

Supplementary Materials

Perception of Aqueous Ethanol Binary Mixtures Containing Alcohol-Relevant Taste and Chemesthetic Stimuli

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Supplementary Tables

Table S1. Two-way ANOVA and Kruskal-Wallis analyses comparing intensity ratings by thermal taste status (TT and TnT) and stimulus concentration (low, medium, high) for orosensations elicited by unary solutions of ethanol, fructose, quinine, tartaric acid and alum sulphate.

Stimulus	Orosensation rated	Two-way ANOVA						Kruskal-Wallis	
		Thermal taste status (TTS)		Stimuli Concentration (Conc)		TTS*Conc		K	P
		F(df)	P	F(df)	P	F(df)	P		
Ethanol	Sweet	17.4 (1, 86)	<0.001	1.2 (2, 86)	0.294	0.8 (2, 86)	0.435	21.5	0.001
	Bitter	3.6 (1, 86)	0.059	10.2 (2, 86)	<0.001	0.3 (2, 86)	0.745	22.1	0.001
	Astringent	23.0 (1, 86)	<0.001	2.7 (2, 86)	0.070	0.4 (2, 86)	0.675	23.9	0.002
	Burning/tingling	3.1 (1, 86)	0.083	95.9 (2, 86)	<0.001	0.6 (2, 86)	0.572	61.7	<0.001
Fructose	Sweet	15.0 (1, 101)	<0.001	58.0 (2, 101)	<0.001	0.2 (2, 101)	0.794	62.2	<0.001
Quinine	Bitter	0.01 (1, 104)	0.933	3.6 (2, 104)	0.030	0.2 (2, 104)	0.806	7.2	0.206
Tartaric acid	Sour	2.2 (1, 110)	0.140	18.5 (2, 110)	<0.001	0.1 (2, 110)	0.885	33.5	<0.001
	Astringent	1.1 (1, 100)	0.318	1.9 (2, 110)	0.149	0.1 (2, 110)	0.891	3.9	<0.001
Alum sulphate	Astringent	1.3 (1, 104)	0.252	15.5 (2, 104)	<0.001	0.5 (2, 104)	0.614	26.5	<0.001
	Sour	13.2 (1, 104)	<0.001	11.9 (2, 104)	<0.001	4.2 (2, 104)	0.018	30.1	0.560

Table S2. Three-way ANOVA comparing the intensity of orosensations elicited by binary mixtures of ethanol and one stimuli (fructose, quinine, tartaric acid, alum sulphate). Factors in each model include thermal taste status (TTS; thermal taster, thermal non-taster), ethanol concentration (5%, 13%, 23% v/v) and stimuli concentration (low, medium, high).

Binary Mixture and Factors in Model	Df	Sweet		Bitter		Sour		Astringent		Burning/tingling	
		F	p	F	p	F	p	F	p	F	p
Fructose & Ethanol											
Overall Model	13, 305	16.2	<0.001	3.4	<0.001	1.2	0.259	4.1	<0.001	31.3	<0.001
TTS	1, 305	40.8	<0.001	0.5	0.472			21.8	<0.001	26.6	<0.001
Ethanol	2, 305	13.1	<0.001	12.9	<0.001			6.5	0.002	185.2	<0.001
Fructose	2, 305	68.0	<0.001	6.8	0.001			4.2	0.016	0.3	0.773
TTS*Ethanol	2, 305	0.3	0.734	0.9	0.388			3.1	0.046	2.6	0.074
TTS*Fructose	2, 305	0.7	0.514	0.5	0.633			0.6	0.543	0.1	0.892
Ethanol*Fructose	4, 305	1.3	0.287	0.4	0.822			0.8	0.549	1.1	0.378
Quinine & Ethanol											
Overall Model	13, 314	3.9	<0.001	1.6	0.087	0.5	0.895	0.6	0.856	19.6	<0.001
TTS	1, 314	23.9	<0.001	0.6	0.437					2.5	0.112
Ethanol	2, 314	9.0	<0.001	2.4	0.090					120.8	<0.001
Quinine	2, 314	1.3	0.264	3.8	0.024					0.5	0.604
TTS*Ethanol	2, 314	2.7	0.067	0.1	0.900					3.9	0.021
TTS*Quinine	2, 314	0.0	0.995	0.7	0.504					0.6	0.574
Ethanol*Quinine	4, 314	0.3	0.909	1.5	0.195					0.3	0.879
Tartaric Acid & Ethanol											
Overall Model	13, 332	0.9	0.573	4.5	<0.001	9.8	<0.001	1.6	0.074	21.4	<0.001
TTS	1, 332			15.9	<0.001	4.3	0.039	1.7	0.195	3.0	0.083
Ethanol	2, 332			14.0	<0.001	19.9	<0.001	4.1	0.018	134.6	<0.001
Tartaric Acid	2, 332			2.6	0.078	36.5	<0.001	3.8	0.024	0.5	0.590
TTS*Ethanol	2, 332			0.4	0.693	0.9	0.393	0.3	0.715	0.8	0.464
TTS*Tartaric Acid	2, 332			1.3	0.284	0.6	0.537	1.0	0.357	0.4	0.675
Ethanol*Tartaric Acid	4, 332			1.4	0.238	1.7	0.147	0.3	0.887	0.7	0.596
Alum & Ethanol											
Overall Model	13, 314	2.7	0.001	2.3	0.007	3.3	<0.001	7.1	<0.001	22.8	<0.001
TTS	1, 314	23.2	<0.001	2.8	0.093	0.7	0.389	30.2	<0.001	3.9	0.049
Ethanol	2, 314	0.2	0.792	9.1	<0.001	4.4	0.013	2.5	0.082	140.9	<0.001
Alum	2, 314	0.9	0.422	0.1	0.962	11.7	<0.001	23.3	<0.001	2.6	0.076
TTS*Ethanol	2, 314	0.1	0.873	1.7	0.185	1.2	0.311	3.0	0.051	0.6	0.530
TTS*Alum	2, 314	1.3	0.267	0.6	0.535	0.3	0.772	0.6	0.570	0.1	0.938
Ethanol*Alum	4, 314	1.7	0.153	1.0	0.428	1.9	0.115	0.7	0.599	0.9	0.441

