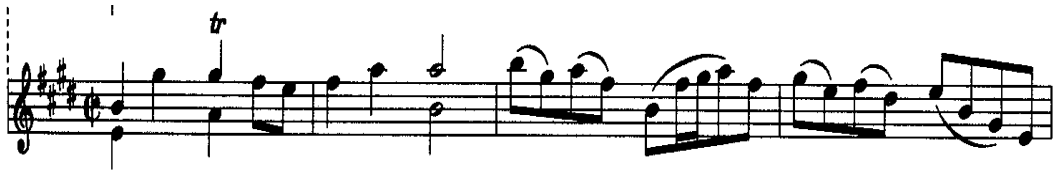
Harvard-MIT Division of Sciences and Technology
HST.725: Music Perception and Cognition
Prof. Peter Cariani



Rhythm: patterns of events in time

HST 725 Lecture 13
Music Perception & Cognition

(Image removed due to copyright considerations.)

www.cariani.com

Upcoming topics

Thursday, March 18 (Cariani)

Melody

Reading: Handel (Chapter 10); Deutsch (Pitch sequences)

Tuesday, March 30 (Cariani)

Presentation on automated music recognitions (Tristan)

Term project topic presentation & discussion (Stephan)

Rhythm I: Rhythm perception

Reading: Handel (Chapter 11); Deutsch (Clarke chapter)

Also begin looking at Snyder, Music & Memory

Upcoming topics II

Thursday, April 1 (Cariani)

Grouping, expectation, and time

- Time perception, event structure, and temporal expectations
- Auditory spectral and temporal integration; chunking of segments
- Auditory scene analysis and organization of voices
- Grouping of sounds – onset, harmonicity, rhythm
- Sound streams (Bregman, Deutsch), polyphony
- Grouping processes and musical structure
- *Reading: Snyder, Music & Memory; Handel, Ch. 7 Stream Segreg*

Tuesday, April 6 (Cariani)

Music, speech and language: parallels and contrasts

Presentation on tonal languages and music (Stephan)

- Reading: Bigand chapter in *Thinking in Sound*

Upcoming topics III

Thursday, April 8 (Cariani)

Emotion and meaning in music
Musical semantics, music and pleasure
Music and long-term memory
Musical style recognition (Victor)

Tuesday, April 13 (K. Howland, music therapist)

"Clinical applications of the neuropsychology of music." Guest speaker Kathleen M. Howland Ph.D., MT-BC, CCC-SLP.

Problem set due

Thursday, April 15 (Oxenham)

Clinical issues. Music exposure and hearing loss.
Music perception: hearing impaired listeners & cochlear implant users

Upcoming topics III

Thursday, April 22 (Tramo)

Effects of cortical lesions on music perception & cognition
Music and cortical function: Janata paper (Victor)
Auditory agnosia: Peretz paper (Stephan)
Music therapy: clinical problems and prospects

Tuesday, April 27 (Cariani)

Developmental psychology of music

Thursday, April 29 (Cariani)

A question of origins: comparative & evolutionary psychology of music

Reading: McDermott & Hauser; other readings TBA

Upcoming topics III

Tuesday, May 4 (Cariani)
Music performance. Organization and timing of movement.

Thursday, May 6
Special topics: absolute pitch, synesthesia, etc.
Audition, vision & other senses: Correspondences & divergences
Synthesis: What would a unified theory of music perception & cognition look like?

Tuesday, May 11
Student Term Project Presentations

Thursday, May 13 (Cariani)
Overview and recap of major themes;

Monday, May 17 All term projects due, noon.

Rhythm: patterns of events in time

- What is rhythm? Perceived pattern of events in time
- What constitutes an event? What makes events salient (accented)?
- How many individual events can we distinguish (< 12/sec)?
- Musical terminology: rhythm, meter, beat, pulse, tempo, accent, phrase, time signatures
- Auditory sense and the time sense (supramodal)
- Meter vs. rhythm (pattern of accented/nonaccented events)
- Rhythmic pattern invariance w. respect to tempo
- Rhythmic induction & expectation
- Rhythmic hierarchies, rhythmic complexity
- The issue of small integer-ratios again; models (clock, osc)
- Polyrhythms; analogy to polyphony
- Interactions between melody & rhythm: accents
- Rhythms: musical, body, and brain; kinesis

Rhythm: general observations I

- Levels of organization (basketball game analogy)
- Underlying temporal framework (tempo, meter)
- Patterning (Rhythm: perception of the grouping & ordering of events)
- Rhythmic pattern arises from grouping of events in time
- Grouping arises from temporal pattern expectancies
  - created through repetition and
  - patterns of salient auditory contrasts (accents)

Ranges of events; intervals from 50 ms to 2 sec
Too short: events fuse
Too long: successive events don't cohere, interact
Pitch (> 30 Hz); infra-pitch (10-30 Hz); rhythm (< 10 Hz)
For a brisk tempo of 120 bpm, 2 Hz,
a quarter note is 500 msec (2 Hz)
an eighth note is 250 msec (4 Hz)
a sixteenth note is 125 ms (8 Hz)
a 32nd note is 62 ms (16 Hz)

Tempo (absolute timescale)

Jones, George Thaddeus. *Music Theory*. New York, Barnes and Noble Books, 1974.

Pulse & meter

(Snyder, Bob. 2000. Music and Memory. MIT Press. ISBN: 0262194414.)

