

Psychophysical Scaling of Sonification Mappings

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Introduction

- ◆ Focus on data sonification:
 - ① *Which auditory display dimension best represents a given data dimension?*
 - ② *What is the direction or “polarity” of the optimal mapping?*
 - ③ *What is the scaling function for that data and display pair?*

Definitions, 1

◆ Data dimension

- *Physical quantity that varies along a continuum*
e.g. temperature, pressure, number of dollars, pleasantness

◆ Display dimension

- *Variable attribute of a display that is used to represent data*
e.g. vertical height of mercury, color, pitch, tempo

◆ Mapping

- *The ordered relation between values on the data dimension and values on the display dimension*
e.g. temperature is “mapped to” pitch

Definitions, 2

◆ Polarity

- *Whether an increase in the data is mapped to an increase or decrease in the display*
e.g. increasing temperature mapped to increasing pitch

◆ Psychophysical scaling function

- *The numerical function that indicates the change in the display dimension required to indicate a given change in the data dimension*
e.g. +5 semitones represents +50 degrees F

Experiment 1: Mapping Preferences

① *Which sound dimension best represents a given data dimension?*

(i.e., is pitch or tempo better for “temperature”?)

- *Sounds:*

9 files, pre-synthesized in Csound at 16-bit, 44.1kHz

Frequency (400, 1000, 2400 Hz) × Tempo (60, 210, 420 bpm)

- *Data Dimensions:*

Temperature, Pressure, Velocity, Size

- *Participants:*

17 undergraduates (14 female, 3 male), reported normal hearing

Exp 1: Demo

A

START
HERE

B

Exp 1: Demo

Which sound best represents something with a hotter temperature?

A

B

Exp 1: Demo

A

START
HERE

B

Exp 1: Demo

Which sound best represents something with a faster velocity?