Table S3. Simple linear regressions used to predict the intensity of orosensations based on the concentration of unary solutions of stimuli (ethanol, fructose, alum sulphate, tartaric acid and quinine). Terms of the regression equation are provided for significant models only.

Stimulus (concentration)	Orosensation	Linear regression parameters			Regression equation terms	
		R ²	F	p	Intensity = m (concentration) + b Intercept (b)	Slope (m)
Ethanol log(% v/v)	Sweet	0.02	2.1	0.152		
	Bitter	0.14	14.2	<0.001	0.016	0.543
	Sour	0.01	0.4	0.508		
	Astringent	0.05	4.5	0.038	-0.018	0.244
	Burning/tingling	0.69	182.6	<0.001	-1.062	1.685
Fructose log(mM)	Sweet	0.51	104.0	<0.001	-1.441	0.957
	Bitter	0.01	1.2	0.270		
	Sour	0.01	0.7	0.391		
	Astringent	0.04	3.7	0.057		
	Burning/tingling	NA	NA	NA		
Quinine log(1+mM)	Sweet	<0.01	0.02	0.865		
	Bitter	0.07	7.5	0.007	0.489	10.819
	Sour	0.02	1.9	0.168		
	Astringent	<0.01	0.1	0.716		
	Burning/tingling	<0.01	0.05	0.822		
Tartaric acid log(mM)	Sweet	<0.01	<0.01	0.947		
	Bitter	0.01	1.0	0.314		
	Sour	0.26	37.4	<0.001	0.007	1.032
	Astringent	0.01	0.6	0.433		
	Burning/tingling	0.01	1.4	0.232		
Alum sulphate log(mM)	Sweet	0.01	0.9	0.358		
	Bitter	0.06	6.6	0.012	0.063	0.234
	Sour	0.17	20.3	<0.001	0.167	0.582
	Astringent	0.21	28.1	<0.001	0.483	0.786
	Burning/tingling	0.02	2.1	0.154		

Table S4. Summary of Mann-Whitney U results comparing the mean number of scales used by TT and TnT when rating water and unary solutions of ethanol, fructose, quinine, tartaric acid and alum sulphate. (# = interpret with caution as the variance of TnT scores is 0).

