

# How Important are Detailed Hand Motions for Communication for a Virtual Character Through the Lens of Charades?

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### Alteration Experiment: Motion Alteration Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(7, 473)} = 27.94, p < 0.001$	$F_{(7, 839)} = 18.61, p < 0.001$	$F_{(7, 839)} = 14.51, p < 0.001$	$F_{(7, 839)} = 6.13, p < 0.001$	$F_{(7, 839)} = 5.74, p < 0.001$
<b>Means &amp; STDs</b>	Original = (0.65, 0.25) Reduced = (0.6, 0.26) Jitter = (0.7, 0.23) Popping = (0.68, 0.2) Smooth = (0.63, 0.26) Passive = (0.34, 0.21) Random = (0.42, 0.18) Static = (0.36, 0.2)	Original = (0.68, 1.39) Reduced = (0.35, 1.53) Jitter = (0.63, 1.21) Popping = (0.41, 1.37) Smooth = (0.7, 1.26) Passive = (-0.24, 1.55) Random = (-0.42, 1.41) Static = (-0.75, 1.47)	Original = (1.43, 1.29) Reduced = (1.2, 1.41) Jitter = (0.79, 1.48) Popping = (1.02, 1.38) Smooth = (1.21, 1.26) Passive = (0.39, 1.57) Random = (0.57, 1.46) Static = (-0.16, 1.71)	Original = (0.66, 1.5) Reduced = (0.66, 1.55) Jitter = (0.26, 1.56) Popping = (0.49, 1.51) Smooth = (0.81, 1.37) Passive = (0.09, 1.63) Random = (0.27, 1.55) Static = (-0.31, 1.58)	Original = (0.67, 1.34) Reduced = (0.66, 1.19) Jitter = (0.58, 1.29) Popping = (0.42, 1.34) Smooth = (0.7, 1.36) Passive = (0.29, 1.46) Random = (0.16, 1.44) Static = (-0.2, 1.55)
Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(7, 839)} = 3.06, p < 0.01$	$F_{(7, 839)} = 3.00, p < 0.05$	$F_{(7, 839)} = 4.18, p < 0.01$	$F_{(7, 839)} = 5.20, p < 0.001$	$F_{(7, 839)} = 2.77, p = 0.05$
<b>Means &amp; STDs</b>	Original = (0.51, 1.48) Reduced = (0.55, 1.5) Jitter = (0.52, 1.34) Popping = (0.35, 1.37) Smooth = (0.58, 1.46) Passive = (0.09, 1.47) Random = (0.16, 1.57) Static = (-0.05, 1.33)	Original = (0.55, 1.4) Reduced = (0.52, 1.31) Jitter = (0.51, 1.4) Popping = (0.2, 1.33) Smooth = (0.45, 1.38) Passive = (0.16, 1.41) Random = (0.08, 1.27) Static = (-0.01, 1.19)	Original = (1.32, 1.11) Reduced = (1.29, 1.07) Jitter = (1.1, 1.31) Popping = (1.05, 1.13) Smooth = (1.29, 1.15) Passive = (0.85, 1.24) Random = (0.9, 1.13) Static = (0.67, 1.33)	Original = (0.99, 1.06) Reduced = (1.12, 1.08) Jitter = (0.83, 1.38) Popping = (0.75, 1.19) Smooth = (0.95, 1.17) Passive = (0.63, 1.29) Random = (0.5, 1.2) Static = (0.32, 1.03)	Overall = (0.92, 1.16)
Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(7, 839)} = 1.44, p = 0.43$	$F_{(7, 839)} = 3.93, p < 0.01$	$F_{(7, 839)} = 1.18, p = 0.95$	$F_{(7, 839)} = 3.12, p < 0.05$	$F_{(7, 839)} = 5.67, p < 0.001$
<b>Means &amp; STDs</b>	Overall = (0.99, 0.87)	Original = (1.1, 0.95) Reduced = (0.86, 1.01) Jitter = (1.04, 1.01) Popping = (0.99, 0.81) Smooth = (1.02, 0.83) Passive = (0.79, 0.94) Random = (0.62, 0.93) Static = (0.72, 0.89)	Overall = (1.2, 0.96)	Original = (0.7, 1.15) Reduced = (0.58, 1.19) Jitter = (0.86, 1.18) Popping = (0.75, 1.1) Smooth = (0.99, 1.1) Passive = (0.66, 1.2) Random = (0.52, 1.06) Static = (0.4, 1.18)	Original = (-0.3, 2.02) Reduced = (-0.86, 1.85) Jitter = (-0.51, 1.9) Popping = (-0.53, 2) Smooth = (-0.33, 1.97) Passive = (-0.92, 1.94) Random = (-0.95, 1.99) Static = (-1.63, 1.84)

