



Health in the noise context: the relativity of absolute health

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ABSTRACT

Noise remains a potent degrader of health in many contexts, capable of inducing severe annoyance and sleep disturbance. However, quantifying the impact of noise on health involves methods that are neither standardized nor always agreed upon. One issue centers on the conceptualization of health, and whether the WHO's guidelines suggesting that noise impact is best measured using health-related quality of life indices is in fact valid. The WHO recommendation is largely based on the fact that, unlike diseases, disability, terminal illnesses or explicit physical insults, health impacts from noise are more insidious and covert, and difficult to disentangle from other processes impacting function. Arguably, however, the WHO's 1948 seminal definition of health represents the prerequisites of good health, and does not necessarily provide a definition of health itself. More holistic definitions can be entertained, for example, good health is the ability of an organism to remain viable and successfully engage goal-directed behaviors within a host environment. Acknowledging that how health is conceptualized determines how health is measured, this paper argues that health-related quality of life has been unfairly marginalized in noise research. Furthermore, rather than being an adjunct to biomedical measures, health-related quality of life measures should be central to noise research. Interestingly, the challenging nature of quantifying the impacts of noise upon health provides a context to examine the broader meaning of health and suggest amendments to those advanced by the WHO.

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1. NOISE AND HEALTH

Modern living is challenging, and managing stress is essential to health and wellbeing. Research is increasingly showing that disagreeable soundscapes can induce annoyance or sleep disruption, whilst positively evaluated soundscapes can be restorative. In its most recent European analysis, the WHO (2011) estimated that 587000 DALYs (disability-adjusted life years) are lost due to noise within European cities and, furthermore, the European Union (2011) calculates that up to 30% of the European population are exposed to nighttime sound pressure levels that can be considered detrimental to sleep. The importance of estimating the impact of noise on health is rarely argued. However, how one should go about relating noise to health is not universally agreed upon, and central to this disagreement is the operationalisation of the two key constructions of "noise" and "health". While the debate around the correct definition of noise mostly centers on which parameter to measure for what duration, for health it is as much as agreeing upon what the core parameters are to begin. This problem is by no means exclusive to the noise context, and in some respects the noise context offers the severest challenge to any definition of health. This paper examines key definitions of health, offers a multi-component model of health, and then considers some key issues in noise and health research.

2. APPROACHES TO HEALTH

Modern medicine exists to protect or restore health, though given its status in both everyday life and scientific enquiry, there surprisingly appears very little interest in how the construct of health is formally defined. Ustun and Jakob (2005) remark that in health there exists definitions-within-definitions, and wryly note that even the term ‘disease’ lacks an appropriate and robust definition. This is of concern because medicine relies upon definitions formulated by health scientists, with standardized concepts and measures affording comparable, reproducible, and clinically important data capable of yielding substantive conclusions able to inform treatment.

Grossly, there are two main approaches to health, the ‘Naturalist’ position and the ‘Normative’ position. The Naturalist position, claiming to be objective and science-driven, is sometimes called the ‘Descriptivist’ position and is synonymous with the biomedical approach. It defines health as what is biologically natural and normal for humans, and is considered by some as the “medicalisation” of health. Operationalised, it involves “hard”, absolute, measurements of organic function, such as heart rate, chemical analyses of blood or other bodily fluids, and the structural integrity of tissue complexes. Central to the Naturalist position is the Reference Class and the normal function expected within it (Boorse, 1997), where normal function is the “statistically typical contribution an organ or mental system makes to an organism’s biological fitness” (p. 7). Health and disease are defined thus:

1. The reference class is a natural class of organisms of uniform functional design; specifically, an age group or a sex of a species.

2. A normal function of a part or process within members of a reference class is a statistically typical contribution by it to their individual survival and reproduction.

