Sound annoyance as loss of options for viability self-regulation

T.C. Andringa[1,2], J.J.L. Lanser[1]

[1] University of Groningen, department of Artificial Intelligence, Nijenborgh 9, Groningen, The Netherlands. t.c.andringa@rug.nl, j.j.l.lanser@rug.nl

[2] INCAS[3], Dr. Nassaulaan 9, 9401 HJ Assen, The Netherlands

INTRODUCTION

Sound annoyance is still ill-defined as scientific concept. In contrast, as a common-sense concept everyone is able to indicate which sounds are annoying and why they annoy. This paper has a single objective: it aims to couple a number of theoretical concepts to the breadth of responses to the question *"Did you loose/gain something in terms of quality of life when the disturbing sound appeared in your life? If so could you please describe?"* These answers were given in an online questionnaire targeted at sound annoyed persons. At the time of writing the questionnaire is still open and 179 respondents had answered. However, the pattern of these answers matched our theoretical expectations, which were based on the premise that for humans the sound of some sources can interfere with life's most basic requirement: the need to remain viable.

Lindvall & Radford (1973) proposed that *"Annoyance may be defined as a feeling of displeasure associated with any agent or condition known or believed by an individual or a group to be adversely affecting them"* (Berglund et al. 1994). This paper proposes a more precise definition of the "adverse effect": namely making it more difficult to self-regulate viability. It starts with an outline of a number of theoretical "ingredients" and their relation to sound annoyance. These ingredients are used to generate a preliminary (sub-)categorization of possible responses. The method section addresses some issues related to the interpretation of the actual responses. The paper ends with a short analysis of the match between the expected answers and the sub-categorization and concluding remarks.

THEORETICAL MODEL

Viability preservation and basic needs

People — and animals in general — need to select a continual and varied sequence of actions to remain viable. Remaining viable entails the continual satisfaction of needs and forms the basis of all motivation (Maslow 1943). The basis of Maslow's theory of motivation is that human beings are motivated by unsatisfied needs to remain viable or to become as viable as possible. Maslow argues that certain lower needs have to be satisfied before higher needs can be addressed. In particular he argued that there are basic needs (physiological, safety, love, and esteem), which have to be fulfilled before a person is able to act unselfishly. He called these "deficiency needs." The more a person is able to fulfill these basal needs, the more the needs change toward personal and social growth, and eventually to self-actualization. Although Maslov's theory is not without critics, only its general theme is required for this paper. In particular we rely on the, undisputed, conclusion that not all needs are equally important and that unsatisfied needs dominate overt behavior.

According to Maslow the satisfaction of basic needs makes or keeps one healthy while preventing need gratification makes one ill or entices one to act selfishly with the purpose to satisfy the need. Maslow's basic needs are related to each other in a

hierarchy of "prepotency". *"This means that the most prepotent goal will monopolize consciousness and will tend itself to organize the recruitment of the various capacities of the organism. The less prepotent needs are minimized, even forgotten or denied. But when a need is fairly well satisfied, the next prepotent ('higher') need emerges, in turn to dominate the conscious life and to serve as the center of organization of behavior, since gratified needs are not active motivators"* (Maslow 1943).

Needs and viability enhancing action selection

Maslov gives conscious processing a central role in need satisfaction. Somehow conscious processing optimizes need satisfaction. This dovetails with Dehaene's analysis of the role of consciousness (Dehaene & Naccache 2001). According to Dehaene *"the more an organism can rely on mental simulation and internal evaluation to select a course of action, instead of acting out in the open world, the lower are the risks and the expenditure of energy"*. Dehaene associates consciousness with a unified neural workspace through which many processes can communicate. Combining Maslow and Dehaene entails that the raison-d'être of cognitive processing and consciousness is the freedom it affords to plan and select viability-preserving and viability-enhancing actions, while balancing available resources, considering multiple time-scales, and taking into account multiple spatial, environmental, and social conditions. This complies with what the WHO defines as health, namely *"a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity"* (WHO 2011)

Pleasure, wellbeing and health as indicators

Wellbeing and health indicate successful maintenance of viability, which makes wellbeing and health indicators of a proper match between viability demands, cognitive capabilities, and environmental affordances. Viability can be defined on different timescales: pleasure and displeasure are typically, but not exclusively, short-term indicators. Wellbeing and health are typically mid-term and long-term indicators respectively. On the short term pleasantness is associated with improving viability or maintaining a high state of viability and unpleasantness is associated with deteriorating viability or a state of reduced viability. Pleasure is therefore an indicator of the satisfaction of needs, while displeasure is an indication of unsatisfied needs. The less the need is satisfied, the more it will fill the contents of consciousness and dominate behavior.