Table 1: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Alteration Experiment: Motion Alteration Post-Hoc Comparisons

Measure	Original							Reduced							Jitter						Popping							
	Re	J	Po	Sm	Ps	Ra	St	O	J	Po	Sm	Pa	Ra	St	O	Re	Po	Sm	Pa	Ra	St	O	Re	J	Sm	Pa	Ra	St
Motion Comprehension	0.9	0.92	0.99	1.0	***	***	***	0.9	0.18	0.37	1.0	***	***	***	0.92	0.18	1.0	0.58	***	***	***	0.99	0.37	1.0	0.83	***	***	***
Perceived Comprehension	0.77	1.0	0.79	1.0	***	***	***	0.77	0.88	1.0	0.7	0.11	**	***	1.0	0.88	0.91	1.0	***	***	***	0.79	1.0	0.91	0.71	**	***	***
Naturalness	0.97	*	0.34	0.95	***	***	***	0.97	0.58	0.99	1.0	**	0.08	***	*	0.58	0.92	0.32	0.43	0.94	***	0.34	0.99	0.92	0.96	*	0.23	***
Realism	1.0	0.44	0.99	1.0	0.07	0.5	***	1.0	0.65	0.99	1.0	0.2	0.7	***	0.44	0.65	0.93	0.09	0.99	1.0	0.08	0.99	0.99	0.93	0.71	0.43	0.95	***
Appeal	1.0	1.0	0.85	1.0	0.4	0.09	***	1.0	1.0	0.95	1.0	0.64	0.25	***	1.0	1.0	0.99	1.0	0.76	0.29	***	0.85	0.95	0.99	0.75	1.0	0.81	*
Familiarity	1.0	1.0	0.99	1.0	0.3	0.55	0.06	1.0	1.0	0.98	1.0	0.39	0.62	0.12	1.0	1.0	0.98	1.0	0.28	0.52	0.05	0.99	0.98	0.98	0.9	0.84	0.97	0.39
Assuredness	1.0	1.0	0.45	1.0	0.34	0.14	*	1.0	1.0	0.75	1.0	0.64	0.39	0.17	1.0	1.0	0.6	1.0	0.47	0.22	0.07	0.45	0.75	0.6	0.82	1.0	1.0	0.94
Friendliness	1.0	0.84	0.64	1.0	0.06	0.13	***	1.0	0.97	0.88	1.0	0.25	0.41	*	0.84	0.97	1.0	0.93	0.77	0.92	0.13	0.64	0.88	1.0	0.77	0.91	0.98	0.23
Trustworthiness	1.0	0.97	0.75	1.0	0.29	*	***	1.0	0.76	0.43	0.98	0.13	*	***	0.97	0.76	1.0	1.0	0.91	0.42	*	0.75	0.43	1.0	0.89	0.99	0.76	0.1
Conscientiousness	0.72	1.0	0.99	1.0	0.2	***	*	0.72	0.9	0.99	0.96	1.0	0.69	0.98	1.0	0.9	1.0	1.0	0.44	*	0.15	0.99	0.99	1.0	1.0	0.73	*	0.35
Openness to Experience	1.0	0.96	1.0	0.5	1.0	0.93	0.51	1.0	0.73	0.97	0.25	1.0	1.0	0.98	0.96	0.73	1.0	0.99	0.87	0.3	0.05	1.0	0.97	1.0	0.72	1.0	0.75	0.27
