the top of a metallic box. A tube shaped like a teat was introduced into the external auditory canal of the ear to be masked. The clock mechanism was started, running for the time needed to study the ear. Bluestone published a model adapted for children, replacing the teat with a cup that encloses the pinna.

• The masking of the normal ear during the Rinne test

Before the introduction of the audiometer, the Barany noisemaker was also used to safeguard the reliability of the Rinne tuning fork test. The Barany noisemaker became obsolete with the appearance of audiometers with an integrated masking noise.

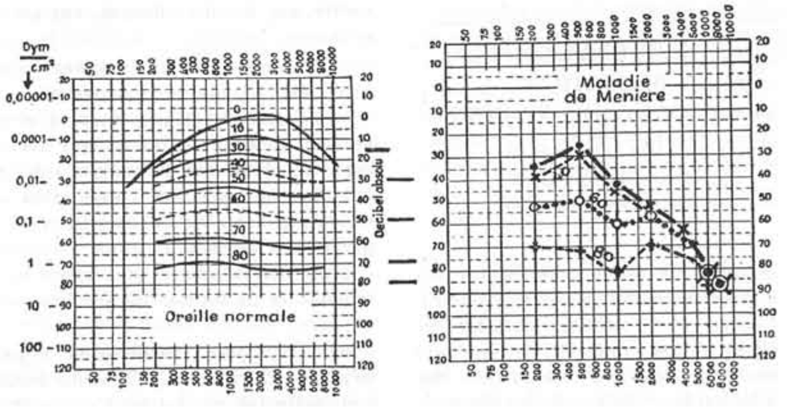
• Screening for auditory simulation with the Lombard test[5]

Another application of the Barany noisemaker was the Ernest Lombard's screening test for auditory simulation. In 1910, he published: "Contribution to the semeiology of deafness to reveal its simulation" in the Bulletin of the Academy of Medicine, 1910, 64, pp. 127-130. The next year in Paris, Lombard published "The sign of the rise of the voice" in the *Annales des maladies de l'Oreille, du Larynx, du Nez et du Pharynx*, 1911, 37, pp. 101-119. The Barany noisemaker was not the only masking device proposed by Lombard for his test. He also had a pressurised air projector in which the nozzle was directed in such a way that the flow was broken at the entrance to the auditory canal (an approach adopted again later by Aubry and Giraud), and also "a deafening phone which is connected to an induction coil, the power of which is regulated as required".

2. The tubular telephone (Figure 7)

This procedure consisted of forcing air through the tube using a Politzer bag as a mouthful of water is being swallowed or, in a more complicated approach, by catheterisation of the tube opening, followed by insufflation with a Ladret de Lacharière ventilating fan. According to George Portmann, this made it possible to deliver more air smoothly under continuous pressure that is built up progressively. The entry of the air into the Eustachian tube was monitored using an "otoscopy" tube (cf. "stetho**scope**"!) that was 60 to 80 cm long and ended in two nozzles: the first was introduced in the patient's ear and the second in the examiner's ear.

It made it possible to ensure, by means of auscultation, that some air penetrated in the middle ear,



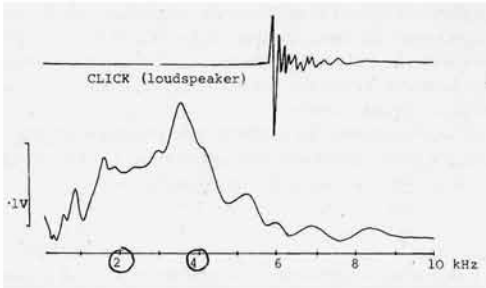


Figure 8. This white noise audiometry compares the masking effect of the noise at the subjective sensory level. Above 2000 Hertz, the noise is less active on the slope of the subjective sensory level in the case of a Ménière patient (right-hand graph).