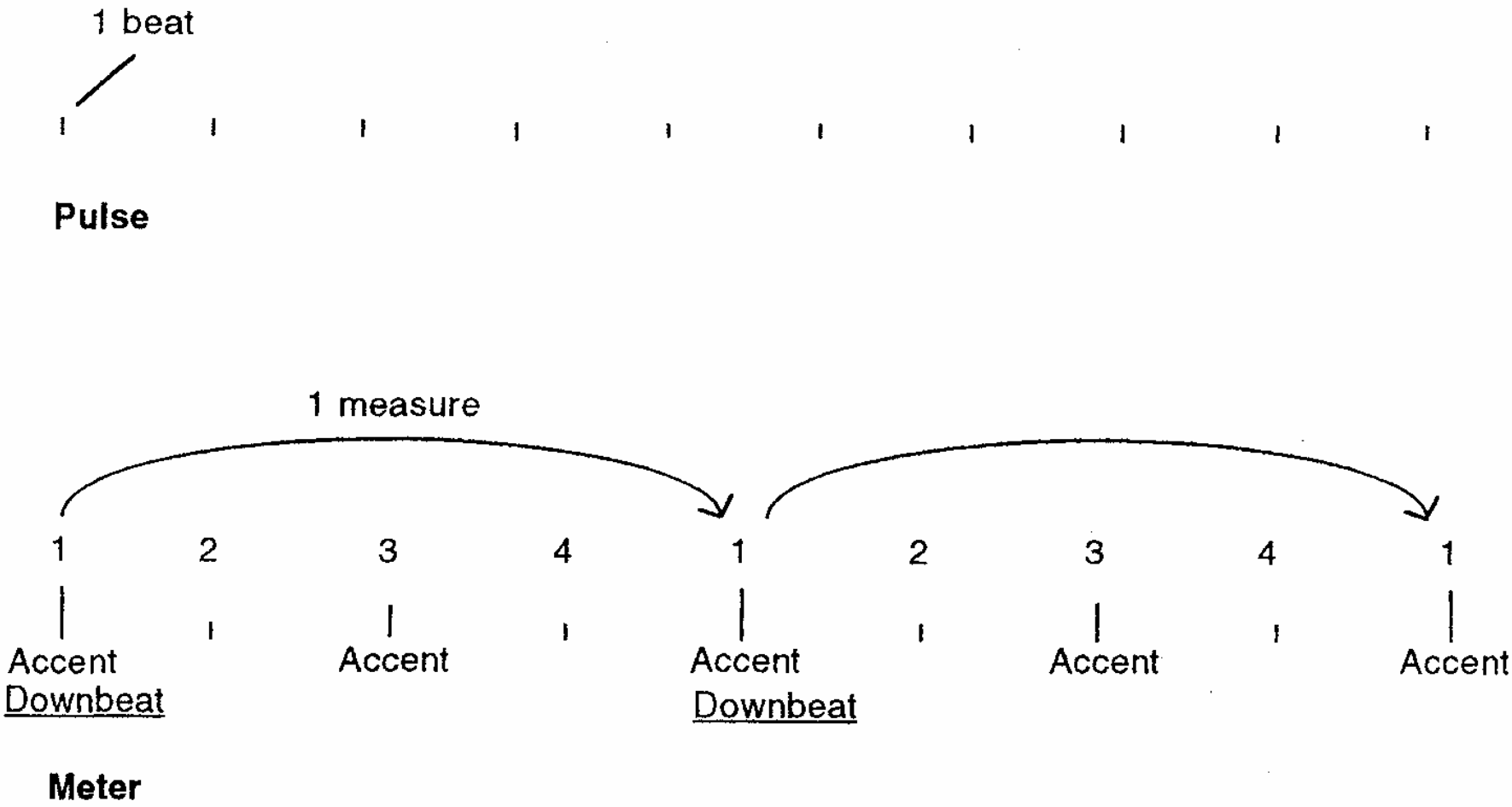
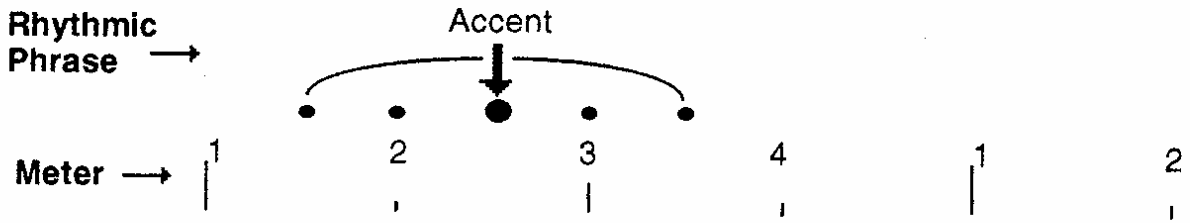


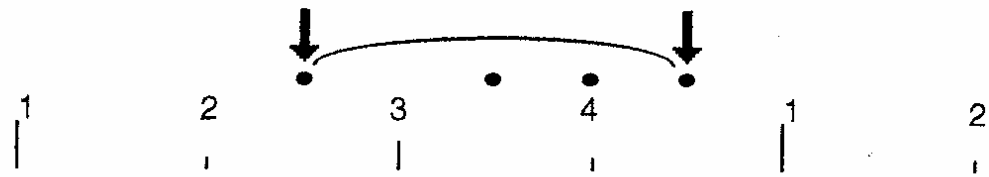
Figure 12.5
Pulse and meter.

Accent -- different means of accenting

(Snyder, Bob. 2000. Music and Memory. MIT Press. ISBN: 0262194414.)



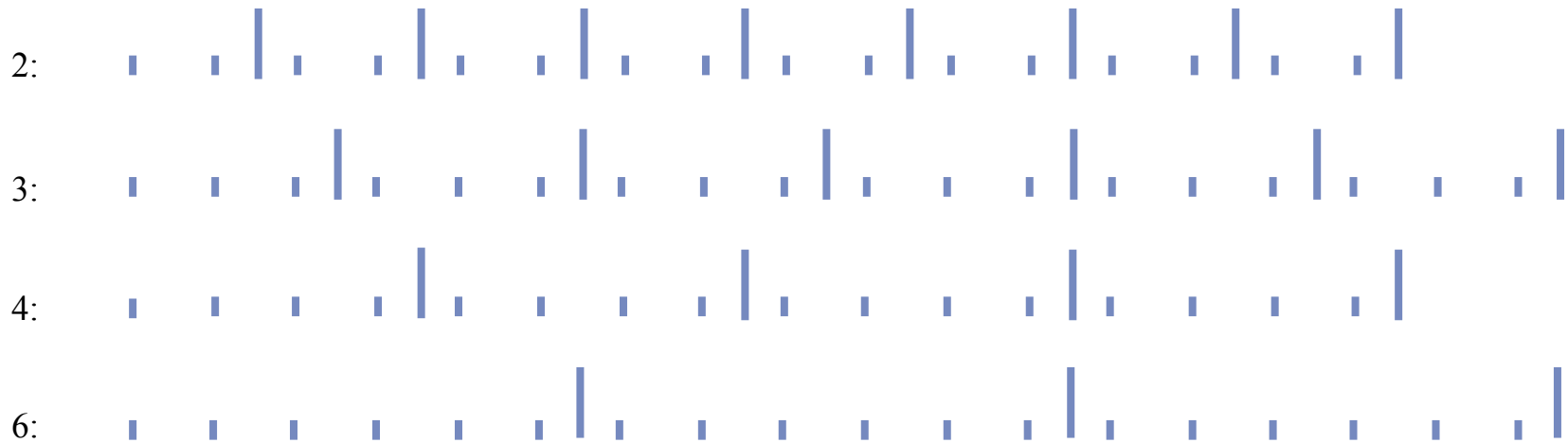
Phenomenal accent: louder event in middle of phrase is accented.