3. A disease is a type of internal state which is either an impairment of normal functional ability.

4. Health is the absence of disease.

The Normative position, in contrast, states that health and disease reflect value judgments. Thus the assessment of health is not absolute, but relative to social norms and the environmental context. In this scheme, desirable states are “*healthy*” and undesirable states are “*diseased*”. The Normative position is captured in the WHO’s definition of Health-Related Quality of Life:

“An individual’s perception of his/her position in life in the context of the culture and value systems in which he/she lives, and in relation to his/her goals, expectations, standards and concerns. It is a broad-ranging concept, incorporating in a complex way the person’s physical health, psychological state, level of independence, social relationships, and their relationship to salient features of their environment”

The strengths and weaknesses of both the Naturalist and Normative positions have been described thoroughly in the literature (.g., Ereshefsky, 2009), and neither can stand alone as a complete and consistent definition of health. Arguably, the WHO definition of health that was formalized in 1948 can be considered a “Hybrid Theory” combining aspects of both the naturalist and normative positions:

“Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”

This definition of health has largely been uncontested since its formulation, though in the last 25 years it has come under some scrutiny, predominantly in the pages of the British Medical Journal (BMJ). The first commentary came from Saracci (1997), who equated the WHO (1948) definition as not one of health but one of happiness. Unfortunately Saracci fails to define happiness and thus convince the reader that the concepts of wellbeing and happiness are equivalent. In fact, they are not. In the psychological literature, happiness is operationalised as a transient emotional state, while

wellbeing is more trait-like and involves cognitive appraisals of life's circumstances. Further, it betrays a mind/body duality that does not always sit well with modern medicine, now expressed as happiness/health, where by default health is assumed to subsume somatic processes (i.e., the biomedical approach). Saracci proceeds to define health as:

“...a condition of wellbeing free of disease or infirmity and a basic universal human right”

and further proposes that appropriate health indicators be mortality, morbidity, and quality of life, thus indicating a hybrid approach to health. In arguing that health is a basic human right, while happiness is not, Saracci distances himself from a number of fundamental human rights declarations, including the obvious one:

“We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness”

where the “the pursuit of happiness” has been interpreted as occupying one's life with the activities that provide for overall wellbeing, thus distinguishing them.

A flurry of editorials submitted to the BMJ in 2008 once again ordered the WHO's seminal definition on parade and ready for inspection. Jadad and O'Grady (2008) suggest that a consensus on what health is (and isn't) will never be realised due to the complexity of the construct, implicitly weaving a Normative stance in the thread of their arguments: *“...that health, like beauty, is in the eye of the beholder”*. In their commentary they strongly advocated for the WHO definition of health and its reference to the “social determinants” of health, as does Davis (2008) who freights this quote from Virchow:

“Medicine is a social science and politics is nothing but medicine on a grand scale”

Further warning against the medicalisation of health and modern medicines' focus on “absence of disease”, Davis offers his own definition:

“Health is best seen as an ongoing outcome from the continuing processes of living well. Living life well would be defined in terms of wealth, relationships, coherence, fitness and adaptability. Disease avoidance would be a minor part of the view on health”

In the same thread, MacFadyen (2008) notes a move by the WHO to facilitate the operationalisation of its definition by developing positive indicators of health, albeit complimentary to existing negative indicators such as mortality.

Observing that the majority of reservations expressed towards the WHO definition largely involve its operationalisation, Guntupalli (2009) emphasizes that it is a theoretical (or philosophical) and not an operational (i.e., scientific) definition, the latter of which finds modern medicine in its comfort zone and the former which does not. Using analogy, she relates the definition of health to the definition of democracy, and notes that in practice neither are 100% achievable. She also argues for social and environmental determinants to be considered in any definition of health, as does Fost (2009), who also drew attention to the fact that health is on a continuum and has a much neglected positive end. Mansfield (2009), noting the differences between preventative medicine (glass half full) and primary care (glass half empty), defines health simply as the ability to participate in constructive activity, and from this definition, “most of us are healthy most of the time”. Zajicek (2009) arguing with a forthright Normative view, attacks modern medicines' (“the third person”) disregard for the feelings of the individual (“the first person”), and in the process decries the monopoly that the physician has on health (i.e., a ‘medicalisation’). He quotes a colourful definition of health formulated by Leriche:

“Health is life lived in the silence of the organs”

which some may argue belongs to the Naturalist position. Rubinelli, Bickenbach and Stucki (2010)

round off the tail by appealing to the instrumental value in operationalising health, which is best measured as functioning referenced to a specific environment.

