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THE MECHANISMS FOR AUDITORY ATTENTION TO ANNOYING-EVENT

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Annoying-event refers to the sound events that are able to induce, identify and cause human annoyance. Auditory attention can help us to perceive a certain auditory event in complex acoustic environment consciously. In this paper, based on the information processing model of human cognitive psychology, the cognitive characteristics test and evaluation of annoying-events are carried out via the Wechat in Chinese. Our surveys showed that the saliency of sound intensity and frequency and its stability in time-domain can distinguish the annoying-event sharply from the acoustic environment or other sound events and trigger the bottom-up (BU) auditory attention mechanism effectively. On the other side, the personal auditory memory, expectations, emotions and the information included in the sound-event would play an important role in forming the top-down (TD) attention mechanism which is related to the task .
Keywords: noise annoyance, auditory attention, sound event, network survey

1. Introduction

Annoying sound events can induce negative emotions[1]. It has been found necessary to understand the mechanisms and to explicit the cognitive patterns of auditory attention to annoying sound events[2][3][4][5]. For example, the mechanisms can be used to identify the obvious annoying sound events in the complex acoustic environment, and then targeted control technology could be taken to achieve a remarkable control with the acoustic environment. It can also provide a shortcut for the design and evaluation of the acoustic quality.

In our study, with the help of Internet surveys, the cognitive characteristics of annoying acoustic events have been tested and evaluated to achieve effective integration of the keys attention cues, which could improve the performance of recognition on annoying sound events and make our cues framework more similar with the human auditory system. In addition, a set of plain Chinese vocabularies is also established to describing the annoying sound events.

2. Survey

2.1 Methods and Questionnaire

During April 18, 2016 to 23, our questionnaire had been sent out through the WeChat as shown in Figure 1.

Figure 1 Network questionnaire

The response rate was 100% and 336 questionnaires were available. The ratio of male to female was1:0.95, among them the ratio of teenagers (20 years old) to young (20-40 years old) to middle-aged (40 years old) was 0.177:1:0.063; the proportion of the student was 64% and of the worker was 36.0%.

The keys of the questionnaire design are: 1) set “annoyed” as the attention task considering exhaustion and exclusion, each question and its corresponding options are designed to describe every common physical property of the sound; 2) each concise question only design for one physical property of the sound; 3) in order to simplify the data processing, for each question the options should not be too much and should be able to characterize all aspects of the corresponding sound attributes as far as possible. Besides, the option should not only be without confusion, repetition, and long unambiguous expression, but also meet daily habits and easy to understand; 4) in order to avoid to the averse to be surveyed, our questionnaire has been designed to be finished in less than 0.5 hours.

The questionnaire involves the physical characteristics of sound including intensity, , frequency, time sequence and variability in different dimensions; in addition, considering people's experience ,perception and interpretation of auditory sensation , there also have items related to h controllable controllability , predictability and universality of the sound.

2.2 Results

The principal component analysis was used to analyze the survey data; the results show that there exist four different types of components that determine whether or not a sound would excite auditory attention due to its annoyance. The four components are shown in Table 1.

Obviously, the explanatory factors of the first principal component are all the most basic characteristics, that is, the intensity, frequency, controllability and universality of sound. These most basic features play a decisive role in capturing annoyed auditory attention. The variability in time domain, the periodicity and unpredictability of a sound, all these could trigger annoyed auditory attention; the continuous sounds would easily cause annoyance and excite auditory attention. The occupational sounds are often not easy to initiate special auditory attention, however, once these sound could not be effectively controlled, it would lead to a strong annoyed auditory attention.