Structural accent: first and last events of phrase are accented.

Metrical accent: first and third beats of measure are accented.

Figure 12.4
Three kinds of accent.



Meter and Accent

The recurrent groups of pulsations are called *meters*: for example, duple meter, triple meter, and quadruple meter. The beats within the measures are counted and accented:

2: one, two | one, two |
3: one, two, three | one, two, three |
4: one, two, three, four | one, two, three, four |
6: one, two, three, four, five, six |

Meter (e.g. 4 pulses per measure/accent)

Definition: The number of pulses between the more or less regularly recurring accents (Cooper and Meyer , 1960).

Most authors define meter similarly, as somehow dependent upon (and perhaps contributing to) patterns of accent. Zuckerkandl (1956), however, views meter as a series of "waves" that carry the listener continuously from one beat to the next. For him, they result not from accentual patterns but simply and naturally from the constant demarcation of equal time intervals.

http://www.music.indiana.edu/som/courses/rhythm/illustrations

Beat

- Beat: "underlying pulse of each bar which is counted" Music Theory, Margaret Richer

Pulse

- **Definition:** A series of regularly recurring, precisely equivalent stimuli (Cooper and Meyer , 1960). According to Parncutt (1987), a chain of events, roughly equally spaced in time.

http://www.music.indiana.edu/som/courses/rhythm/illustrations

Accent

Definition: Accent is defined differently by different authors. The following is a sampling of definitions. Cooper and Meyer (1960) define accent as "a stimuli (in a series of stimuli) which is *marked for consciousness* in some way." They regard accent as a relational concept and as axiomatic in that it is understandable experientially but undefined causally. Lerdahl and Jackendoff (1983) define three kinds of accent, a) *metrical* , which denotes a beat (a time point) that is relatively strong in its metrical context, b) *phenomenal* , a surface emphasis or stress given to a moment in the musical flow, and c) *structural* , denoting an accent caused by melodic/harmonic points of gravity in a phrase or section, especially a cadence.

http://www.music.indiana.edu/som/courses/rhythm/illustrations/pulse.html

Factors that cause events to be accented: auditory contrast, salience

- note duration
- note intensity
- sharpness of attack
- melodic contour/ pitch change
- regularity of timing (accented beats are "on time")
- position within a metrical organization

- According to Cooper & Meyer (1960), an accented tone must be set off from the rest of the series in some way (i.e. a salient contrast)

rhythm: *(general def.) patterning of events in time*

- **rhythm Definition:** The way in which one or more unaccented beats are grouped in relation to an accented one. The five basic rhythmic groupings include: iamb (unstressed/stressed), anapest (unstressed/unstressed/stressed), trochee (stressed/unstressed), dactyl (stressed/unstressed/unstressed), and amphibrach (unstressed/stressed/unstressed) (Cooper and Meyer , 1960).

http://www.music.indiana.edu/som/courses/rhythm/illustrations

Repetition of a rhythmic pattern establishes the pattern

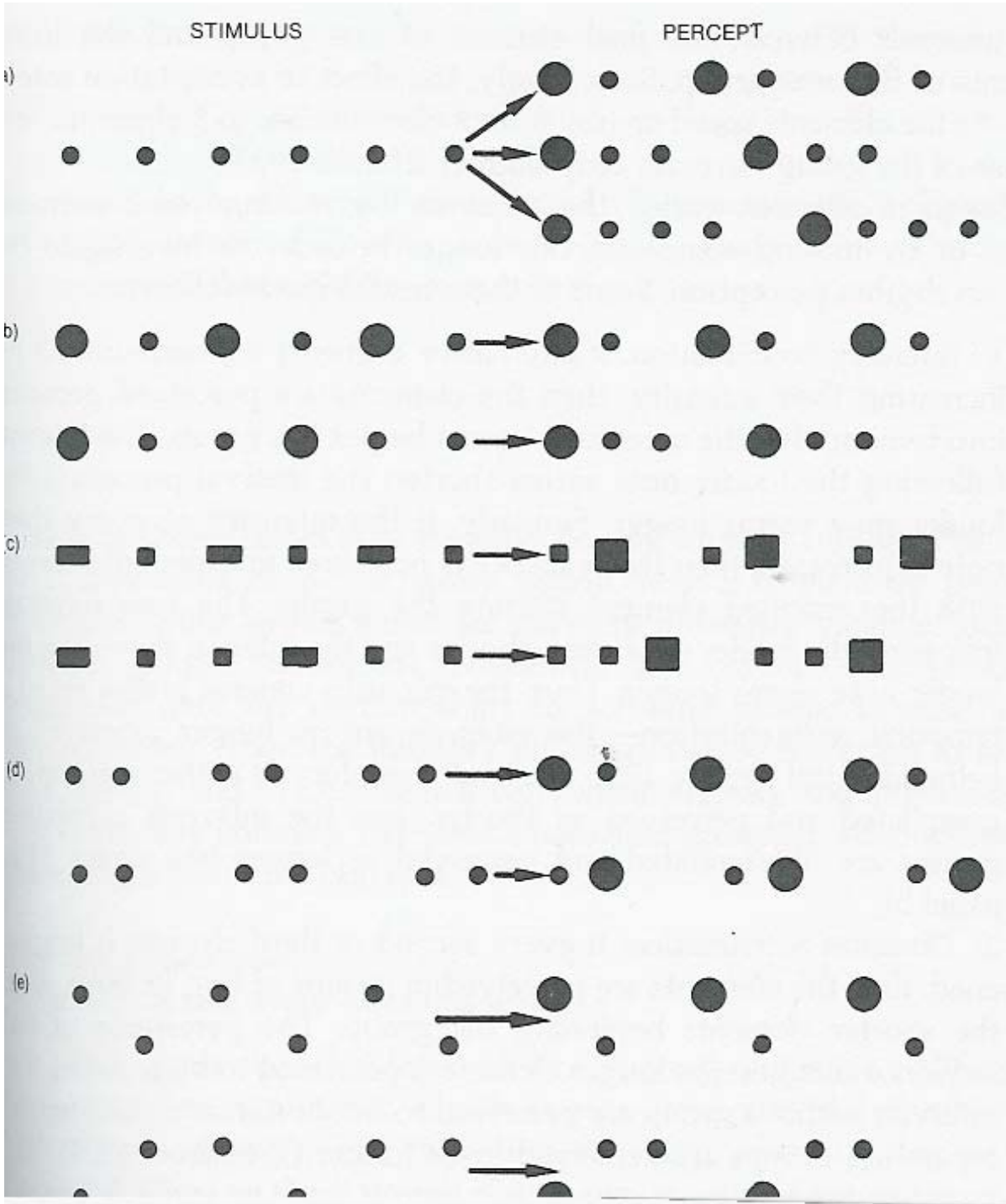
Jones, George Thaddeus. *Music Theory*. New York, Barnes and Noble Books, 1974.

