



the rise and fall of “volume”

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plan of the talk

- ① The Broader Project
- ② Measurement I: *adjustment + instruction*
- ③ “Volume”: *A Brief History*
- ④ Measurement II: *multidimensional scaling*
- ⑤ Morals

the project

- ✧ Psychophysics represents judgments of sensory (dis)similarity (distance) with geometrical models.
 - ❖ The color solid
 - ❖ The taste tetrahedron
 - ❖ Linear models of loudness, heat, brightness, etc.
- ✧ A realism question: **do these models veridically represent *psychological kinds*?**

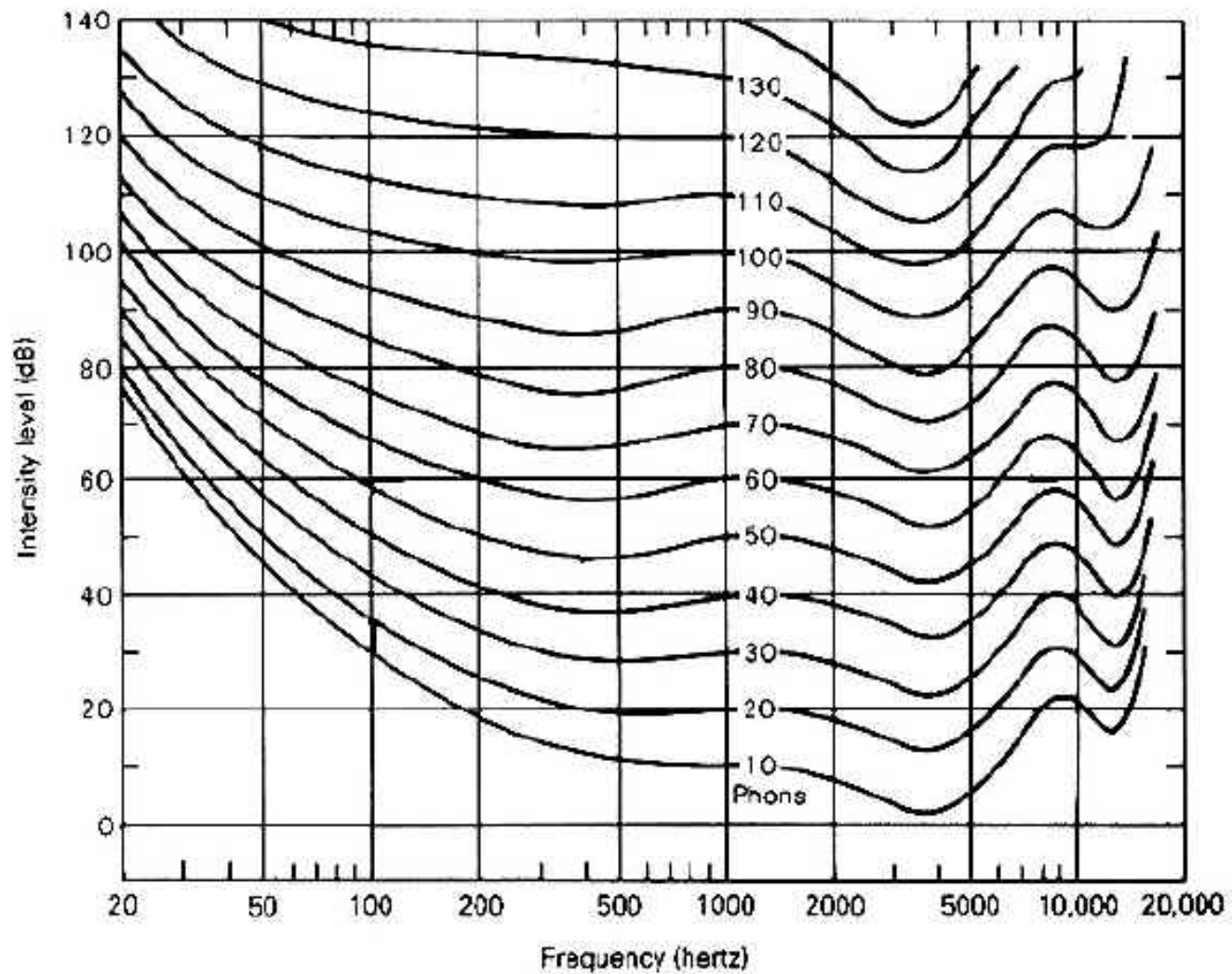
the project

- ✧ Psychological kinds?
- ✧ Strong thesis: **natural kinds** — robust, investigator independent, categories in nature.
- ✧ Weaker thesis: **genuine kinds**
“A *genuine kind* is a valid kind in a well-ordered scientific research program.” ~ Q. Spencer

measurement I: adjustment + instruction

Procedure:

1. Present 2 stimuli to the subject
2. Allow subject to adjust one physical feature of *stimulus b*, asking them to adjust it until the corresponding sensation is equal to that induced by *stimulus a* **w/r/t attribute X**.
 X = loudness / brightness / warmth / pitch / etc.
3. Graph subject's sensitivity / indifference against objective features of stimulus (**Weber curve**).