Social Presence	0.56	0.99	0.98	1.0	0.23	0.18	***	0.56	0.94	0.95	0.63	1.0	1.0	0.17	0.99	0.94	1.0	1.0	0.76	0.69	***	0.98	0.95	1.0	0.99	0.79	0.72	***
Measure	Smooth							Passive							Random						Static							
	O	Re	J	Po	Pa	Ra	St	O	Re	J	Po	Sm	Ra	St	O	Re	J	Po	Sm	Pa	St	O	Re	J	Po	Sm	Pa	Ra
Motion Comprehension	1.0	1.0	0.58	0.83	***	***	***	***	***	***	***	***	0.59	1.0	***	***	***	***	***	0.59	0.78	***	***	***	***	***	1.0	0.78
Perceived Comprehension	1.0	0.7	1.0	0.71	***	***	***	***	0.11	***	**	***	0.97	0.1	***	**	***	***	***	0.97	0.63	***	***	***	***	***	0.1	0.63
Naturalness	0.95	1.0	0.32	0.96	***	*	***	***	**	0.43	*	***	0.99	0.07	***	0.08	0.94	0.23	*	0.99	***	***	***	***	***	0.07	***	
Realism	1.0	1.0	0.09	0.71	**	0.12	***	0.07	0.2	0.99	0.43	**	0.98	0.48	0.5	0.7	1.0	0.95	0.12	0.98	0.06	***	***	0.08	***	***	0.48	0.06
Appeal	1.0	1.0	1.0	0.75	0.28	*	***	0.4	0.64	0.76	1.0	0.28	1.0	0.12	0.09	0.25	0.29	0.81	*	1.0	0.5	***	***	***	*	***	0.12	0.5
Familiarity	1.0	1.0	1.0	0.9	0.12	0.29	*	0.3	0.39	0.28	0.84	0.12	1.0	1.0	0.55	0.62	0.52	0.97	0.29	1.0	0.96	0.06	0.12	0.05	0.39	*	1.0	0.96
Assuredness	1.0	1.0	1.0	0.82	0.71	0.41	0.16	0.34	0.64	0.47	1.0	0.71	1.0	0.98	0.14	0.39	0.22	1.0	0.41	1.0	1.0	*	0.17	0.07	0.94	0.16	0.98	1.0
Friendliness	1.0	1.0	0.93	0.77	0.09	0.21	***	0.06	0.25	0.77	0.91	0.09	1.0	0.95	0.13	0.41	0.92	0.98	0.21	1.0	0.83	***	*	0.13	0.23	***	0.95	0.83
Trustworthiness	1.0	0.98	1.0	0.89	0.44	0.08	***	0.29	0.13	0.91	0.99	0.44	0.99	0.49	*	*	0.42	0.76	0.08	0.99	0.94	***	***	*	0.1	***	0.49	0.94
Conscientiousness	1.0	0.96	1.0	1.0	0.58	*	0.23	0.2	1.0	0.44	0.73	0.58	0.84	1.0	***	0.69	*	*	*	0.84	0.99	*	0.98	0.15	0.35	0.23	1.0	0.99
Openness to Experience	0.5	0.25	0.99	0.72	0.32	*	***	1.0	1.0	0.87	1.0	0.32	0.98	0.7	0.93	1.0	0.3	0.75	*	0.98	1.0	0.51	0.98	0.05	0.27	***	0.7	1.0
Social Presence	1.0	0.63	1.0	0.99	0.29	0.23	***	0.23	1.0	0.76	0.79	0.29	1.0	0.1	0.18	1.0	0.69	0.72	0.23	1.0	0.13	***	0.17	***	***	***	0.1	0.13