Accent causes grouping which determines perceived rhythmic pattern

Rhythm is a perceptual attribute

(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.)

Figure 11.1
"Subjective" rhythm. A series of equally timed elements (i.e., equal temporal intervals between the onset of successive identical elements) is perceived as rhythmical. A series of identical elements, as in (*a*), is perceived to form groups of 2, 3, or 4 elements. The initial element of each group is perceived to be accented (represented by a bigger filled circle), and the time intervals between elements do not appear equal. If every second or third element is more intense, as in (*b*), the elements are perceived to form groups so that the more intense elements begin each group and there appear to be longer intervals between groups. If every second or third element is longer, as in (*c*), the elements are perceived to form groups so that the longer duration elements are the last elements of each group, the longer duration elements appear accented, and there appear to be longer intervals between groups. If every second interval between two elements is increased so that the elements form groups temporally, as in (*d*), then the first elements of each group appears accented if the longer interval is slightly greater than the other intervals, but the last element of each group appears accented if the longer interval is much greater than the other interval. If the elements are different frequencies, as in (*e*), then the elements are perceived to form groups so that the higher-pitch element begins each group and appears accented, and the interval between groups appears longer. If one note occurs less often, it may appear to be accented and begin each group.



Expressive timing & expectation

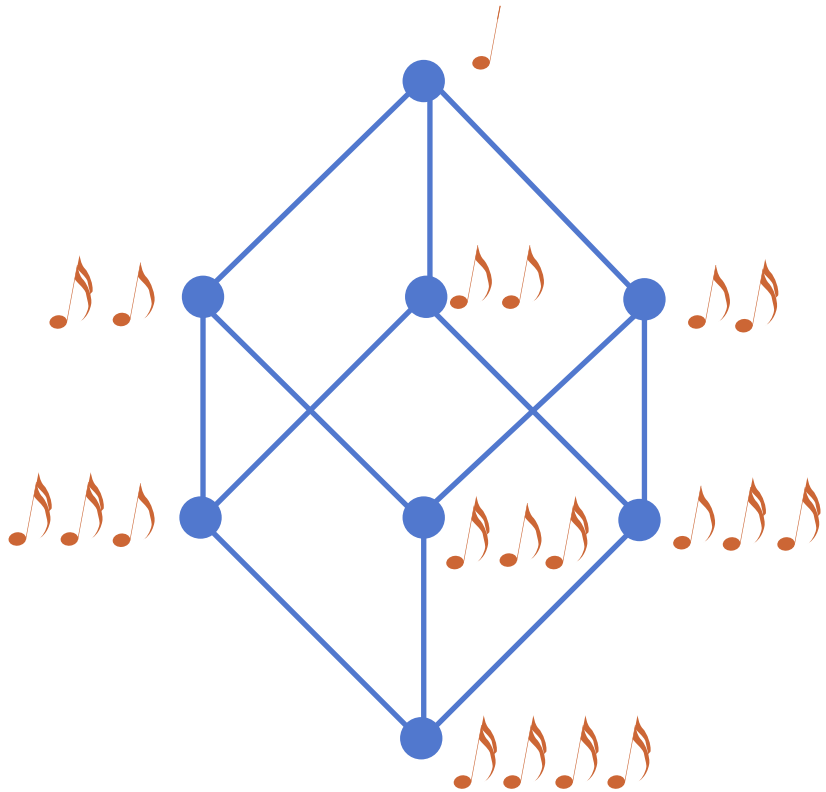
expressive timing Definition:

Music psychologists' term for the deviations from a strictly uniform pulse that occur in live performance. These deviations most commonly occur near the ends of phrases and other grouping units. See Todd (1985).

http://www.music.indiana.edu/som/courses/rhythm/illustrations

Rhythmic elaboration

EXAMPLE OF ELABORATIONS OF A QUARTER NOTE



Elaboration

 is an *elaboration of* 

 is an *elaboration of* 

and so on.....

Syncopation

Jones, George Thaddeus. *Music Theory*. New York, Barnes and Noble Books, 1974.

rhythmic, metrical dissonance

- **metrical dissonance Definition:** According to Krebs (1987), a situation in which the pulses in two metrical levels are not well aligned, either because the duration of the pulses in one level is not an integral multiple or division of the duration of the pulses in the other level, or because the pulses in one level are displaced by some constant interval from those in the other level. See also Yeston's rhythmic dissonance .

http://www.music.indiana.edu/som/courses/rhythm/illustrations

Polyrhythms

(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.)