Stimuli	Concentration	TT		TnT		<i>U</i>	<i>p</i>
		<i>n</i>	<i>M</i>	<i>n</i>	<i>M</i>		
Water	N/A	18	0.7	11	0.1	169.5	0.001
Ethanol	5% <i>v/v</i>	18	1.4	11	1.0	143.0	0.009
	13% <i>v/v</i>	18	2.4	11	1.8	153.0	0.012
	23% <i>v/v</i>	18	2.4	11	2.0	134.0	0.113
Fructose	140 mM	21	1.3	13	0.9	182.5	0.032
	280 mM	21	1.1	13	1.0	148.5	0.798
	960 mM	21	1.1	13	1.0	156.0	<0.001 [#]
Quinine	0.025 mM	21	1.4	14	1.2	165.5	0.571
	0.040 mM	21	1.4	14	1.1	180.5	0.251
	0.100 mM	21	1.4	14	1.1	183.0	0.210
Tartaric acid	2.75 mM	22	1.5	15	1.2	206.0	0.200
	6.91 mM	22	1.4	15	1.5	160.5	0.208
	17.4 mM	22	1.7	15	1.3	207.5	0.178
Alum sulphate	0.73 mM	21	1.0	14	0.7	188.0	0.161
	2.05 mM	21	2.0	14	1.4	213.5	0.021
	5.43 mM	21	2.4	14	1.6	217.0	0.015

Table S5. Summary of Mann-Whitney U results comparing the mean number of scales used by TT (*n* = 21) and TnT (*n* = 13) when rating binary solutions of fructose and ethanol.

Fructose Concentration	Ethanol Concentration (<i>v/v</i>)	TT		TnT		<i>U</i>	<i>p</i>
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		
140 mM	5%	1.7	0.2	1.4	0.2	155.5	0.569
	13%	2.3	0.2	1.9	0.3	168.5	0.251
	23%	2.4	0.2	2.2	0.2	156	0.496
280 mM	5%	1.8	0.2	1.5	0.2	164	0.334
	13%	2.4	0.2	2.2	0.2	160	0.417
	23%	2.4	0.2	2.4	0.3	131	0.823
960 mM	5%	1.4	0.1	1.1	0.1	191	<0.001
	13%	2.1	0.1	1.9	0.2	160.5	0.418
	23%	2.8	0.2	2.4	0.2	170.5	0.216

Table S6. Summary of Mann-Whitney U results comparing the mean number of scales used by TT ($n = 21$) and TnT ($n = 14$) when rating binary solutions of quinine and ethanol.

Quinine Concentration	Ethanol Concentration (v/v)	TT		TnT		<i>U</i>	<i>p</i>
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		
0.025 mM	5%	1.6	0.2	1.4	0.1	167	0.540
	13%	2.0	0.2	1.6	0.2	175	0.364
	23%	2.4	0.2	1.9	0.3	183	0.238
0.040 mM	5%	1.5	0.2	1.4	0.1	162.5	0.967
	13%	2.1	0.2	1.9	0.3	173	0.364
	23%	2.6	0.3	2.1	0.2	175	0.355
0.100 mM	5%	1.8	0.2	1.3	0.1	192	0.110
	13%	2.3	0.2	1.8	0.3	192.5	0.118
	23%	2.3	0.2	1.9	0.2	182.5	0.222

Table S7. Summary of Mann-Whitney U results comparing the mean number of scales used by TT ($n = 22$) and TnT ($n = 15$) when rating binary solutions of tartaric acid and ethanol.

Tartaric Acid Concentration	Ethanol Concentration (v/v)	TT		TnT		<i>U</i>	<i>p</i>
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		
2.75 mM	5%	1.9	0.2	1.4	0.2	212	0.136
	13%	2.3	0.2	2.1	0.2	183	0.599
	23%	2.3	0.2	1.9	0.2	209.5	0.182
6.91 mM	5%	1.8	0.1	1.7	0.2	189	0.468
	13%	2.5	0.2	2.5	0.3	166.5	0.983
	23%	2.8	0.2	2.0	0.2	235	0.027
17.4 mM	5%	1.8	0.2	1.3	0.1	215	0.086
	13%	2.6	0.2	2.3	0.3	197.5	0.311
	23%	2.6	0.3	2.4	0.3	186	0.482

Table S8. Summary of Mann-Whitney U results comparing the mean number of scales used by TT ($n = 21$) and TnT ($n = 14$) when rating binary solutions of alum sulphate and ethanol.

Alum Sulphate Concentration	Ethanol Concentration (v/v)	TT		TnT		<i>U</i>	<i>p</i>
		<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>		
0.73 mM	5%	1.7	0.2	1.4	0.2	175.5	0.355
	13%	2.5	0.2	1.7	0.2	220.5	0.007
	23%	2.4	0.2	1.9	0.2	184	0.210
2.05 mM	5%	2.1	0.2	1.4	0.1	203	0.050
	13%	2.7	0.2	2.2	0.3	186	0.166
	23%	2.7	0.2	2.2	0.3	181	0.267
5.43 mM	5%	2.3	0.2	1.7	0.2	205	0.040
	13%	2.8	0.2	2.1	0.3	199	0.075
	23%	2.6	0.3	2.4	0.3	166	0.568