A

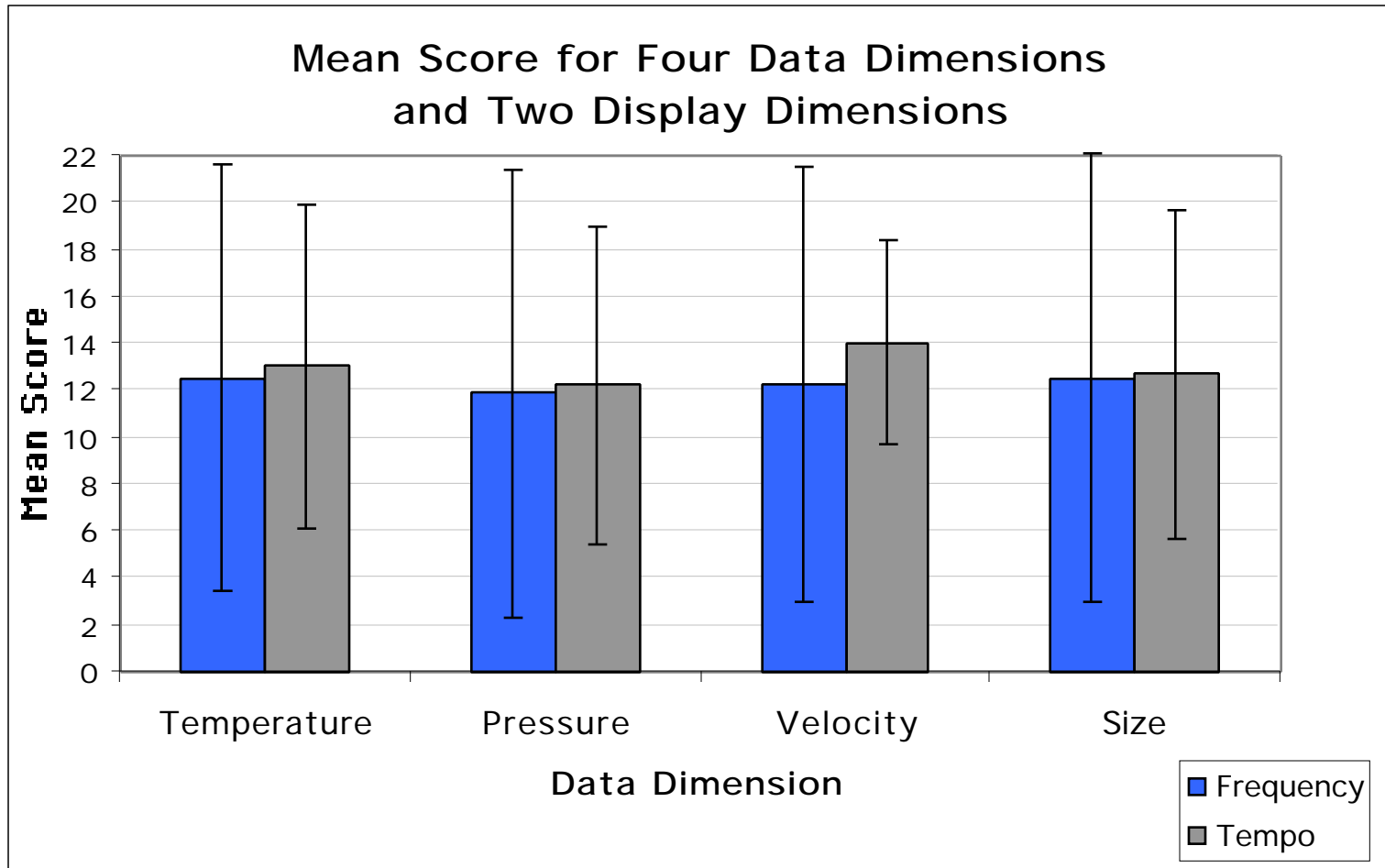
B



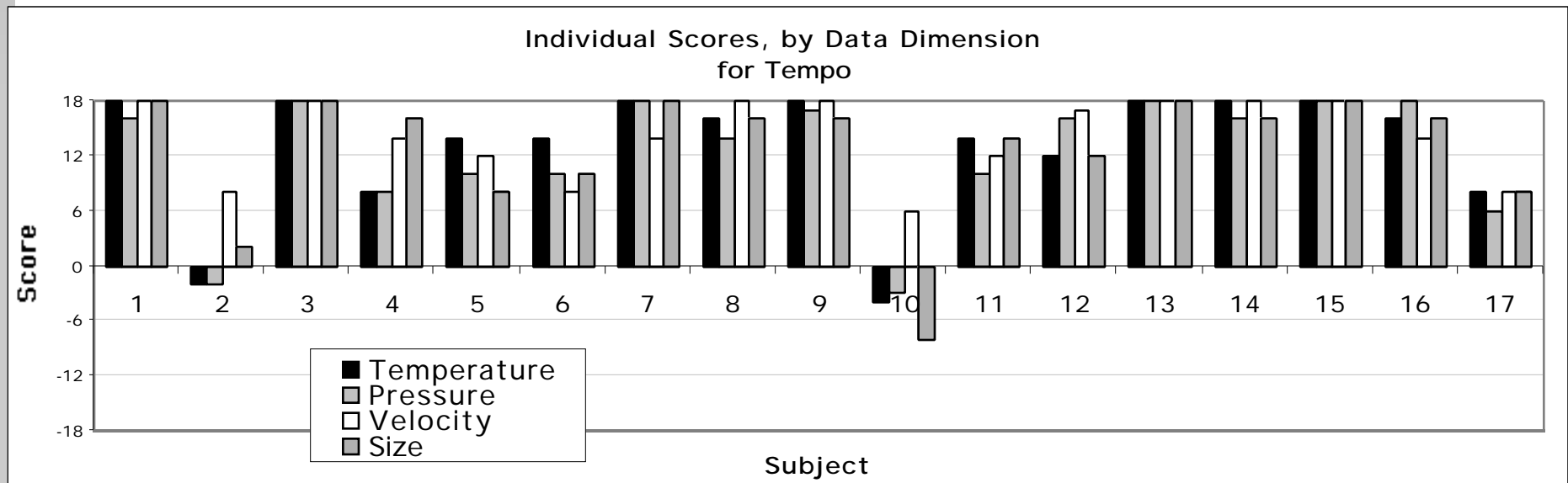
