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Supplementary Material

1. Participants Demographic Information

Pid	Age	Gender	Edu.	Occupation	FV	OA(year)
1	28	Female	M.S.	Recently Graduated	N	6
2	20	Male	A.A.	Developer Intern	N	0
3	22	Female	H.S.	Security support analyst	N	11
4	36	Male	H.S.	IT Specialist	N	0
5	39	Male	PhD	Student	N	30
6	24	Male	B.S.	Unemployed	N	0
7	25	Male	H.S.	Student	N	0
8	24	Female	B.S.	Business development representative	Y	0
9	26	Male	B.S.	Student	Y	0
10	32	Male	J.D.	Self-employed	N	1
11	31	Female	M.S.	Rehabilitation counselor	N	8
12	38	Female	B.S.	Student	N	0
13	30	Female	H.S.	Unemployed	Y	0
14	29	Female	M.S.	Youth Services Coordinater	N	13
15	37	Male	M.Ed.	Student	N	7
16	26	Male	B.S.	Attorney	N	0
17	35	Female	PhD	Counselor	N	0
18	35	Male	A.A.	Accessibility digital analyst	N	20
19	38	Male	B.S.	Technical Data Analyst	Y	0
20	27	Male	H.S.	Unemployed	N	0

Table 1: Demographics of participants. *Pid=Participant ID, Edu.=Education, FV=Functional Vision, OA=Onset Age*. (H.S.=High School, B.S.=Bachelors of Science, M.S.=Masters of Science, J.D.=Doctor of Jurisprudence, A.A.=Associates, M.Ed.=Master of Education, PhD=Doctor of Philosophy).

2. Study Part 2 Stimuli

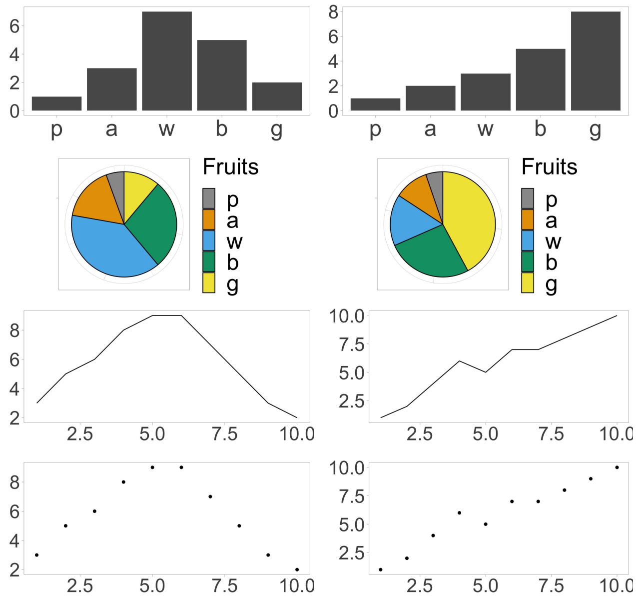

Figure 1: Visualized versions of study stimuli. Left: Monotonic Trend, right: Bell Curve with Noise.

3. Panning Results

We have also considered panning as one of the auditory channels in our experiment. We did not require people to wear headphones or earphones in our setting. As a result, 7 out of 20 participants wore headphones with stereo sound support, and one participant used a laptop with stereo sound outputs. Therefore, the result might be influenced by their audio setting. We will discuss the experiment settings and the findings below.

3.1. Part 1: Evaluating Intuitiveness and Accuracy on Mapping Auditory Channels to Data

3.1.1. Study Stimuli

- **Panning:** Pan controls enable the distribution of a sound signal over the two channels of a stereo speaker, creating an illusion of whether the sound source is to the listener's left or right. We mapped data values to panning settings between 90°to the left

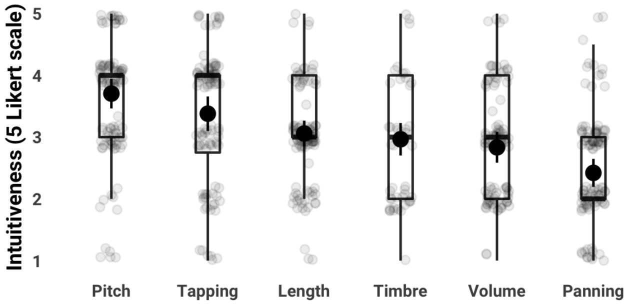

Figure 2: Evaluating intuitiveness by auditory channels, including panning. Panning appears to be the least intuitive channel among all.