Supplementary Figures

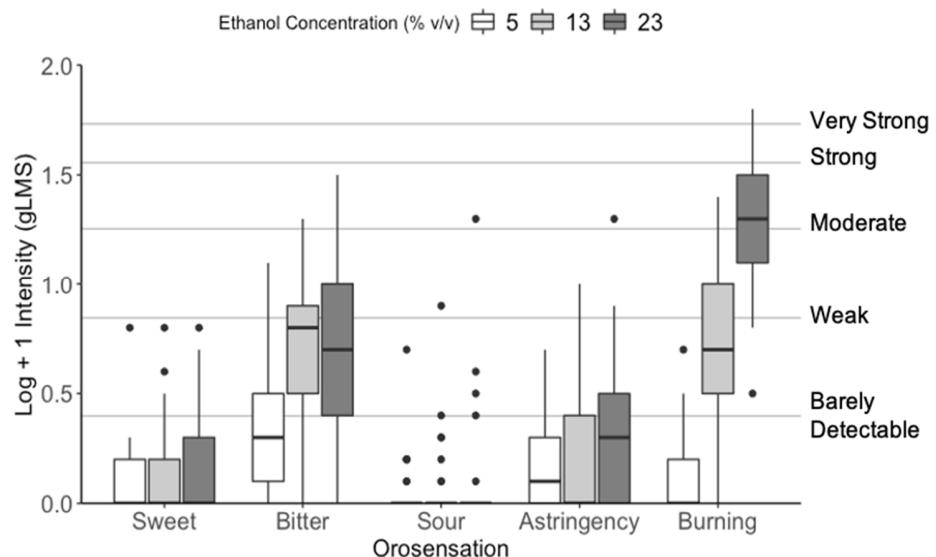


Figure S1. Boxplots of mean responsiveness to orosensations elicited by unary solutions of ethanol. Data is for participants that completed all sessions (3A–3D; $n = 29$).

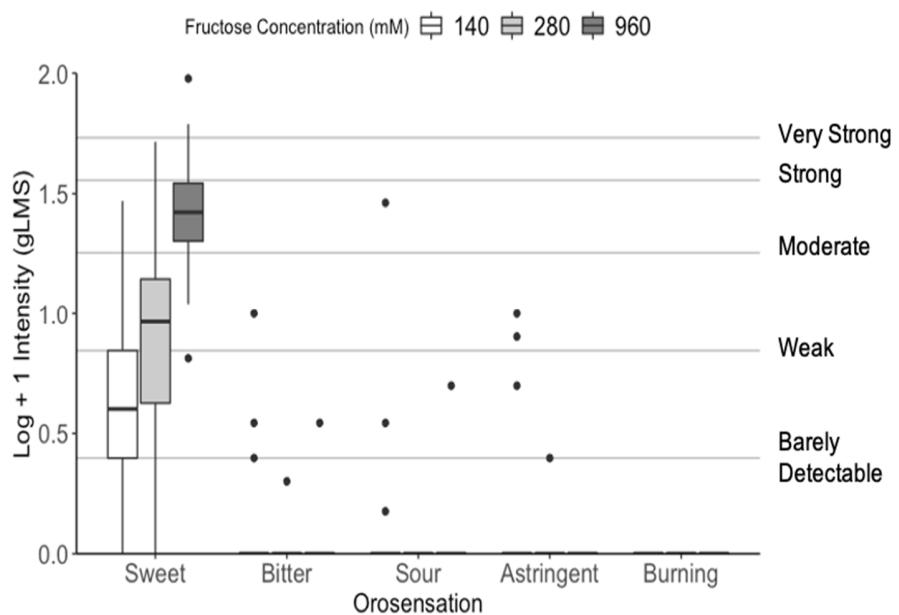


Figure S2. Boxplots of mean responsiveness to orosensations elicited by unary solutions of fructose. Data is for participants that completed all Session 3A ($n = 34$).