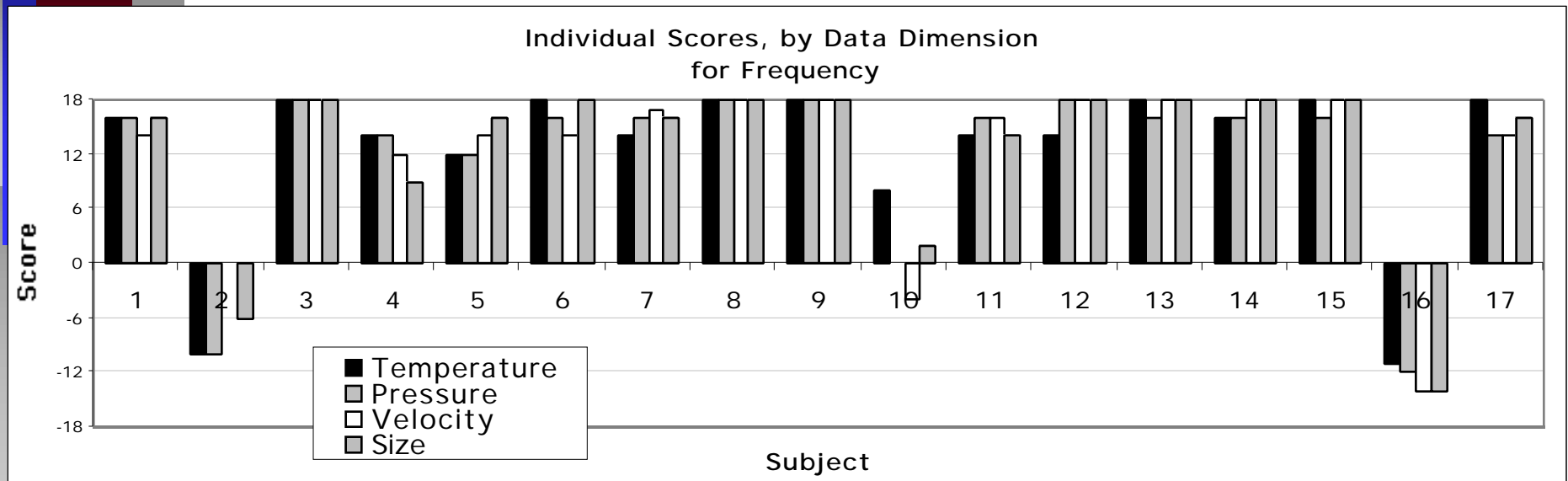
Exp 1: Demo

