

SHORT AND SWEET

Sex difference in subjective duration of looming and receding sounds

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Abstract. Looming sounds (sounds increasing in intensity over time) are more salient than receding sounds (a looming sound reversed in time). For example, they are estimated as being longer, louder, and more changing in loudness than receding sounds. Some authors interpret the looming salience as evolutionarily adaptive, because it increases the margins of safety of the perceiver in the case of preparatory behaviours (eg a motor reaction to an approaching sound source). Recently, Neuhoff et al (2009, *Journal of Experimental Psychology: Human Perception and Performance* **35** 225–234) found that females more than males show overestimation of the spatiotemporal properties of virtually simulated looming sound sources. Here, I investigated whether the sex difference could be observed for the subjective duration of looming and receding sounds, and found that females more than males overestimate the duration of looming sounds in comparison to receding sounds.

An object moving towards a perceiver generates an acoustic array of increasing intensity at the perceiver's ear. If the object moves away from the listener, the proximal stimulation is identical but time reversed. The perception of sounds increasing or decreasing in intensity (respectively, looming and receding sounds from now on in the text) has been extensively investigated by auditory scientists (eg DiGiovanni and Schaluch 2007; Grassi 2003; Grassi and Darwin 2006; Neuhoff 1998, 2001; Olsen and Stevens 2010; Schlauch et al 2001; Stecker and Hafter 2000), and the outcomes of their studies show a coherent result. Looming and receding sounds are physically identical if time reversed. However, the former are perceived as more salient than the latter (Hall and Moore 2003). For example, looming sounds are perceived as longer (DiGiovanni and Schaluch 2007; Grassi 2003; Grassi and Darwin 2006; Schlauch et al 2001), louder (Stecker and Hafter 2000), and more changing in loudness (Neuhoff 1998, 2001; Olsen and Stevens 2010) than receding sounds.

In several studies, Neuhoff and colleagues (eg Neuhoff 1998, 2001; Neuhoff et al 2009) argued that the looming salience could be evolutionarily advantageous because it increases the margins of safety in the case of preparatory behaviours to the approaching sound source (eg a motor reaction). This evolutionary interpretation finds support in the results of a recent study that shows a sex difference in the perception of the spatiotemporal properties of virtually simulated looming sound sources (Neuhoff et al 2009). Females (more than males) overestimate arrival time and arrival position of the moving sound source. Authors argue that females (more than males) may benefit by this overestimation: because of the different physical characteristics (eg females being on average slower than males—McDowell et al 2005) this overestimation guarantees to females a longer time for preparatory behaviours to the approaching sound source (eg a motor reaction). Here, I investigated whether females (more than males) overestimate the duration of looming sounds in comparison with receding sounds.

Eighteen males and eighteen females participated in the experiment. Sounds were synthesised at 44.1 kHz and 16 bits, and were presented diotically with Sennheiser HD414 headphones in a sound-attenuated booth. Peak level for all sounds was 85 dB SPL. Stimuli consisted of looming and receding sounds of 1050, 1200, 1350, 1500, 1650,

1800, 1950 ms duration. The sounds' waveform was a five harmonics complex tone ($F_0 = 500$ Hz). Looming sounds were obtained by modulating the amplitude of an amplitude-steady sound with a raised cosine ramp. The receding sounds were looming sounds played backward in time. Stimuli were combined in pairs separated by a 500 ms silent interval. Each pair included two different stimuli (either in duration, envelope, or both) whose order was counterbalanced. The resulting 182 pairs were presented twice in random order in three blocks. Two blocks consisted of pairs of envelope-similar sounds (ie looming with looming, receding with receding); the third block consisted of pairs of envelope-different sounds. Listeners took blocks in counterbalanced order. After each pair, listeners were asked to choose which sound was longer in duration.

The proportion of "longer" responses was calculated for each sound and separately for each block and listener. The responses resulting from pairs of envelope-different sounds (ie looming with receding) were subjected to a 2 (looming versus receding) by 7 (duration) two-way ANOVA with the sex of the subject as between factor. The proportion of "longer" responses increased as a function of the sound duration ($F_{6,204} = 657.11$, $p < 0.0001$) and independently of the sex of the participant ($F_{6,204} = 1.90$, $p > 0.05$). The looming sounds were judged "longer" than receding sounds ($F_{1,34} = 52.95$, $p < 0.0001$), and females judged looming sounds even longer than males ($F_{1,34} = 7.07$, $p = 0.009$) (see figure 1a). The remaining interactions were not significant. Two further one-way ANOVAs were conducted on the responses resulting from pairs of envelope-similar sounds (ie either both looming or both receding). Here, the proportion of "longer" responses increased as a function of the sound duration (respectively $F_{6,204} = 484.17$, $p < 0.0001$ for looming sounds and $F_{6,204} = 480.22$, $p < 0.0001$ for receding sounds) but independently of the sex of the listener (both $F_s < 1$ —see figure 1b).