Table 2: \* indicates a post-hoc p-value of <0.05, \*\* of <0.01, and \*\*\* values are <0.001. Conditions are abbreviated: Original = O, Reduced = Re, Jitter = J, Popping = Po, Smooth = Sm, Passive = Pa, Random = Ra, Static = St.

### Alteration Experiment: Motion Alteration Graphs

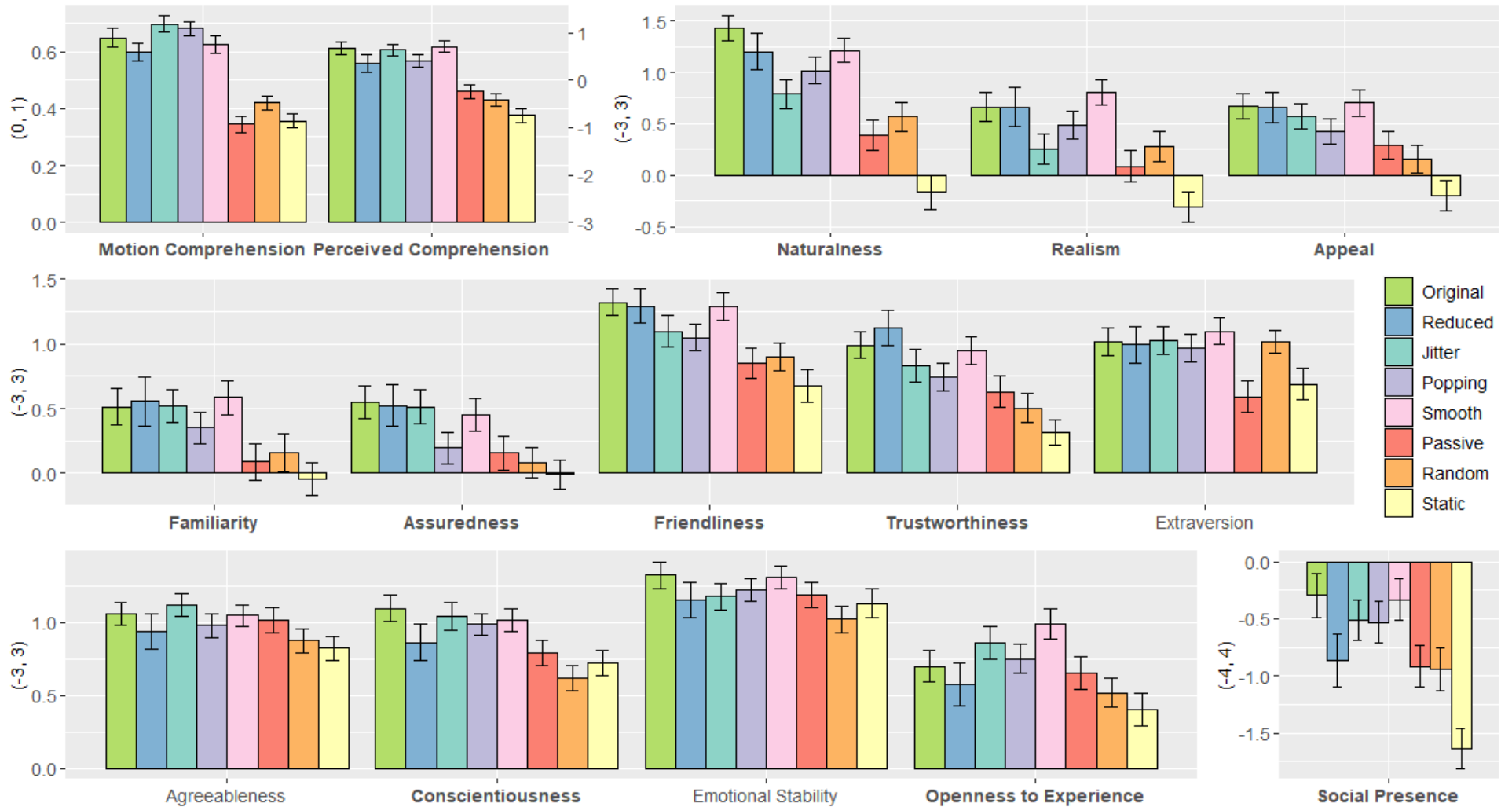


Figure 1: All graphs for the Motion Alteration condition of the Alteration Experiment. Bolded measures had significant differences between Motion Alterations. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Alteration Experiment: Avatar Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(1, 473)} = 9.47, p < 0.01$	$F_{(1, 839)} = 5.51, p < 0.05$	$F_{(1, 839)} = 1.45, p = 0.32$	$F_{(1, 839)} = 55.65, p < 0.001$	$F_{(1, 839)} = 13.45, p < 0.01$
<b>Means &amp; STDs</b>	Realistic = (0.6, 0.26) Mannequin = (0.54, 0.26)	Realistic = (0.29, 1.5) Mannequin = (0.05, 1.46)	Overall = (0.79, 1.53)	Realistic = (0.74, 1.42) Mannequin = (-0.04, 1.6)	Realistic = (0.58, 1.32) Mannequin = (0.22, 1.48)
<b>Post-Hoc</b>	$p < 0.01$	$p < 0.05$		$p < 0.001$	$p < 0.001$

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Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(1, 839)} = 30.7, p < 0.001$	$F_{(1, 839)} = 10.07, p < 0.05$	$F_{(1, 839)} = 3.77, p = 0.09$	$F_{(1, 839)} = 1.48, p = 0.31$	$F_{(1, 839)} = 0.00, p = 0.99$
<b>Means &amp; STDs</b>	Realistic = (0.6, 1.39) Mannequin = (0.06, 1.46)	Realistic = (0.44, 1.31) Mannequin = (0.15, 1.37)	Overall = (1.05, 1.21)	Overall = (0.75, 1.21)	Overall = (0.92, 1.16)
<b>Post-Hoc</b>	$p < 0.001$	$p < 0.01$			

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Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(1, 839)} = 13.60, p < 0.01$	$F_{(1, 839)} = 0.37, p = 0.69$	$F_{(1, 839)} = 0.20, p = 0.96$	$F_{(1, 839)} = 1.24, p = 0.34$	$F_{(1, 839)} = 6.26, p < 0.05$
<b>Means &amp; STDs</b>	Realistic = (1.09, 0.85) Mannequin = (0.88, 0.89)	Overall = (0.9, 0.93)	Overall = (1.2, 0.96)	Overall = (0.69, 1.15)	Realistic = (-0.56, 1.98) Mannequin = (-0.92, 1.97)
<b>Post-Hoc</b>	$p < 0.001$				$p < 0.05$

Table 3: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Alteration Experiment: Avatar Graphs