Equal loudness contours graphed against the two attributes that define the stimuli: frequency and intensity.

Fletcher & Munson, 1933

measurement I: adjustment + instruction

- ✧ Features of instruction-guided measurement:
 1. Researcher must begin with assumptions about:
 - i. A perceptual attribute
 - ii. The corresponding stimulus feature(s)
 2. Logically, consistency in measurement outcomes **abductively** confirms
 - i. Legitimacy (**reality?**) of the perceptual attribute
 - ii. (**Causal?**) correspondence relation between that attribute and identified stimulus feature(s)

aside: attributes

- ✧ (psycho)logical fact:
Sensory attributes need not (do not) correspond 1-to-1 with stimulus features.
- ✧ Logically, this holds for general number of attributes as well:
 - ❖ In particular, stimuli defined by 2 dimensions of variation may generate sensations characterized by $n > 2$ dimensions of attribute variation.
 - ❖ *Is this also a psychological fact?*

tonal attributes

- ✧ Pure tone stimuli are defined by two features:
 1. Intensity
 2. Frequency

- ✧ Classically, perceived tones have two attributes:
 1. Loudness
 2. Pitch

... but are there more?

a brief history of “volume”

✧ 1916:

Rich argues from consistent measurements of “volume” w/r/t pitch that it is an attribute of tonal sensation (and not mere metaphor or association).

✧ 1924:

Halverson shows “volume” judgments vary also with intensity and argues that the difference in “volume” and loudness limens indicates they constitute “separate attributive dimensions.”

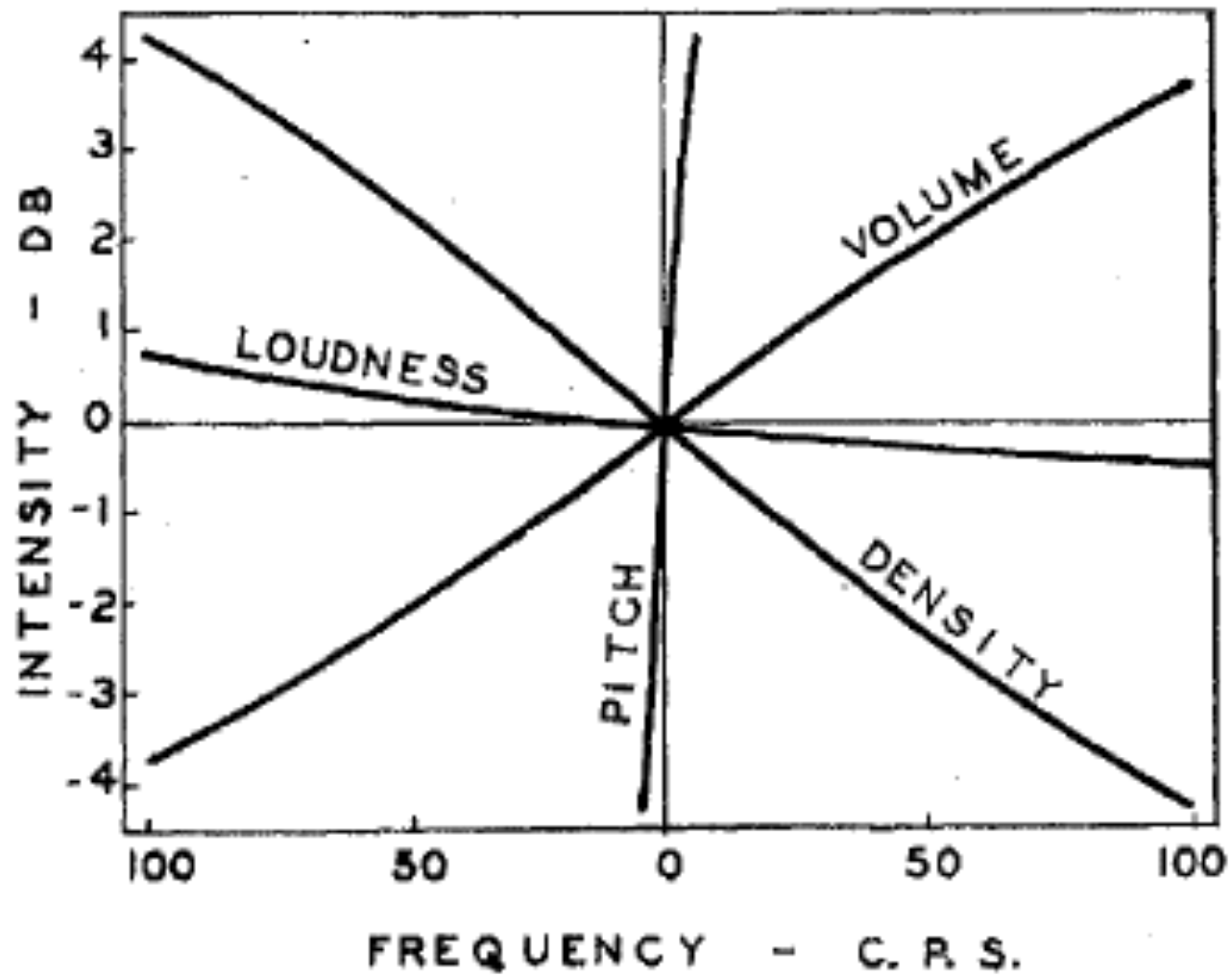
a brief history of “volume”

