

Context Effects in Musicians with Absolute Pitch

Kathleen R. Agres & Dr. Lori L. Holt
 Psychology Dept., Carnegie Mellon University

Introduction

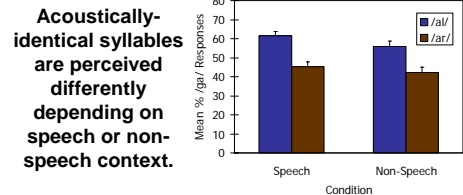
One of the most significant challenges for cognitive models of speech perception is explaining the effect of context on speech identification.

Acoustic, phonological, syntactic, and semantic context can all shift the perceived identity of a speech sound.

For example, two identical acoustic segments can be labeled as different phonemes, depending on adjacent context.

Mann (1980) demonstrated that preceding syllable /al/ or /ar/ context influences how a following consonant is perceived.

In another study (Holt & Lotto, 2001), two nonspeech precursors modeled limited characteristics of the acoustic structure of /al/ and /ar/. Tones were situated at /al/ and /ar/ F2 and F3 offset frequencies. Though not perceived as speech, these stimuli captured some of the spectral characteristics of /al/ and /ar/.



Context effects may be based on general auditory mechanisms sensitive to spectral information. If so, context effects should not depend on the identity of the sounds. (✓ = previously demonstrated)

Preceding Context

Test stimulus	Speech	Non-speech
Speech	✓	✓
Non-speech	✓	?

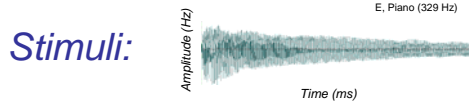
What has not yet been well established is whether spectral contrast effects operate similarly for purely non-speech stimuli. Experimentally, this is difficult to test because most people do not have labels for non-speech sounds.

Musicians with absolute pitch may be the answer:

Absolute pitch is the ability to name musical pitches without an external reference frame.

Research Question

Do musicians with absolute pitch label an ambiguous pitch as a function of the frequency of a precursor note?



Each stimulus was 500 ms long and stimuli were matched in overall RMS amplitude. Stimuli were synthesized (Acid Pro 4.0) to mimic the timbre of a piano. Synthesis allowed us to create notes that fall halfway in-between the half-steps on a piano. Pure sine-wave tones with the same frequencies were also created.



There are 100 cents in a half-step. Each ambiguous pitch synthesized for this experiment falls 50 cents in-between a half-step.

Experiment 1

Absolute pitch screening test

- Listeners heard two blocks of stimuli – one of piano tones and one of pure tones.
- Every perfect Western pitch was presented 5 times.
- Listeners identified the note from all possible alternatives (All within a single octave)

Chance performance would be 1/12, or 8.33%.

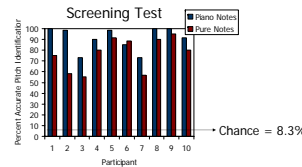
Pitch context test

- One block of piano tone trials and one block of pure tone trials were presented.
- Listeners heard two consecutive notes on each trial.
- The second, target, note was always one of three ambiguous pitches (between C and C#, D and D#, or E and F).
- The first, precursor, note was either Higher in pitch or Lower in pitch than the target. The precursor was always a perfect pitch from the Western music scale.
- After listening to both notes, listeners chose between the two perfect pitches surrounding the ambiguous target (e.g., if the target was E+ 50 cents, the listener chose E or F).

Results & Conclusion

Results

All of the subjects who participated in the experiment were far above chance for naming pitches.



In the test, approximately one-half of the musicians consistently assigned the ambiguous pitches as the pitch 50 cents above the note. The other half chose the pitch 50 cents below. Thus, musicians may have been too consistent in their labeling to be influenced by context.

Conclusion

The frequent presentation of a small number of ambiguous pitches led the musicians to assign a consistent label to the pitches. In other words, the musicians got used to hearing the "mistuned" pitches and began reporting an ambiguous tone as the same pitch (e.g., F rather than E) every time they heard it, regardless of the precursor. A follow-up experiment attempted to address this concern.

Experiment 2

Screening test

The same as the previous pre-test.

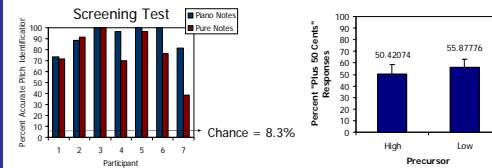
Pitch context test

- Filler trials were added to make the pitch manipulation less apparent. These trials were completely unambiguous and exhaustively sampled 1, 2, 3, 4, 5, 6, 7, 8, and 9 step comparisons between the perfect pitches.
- Additional ambiguous notes were also added. Each ambiguous note was paired with 1- and 2-step (where possible) High and Low piano tone precursors.
- Each target was presented twice per block of trials, whereas fillers were heard once per block.
- The block of pure tones was removed because most musicians had a harder time identifying these notes. Testing only piano notes across two blocks allowed us to increase the number of comparisons as well.

Conclusions

Results

Musicians chose the higher of the two pitches surrounding the ambiguous tone equally as often as the lower of the two, independent of the precursor pitch, ($t_{(13)}=1.31, p=.21$).



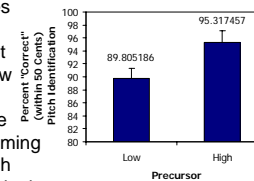
Implications for spectral contrast with non-speech:

This experiment found no evidence of spectral contrast in musicians with absolute pitch.

However, there was evidence of an unpredicted effect of context.

Surprising results:

Musicians were statistically more accurate ($t_{(13)}=3.80, p=0.002$) at naming pitches when there was a High precursor before the target than when there was a Low precursor. In fact, the musicians were even more accurate ($M=95.3\%$) at naming pitches preceded by a High precursor than in isolation in the screening test ($M=91.4\%$).



This generates many questions about the nature of pitch identification such as, "Do pitches of a certain frequency range contribute to pitch identification mechanisms? How would a High precursor foster the ability to accurately identify a pitch?" These are questions that need to be investigated in future studies.

Acknowledgements

This research was generously funded by a Small Undergraduate Research Grant (SURG).