Overall, results revealed that both males and females overestimated the subjective duration of looming in comparison to receding sounds. However, the difference in subjective duration was larger for females than males, suggesting that the sex difference observed by Neuhoff et al (2009) with a virtually moving sound source can be observed also for subjective duration with a simple sound monotonically increasing in intensity. Furthermore, the identical results obtained by males and females in

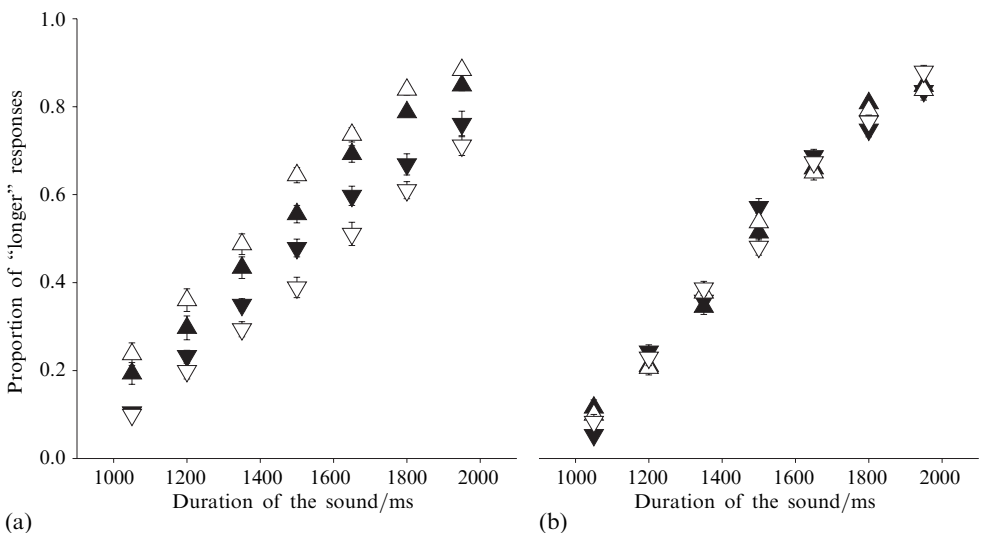


Figure 1. Proportion of "longer" responses as a function of the sound duration. (a) The results of the comparisons between envelope-different sounds (ie looming with receding); (b) the results of the comparison of envelope-similar sounds (ie either both looming or both receding). Open symbols represent data for females; solid symbols represent data for males. Pointing-up triangles represent looming sounds and pointing-down triangles represent receding sounds. Vertical bars are ± 1 SEM.

judging the duration of pairs of envelope-similar sounds reveal that the sex difference observed here does not depend on different perceptual skills in judging the duration of looming and receding sounds. The current results can be interpreted in line with the speculations of Neuhoff and colleagues (Neuhoff 1998, 2001; Neuhoff et al 2009), namely that the salience of looming sounds over receding sounds may enlarge the margins of safety for preparatory behaviours to an approaching sound source. Moreover, that females more than males may benefit by this augmented salience of looming sounds.

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References

- DiGiovanni J J, Schlauch R S, 2007 “Mechanisms responsible for differences in perceived duration for rising-intensity and falling-intensity sounds” *Ecological Psychology* **19** 239–264
- Grassi M, 2003 “Differenza nella durata percettiva di suoni crescenti o calanti in intensità: permanenza o decurtamento?” *Giornale Italiano di Psicologia* **30** 659–663
- Grassi M, Darwin C J, 2006 “The subjective duration of ramped and damped sounds” *Perception & Psychophysics* **68** 1382–1392
- Hall D A, Moore D R, 2003 “Auditory neuroscience: The salience of looming sounds” *Current Biology* **13** 91–93
- McDowell M A, Fryar C D, Hirsch R, Ogden C L, 2005 *Anthropometric Reference Data for Children and Adults: U.S. Population, 1999–2002* (Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics)
- Neuhoff J G, 1998 “Perceptual bias for rising tones” *Nature* **395** 123–124
- Neuhoff J G, 2001 “An adaptive bias in the perception of looming auditory motion” *Ecological Psychology* **13** 87–110
- Neuhoff J G, Planisek R, Seifritz E, 2009 “Adaptive sex differences in auditory motion perception: Looming sounds are special” *Journal of Experimental Psychology: Human Perception and Performance* **35** 225–234
- Olsen K N, Stevens C J, 2010 “Perceptual overestimation of rising intensity: is stimulus continuity necessary?” *Perception* **39** 695–704
- Schlauch R S, Ries D T, DiGiovanni J J, 2001 “Duration discrimination and subjective duration for ramped and damped sounds” *Journal of the Acoustical Society of America* **109** 2880–2887
- Stecker G C, Hafer E R, 2000 “An effect of temporal asymmetry in loudness” *Journal of the Acoustical Society of America* **107** 3358–3368

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