Figure 9. On the right, there is a profile showing click frequencies. On the left, we see the amplitude of vibration of a loudspeaker emitting a "click" over time: note the briskness and the amplitude of the initial phase of the click.

and also to determine how it did so. Escat described an entire symptomatology which was reminiscent of pulmonary auscultation. For instance, he spoke about "a souffle - mellow or full or broad - which was followed by a smooth tympanic click" in healthy patients; or about "crackling rales, often very thin" in the case of fluid exudation in the middle ear; or about "a simple whistling" in the case of a point-shaped perforation of the tympanic membrane; or about "a whistling mixed with moist rales" in the case of perforation of the tympanic membrane with exudation in the middle ear; or finally about "a weak souffle, sometimes staccato, and not followed by a click" in the case of a severe tubular obstruction. Georges Portmann was still using this procedure in the 1940s.

3. Tonal audiometry after Langenbeck (Figure 8)

Langenbeck's work dates from the 1950s. In cases of recruitment, it is conceivable that the masking effect caused by the noise on a pure tone varies according to the subjective perception of the intensity of the pure tone. This makes it possible to study recruitment using auditory levels in the presence of noise.

In fact, comparing two audiograms – one from a normal subject, and the other from a Ménière patient – demonstrates that, in the Ménière patient, the ear suffering from recruitment withstands better the masking effect of the noise: the curves of the hearing levels fall hardly at all in spite of the increase in the noise. On the contrary, the hearing level of a normal subject declines regularly in accordance with the intensity of the noise.

4. The click used in the measurement of the evoked auditory potentials of the brain stem (Figure 9)

The click is a stimulus. Its advantage is its suddenness, which allows for the synchronous discharge of a large number of nervous fibres, making it visible against the background of cerebral activity. This cannot be done using a pure tone with a longer rise time. The "click" is **a noise** which is, by definition: **a complex sound, the different frequencies of which are not linked together by multiples or submultiples expressed by whole numbers (in other words, there are no harmonics)**. Figure 9 shows the different frequencies present in a "click" and, indeed, there are no harmonics of a particular frequency, but a series of frequencies that are not linked by harmonic connections.

5. The masking device of Vernon (first generation) and the second-generation noise generator[6] (Figure 10)

In both cases, these are noise maskers but they are based on different principles. The first-generation devices are masking devices and they were introduced by Vernon. The underlying principle is simple: the intensity of the noise exceeds that of the tinnitus and so masks it.

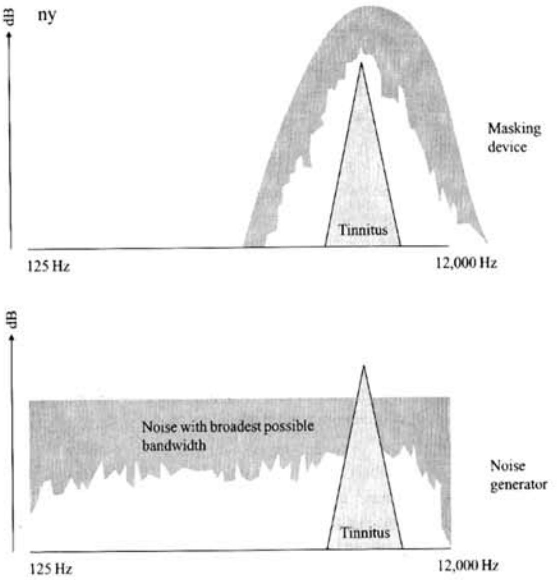


Figure 10. The range of the tonal frequencies making up the noise to combat the tinnitus is shown in light grey, resembling the profile of a chain of mountains. In the first case, the noise envelopes the tinnitus: it conceals it. In the second case, the noise drowns it, makes it a part of everyday life, by overflowing it from all directions as far as the frequencies are concerned, but not by masking it in the proper sense.

The second type is called “a noise generator”. The aim is not to mask the tinnitus but, by presenting the ear with a large range of non-masking tonal frequencies which go far beyond the frequency of the tinnitus, to create a distraction, make the tinnitus less alarming and, as it were, to desensitise the ear to the tinnitus. That process demands, by contrast with the simple masking device, a relatively long period of training (several hours a day over several months) to be effective.

