DO URBAN SOUNDSCAPES INFLUENCE VISUAL ATTENTION?

Tristan D. Loria and Frank A. Russo
Dept. of Psychology, Ryerson University, Toronto, Ontario, Canada.
tristan.defrancescol@ryerson.ca / russo@ryerson.ca

1. INTRODUCTION

Attention is vital to the survival of all organisms. Regardless of size or strength, every organism must adaptively shift its attention in order to survive. Research by Easterbrook (1959) highlights the importance of arousal as a determinant for alternating between broad based, and locally based visual attention. His hypothesis states that increases in arousal lead to attentional selectivity, which in turn supports appropriate responding. However, the modern city often provides a cacophonous auditory environment saturated with opportunities for attentional selectivity, and hence distraction. In the current investigation we use an empirically validated behavioural measure to assess whether urban soundscapes have an influence on visual attention.

1.1. Soundscapes effects: Short-term and Long-term

The urban soundscape has been identified as a source of deleterious effects on human health and performance. In particular, aversive soundscape exposure over the short term has been linked to increases in heart rate (Raggam et al. 2006) and delayed stress recovery following the offset of an accute stressor (Ulrich et al. 1991).

The effect of long-term exposure to aversive soundscapes has also been assessed empirically. Shield and Dockrell (2008) demonstrated that exposure to aversive soundscapes in the classroom can be detrimental to school performance. In addition, long-term exposure to aversive soundscapes has been linked to a plethora of health problems including, but not limited to: cardiovascular health, sleep disturbances, hypertension, and hearing loss (Aydin & Kaltenbach 2007; Basrur, 2001). Taken together, these results suggest that soundscapes can influence auditory and non-auditory processes.

1.2. Purpose and Hypothesis

The purpose of this study was to determine whether soundscapes influence visual attention. Motivated by previous research on the subject of attentional fluctuations as mediated by affect and arousal levels (Gable and Harmon-Jones, 2010), we hypothesized that soundscapes would influence the focus of attention, and that the effect would vary with type of exposure.

2. METHOD

2.1 Participants

68 undergraduate students at Ryerson University (53 females) were recruited for participation. The average age of participants was 21 years (SD=6.10). Participants were randomly assigned to one of three exposure conditions: concurrent, prolonged, and brief. Participants in the *concurrent* condition (n=14) heard the soundscapes continuously, making a visual judgment while the soundscape played. Participants in the *prolonged* condition (n=19) heard the soundscapes for forty-five seconds, followed by a visual judgment. Participants in the *brief* condition (n=35) heard the soundscapes for fifteen seconds, followed by a visual judgment.

2.2 Procedure

Thirty two-minute soundscapes were recorded binaurally to a TAS-DR-1 Tascam Portable Solid State Digital Audio Recorder using SP-BMC-20 Audio Technica subminiature omnidirectional microphones (with windscreens) clipped above each ear. Sound pressure levels were also recorded simultaneously using an Extech 407768 sound level meter with dB(A) weighing. All soundscapes used in this study as well as data about accompanying sound levels are available as part of the torontosoundmap.com.

The main study was conducted in a double-walled IAC sound attenuated chamber. A Mac MINI computer presented auditory stimuli over SONY MDRXD200 circumaural headphones. Visual stimuli were presented using an ACER X243w computer screen situated 35 cm away from the participant. After hearing one of thirty soundscapes, the participant was asked to make a visual discrimination on global or local features of a Navon stimulus (1977). A Navon stimulus is a large letter made up of smaller letters. For example, a large “H” composed of small “T”s. In a global trial involving this example, participants might be asked to respond “H” or P” (in this case H is correct). In contrast, for a local trial involving this example, participants might be asked to respond “O” or “T” (in this case T is correct). While accuracy rates tend to be near ceiling, the reaction times are indicative of the participant’s focus of visual attention.

2.3. Subjective and Acoustic Analysis

Using likert-scales, participants provided subjective appraisals of each soundscape. These appraisals included valence (pleasant/unpleasant), arousal (calm/excited), stress (not at all / extremely). In addition, participants indicated the maximum exposure (in minutes) they could tolerate each soundscape. Objective analyses of soundscapes were conducted using MIRtoolbox, a freely available MATLAB toolbox, which supports extraction of low and mid-level acoustic features from audio recordings (Lartillot and Toivianinen, 2007). The most predictive feature derived from this analysis was spectral irregularity (1), defined as amplitude variation throughout the successive peaks of the spectrum (Jensen, 1999):

$$\left(\sum_{k=1}^{N}(a_{k-}a_{k+1})^2\right)/\sum_{k=1}^{N}a_k^2$$

3. RESULTS AND DISCUSSION

For each participant, a local bias estimate was determined for each soundscape by subtracting global from local reaction time (RT). Local bias estimates were subjected to a 3-way analysis of variance (acute, prolonged, or concurrent). There was a main effect of soundscape, F (29, 1885) = 2.1, p < .001, which suggests that the influence of the soundscapes assessed was variable. Mean RTs for local and global targets (collapsed across exposure types) are plotted in Figure 1.