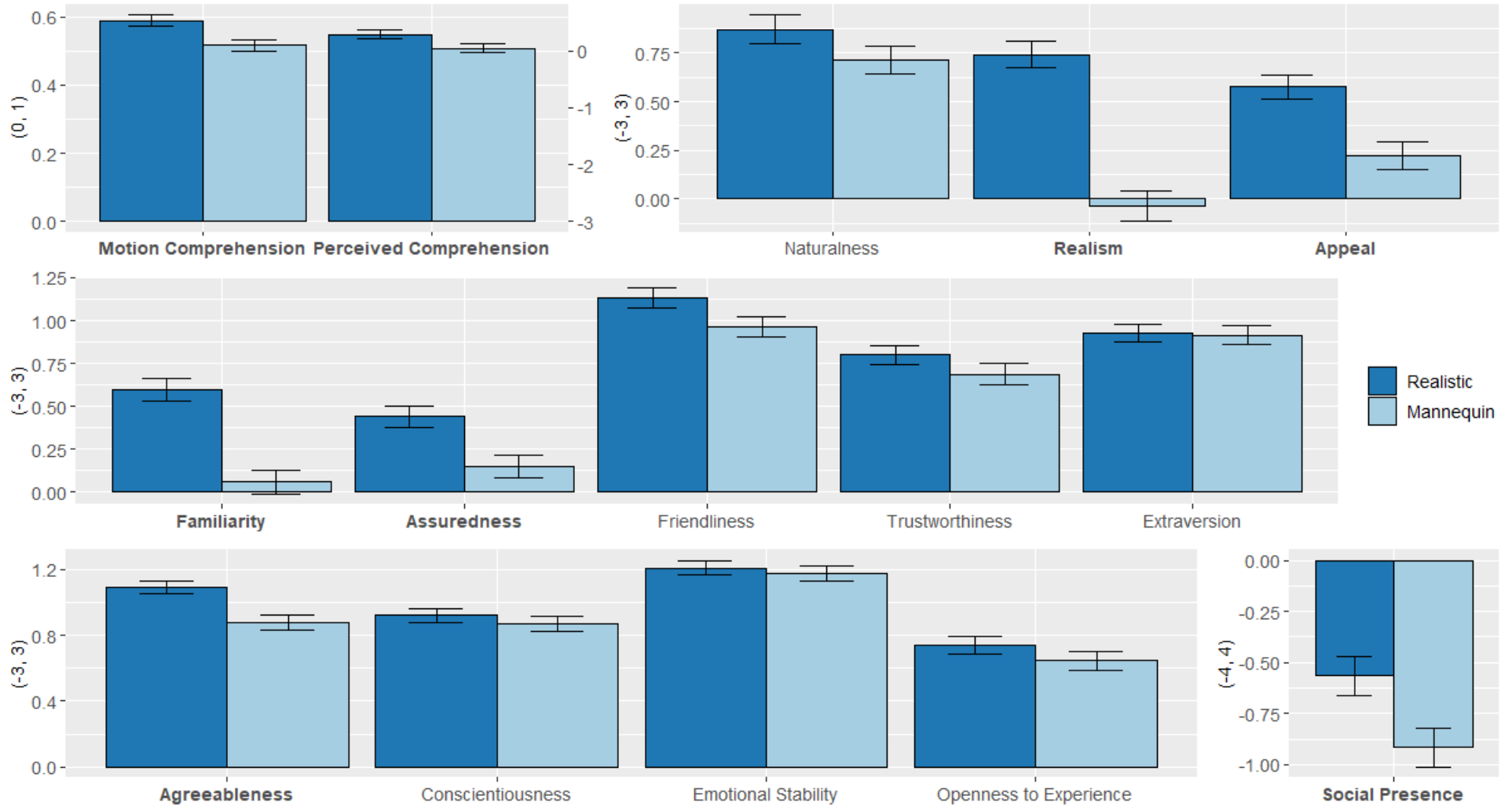


Figure 2: All graphs for the Avatar condition of the Alteration Experiment. Bolded measures had significant differences between Avatars. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Alteration Experiment: Clip Length Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(1, 473)} = 30.59, p < 0.001$	$F_{(1, 839)} = 12.17, p < 0.01$	$F_{(1, 839)} = 11.18, p < 0.01$	$F_{(1, 839)} = 6.39, p < 0.05$	$F_{(1, 839)} = 10.52, p < 0.01$
<b>Means &amp; STDs</b>	Short = (0.61, 0.21) Long = (0.5, 0.3)	Short = (0.34, 1.33) Long = (-0.01, 1.62)	Short = (0.96, 1.44) Long = (0.62, 1.59)	Short = (0.49, 1.51) Long = (0.22, 1.61)	Short = (0.55, 1.31) Long = (0.24, 1.49)
<b>Post-Hoc</b>	$p < 0.001$	$p < 0.001$	$p < 0.01$	$p < 0.01$	$p < 0.01$