Done!
Thank you.

Exp 1: Results



Exp 1: Results (Individuals)



Experiment 2: Scaling the Dimensions

- ① *Which auditory display dimension best represents a given data dimension?*
 - ② *What is the direction or “polarity” of the optimal mapping?*
 - ③ *What is the scaling function for that data and display pair?*
- ◆ **Sounds:**
- *Set 1: Tempo*
(45, 60, 105, 150, 210, 270, 420, 500, 550, 600 bpm)
 - *Set 2: Frequency*
(100, 200, 300, 400, 800, 1000, 1400, 1800, 2400, 3200 Hz)
- ◆ **Participants:**
- *132 undergraduates (91 female, 41 male)*

Exp 2: Demo

Pressure

Play sound...

Next

Exp 2: Demo

Pressure

Play sound...

35

Next

Exp 2: Demo

Pressure

Play sound...

Next

Exp 2: Demo

Pressure

Play sound...

50

Next

Exp 2: Demo

Pressure

Play sound...

Next

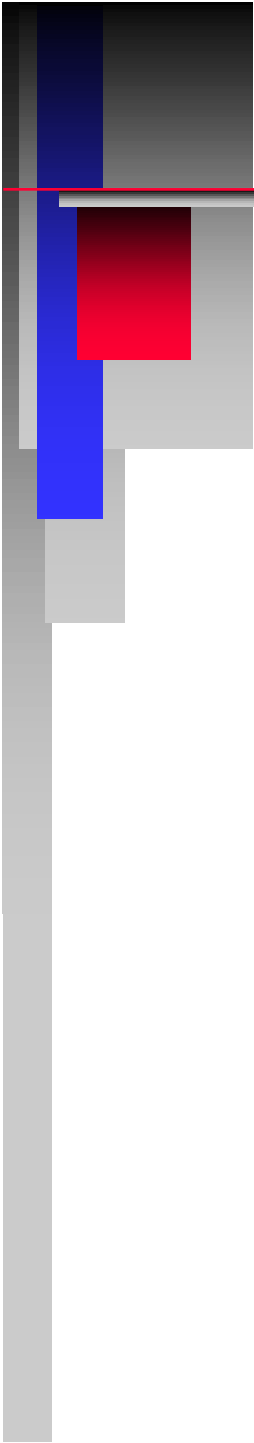
Exp 2: Demo

Pressure

Play sound...