III. Noise in music, Luigi Russolo and Bruitism (or Futurism): 1913[7]

(Figures 11,12,13)

In the early 20th century, the world changed considerably, not only because of the disruption due to the First World War. The terrifying Mechanisation of the late 19th century gave way to Technology, which was at least cleaner and which had charms to which some artists were susceptible. The pace and energy of urban life captivated more than one artist, in spite of Saint Saens’ assertion in 1914: “*I foresee, without any gaiety in my heart, the advent of noise*”. The new generation of artists included the Italian writer F. T. Marinetti, who claimed: “*the roaring of a motor car is more beautiful than the Victory of Samothrace*”

A certain **Luigi Russolo** (1885-1947), who was both painter and musician, followed close behind him. In March 1913, he published a manifesto addressed to his fellow-musician Pratella entitled “The art of noises”. It was to become the creed of Bruitism (or Futurism) (Figure 11). Russolo started from the principle that music had to take its inspiration from the reality of the sounds of the world, even if it meant treating it musically to touch the soul, which is the ultimate aim of music. But sonorous reality was in fact noise! There was no longer any question of pleasing the ear.

In the past, “noise was exceptional; it was limited to lightning, to the noise of a waterfall, to the roaring of a wild animal”. By contrast, in Russolo's new view, it is noise that has occupied the field of daily life and musicians can no longer deny the evidence of what should be their true source of inspiration. Even though his claims were probably excessive, they got more than one musician thinking: “we must break at any price with that limited circle of the pure tones and conquer the infinite variety of the tone-noises. We have had enough of the great masters... That is why we take much more pleasure in combining, in an ideal way, the sounds of trams, motor cars, horse-drawn carriages and yelling masses than in listening to the Heroic or Pastoral symphony, for instance”.

Adopting an approach which he wanted to be scientific, he reviewed the different types of noise, breaking them down into six families:

1. Roars, Thunderings, Explosions, Hissing roars, Bangs, Booms
2. Whistling, Hissing, Puffing
3. Whispers, Murmurs, Mumbling, Muttering, Gurgling
4. Screeching, Creaking, Rustling, Buzzing, Crackling, Scraping
5. Noises obtained by beating on metals, woods, skins, stones, pottery, etc.


L'ART DES BRUITS

Manifeste futuriste

tous les droits et toutes les possibilités, j'ai conçu la rénovation de la musique par l'Art des Bruits.

Luigi Russolo

Peintre

MILAN, 11 Mars 1913.

DIRECTION DU MOUVEMENT FUTURISTE: Corso Venezia, 61 - MILAN

Figure 11. Opening and closing lines of Russolo's manifesto

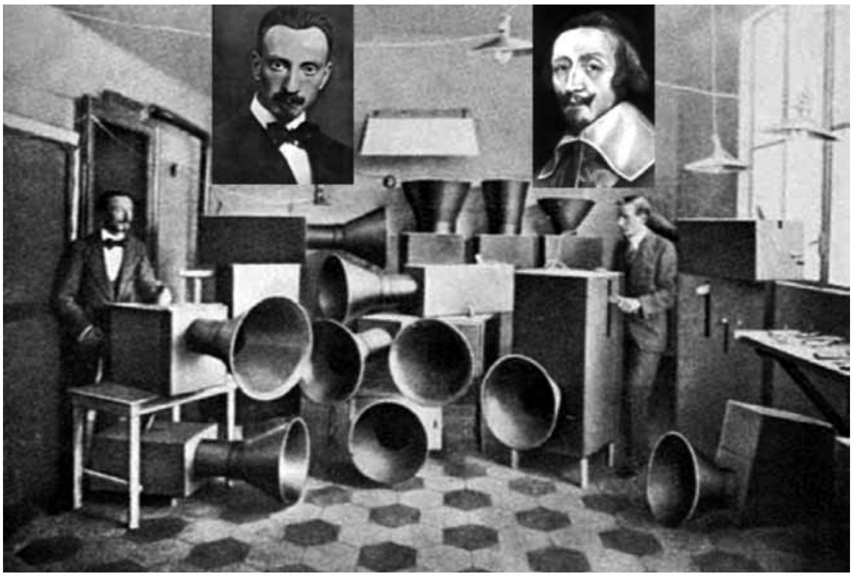


Figure 12. Luigi Russolo (on the left) and his friend Ugo Pati with a few "Intonarumori" in 1913. Furthermore, Russolo liked a joke. He loved to pretend that he was a descendant of Cardinal Richelieu... something that was absolutely untrue. Nevertheless, the resemblance is indeed striking on this portrait painted by Philippe de Champagne, a Belgian painter born in Brussels.