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Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(1, 839)} = 7.09, p < 0.05$	$F_{(1, 839)} = 1.92, p = 0.29$	$F_{(1, 839)} = 4.45, p = 0.08$	$F_{(1, 839)} = 0.22, p = 0.64$	$F_{(1, 839)} = 1.02, p = 0.73$
<b>Means &amp; STDs</b>	Short = (0.46, 1.35) Long = (0.19, 1.54)	Overall = (0.3, 1.35)	Overall = (1.05, 1.21)	Overall = (0.75, 1.21)	Overall = (0.92, 1.16)
<b>Post-Hoc</b>	$p < 0.01$		$p < 0.05$		

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Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(1, 839)} = 3.62, p = 0.20$	$F_{(1, 839)} = 0.29, p = 0.69$	$F_{(1, 839)} = 0.19, p = 0.96$	$F_{(1, 839)} = 13.55, p < 0.01$	$F_{(1, 839)} = 3.29, p = 0.10$
<b>Means &amp; STDs</b>	Overall = (0.99, 0.87)	Overall = (0.9, 0.93)	Overall = (1.2, 0.96)	Short = (0.83, 1.1) Long = (0.54, 1.19)	Overall = (-0.74, 1.98)
<b>Post-Hoc</b>				$p < 0.001$	

Table 4: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Alteration Experiment: Clip Length Graphs

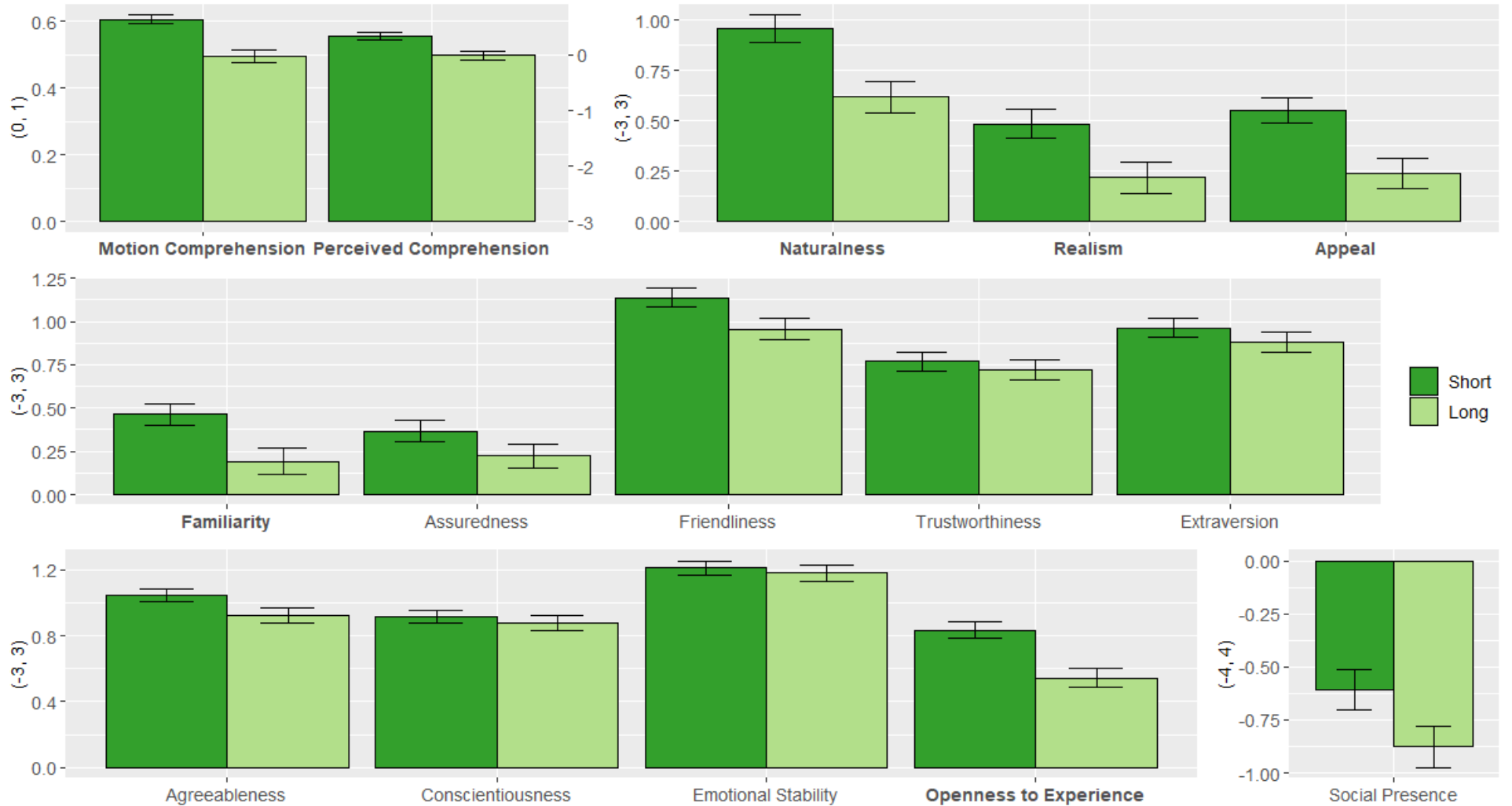


Figure 3: All graphs for the Clip Length condition of the Alteration Experiment. Bolded measures had significant differences between Clip Lengths. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).