16

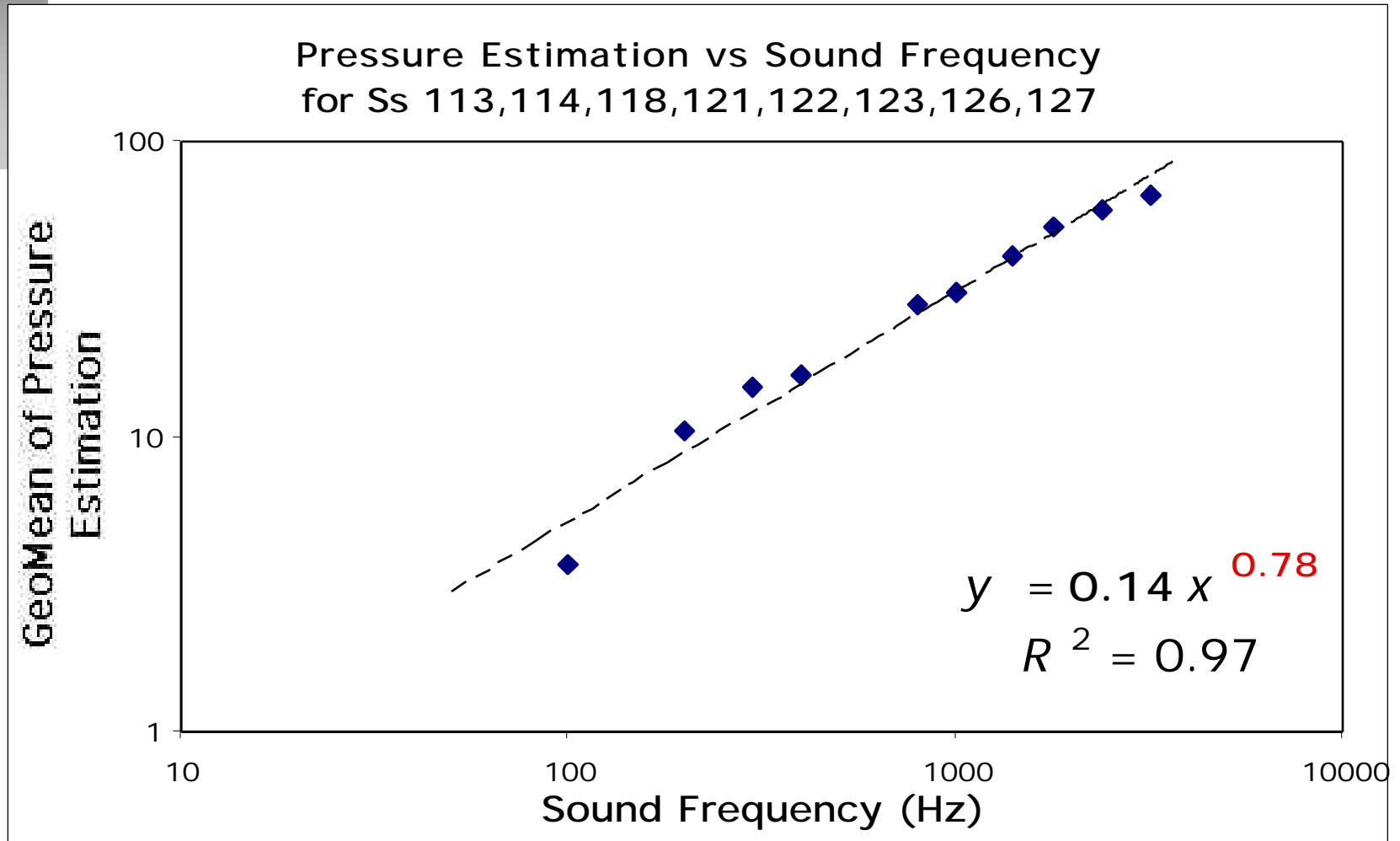
Next



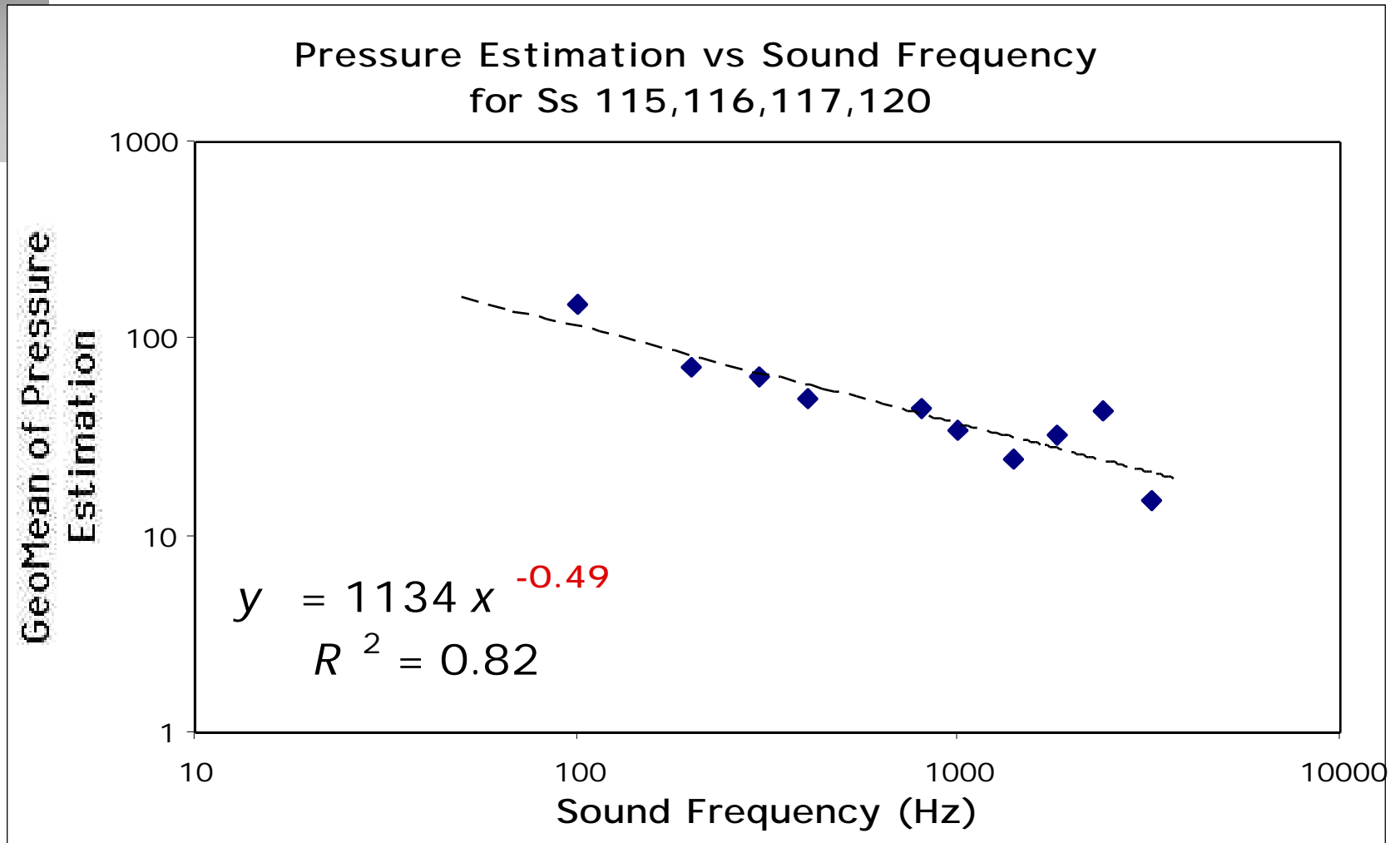
Exp 2: Demo

Done!
Thank you.