Need satisfaction and emotions

Emotions are also directly associated with need satisfaction. The combination of the dimensions pleasure–displeasure and activation–deactivation (corresponding to the inclination to act) is called core-affect (Russell 2003). Core affect describes a motivational state, which leads to particular forms of *action readiness*: a term that can be defined as emotion (Frijda 1986). This allows a natural coupling between an emotion and behavioral options; for example options afforded by particular sounds (Andringa 2010a). Emotions – defined as action readiness – correspond then to a general strategy to satisfy the need. If the overall strategy changes, the associated emotion changes as well, which is called emotion regulation (Cole et al. 2004). This entails that when someone is stressed he or she might try to come-up with a strategy that re-establishes perceived control. Success in this process is measured in terms of transition to a more pleasurable emotional state.

Annoyance and irrelevant stimuli

Pleasant stimuli indicate behavioral options that help to maintain or reach high viability. Unpleasant or annoying stimuli either reduce viability or make it more difficult to improve viability. Perception should not be unnecessarily sensitive to irrelevant stimuli and discard them effortlessly if possible. However some "irrelevant" stimuli may require detailed (conscious) processing before they can be deemed irrelevant for viability optimization (Andringa 2010b). While the conscious processing of these stimuli does not contribute to need satisfaction, it requires effortful processing and has therefore a parasitic influence on viability regulation. For a more detailed description of this aspect see Andringa & Lanser (2011).

Restoration

Attention restoration theory (ART) (Kaplan 1995) proposes that after the prolonged use of effortful directed attention – an attentional state typically associated with work, but which can also be important for pleasurable activities, such as reading a novel – it becomes more difficult to direct attention and to suppress external distractions. Since an attentionally fatigued person is prone to make errors (Staats et al. 2003) and less able to reach desired (mental) goals (i.e., to self-regulate viability) he/she experiences irritability. Being in an environment that does not pose any demands on directed attention provides time for the inhibitory mechanisms involved in directed attention to return towards a normal state. This restores the capacity for directed attention. According to ART four components are important for restoration through suspending directed attention. *"Fascination (use of involuntary, effortless, attention), Being-Away (a physical or cognitive relocation of ones self from everyday activities), Compatibility (a match between the individual's desired activity/behavior and the environment) and Extent (the scope and connectedness of the environment)"* (Payne 2009). Together these components ensure effortless immersion in an environment that is pleasant, suitable for the current personal goals, and which involves minimal directed attention.

"Home sweet home"

In terms of viability self-regulation a home is ideally the place to address many levels of Maslov's hierarchy of needs. At home we satisfy our physiological needs while we eat, drink, and sleep. In addition we satisfy many safety needs in terms of health and well-being and a home is a safety net against accidents and illnesses. In addition homes are places for feelings of love and belonging, especially when we share it with loved ones and when we invite our friends. Houses may even be part of our expression of identity and a source of self-esteem. Finally many homes provide ample opportunities for self-actualization, either implicitly by the activities that it allows or explicitly in the form of rooms optimized for, for example, hobbies.

In addition according to Evans et al. (2003) *"Home is a place that reflects identity and provides security and maximum control. Good housing offers protection not only from the elements but also from negative social conditions. It is a primary territory where we can regulate interpersonal contact. Poor housing quality reduces behavioral options, diminishes mastery, and contributes to a general sense of helplessness."*

All in all this entails that people in- and explicitly expect that homes should be used for a wide range of need satisfaction activities. In fact it should be a place that is suitable for all of Maslov's levels of needs, but especially a place where basic needs

such as sleep (or more general restoration) could be satisfied. Because this paper is aimed at sound annoyance at home we expect that people might refer to the loss of core-qualities of their home due to sound annoyance.