In 2011, the BMJ solicited further debate on the definition of health, hosting commentary of a paper composed by Huber et al., (2011) asserting that the WHO definition was “...*no longer fit for purpose*”. They propose a definition of health that can be described as representing ‘minimum wellbeing’, albeit one with an environmental component:

“Health is the ability to adapt and self-manage”

Huber et al., further relate this concept to the “three domains of health”: physical health (e.g., allostasis), mental health (e.g., coherence), and social health (e.g., coping). Betraying a hybrid position, they then go on to advocate the use of objective (‘health status’) and subjective (‘quality of life’) indicators of health. Their opposition to the WHO definition appears to revolve around the term “*complete*” and the subsequent difficulties it endows upon measurement. One wonders if this objection would be removed simply by emphasizing the scalar quality of health and slightly amending the WHO definition:

“Complete health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”

But, as Tallini (2011) and others (Guntupalli, 2009) point out, the WHO’s definition represents an aspiration or an ideal, not an operationalisation, whilst Huber’s reductionist approach defines survival rather than health. Complete wellbeing may indeed be a far-reaching concept, but given science’s penchant for benchmarking measurements against gold standards, one might think such a definition would be well received. Lewis (2011) further defends the WHO definition as an ideal, suggesting that Huber et al., advance stigma and shame on individuals not considered healthy. Tallini (2011) further joins the chorus for a holist definition of health that would include what some consider determinants, and paraphrases the incumbent WHO definition thus:

“Health is a state of physical, mental, and social wellbeing, which gives a sense of completeness”

Shilton et al., (2011), again echo the call for a definition of health that reflects underlying determinants, presenting yet another variation on the health theme:

“Health is created when individuals, families, and communities are afforded the income, education, and power to control their lives; and their needs and rights are supported by systems, environments, and policies that are enabling and conducive to better health”

though this definition comes across as somewhat circular.

Extraneous to the debate carried by the BMJ, two papers in the general literature also tackled health and how to define: Salomon et al., (2003) propose the ‘domain-capacity’ model and Bircher (2005) the ‘potential-demand’ model. The Salomon paper is notable for its reductionist approach, attempt to separate the concepts of health and wellbeing, and to exclude determinants of health from any core definition. Additionally, they staunchly oppose subjective evaluations of health, though they tactfully avoid discussing the distinction between “*self-evaluation*” and “*self-report*”. Adopting the Naturalist position they define health thus:

“Health is an attribute of individuals, which is best operationalized as a multidimensional set of domains. The threshold for loss of health in any given domain reflects societal norms or standards”

They further propose that these core health domains can be measured in units of capacity. Capacity refers to the ability/disability to perform a particular action in a standardised environment, for example, walking a set distance under set conditions. Capacity is contrasted to performance, which assesses a domain in the individual’s lived environment. Salomon et al. are critical of performance as a valid

measure of health, and this lack of ecological validity is perhaps the Achilles heel of their arguments, alongside their constant and non-scientific appeals to “*common-sense*” understandings, notions and interpretations of health. Additionally, their attack on the WHO definition, which they call a “*lofty ideal*” (p. 302) is perhaps unwarranted, because if one accepts their approach as an operationalisation of health, then there is no reason why the two cannot sit alongside one another as say political constitutions and statutory law do. Their general approach could be summarized by changing the WHO definition thus:

“Health is a state of complete physical, mental and social functioning and not merely the absence of disease or infirmity”

Bircher (2005) describing a dynamic concept of health and disease, takes a more hybrid approach to health:

“Health is a dynamic state of wellbeing characterized by a physical, mental, and social potential, which satisfies the demands of life commensurate with age, culture, and personal responsibility. If the potential is insufficient to satisfy these demands the state is disease”

where disease is defined as a need for medical attention. Bircher models the relationship between health and disease in terms of balance between demands and potential. Demands relate to physical (e.g., nutrition), social (e.g., stigma) and environmental factors. Potential, conceptually similar to capacity, is divided into the genetically-determined biological potential and experientially-determined personal potential. Of interest is the personal potential and Bircher’s discussion of coherence, which has striking analogies with the aforementioned WHO definition of quality of life.

