

## HOMEWORK DUE NOVEMBER 1, 2018 at 6PM

1. The Pitch Study Group presented the case of a 21 year-old man, Case A1+ (a.k.a. Case MHS), who had impaired pure-tone pitch perception after bilateral strokes that destroyed all of the right and left transverse gyrus of Heschl, all of the right superior temporal gyrus, and all of the posterior left superior temporal gyrus. They also presented the combined microelectrode-microanatomical study of Old World monkeys by Morel, Kaas, and colleagues that showed the granular layer with the densest staining of nuclear and cytoplasmic acidic proteins (Nissl substance) was: 1) housed in the macaques' rudimentary homolog of Heschl's gyrus; 2) overlapped the granular layer with the densest staining of acetylcholinesterase; and 3) contained cells that were finely-tuned to pure-tone frequency at low tone amplitudes. These three microanatomical and electrophysiological properties are hallmarks of primate primary auditory cortex (A1). Therefore, it is likely that Case A1+'s stroke wiped out all of A1 in both cerebral hemispheres.

A previous experiment showed that consonance perception was also impaired in Case A1+ (see Figure 7 of Tramo et al. 2001, *Neurobiological Foundations for the Theory of Harmony in Western Tonal Music*). Figure 7a shows he performed at chance on a one-interval, two-alternative forced-choice task that employed the method of constant stimuli and required him to judge whether a musical chord (major triad) sounded consonant or dissonant. In half the trials, the major triad was mistuned by flattening one note (the fifth) by a fraction of a semitone. There are three possibilities for why his performance was impaired: 1) he had trouble judging the in-tune chords as consonant; 2) he had trouble judging the mistuned chords as dissonant; or 3) he had trouble judging both in-tune and mistuned chords.

Figure 7b shows the results of what is called an "error analysis." The error analysis reveals which of the above three possibilities is true. This pattern of performance is called a "response bias" experimental psychology. Place an X on the line next to the correct interpretation of Figure 7b (2 points):

- Case A1+ had trouble judging the in-tune chords as consonant
- Case A1+ had trouble judging the mistuned chords as dissonant
- Case A1+ had trouble judging both in-tune and mistuned chords

2. There are two main theories about why some musical intervals and chords sound consonant and others dissonant. Helmholtz and his disciples argued that forming the percept of consonance depends on "the absence of roughness" caused by frequencies in the stimulus that are too close together to be resolved by mechanical filters in the cochlea of the inner ear and neural filters in the central auditory nervous system. The

more dissonant a chord sounds, the greater the sum total of the roughness produced by its unresolved tone frequencies. Some of you had the opportunity to hear what the roughness produced by two pure-tones sounds like when you played with the two function generators I brought to class. (*Note:* If you didn't have the opportunity to play with the function generators and want to find your roughness detection threshold, please email me and I will bring them to class again.) Stumpf and his disciples argued that roughness has nothing to do with consonance and dissonance – they have to do with the pitch relationships of notes in the chord and whether or not they “fused” into a harmonic whole. (Stumpf was among the founders of Gestalt Psychology.)

We did an additional experiment (Figure 7c) to sort out whether Case A1+'s ability to perceive roughness had anything to do with the results we found in Figure 7a. (For the full experiment from which Figure 7a was derived, see Tramo et al. 1990 in the references.) This Thursday, the Harmony Study Group will present a recent paper by McDermott and colleagues that addresses whether or not the absence of roughness is the psychoacoustic basis of tonal consonance.

Figure 7c shows the results of a one-interval, two-alternative forced-choice experiment employing the method of constant stimuli. Two simultaneous pure-tones were presented to Case A1+ and normal controls. The frequency difference between the tones was varied in several steps from zero to 4 semitones. (*Note:* “1/16” on the x axis should read “1/6.”) Tone amplitudes and durations were held constant. Listeners had to judge whether the two tones sounded “smooth” or “rough.”

Place a “T” on the line next to the following propositions that are true and an “F” next to the propositions that are false:

- T  F The population statistics for the normal population show a lot of variability in performance. (2 points)
- T  F When the two pure-tones were less than a semitone apart, they sounded rough more often than they sounded smooth. (2 points)
- T  F When the two pure-tones were more than a semitone apart, they sounded smooth more often than they sounded rough. (2 points)
- T  F When the two pure-tones were a semitone apart, they sounded smooth about half the time and rough about half the time. (2 points)
- T  F Case A1+'s performance was near the mean of the normal population's performance. (2 points)

3. True or false? Place a T or F on the line preceding the proposition:

\_\_T\_\_ Case A1+'s performance in Figure 7a cannot be explained by impaired roughness perception (2 points)

\_\_T\_\_ Taken together, the results in Figure 7a, 7b, and 7c suggest Helmholtz and his disciples are wrong: forming the percept of tonal consonance does not depend entirely on the absence of roughness (2 points)

\_\_T\_\_ Taken together, the results in Figure 7a, 7b, and 7c and the results on pure-tone pitch perception presented by the Pitch Study Group suggest that forming the percept of tonal consonance depends on the pitch relationships of notes comprising a musical chord (2 points)

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