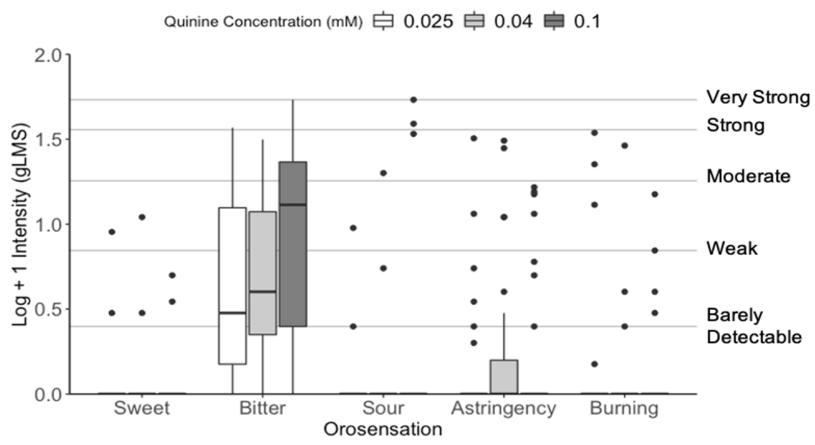


Figure S3. Boxplots of mean responsiveness to orosensations elicited by unary solutions of quinine. Data is for participants that completed all Session 3D ($n = 35$).

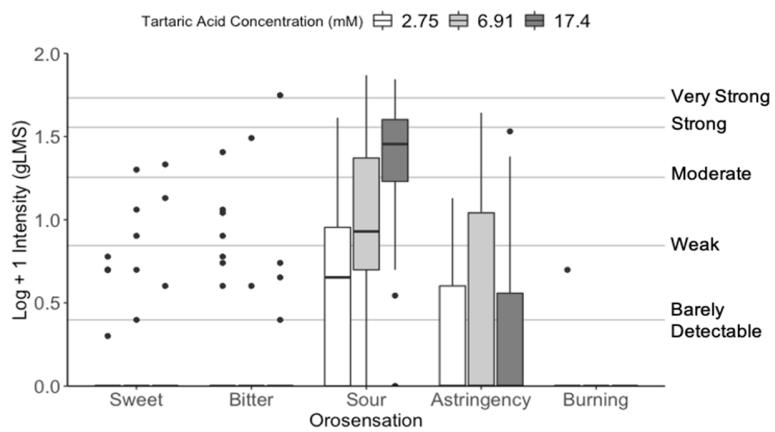


Figure S4. Boxplots of mean responsiveness to orosensations elicited by unary solutions of tartaric acid. Data is for participants that completed all Session 3C ($n = 37$).

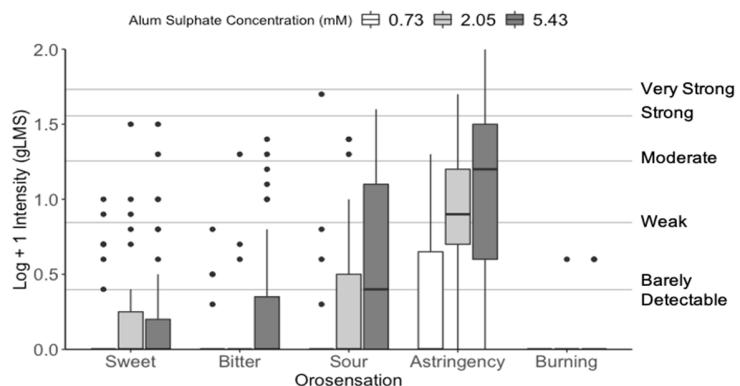


Figure S5. Boxplots of mean responsiveness to orosensations elicited by unary solutions of alum sulphate. Data is for participants that completed all Session 3A ($n = 36$).