3. A SOUND MODEL OF GOOD HEALTH

One can harvest the components or themes of health from the preceding section, which summarized a medically-oriented (as opposed to philosophically) debate on how health should be defined. While different voices called for different components, or sometimes the same components but with different weightings, there is no reason why a model cannot be developed containing a broad range of components. A broader model will necessarily contain a greater number of necessary conditions for health, of which some may be considered “determinants”. Thus it should include the environmental and social contexts in which one exists. Other necessary conditions will relate to the functioning of organ systems, in which strictly objective bioelectrical, biochemical, or biomechanical metrics are required. Further, a systemic approach accounting for an individual’s success in their immediate environment (i.e., performance) necessitates subjective evaluations, that is, health-related quality of life measures. Such a model will necessarily be hybrid in nature. Additionally, unlike Salomon et al., we offer an example of a “*common-sense understanding of health*” and derive inspiration from it. The New Zealand Māori describe a holistic approach to health and wellness: Te Whare Tapa Whā. Here the four cornerstones of health are whānau (*the family*), tinana (*the physical*), hinengaro (*the mental*) and the wairua (*the spiritual*).

Figure 1 is a schematic representation of our model of health. Implicit in Figure 1 is that health is the state of a system, and that because the system is not a closed one, it cannot be readily divorced from the other factors that influence it. Furthermore, when we measure health, we are really measuring components of health rather than evaluating the system in its entirety. This serves indicators of how health can be degraded, or improved, all which can be considered central to a sound definition of health. For example, disability ramps, safer roads, and sanitation are all examples of environmental elements that can impact health.

The environment The importance of the physical spaces in which an individual exists is self-evident, and the importance of the environment to public health was noted by Hippocrates. Indeed, Williamson (1884-1953) even went so far as to define health as “the faculty for mutual synthesis with one’s environment”. An organism’s environment contains numerous forces able to assist or impede goal-directed behavior, some of which can be found in Figure 1 (broken arrows).