Exp 2: Results (majority)



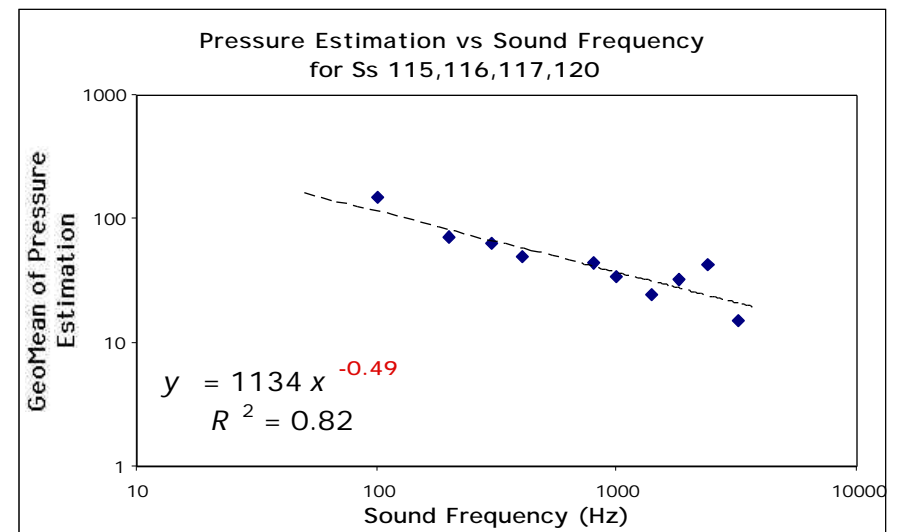
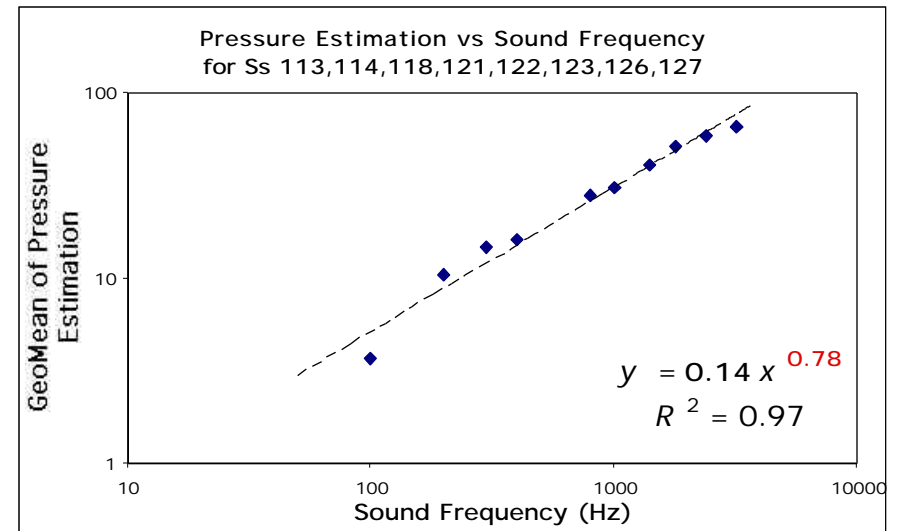
Exp 2: Results (minority)