### Intensity Experiment: Jitter Intensity Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(3, 255)} = 1.32, p = 0.48$	$F_{(3, 458)} = 3.67, p = 0.08$	$F_{(3, 458)} = 29.53, p < 0.001$	$F_{(3, 458)} = 4.74, p < 0.05$	$F_{(3, 458)} = 5.45, p < 0.01$
<b>Means &amp; STDs</b>	Overall = (0.65, 0.23)	Overall = (0.44, 1.37)	Original = (1.43, 1.29) JitterLow = (0.79, 1.48) JitterMed = (0.36, 1.64) JitterHigh = (-0.33, 1.59)	Original = (0.66, 1.5) JitterLow = (0.26, 1.56) JitterMed = (0.31, 1.55) JitterHigh = (-0.05, 1.47)	Original = (0.67, 1.34) JitterLow = (0.58, 1.29) JitterMed = (0.21, 1.47) JitterHigh = (0.05, 1.47)
Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(3, 458)} = 3.03, p = 0.10$	$F_{(3, 458)} = 16.27, p < 0.001$	$F_{(3, 458)} = 3.13, p = 0.07$	$F_{(3, 458)} = 3.29, p = 0.14$	$F_{(3, 458)} = 0.58, p = 0.74$
<b>Means &amp; STDs</b>	Overall = (0.34, 1.42)	Original = (0.55, 1.4) JitterLow = (0.51, 1.4) JitterMed = (-0.12, 1.43) JitterHigh = (-0.52, 1.49)	Overall = (1.07, 1.19)	Overall = (0.78, 1.16)	Overall = (0.95, 1.13)
Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(3, 458)} = 1.70, p = 0.39$	$F_{(3, 458)} = 6.44, p < 0.01$	$F_{(3, 458)} = 16.10, p < 0.001$	$F_{(3, 458)} = 1.52, p = 0.36$	$F_{(3, 458)} = 4.23, p < 0.05$
<b>Means &amp; STDs</b>	Overall = (1, 0.88)	Original = (1.1, 0.95) JitterLow = (1.04, 1.01) JitterMed = (0.88, 0.92) JitterHigh = (0.62, 0.95)	Original = (1.33, 0.97) JitterLow = (1.18, 1) JitterMed = (0.83, 1.17) JitterHigh = (0.43, 1.23)	Overall = (0.75, 1.14)	Original = (-0.3, 2.02) JitterLow = (-0.51, 1.9) JitterMed = (-0.83, 1.98) JitterHigh = (-1.12, 1.92)

Table 5: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Intensity Experiment, Jitter: Motion Intensity Post-Hoc Comparisons

Measure	Original			JitterLow			JitterMed			JitterHigh		
	JL	JM	JH	O	JM	JH	O	JL	JH	O	JL	JM
Naturalness	**	***	***	**	0.14	***	***	0.14	**	***	***	**
Realism	0.16	0.27	***	0.16	0.99	0.35	0.27	0.99	0.21	***	0.35	0.21
Appeal	0.96	0.05	**	0.96	0.18	*	0.05	0.18	0.82	**	*	0.82
Assuring	1.0	**	***	1.0	**	***	**	**	0.13	***	***	0.13
Conscientiousness	0.98	0.31	***	0.98	0.56	**	0.31	0.56	0.13	***	**	0.13
Emotional Stability	0.74	**	***	0.74	0.08	***	**	0.08	*	***	***	*
Social Presence	0.83	0.15	**	0.83	0.6	0.07	0.15	0.6	0.65	**	0.07	0.65

Table 6: \* indicates a post-hoc p-value of <0.05, \*\* of <0.01, and \*\*\* values are <0.001. Conditions are abbreviated: Original = O, JitterLow = JL, JitterMed = JM, JitterHigh = JH.