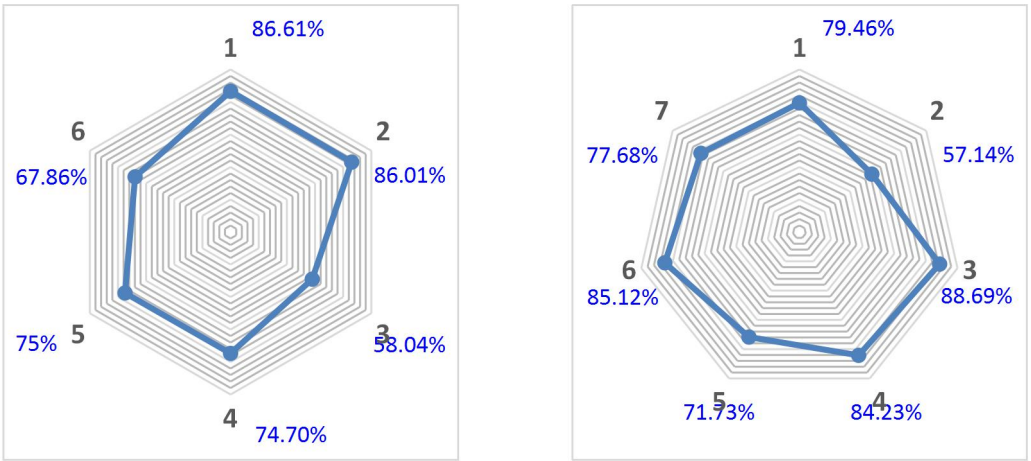
As shown in Figure 2, the intensity and frequency are always the decisive factors to the annoyance. When auditory attention is considered, the variability is intensity and frequency of the sound, the irregular and intermittent in time, the listening experience, the universality and controllability of the sound, also the experience of the listeners, all of these would affect the annoyed auditory attention.

3. Conclusions

In this paper, the cognitive characteristics of annoyed auditory attention have been tested and evaluated to achieve effective integration of the keys attention cues. Our studies show that: the saliency of sound intensity and frequency and its stability in time-domain can distinguish the annoying-event sharply from the acoustic background and trigger the annoyed auditory attention by bottom-up mechanism. On the other side, the personal auditory memory, expectations, emotions and the information included in the sound-event would play an important role in forming the top-down attention mechanism which is based on a voluntary basis or related to the task.

Table 1 Survey data analysis results by the principal component analysis

Investigated Item	Four Principal Components			
	I	II	III	IV
Sound Intensity	.682	-.115	.048	-.273
Frequency	.608	.077	-.419	.434
Controllability	.571	.070	-.395	.548
Universality	.505	-.364	.057	.001
Variability in frequency	.470	-.391	.108	-.259
Specificity	.428	-.365	.338	.209
Variability in sound intensity	.410	.279	.034	.020
Periodicity	.412	.564	.100	-.217
Predictability	.406	.519	.210	-.126
Variability in time	.119	-.513	.408	.194
Stability	-.042	.171	.666	.335
Changing speed	.259	.325	.479	.087
Professional attributes of sound	.467	-.124	-.130	-.551



(a) (b)

Figure 2 Main factors to initiate the annoyed auditory attention

(a) Factors related to the physical properties of sound (1=high intensity, 2= high frequency, 3=steady-state sound, 4=rapidly changing sound, 5=intensity from weak to strong, 6=frequency from low to high)

(b) Factors related to the listener (1= Irregular change, 2= Intermittent, 3= Passive accepted, 4= suddenly appear, 5= be unfamiliar with, 6=strange, 7= the occupational sound)

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REFERENCES

1 Coensel B. D., et al. A model for the perception of environmental sound based on notice-events. *Journal of the Acoustical Society of America*, **126**(2): 656-665,(2009).

2 Coensel B. D., Botteldooren D.. A model of saliency-based auditory attention to environmental sound. *Proceeding of 20th International Congress on Acoustics, ICA 2010*, Sydney, Australia, 23-27 (2010).

3 Schulte-Fortkamp B.. The meaning of annoyance in relation to the quality of acoustic environments. *Noise Health*, 4:13–18,(2002).

4 Fritz J. B. et al. Auditory attentions—focusing the searchlight on sound. *Current Opinion in Neurobiology*, **17**(4):437-455, (2007).

5 Sussman E. S. et al. The role of attention in the formation of auditory streams. *Perception & Psychophysics*, **69**(1):136-152, (2007).