Exp 2: Summary

Display Dimension: Frequency

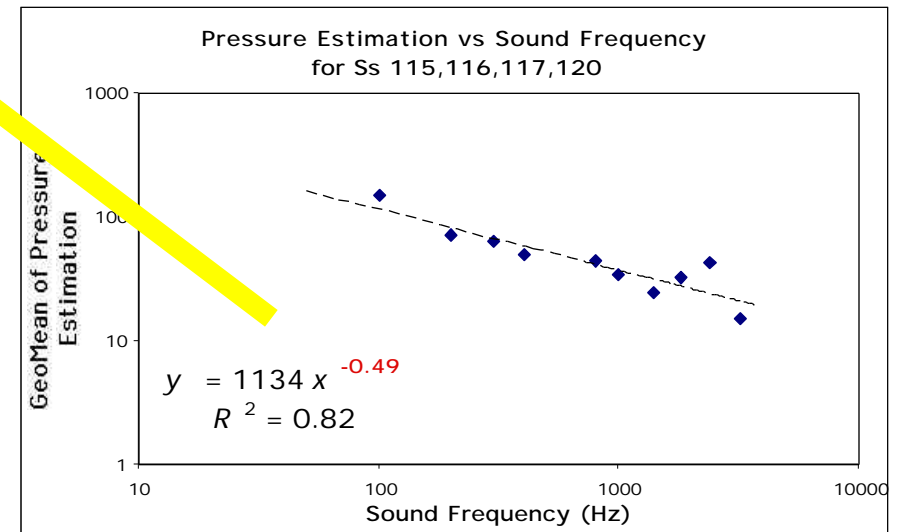
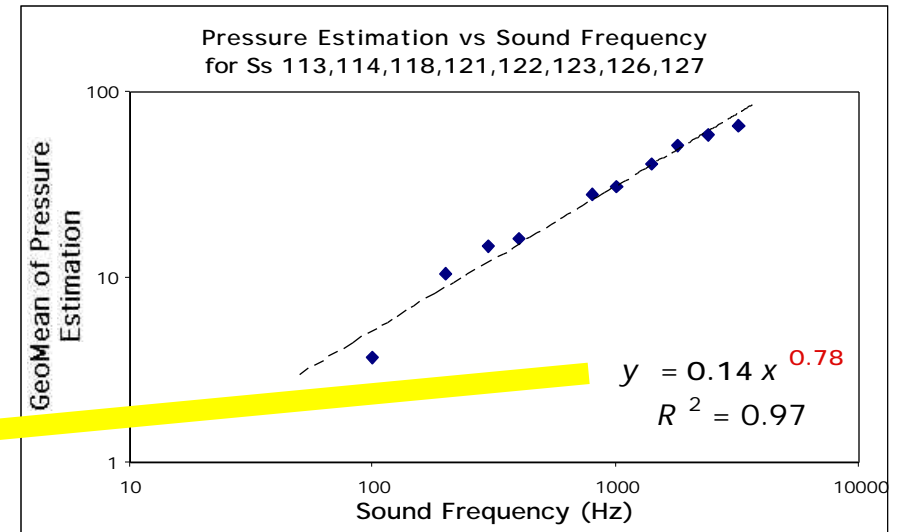
Data Dimension	(N)	Slope (b)	SE(b)
Temperature	(11)	0.95	0.12
	(2)	-0.69	0.04
Pressure	(8)	0.78	0.05
	(4)	-0.49	0.08
Velocity	(14)	1.06	0.03
	(2)	-0.17	0.03
Size	(7)	0.90	0.05
	(12)	-0.76	0.08



Exp 2: Summary

Display Dimension: Frequency

Data Dimension	(N)	Slope (b)	SE(b)
Temperature	(11)	0.95	0.12
	(2)	-0.69	0.04
Pressure	(8)	0.78	0.05
	(4)	-0.49	0.08
Velocity	(14)	1.06	0.03
	(2)	-0.17	0.03
Size	(7)	0.90	0.05
	(12)	-0.76	0.08



Exp 2: Summary

Display Dimension: Frequency

Display Dimension: Tempo

Data Dimension	(N)	Slope (b)	SE(b)	Data Dimension	(N)	Slope (b)	SE(b)
Temperature	(11)	0.95	0.12	Temperature	(11)	0.43	0.04
	(2)	-0.69	0.04		(6)	-0.48	0.05
Pressure	(8)	0.78	0.05	Pressure	(10)	0.68	0.06
	(4)	-0.49	0.08		(5)	-0.72	0.06
Velocity	(14)	1.06	0.03	Velocity	(11)	1.04	0.06
	(2)	-0.17	0.03		none	-	-
Size	(7)	0.90	0.05	Size	none	-	-
	(12)	-0.76	0.08		(16)	-0.94	0.07