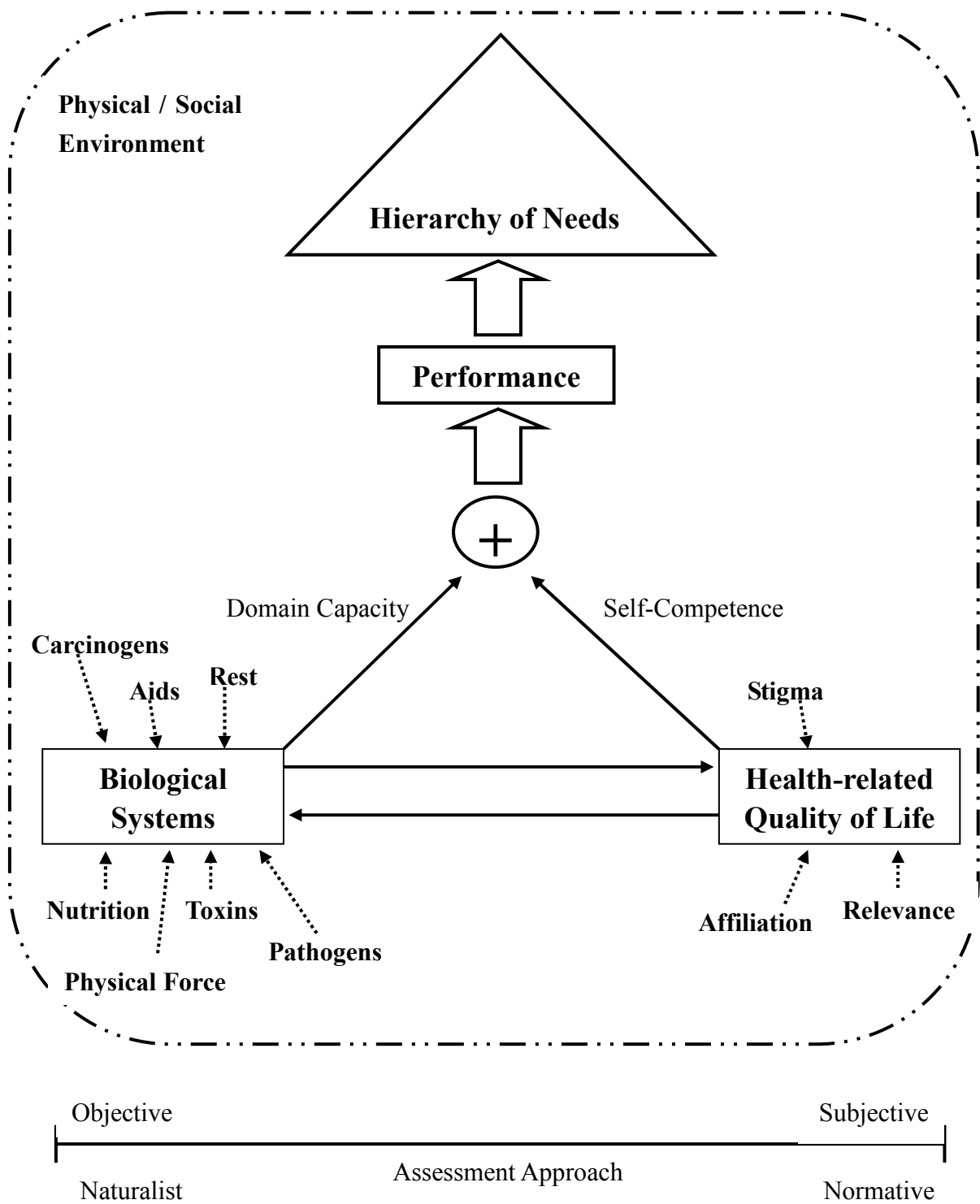


Figure 1 – Schematic Representation of “Health” as conceptualized by the Authors.

The components of the model are thus:

Hierarchy of needs Synonymous with Maslow, an individual's needs fluctuate across time, and constitute desirable outcomes from behaviour executed within the environment. Some of these can be considered health determinants (Fig. 1, broken arrows), though arguable all contribute to the wellbeing of an individual, which in turn positively impacts other components in the system. Measurement is broad, and the hierarchy is perhaps best understood phenomenologically.

Biological Systems The organs, tissues, cells and molecular entities that constitute the structure of the individual, and the processes (i.e., functions) they host. Measurement of these structures and processes exemplify the biomedical operationalisation of health.

Health-related Quality of Life The individual's subjective assessment of the ability of their organ systems (i.e., capacity) to realize their goals and aspirations within the confines of the environment they occupy and the circumstances in which they find themselves. We justify the inclusion of this component by noting that in some circumstances an over- or under-estimation of capacity poses a risk to our viability. Note that this component is not a gatekeeper and does not determine whether a particular goal-directed behaviour is or isn't performed. Operationalisation includes measuring those health states that we value, that is, those that afford successful goal-directed behaviours.

Performance The integration of capacity (or Bircher's 'potential' dimensions) and self-confidence, when producing a goal-directed behaviour. Performance may or mayn't result in the gratification of a need from the hierarchy.

At the lower reach of Figure 1 a continuum representing the measurement approaches to these components can be found. On the left, the objective measures are those typically associated with medical assessments in primary care, tests to obtain blood glucose levels for example. These 'bottom up' measurements can be used to quantitatively estimate the current operational range of an organ system (i.e., capacity), and typically have high internal validity. To the right is subjective appraisal, 'top-down' relative measures (or evaluations in the Normative scheme) that provide information on the quality of health. Subjective assessments are self-referential and in the absence of viable objective measurements are by necessity self-report, and would be expected to have strong ecological validity. One difficult emerges with this continuum – where to put “*self-report*” data such as those associated with psychiatric measures or inventories probing everyday functioning? For example, should measures of capacity relying upon self-report data be placed in the middle of the continuum? And by extension, performance?

Because it is a continuum, measurement approaches can differ even within a given function. For example, sleep can be quantified by using electroencephalograms, or qualified by asking an individual how satisfied they were with their sleep. As Figure 1 indicates, the operating limits of the (objectively measured) organ systems and the (subjectively measured) individual's judgment as to whether a particular goal can be realized given these limits defines performance. While one could argue that performance itself could be objectively measured using behavioral observations, more challenging issues would arise when trying to predict performance. All occurrences in space-and-time, i.e., the constituents of our universe, can be divided in physical or psychological events – this being the basic premise of the philosophical doctrine known as dualism. Arguably Figure 1 manifests such a doctrine, and so the integration of capacity and self-competence presents measurement challenges at all levels of description, and we treat the integrator itself as a black box. While some have argued that the development of single indices representing the sum of capacity and quality-of-life measures are not, *prima facie*, unreasonable (Bircher 2005), and indeed some already exist in mainstream medicine (e.g., Axis V in the DSM-4R; the SF-36), others have issued warnings in regards to the collapsing objective and subjective dimensions (Power, 1999). Instead, a categorical approach may be more useful, as Figure 2 demonstrates.