Audition-specific properties

However why (some) sounds may reduce the core-qualities of a home is not directly clear. To understand this relation it is useful to treat hearing and listening as different processes that balance on one hand the need to be sensitive to potentially relevant novel stimuli and on the other hand the need to determine behavioral options afforded by sounds (Andringa 2010b). Hearing is a bottom-up, signal-driven process that helps individuals to "ground in" and "connect to" their environment (e.g., a living room or garden) and to direct their attention to potentially relevant sounds.

Hearing is a background process that is always "on" and it is not under voluntary control. Sometimes the hearing process may deem a stimulus important enough to warrant full conscious analysis, for example because it is particularly loud or otherwise salient or meaningful. This is related to Job's (1999) conclusion about auditory sensitivity: *"two distinct factors appear: one related to loud noises (road traffic, lawn mower), and the other related to quieter noise situations which are nonetheless distracting (rustling papers at the movies, people talking while watching television). More research is needed to address the relationships between these factors, reaction and other health effects."*

Hearing can be contrasted with listening. Listening is a top-down, knowledge and need driven process that allows the perceiver to segregate and group sounds into auditory objects and to allow the activation of appropriate behavioral options. Listening is only possible when conscious and is a form of directed attention (namely directed attention aimed at specific sonic stimuli, which is also called selective attention). Because listening is part of conscious processing it is serial, semantically related to the content of consciousness, and it is in part under voluntary control.

Sound annoyance occurs when stimuli that are deemed as potentially relevant by the hearing process are evaluated as irrelevant by the listening process. Because listening involves more effortful selective attention this entails that these (irrelevant) sounds are able to claim part of conscious processing; which means that the individual has lost some of its freedom to self-regulate viability. The impact of this loss depends on the fraction of time attentional resources are not available for desired tasks (which might also be a measure of mental effort).

PREDICTIONS

This paper addresses the question "Did you loose/gain something in terms of quality of life when the disturbing sound appeared in your life? If so could you please describe?" There are many ways in which a reduction of the options to self-regulate viability may become apparent from verbal reports. Somewhat arbitrarily one might group these in a number of classes such as reports addressing emotions and restoration, attention and perception, loss of core qualities of one's home, health effects, and social factors.

We predict that respondents report that they have difficulty to experience positive emotions or even that they experience more negative emotions. Stress is another emotional indicator because it indicates a lack of perceived control. Somewhat relat-

ed is when respondents report that they experience either a reduction of opportunities to rest and relax, or even that they actually experience less restoration during the day or a lower quality sleep. Another way to indicate reduced viability self-regulation options is in terms of attention, for example difficulties to concentrate (especially on restorative tasks like reading or listening to quiet music) or attention-related difficulties in other tasks such as working or studying. Associated with this are audition related effects, such as difficulty to hear pleasant ambient sounds (e.g., birds) or difficulties to communicate. In the first case it is more difficult to maintain quiet fascination, in the second case social communication becomes more effortful.

Another broad class of responses pertains to the loss of core qualities of the home and the living environment. The most obvious loss is of quietness due to intruding sounds. But this may extend to a general loss of core qualities of the living environment (such as a loss of rural quality), or a specific loss of options indoors (such as the inability to open windows in summer) and outdoors (such as a less enjoyable garden). Finally it is possible that people report about social aspects or about direct health effects. An overview of these (sub-)categories is given in Table 1.

METHOD

To test whether the response types of the open question were actually representative for the respondent, we used the first 179 completed questionnaires in the first 6 weeks of an online survey available via www.soundannoyance.com targeted to sound annoyed persons in home situations. The questionnaire is available in Dutch and English. The survey addresses the question: *"Why do some people, whom we may term "sensitized", end up being highly distracted and annoyed by some sound types, forcing them to listen, rather than just hearing and ignoring the sounds?".* The total questionnaire comprises 84 questions of which maximally 77 were presented to participants. For this paper we used only one question: *"Did you loose/gain something in terms of quality of life when the sound appeared in you life? If so could you please describe?*

In this paper we perform a *qualitative* analysis: namely a check whether the (sub)categories in table 1 cover the breadth of qualitative responses. The analysis was based on 179 completed questionnaires. The main annoying sources for these participants where 'road traffic' (23.5 %), 'aircraft' (19.0 %) and 'neighbors' (16.8 %). Female/Male groups where equally divided (48.6 %) and (50.8 %). The average age was 53. 72 % of the participants was higher educated (minimally college/university).