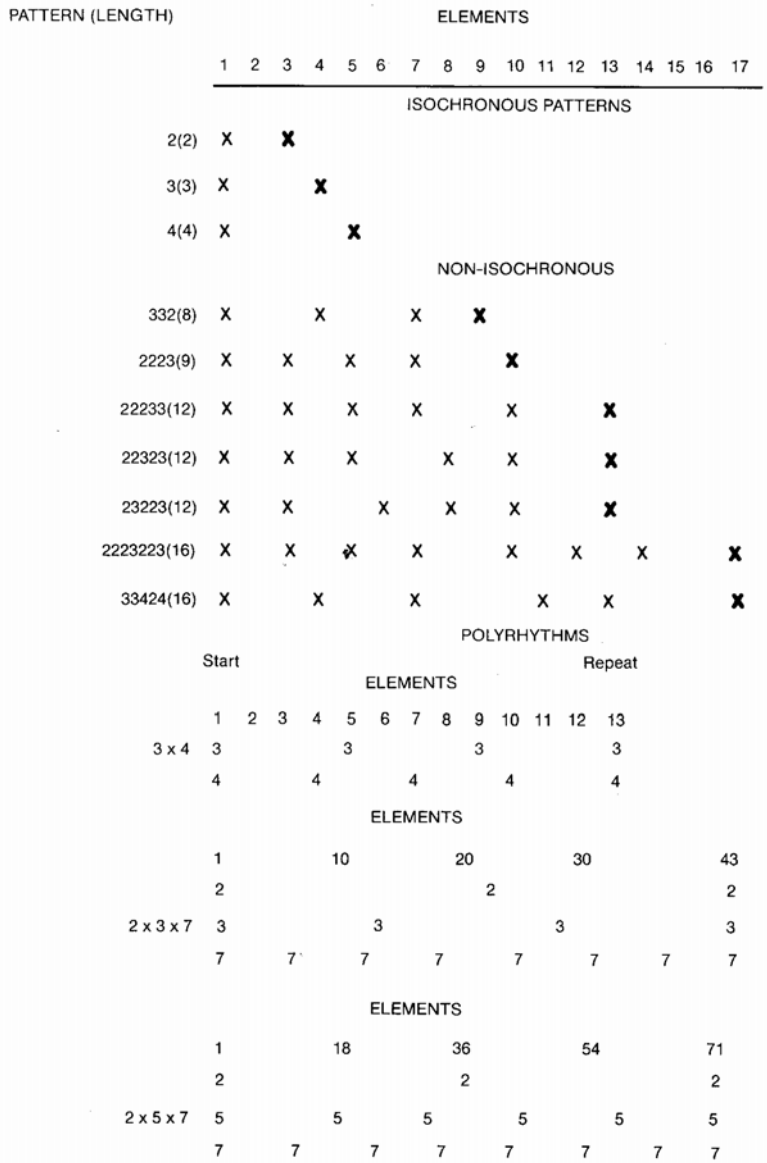
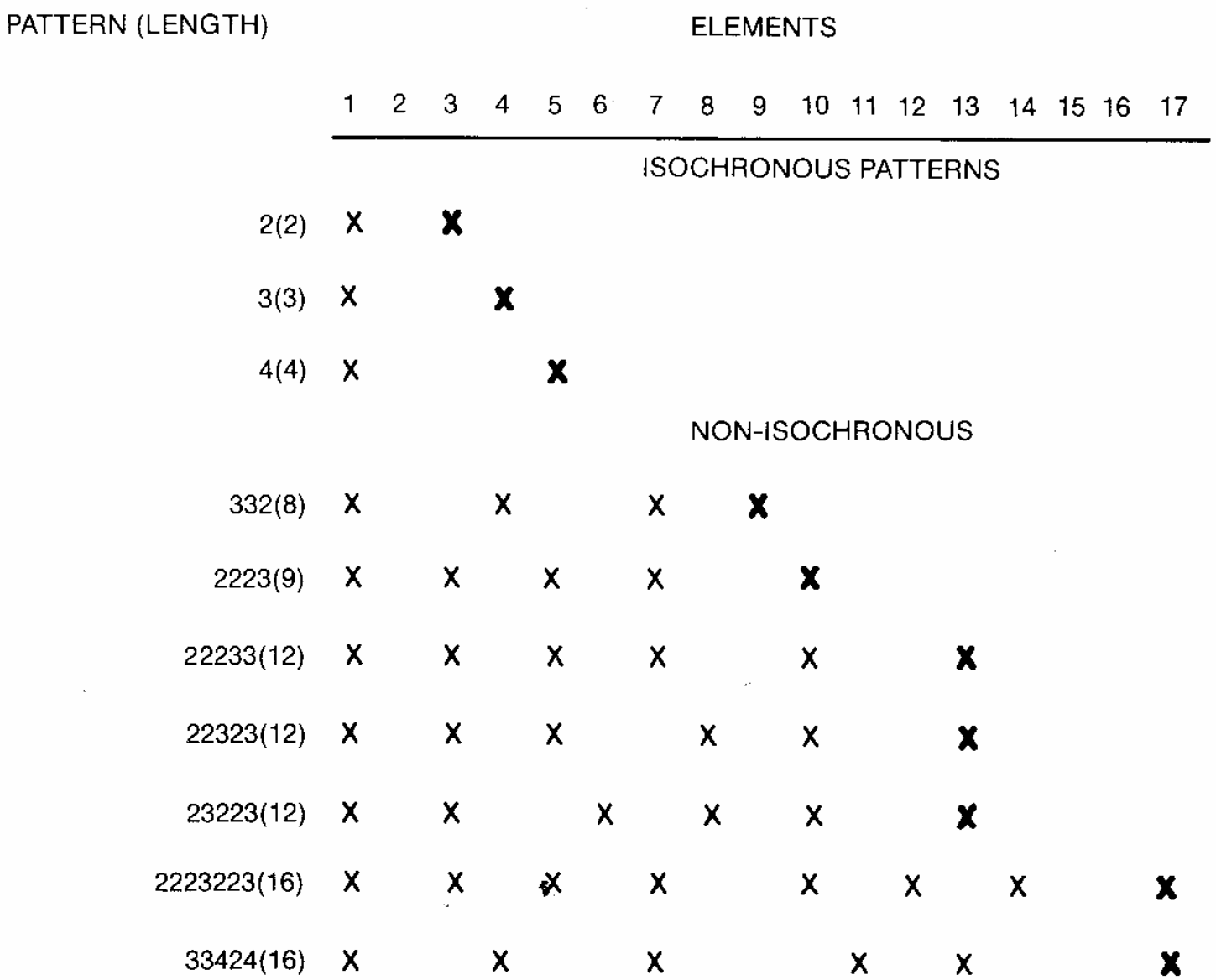


Figure 11.5
Rhythmic patterns that are used in the drum music of Africa. Typically several rhythmic lines are played simultaneously, and often a master drummer improvises on top of the repeating rhythmic patterns. Polyrhythms are defined as the simultaneous presentation of two isochronous patterns that do not share a common denominator. Three examples are shown. The element at which the polyrhythm repeats can be calculated by multiplying the number of elements in each line together (e.g., the pattern 2 × 5 × 7 ends on the 70th element and repeats on the 71st element).