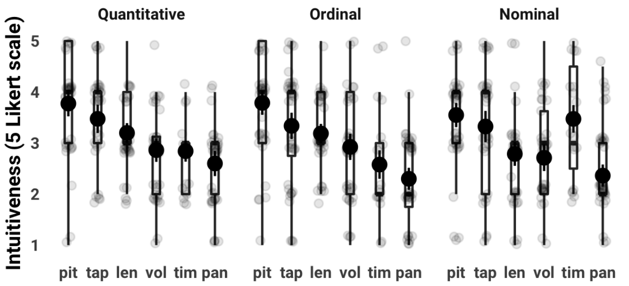

Figure 3: Evaluating intuitiveness by auditory channel and data type, including panning.

and 89°to the right, which was a default setting of the software we used to generate sonification based on research [WC03].

The default setup used a panning setting of 1% to the left.

We combined the panning channel and the two polarities (except timbre), resulting in 2 data encodings (panning-positive and panning-negative). These were then conjugated with the three data types (Quantitative, Ordinal, and Nominal), yielding 6 conditions (Q-panning-positive, Q-panning-negative, O-panning-positive, O-panning-negative, N-panning-positive, N-panning-negative).

3.1.2. Results

Panning appears to be the least intuitive audio channel among all other auditory channels, where the length were rated even more intuitive than panning conditions (t=2.82, p<0.01). The timbre and panning conditions were significantly different in terms of self-rated intuitiveness (t=-2.76, p<0.01). The volume conditions were rated higher than the panning condition (t=-2.84, p<0.01). Length and volume (t=-1.65, p=0.10) and length and panning (t=-0.80, p=0.42) were not reliably different. However, we found reliable differences between length and panning conditions (t=-4.54, p<0.001), and between panning and panning conditions (t=-2.76, p=<0.05).

Considering accuracy, we found no reliable difference between length and panning (t=1.61, p=0.11) when encoding quantitative data. The length encoding was significantly more accurate than panning conditions (t=2.27, p<0.05) in the case of ordinal data.

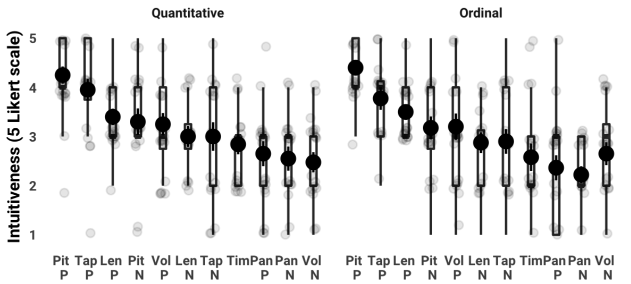

Figure 4: Evaluating intuitiveness by auditory channel and polarity, including panning. The rankings of the quantitative data and ordinal were similar. Refer to figure 3 for the ranking of nominal data. *P=Positive, N=negative*

Considering polarity, the length-positive encoding was only reliable for panning-negative condition (t=3.02, p<0.05).

3.2. Part 2: Does Data-level Intuitiveness Transfer to Visualization Communication?

3.2.1. Study Stimuli

For bar chart and pie chart (1N-1Q), panning is considered as a quantitative input, speech/temporal dimension as a nominal input (positive polarity, discrete sounds). For line chart and scatter plot (1Q-1Q), panning is considered as a quantitative input, temporal dimension is considered as another quantitative input (positive polarity, continuous and discrete sounds).

3.2.2. Results

Panning was found as one of the least intuitive channels to represent bar chart. For pie chart, panning received 3 votes, which is same as pitch. For line chart and scatter plot, panning(continuous and discrete) was not among the top-rated channels.

The result of the "panning" conditions where we encoded the data using the distribution of a sound signal over the two channels of a stereo speaker can be found d in Supplemental Material.

Our result for panning conditions may be impacted by the environment setting, but it would be valuable to include it as a reference for future work. We speculate that lower intuitiveness and accuracy of the panning conditions might be caused by the lack of stereo audio support in some participants' audio devices. However, this may represent the organic ratio of the environment where people would consume audio charts.

References

[WC03] WALKER B. N., COTHRAN J. T.: Sonification Sandbox: A Graphical Toolkit for Auditory Graphs. In Proceedings of the 9th International Conference on Auditory Display (Boston, MA, USA, 2003), pp. 161–163. ii