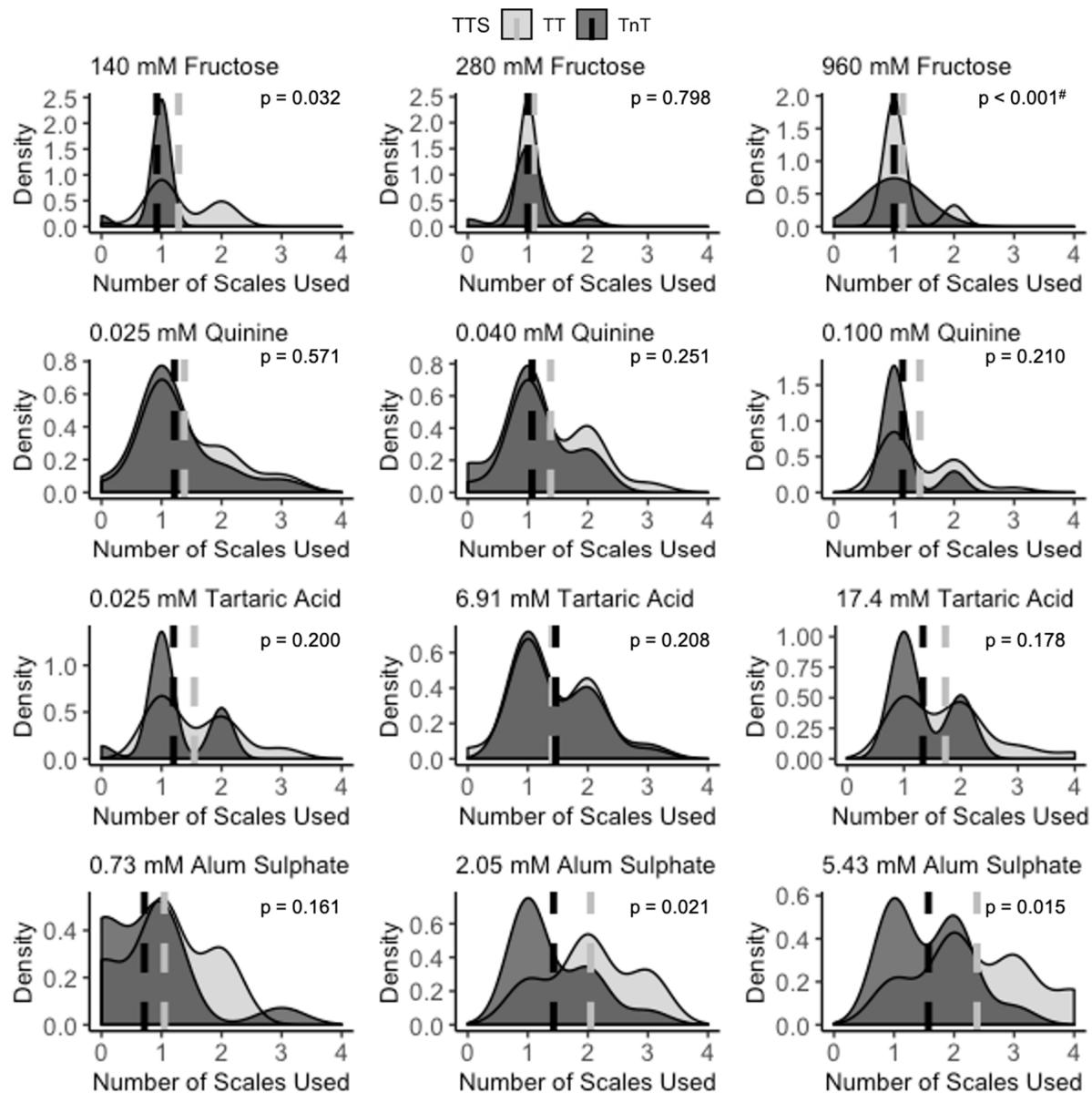


Figure S6. Kernel density estimates of the mean number of scales used by thermal tasters (TT, $n = 21-22$) and thermal non-tasters (TnT, $n = 13-15$) when rating unary aqueous solutions of fructose, alum sulphate, tartaric acid and quinine. Dashed lines indicate the mean values and p-values indicate if the medians differ significantly (NS = not significant, # = interpret with caution as the variance of TnT scores is 0).