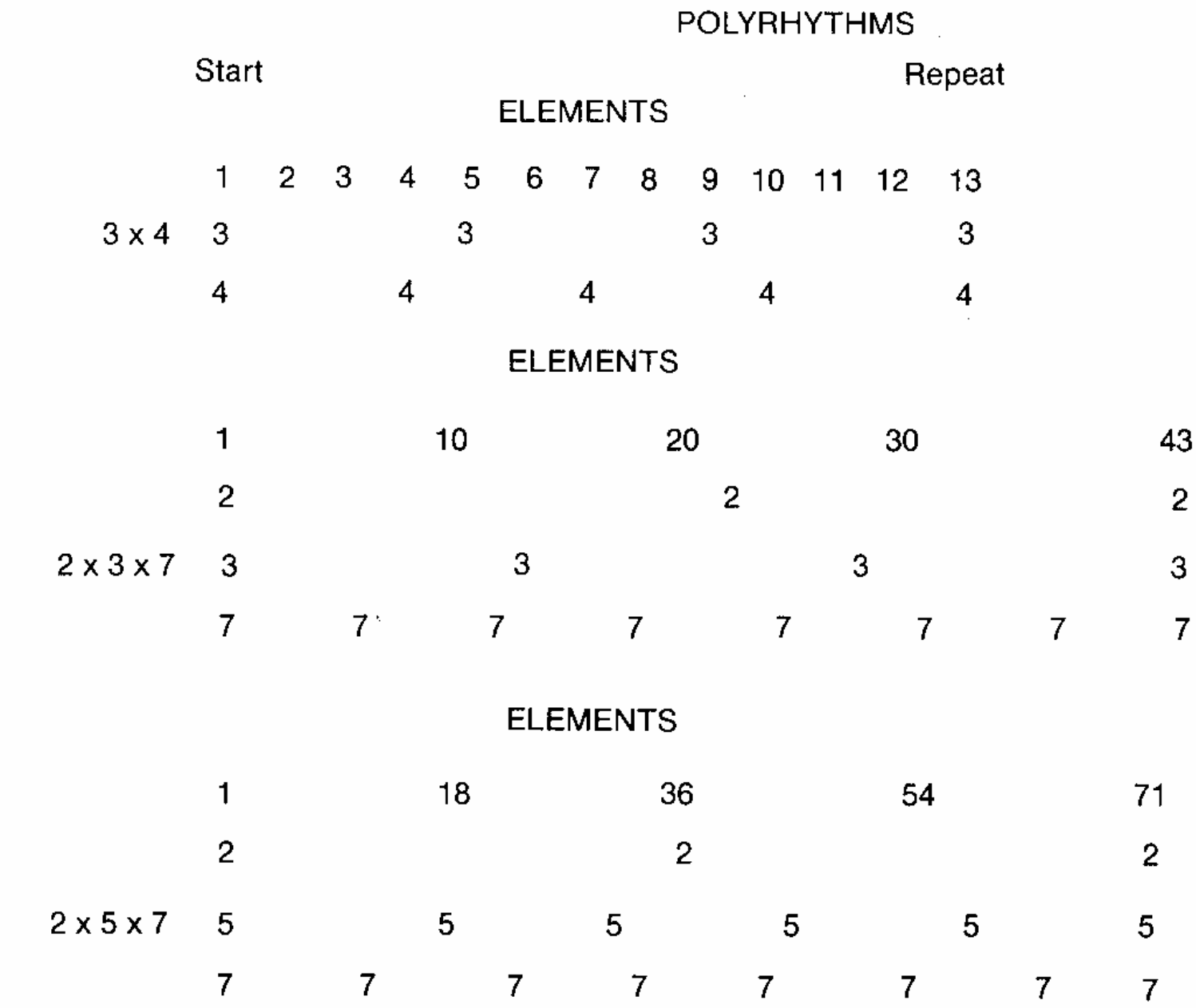
Isochronous & nonisochronous rhythms



(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.

Polyrhythms (polyrhythms:rhythm::polyphony:melody)

(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.



Rhythm & Grouping

- Three examples from
- Bregman & Ahad
- Auditory Scene Analysis CD
- African xylophone music

  interference between rhythmic patterns

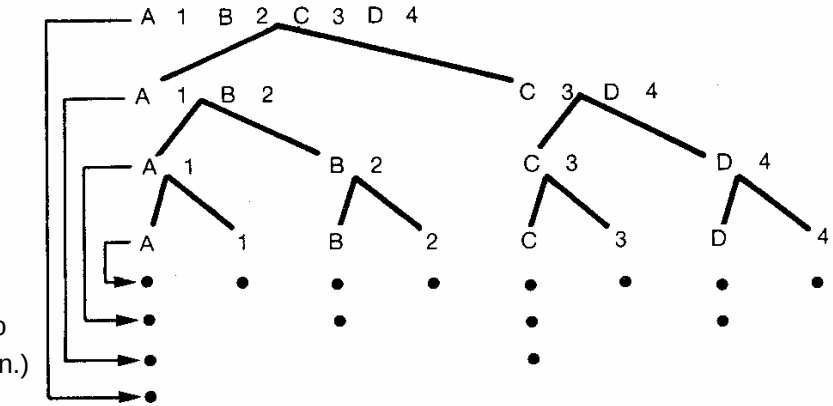
  separation of patterns via pitch differences