The open question "*Did you gain something*" was usually answered in terms of the gain of something negative, like: "*I gained a lower quality sleep*" and "*I gained irritation*". A few were positive: *"More contact with neighbours*" or ambiguous "*We decided to move for more privacy*". All clearly negative gain formulations were treated as the answer to *"What did you loose in terms of quality of life*".

The freeform answers are usually concise and easily interpretable, but involve ambiguous details. In general we have followed a "greedy approach" in which we interpreted the answers towards the expectations in Table 1. This was generally quite straightforward, however a number of standard assumptions about the meaning of phrases were applied. For example the phrases "*peace and quiet*", "*peace and tranquility*", or variants occurred quite frequently. The phrase is interpreted as a combination as a (peaceful) state-of-mind and a (quiet or tranquil) state of the environment

Table 1: Overview of (sub)categories and percentages that the (sub)category was mentioned in the response to the question *"What did you loose in terms of quality of life after the annoying sound appeared in your life"*

Category	Subcategory	Description	Prevalence
Emotions		**Emotions as action readiness correspond to evaluations of the current state that have to be responded to.**	**42 %**
	Less pleasure	The reduction of pleasure is a first indication of a viability self-regulation challenge.	25 %
	More negative emotions	Negative emotions are a sign of a perceived problem to be addressed (quickly if possible).	11 %
	More stress	Stress is a sign that the perceived problem could not be solved (quickly) and that full restoration is no longer possible.	6 %
Restoration		**Reduced restoration or options for restoration are a main effect of annoying sounds by making it more difficult to maintain restorative mental states.**	**71 %**
	Less tranquillity	Disturbing stimuli may suspend restorative states state-of-mind especially of soft fascination tasks (such as reading, listening to quiet music).	25 %
	Less restoration	This subcategory indicates reduced access to an efficacy known restorative mental states as reading, quiet enjoyment of garden, etc.	22 %
	Lower quality sleep	Sleep is the most important restorative state. Structural interference with sleep is a direct health threat.	25 %
Attention		**Intruding sounds may also interfere with mental states that are not necessarily restorative, but important for task performance.**	**15 %**
	Difficulty to concentrate	A difficulty to concentrate indicates the presences of an "effective" sonic distractor. Especially difficulties to focus on soft fascinating tasks.	11 %
	Difficulties with other tasks	Sometimes the disturbance might be generally debilitating or preventing one to work at home.	5 %
Perception		**One of the obvious effects of intrusive sounds is the ability to mask environmental or communicative sounds. Masking of environmental sounds "disconnects" from the environment, while masking communicative sounds makes communication more effortful.**	**6 %**
Health		**The result of reduced viability self-regulation options is lower health.**	**5 %**
Change in living conditions		**The home environment is important for viability self-regulation and can be separated in a number of different categories.**	**68 %**
	Absence of peacefulness	Unwanted sounds may mask or attract attention away from soft background sounds that are characteristic of an undisturbed environment and that we may interpret as peaceful (which is important for restoration).	15 %
	Loss of environmental quality	Intruding sounds may interfere with essential qualities of the environment, rendering it less suitable for the viability self-regulation purposes.	8 %
	Less profit of being inside	This refers to the reduced use of the inside of the home for viability regulation (especially restoration).	18 %
	Less profit of being outside	Refers to the reduced use of, typically, the garden or balcony for viability regulation (especially restoration).	27 %
Social		**Social aspects of sound annoyance (such as not being taken seriously) tend to exacerbate sound annoyance.**	**11 %**
	Irritations towards others	This subcategory represents irritation towards individuals, groups, or in general social decision making.	9 %
	Irritation toward self	Sometimes people are judged as "complainers".	1 %

