Comments

Comment by Kollmeier:

Since you used the Greenwood-scale as frequency scale, a linear chirp in your definition is approximately a logarithmic chirp in physical units – this is a very unnatural stimulus. The difficulties your subjects have with discriminating such stimuli may therefore be plausible.

How would a natural formant transition (which is limited by the dynamics of the articulation apparatus) look like in the coordinates you are using?

Reply:

While it is true that formant transitions slow down as they approach their intended target frequency, to my knowledge there is nothing that would indicate that, at the onset, their trajectory is best described as being linear in Hz. Although tracing formants of natural speech is quite error-prone, models (see, e.g., Mrayati, Carré, and Guérin 1988) approximate the vocal tract with a series of resonators that act, within limits, similar to constant-Q filters. The most realistic simplification of formant trajectories, therefore, may be a chirp with a negatively accelerating frequency change. Of course, all this may not be relevant for first-formant or low second-formant transitions since, when individual components are resolved, the formant peak during transitions follows a step function and, therefore, its trajectory is neither linear, nor logarithmic.


Comment by Moore:

You stated that your stimuli for experiment 1 were designed so that “the only valid cue for the discrimination was the velocity of the frequency change.” However, for each glide, subjects could “compute” the velocity as the difference between the starting and ending frequencies divided by the duration. Thus, the subjects were not forced to judge velocity per se, although they may well have done this.

Dooley and Moore (1988) adopted a different approach to measuring sensitivity to differences in rate of change of frequency. They measured duration discrimination for tones that were either fixed in frequency and level, or that gilded in frequency and/or level over a fixed extent. For the gliding stimuli, the rate of change of frequency and/or level co-varied with duration. Dooley and Moore found that duration discrimination was better for the gliding stimuli than for the steady stimuli, and argued that this indicated a sensitivity to the rate of change of frequency and/or level. It is noteworthy that the Weber fraction for “velocity” inferred from their results was about 0.06, which is much smaller than estimated by you. The discrepancy might partly be due to the fact that you used greater sweep
extents than Dooley and Moore. However, a more likely explanation arises from the
method that you used, which involved standard and variable stimuli falling in
different frequency regions. It may be difficult for subjects to compare glide rates
for such stimuli, in the same way that it is difficult to compare the fundamental
frequencies of complex tones that are filtered into different frequency regions or
have no harmonics in common (Moore and Glasberg 1990; Moore, Glasberg and

Carlyon, R. P. and Shackleton, T. M. (1994) Comparing the fundamental frequencies of
Am. 95, 3541-3554.
Dooley, G. J. and Moore, B. C. J. (1988) Duration discrimination of steady and gliding tones:
a new method for estimating sensitivity to rate of change. J. Acoust. Soc. Am. 84, 1332-
1337.
Moore, B. C. J. and Glasberg, B. R. (1990) Frequency discrimination of complex tones with
pure tones and for complex tones with overlapping or non-overlapping harmonics. J.
Moore, B. C. J. and Moore, G. A. (2003) Discrimination of the fundamental frequency of
complex tones with fixed and shifting spectral envelopes by normally hearing and

Reply:

While it is true that the experiments do not permit distinction between perceiving
velocity of frequency change or computing a duration-weighted extent of frequency
change, no such distinction is possible in the results of any other study that
attempted to evaluate sensitivity to the rate of frequency change using direct
methods. Comparison between the Dooley and Moore (1988) velocity JND’s
estimated indirectly from duration discrimination and our data, indeed, appears to
be difficult. Moore is probably correct when he assigns our large velocity JND
estimates to the large stimulus uncertainty that we used, in order to serve as a
guarantee that neither duration nor the extent of frequency change would co-vary,
and thereby be confounded, with velocity. However, further (and presently yet
unpublished) results from our laboratory in which the degree of frequency
uncertainty was systematically reduced showed that, in the lowest uncertainty
condition (in which the only uncertainty was associated with duration), our 79.4
percent correct thresholds decreased to about 0.1 – a figure comparable to Dooley’s
and Moore’s 70.7 percent correct threshold of 0.061.