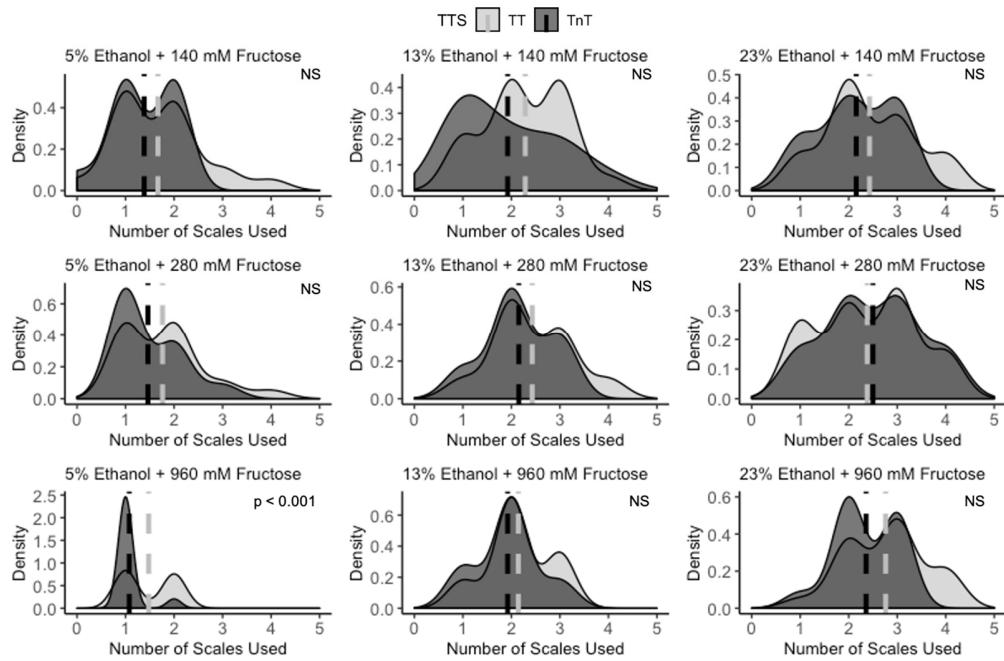


Figure S7. Kernel density estimates of the mean number of scales used by thermal tasters (TT, $n = 21$) and thermal non-tasters (TnT, $n = 13$) when rating binary solutions of fructose and ethanol. Dashed lines indicate if the medians differ significantly (NS = not significant).

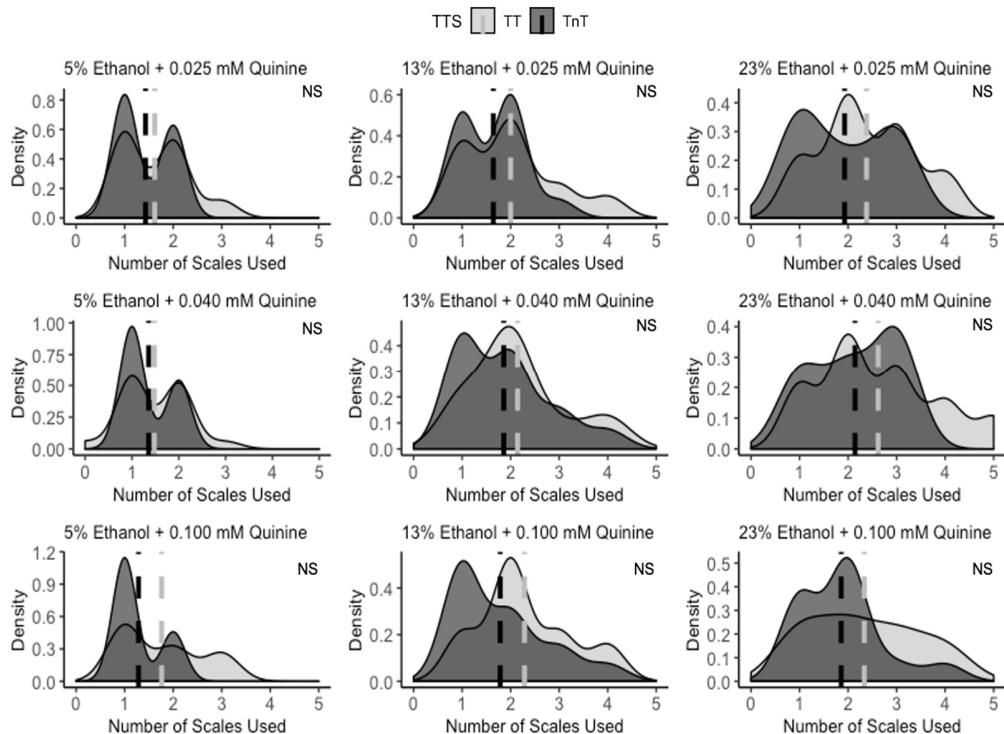


Figure S8. Kernel density estimates of the mean number of scales used by thermal tasters (TT, $n = 21$) and thermal non-tasters (TnT, $n = 14$) when rating binary solutions of quinine and ethanol. Dashed lines indicate if the medians differ significantly (NS = not significant).