6. Voices of animals and people, Shouts, Screams, Shrieks, Wails, Hoots, Howls, Death rattles, Sobs

He asserted that these are the most basic and fundamental noises, and that all other noises are only associations and combinations of these.

Shortly thereafter, Russolo started building "noisemakers" with his friend Ugo Patti (Figure 12). They looked like big boxes of bright colours: yellow, green, pink, red (Russolo was also a painter) from which trumpets protruded. These noisemakers were named "Intonarumori". They produced noises of motorbikes, motor cars, engines and trains moving at high speed. The noises were produced by a strange system of handles and levers used to control their pitch. In 1914, public concerts were given in Italian cities like Milan and Genoa or "the Coliseum" in London, accompanied by a symphonic orchestra.

Russolo was not content with reproducing existing noises; he wanted to combine them, change their timbre and their rhythm with the aim of touching the soul, the listeners' sensibilities. Among the presented works, there was "Wakening of a capital city", "Meeting place of motor cars and aeroplanes", "People dining on the terrace of the casino"... In 1924, he presented a new instrument called the "Rumorharmonium" or "Russolophone". It was like an upright piano equipped with three amplifiers. It produced noises and triads as well. For a while, this instrument was used as an accompaniment for the silent movies of the age but the advent of the talking movies from 1929 onwards put an end to this experiment. Russolo's life came to an end rather sadly. Having refusing to cooperate with the Fascist movement of Mussolini, which had supreme control over "Futurist" music, Russolo sank into oblivion and died in poverty in 1946. However, "Bruitism" was certainly known to a number of leading musicians, such as Stravinsky, Ravel, Milhaud, Edgard Varèse, Luciano Bério and others. The electronic music of Pierre Schaeffer and Pierre Henry was also indebted to the legacy of "Bruitism".

- In his opera "Porgy and Bess", which was staged for the first time on Broadway in 1935, and reworked in subsequent years, George Gershwin acknowledged in his way the concept of noise in Scene 3 of Act 3 by inserting a "**Symphony of Noise**", reproducing the sonorous and

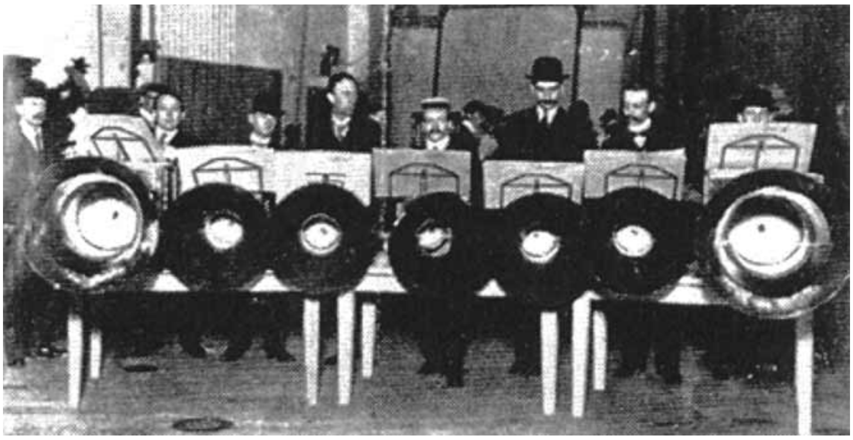


Figure 13. The first concert with the "Intonarumori" in 1914

laborious awakening of the city: one person is sawing wood, another is still snoring, children are skipping, somebody is beating an egg, another is beating a carpet... And all these disparate noises combine and gradually acquire the same rhythm before moving into a Charleston. After being neglected for 70 years, this part of the original score for the incidental music by Gershwin was restored to the public domain by Nikolaus Harnoncourt in his recent compact disc from 2009.

Conclusion

This paper defended and described Noise, demonstrating its potential benefits. We could also have mentioned snowy crepitation in the case of subcutaneous emphysema or abdominal borborygmus...

Finally, it would be reprehensible to fail to mention the foot-soldiers of the world of noise, those familiar noises that awaken children's awareness of the world of sounds and introduce them to the external environment. Or these noises that calm the anxieties of isolated men immersed in silence. No, Noise is not only the harmful waste of the world of sounds.

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