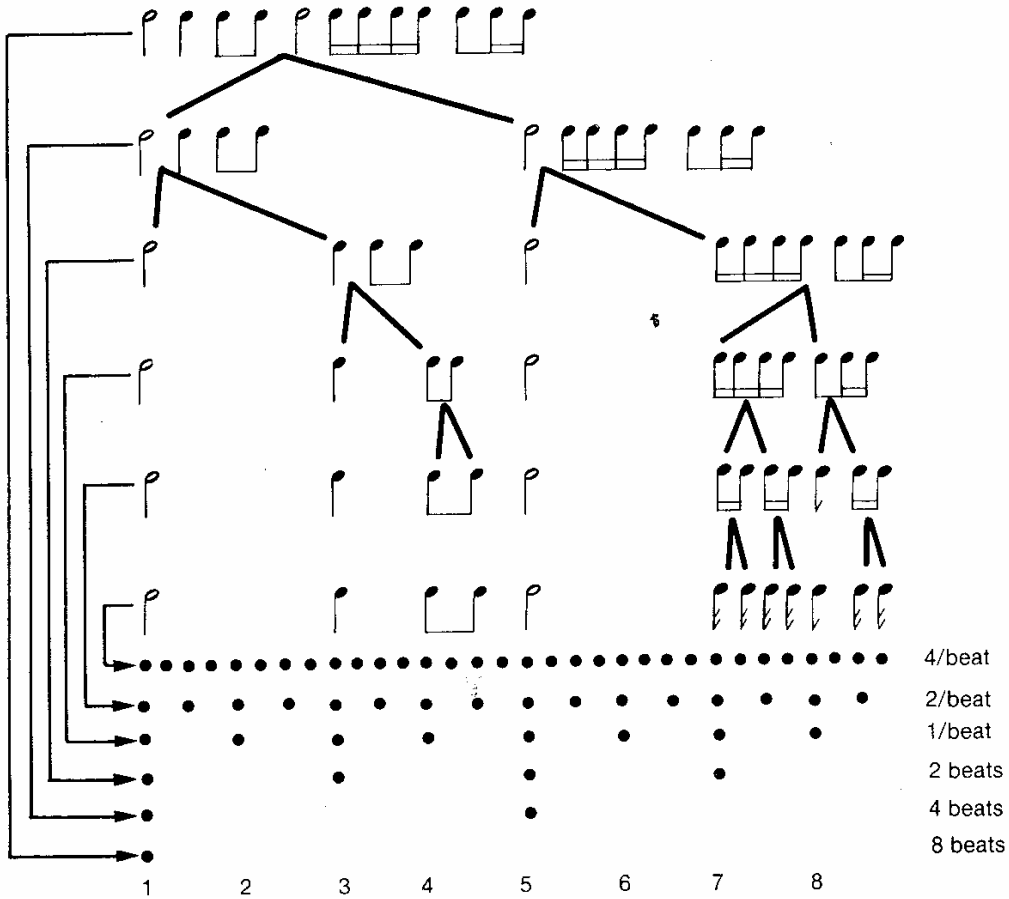
  separation of patterns via timbral diffs

Conflicting rhythms interfere unless the events can be separated out in separate streams

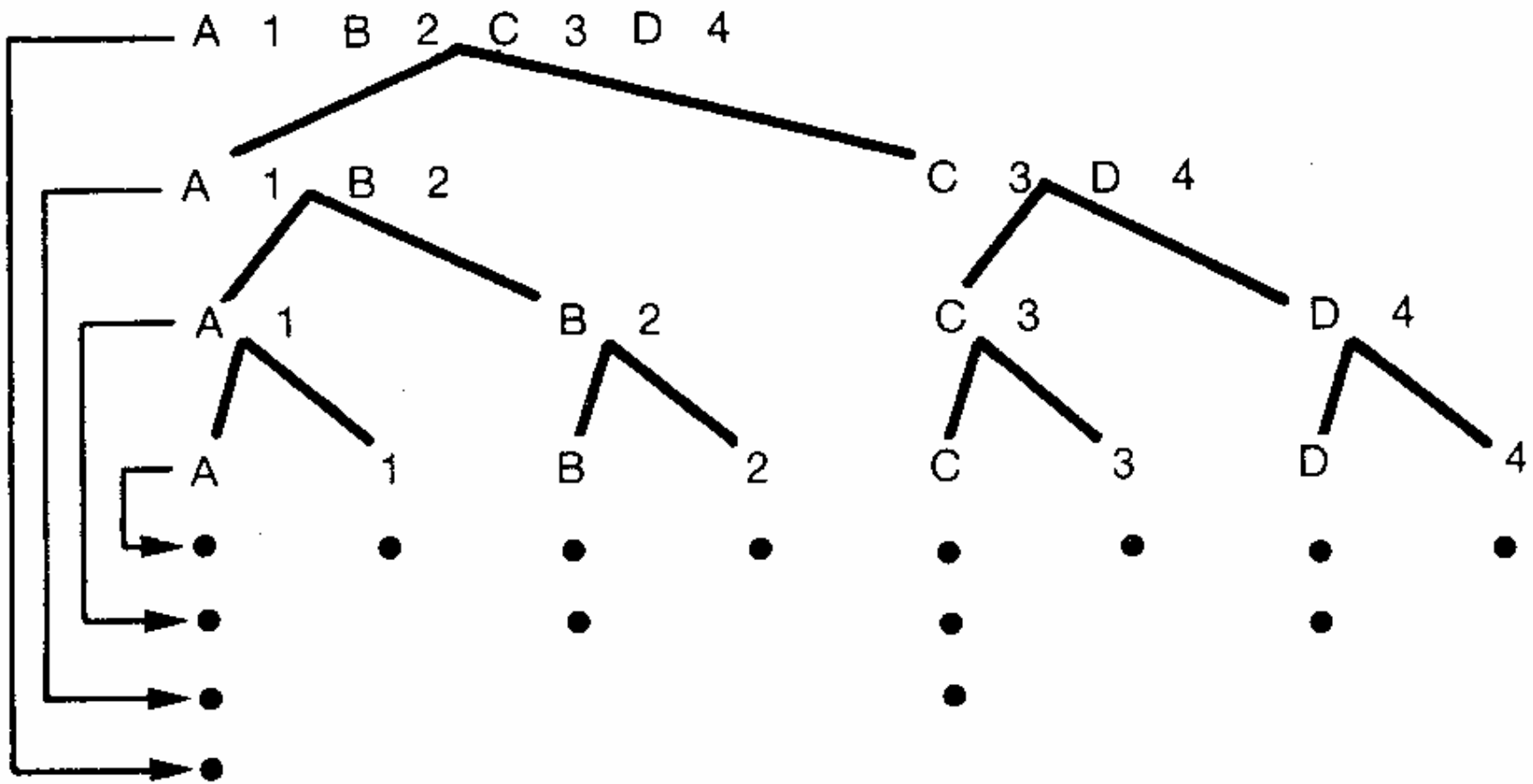
Rhythmic Hierarchy

(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.)