✧ 1934:

Stevens shows four attributes of tonal sensation vary independently: *pitch*, *loudness*, *volume*, and *density* — each as a (distinct) function of both stimulus intensity and frequency.

✧ 1935:

Boring argues that Stevens' results show that sensory attributes of a stimulus defined by n features may themselves have $m > n$ dimensions of variability.



a brief history of “volume”

- ✧ 1940:
Thomas measures equal-volume contours.
- ✧ 1962:
Stevens shows that loudness is proportional to density times volume: $L \propto D \times V$.
- ✧ 1971:
Gulick measures volume distances by having subjects adjust comparison tones to double and half the volume of a baseline tone.



Google n-gram showing peak in reference to “tonal volume” in the English corpus in the late 1930’s / early 1940’s, and subsequent gradual decline.

doubts about “volume”

- ✧ Are volume / density really primitive (**natural; genuine**) attributes of tone perception?
- ✧ Phenomenological doubts:
 - ✧ Rich’s subjects report different access to volume:
 - ✧ Direct perception
 - ✧ Kinaesthetic perception
 - ✧ Calculation via visual imagery
 - ✧ Stevens needed to train “uninitiated” subjects on density by providing exemplars. (Stevens & Davis, 1938)

doubts about “volume”

- ✧ Operationist response:

Establishment of a procedure for consistent measurement (discrimination) is all that is required to legitimate a psychological concept. (Stevens, 1935)

- ✧ Physiological posit:

Correlates in Organ of Corti (Stevens, 1934 / Boring, 1935)

- ✧ Loudness: total excitation
- ✧ Pitch: position of maximal stimulation (peak)
- ✧ Volume: spread of excitation around peak
- ✧ Density: local ratio of excited to unexcited fibres

measurement II: multidimensional scaling

- ✧ Shepard (1962) proposes a method for reducing large dimensional (psychophysical) data into a smaller number of dimensions.
 1. Made possible by computers
 2. Can transform qualitative judgments of similarity (or confusion) into Euclidean distances
 3. Assumes monotonicity in data

measurement II: multidimensional scaling

✧ Justification:

1. Recovery or standard results (eg color circle)
2. Mathematical – preserves differences in distance (up to monotonic transformation)
3. Epistemic – rotation of simplex allows discovery of principle axes (= attributes)

No antecedent assumption of attributes (nor special instruction) needed!

whence “volume”?

- ✧ Recall: $L \propto D \times V$.
- ✧ Loudness, density, and volume not independent.
- ✧ Judgments of distance appealing only to loudness will be equivalent to those involving density and volume up to monotonicity.
- ✧ Thus, multidimensional scaling for lowest dimensional space preserving distances will find pitch and loudness, not P, L, D, and V, nor P, D, and V.

- ✧ Norms of multidimensional scaling incompatible with those of general operationism.
 - Minimum dimensionality need not preserve all consistently measurable “attributes.”
- ✧ Drive toward multidimensional techniques correlates with rise of epistemic humility in psychophysics.
 - Increasing irrelevance of “volume” symptom of this.

morals

- ✧ Has anything been lost?
- ✧ Attributes candidates for psychological kinds.
Attributes dissociated from focusable discriminatory behavior and articulable phenomenological differences.
- ✧ Is inference from minimum number of axes to kinds **more/less** robust than inference from consistent task performance on instruction?



Thank you!