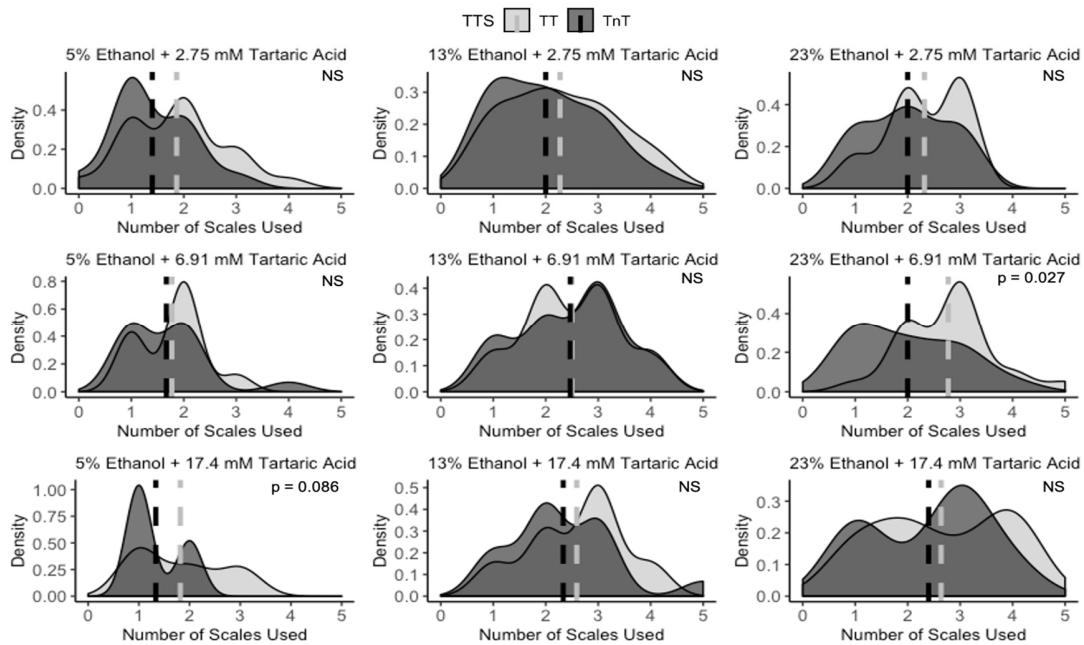


Figure S9. Kernel density estimates of the mean number of scales used by thermal tasters (TT, $n = 22$) and thermal non-tasters (TnT, $n = 15$) when rating binary solutions of tartaric acid and ethanol. Dashed lines indicate the mean values and p-values indicate if the medians differ significantly (NS = not significant).

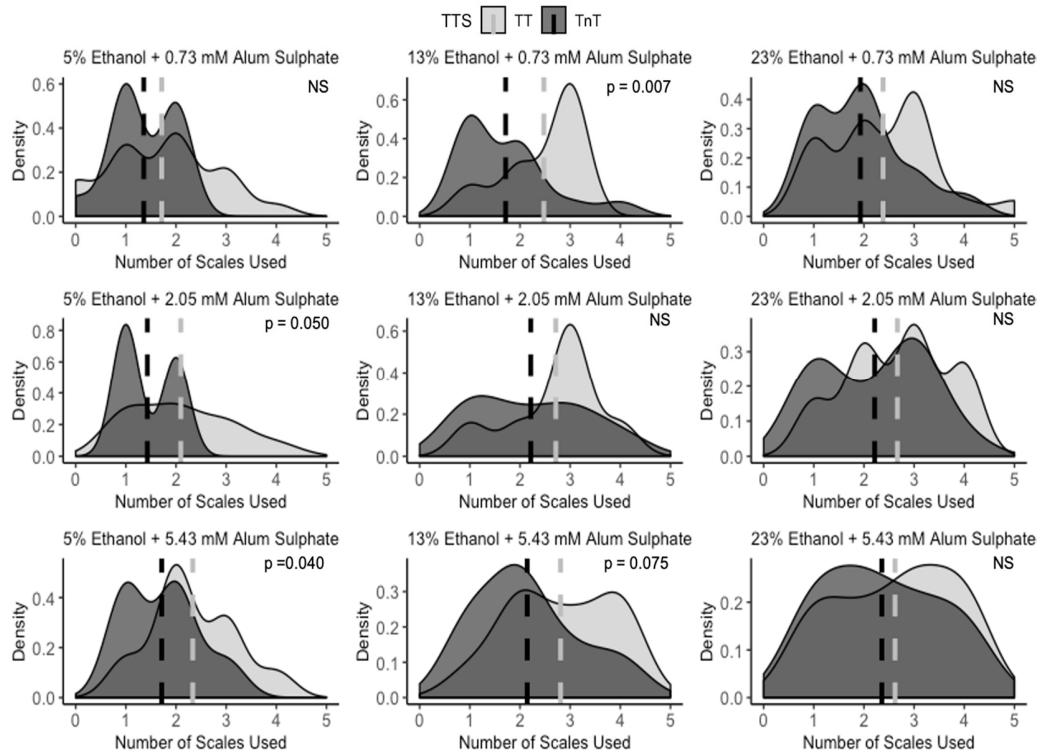


Figure S10. Kernel density estimates of the mean number of scales used by thermal tasters (TT, $n = 21$) and thermal non-tasters ($n = 14$) when rating binary solutions of alum sulphate and ethanol. Dashed lines indicate the mean values and p-values indicate if the medians differ significantly (NS = not significant).