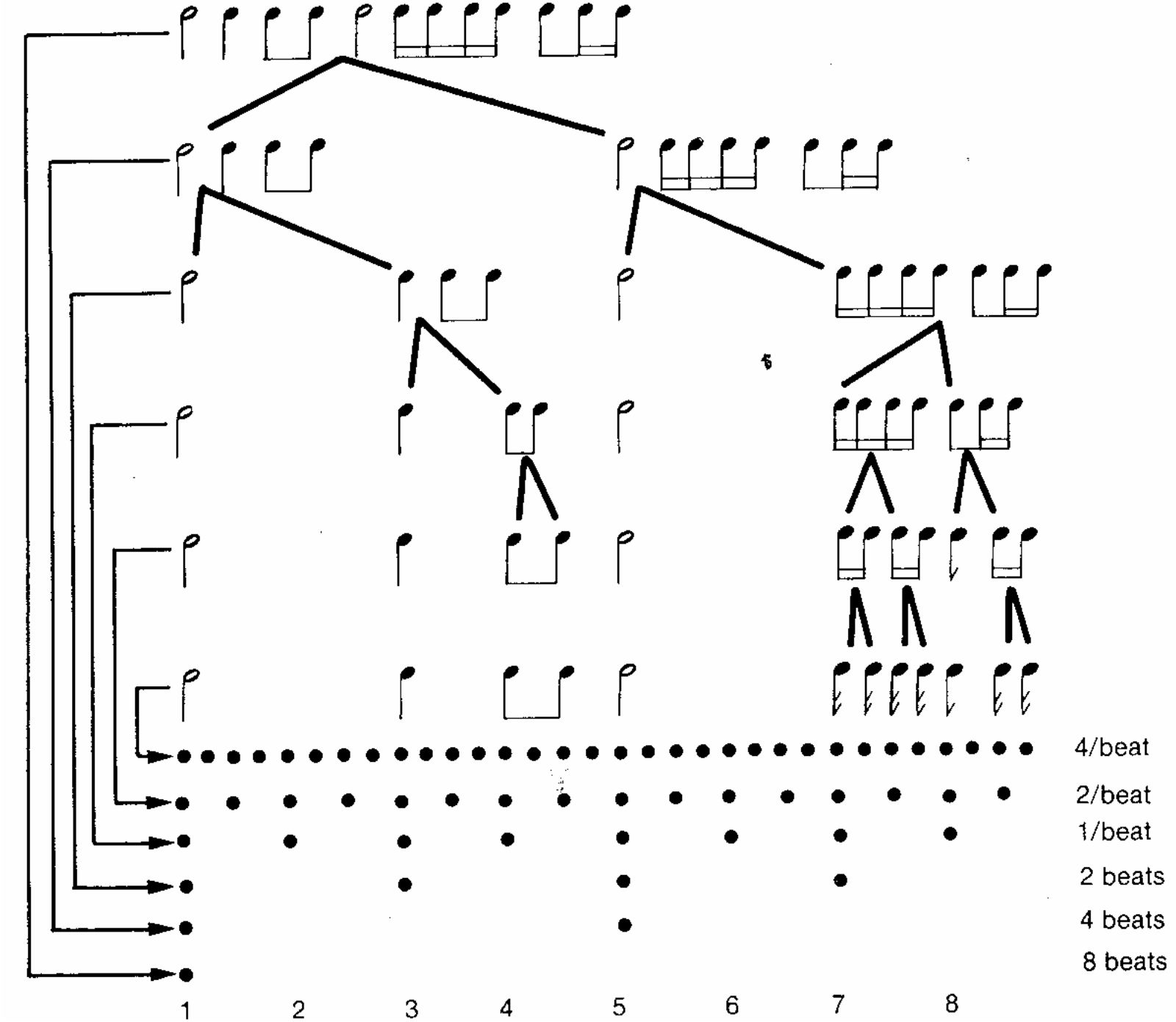


Rhythmic Hierarchy



(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.

(Series of figures from Handel, S. 1989. Listening: an Introduction to the Perception of Auditory Events. MIT Press. Used with permission.



General guidelines

Computer or typewritten papers, 12 pt. type, 1 inch margins

Text can be single-or double spaced

Computer formats: MS Word, RTF, PDF

Submit final papers email attachment

Hardcopy can be submitted by prior arrangement.

Collaboration is encouraged, but the final paper itself is your own work. Don't copy sections.

Reference citations should include all relevant information needed to access the work. Any format is fine (if in doubt consult Chicago Manual of Style or other standard reference or use a reference format in a professional journal, e.g. Psychological Review). URLs are fine, but no more than half the references should be URLs (give URL & date accessed).

Guidelines - term papers or reviews

Term papers (reviews, discourses)

quality is more important than quantity

no upper limits on length;

Suggested structure (suggested relative lengths):

Introduction to problem area (10%)

Restrict your topic, present the essentials that the reader needs to understand the issues

Review of existing theories/hypotheses (25%)

Review of existing empirical studies (25%)

General discussion, synthesis (30%)

Conclusions (10%)

References

Attack-point vs gestural rhythm

- **attack-point rhythm**
- **Definition:** Rhythm conceived as a precise series of durations and attack points abstracted from notated values and a metronomic pulse. For example, the attack-point rhythm of a the opening phrase of a piece refers to the abstract temporal relationships among the individual pitches of the melody. In contrast to gestural rhythm, attack-point rhythm considers the temporal distance between events rather than the flow of musical energy occurring between them. See Graybill (1990).

stress

- **stress Definition:** Dynamic intensification of a beat regardless whether it is accented or unaccented. Stress does not affect the accentual status of a note, but it may change the rhythmic grouping (Cooper and Meyer , 1960).

Pulse

- **Definition:** A series of regularly recurring, precisely equivalent stimuli (Cooper and Meyer , 1960). According to Parncutt (1987), a chain of events, roughly equally spaced in time.

http://www.music.indiana.edu/som/courses/rhythm/illustrations