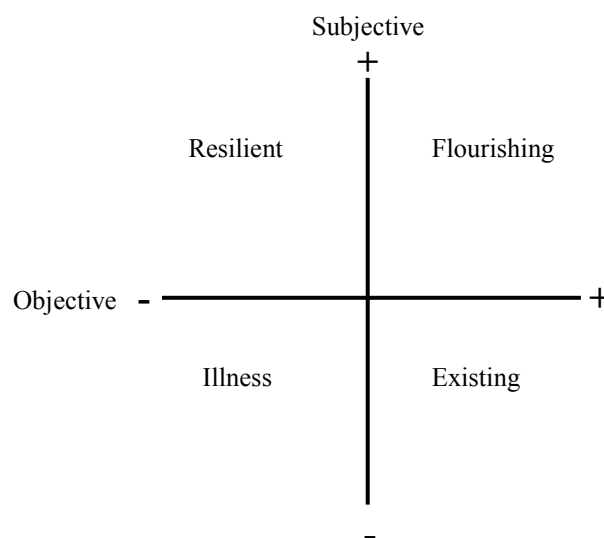


Figure 2 - Categories representing the status of the health system detailed in Figure 1.

4. RESOUNDING CHALLENGES IN NOISE AND HEALTH

Here we suggest candidates for the ‘hard’ questions in Noise and Health research, in the hope that researchers take up the challenge in future studies.

Objective vs. Subjective Measurement Approaches The exclusion and deriding of subjective evaluations of health in noise and health research is ever-present and unfounded. The use of one-or-other measurement approach will depend entirely on the research question. For epidemiological research targeting large samples in which objective evaluations are not feasible, the use of subjective measures of health should not be considered a compromise. The challenge is to develop noise-specific quality of life measures able to provide more sensitive and discriminating metrics.

Direct vs. Indirect Health Effects Salomon et al., (2003) define cognition and sleep as direct indicators of health. Agents modifying these two processes must therefore be considered direct health effect. Noise can impact both cognition and sleep and must be considered a direct health effect. Some will argue that both these health indicators are in turn modified by annoyance. Research is needed to determine whether annoyance is a mediator between, say, noise and cognition, or merely a product of cognition impeded by noise.

Adverse Health Effects Lercher (1996) comments that the ambiguity surrounding what does, and does not, constitute an adverse health effect in the noise context has ultimately led to diluted conclusions as to the toxicity of noise. Bircher (2005) reports that progress in social and preventative medicine has acknowledged the cumulative consequences of health determinants. Arguably, one such health effect is noise, but how to disentangle it from other determinants is one of the greatest challenges in noise and health. How to show that noise is an adverse health effect is another, though we suspect the issue will not be put to rest with data, but rather theory.

A Formal Medical Definition of Annoyance The development of a standardized description of noise annoyance that is both clinically relevant and suitable for epidemiological health studies. For example, is the symptom “irritability” listed by in both the DSM and ICD-10 in the categorization of anxiety equivalent to noise annoyance?

Noise Sensitivity or Belligerent Personality Type? The negative affect hypothesis of noise annoyance enjoys popular support in the epidemiological literature. However, in the clinical literature there exists substantiated mechanisms at the biological level of description that have been formulated to explain phenomenological accounts of sensory overload and deficits in selective attention. Thus further research is needed into both the biological and psychological underpinnings of noise sensitivity.

Nocebo Effect vs. Halo Effect The relationship between noise and health is argued by some to be merely psychosomatic and exemplified by the “*nocebo effect*”. However, the few studies examining the nocebo effect in the noise context produce findings that may also be explained by the halo effect. The two effects are quite different, in the former the individual truly believe the harmful impacts of noise, and therefore the noise impacts health through psychological processes (the power of voodoo if you will). In contrast, the halo effect involves the individual reporting to practitioners or researchers what they feel is expected of them, often due to perceptions of authority. Further research is required to disentangle the two effects.

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