allowing a peaceful state-of-mind. We attributed this to less restoration and less tranquillity respectively. A variant of this is "*One needs enough rest, for example to sit calmly in the garden and enjoy*", which scores on less enjoyment, less tranquility ("*calmly*"), less restoration ("*needs enough rest*") and less profit of being outside. The sentence "*Rest in the garden/neighbourhood and in the home*" does not score on restoration (although it might pertain to that). Because of the direct connection to the

environment it scores on all aspects of a change in living conditions. In general the isolated phrase *"loss of rest"* was assigned both to less restoration and the absence of peacefulness.

The variant "*It steals my silence and my rest*" scores on irritation towards others because stealing is a "social" activity, but it is unclear in this case whether the "it" is the annoying sound or the whole social situation that gave rise to "it". The phrase "it is impossible to relax and read etc. in the garden" scores on less restoration and less profit of being outside. The phrase *"Irritation that I have to avoid consciously"* scores on more negative emotions and difficulty to concentrate because of the conscious effort that cannot be used for self-chosen tasks.

One particular difficulty is the interpretation of the Dutch word "*woongenot*" which may cover all aspects of the "enjoyment of a home". The loss of the enjoyment of a home typically was attributed to less pleasure and to less profit of being inside, even though it might also pertain to the garden.

A number of phrases referred directly to the theme of this paper. For example *"I lost all quality of life"* scores on less pleasure, but makes a deeper point that almost literally reflects the inability to reach or satisfy Maslov's higher needs. The same seems the case with *"Since I moved it is not so bad, but it still dominates my life when I am at home"*. A phrase like "*I lost my freedom at home and on my balcony*" scores on the loss of profit of being in- and outside, but it might also refer directly to the title of this paper.

Only 4 answers could not be assigned to any of the predefined (sub-)categories. Two of these referred an equivalent monetary value: *"If I had known this I would not have bought this expensive apartment"* and "*I am willing to pay a lot of money not to be forced to hear the sound of airplanes"*.

RESULTS

Each response typically led to 2.1 subcategory scores in table 1. The most important categories were restoration (71 %), change in living conditions (68 %) and emotions (42 %). The subcategories that were mentioned most were less profit of being outside (27 %), less pleasure (25 %), less tranquility (25 %), lower quality sleep (25 %), and less restoration (22 %). Lower health (5 %) was a less important category. This suggests that sound – probably due to the current noise legislation – is a low level stressor without many directly observable health effects, which is consistent with the recent conclusion (WHO 2011) that sound annoyance kills on the long terms through stress-related illnesses in a way that is not easily attributable in individual cases.

Only 6 % mentioned perceptual problems associated with masking of interesting sounds, of these about half were a remark about difficulties listing to speech or music, the other half mentioned the inability to hear normal background sounds. 8 % mentioned the loss of environmental qualities, such as the disturbance of the rural or idyllic quality.

We warn against a use of the quantitative results. This is a qualitative analysis with the purpose to determine whether or not the theoretical model is able to cover the responses. We believe that this can be concluded from the data. Quantitative results are only possible after a more careful design, which allows much more control over the responses. The pattern of responses provides ample indication for a specifically targeted and more detailed analysis.

CONCLUSION

In this paper we outlined a number of interrelated scientific concepts that pertain to sound annoyance and we checked that these concepts allowed us to cover the breadth of responses when sound annoyed people are asked what they have lost in terms in quality of life after the annoying sound appeared. The whole picture suggests that people talk about what can be interpreted scientifically as 1) reduced restoration through reduced access to restorative attentive states, 2) reduced use of the home environment, especially for restoration, and 3) less positive and more negative emotions, in particular stress. The overall pattern suggests that sound annoyance predominantly reduces the number of options for restoration and other forms of viability self-regulation.

This supports our interpretation of annoying sounds as challenges to self-regulate viability, which allowed us to couple Maslov's theory of motivation, the content of consciousness, emotions as action readiness, displeasure as viability-self-regulation challenge, and wellbeing and health as indicators of successful viability maintenance.

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