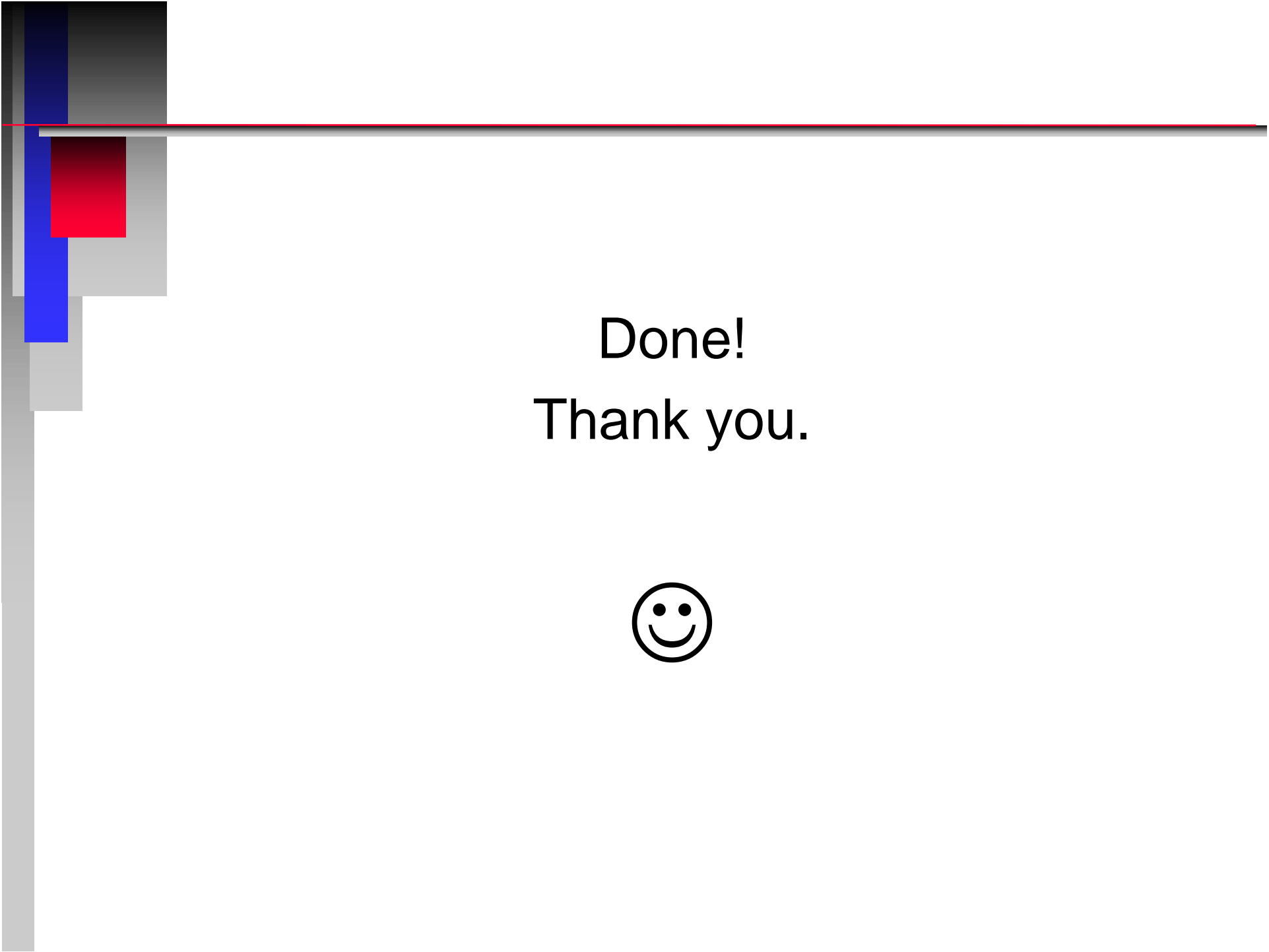
Experiment 3: Validation Task

- ◆ Need to determine if performance is affected by scalings
(we know it can be affected by mappings)
- ◆ Weather task allows:
 - *Status*
 - *Trend*
 - *Comparision*
 - *Synthesis*
 - *Interesting task environment*
- ◆ Details TBD



Directions

- ◆ More data dimensions
- ◆ More sound dimensions
(& more interesting/aesthetic sounds!)
- ◆ More mappings
- ◆ More listener groups, cultures
- ◆ More task domains



Done!
Thank you.