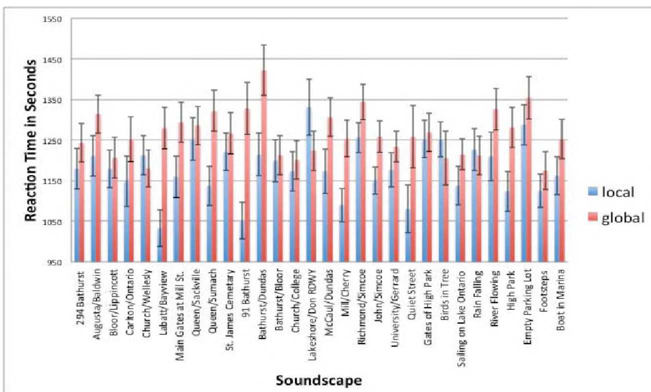

Figure 1: Mean RT for Local and Global Targets.

The main effect of exposure type and its interaction with soundscape were not significant, which suggests that soundscapes tend to have an immediate influence over visual attention.

To better understand the main effect of soundscape we correlated average local bias estimates (drawn from the prolonged exposure group) with subjective appraisals and acoustic features. Although none of the correlations involving acoustic features was significant, local bias estimates were significantly correlated with subjective variables. Increases in spectral irregularity were correlated with increases in stress, decreases in valence, and decreases in maximum exposure judged to be tolerable. Future work will incorporate physiological measures to better understand the subjective findings reported here. Our motivation for this ongoing program of research is to inform an emerging dialogue between urban planners, architects, and acousticians, concerning the sound quality of our cities.

REFERENCES

Aydin, Y., & Kaltenbach, M. (2007). Noise perception, heart rate and blood pressure in relation to aircraft noise in the vicinity of the Frankfurt airport. *Clinical research in cardiology: German Cardiac Society*, *96*(6), 347-58. doi:10.1007/s00392-007-0507-y

Basrur, V. S. (2000) Health Effects of Noise. City of Toronto, Community and Neighbourhood Services, Toronto Public Health, Health Promotion and Environment Protection Office

Easterbrook, J.A. (1959). The effect of emotion on cue utilization and the organization of behavior. *Psychological Review, 66,* 183–201.

Gable, P., & Harmon-Jones, E. (2010). The Blues Broaden, but the Nasty Narrows: Attentional consequences of Negative Affects Low and high in Motivational Intensity. Psychological Science, 21(2), 1-5. doi: 10.1177/0956797609359622

Jensen, K.K. (1999). Timbre models of musical sounds. Report 99/7, University of Copenhagen. ISSN: 0107-8283.

Lartillot, O., & Toiviainen, P. (2007). A Matlab Toolbox for Musical Feature Extraction From Audio, *International Conference on Digital Audio Effects*, Bordeaux.

Navon, D. (1977). Forest Before Trees: The Precedence of Global Features in Visual Perception. Cognitive Psychology, 9, 353-383. doi:10.1016/0010-0285(77)90012-3

Raggam, B. R., Cik, M., Holdrich, R. R., Fallast, K., Gallasch, E., Fend, M., Lackner, A., & Marth, E. (2007). Personal noise rankings of road traffic: Subjective estimations versus physiological parameters under laboratory conditions. *International Journal of hygiene and Environmental Health*, 210, 97-105. doi: 10.1016/j.ijheh.2006.08.007

Shield, B. M., & Dockrell, J. E. (2008). The effects of environmental and classroom noise on the academic attainments of primary school children. The Journal of the Acoustical Society of America, 123(1), 133-44. doi:10.1121/1.2812596

Ulrich, S. R., Simons, F. R., Losito, D. B., Fiorito, E., Miles, A. M., & Zelson, M. (1991) Stress recovery during exposure to natural urban environments. Journal of Environmental Psych., 11, 201-230. doi:10.1016/S0272-4944(05)80184-7