### Intensity Experiment: Jitter Graphs

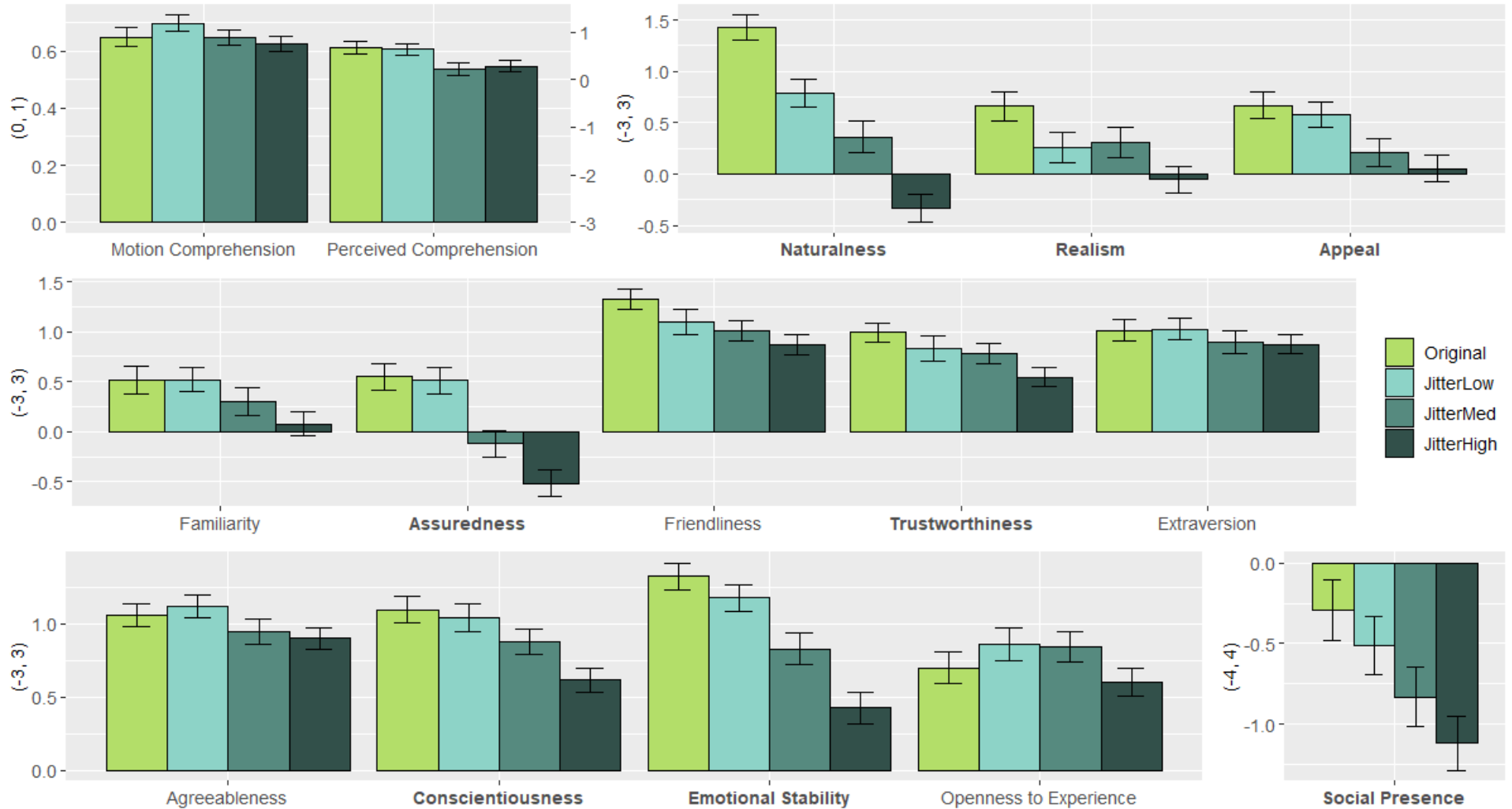


Figure 4: All graphs for the Jitter Intensity Levels of the Intensity Experiment. Bolded measures had significant differences between levels. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Intensity Experiment: Popping Intensity Results

<b>Measure</b>	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(3, 247)} = 0.64, p = 0.88$	$F_{(3, 456)} = 1.49, p = 0.51$	$F_{(3, 456)} = 2.42, p = 0.23$	$F_{(3, 456)} = 0.35, p = 0.90$	$F_{(3, 456)} = 0.86, p = 0.54$
<b>Means &amp; STDs</b>	Overall = (0.66, 0.22)	Overall = (0.47, 1.38)	Overall = (1.13, 1.34)	Overall = (0.59, 1.47)	Overall = (0.58, 1.32)
<b>Measure</b>	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(3, 456)} = 0.63, p = 0.73$	$F_{(3, 456)} = 1.43, p = 0.74$	$F_{(3, 456)} = 1.12, p = 0.48$	$F_{(3, 456)} = 1.00, p = 0.59$	$F_{(3, 456)} = 1.37, p = 0.49$
<b>Means &amp; STDs</b>	Overall = (0.46, 1.41)	Overall = (0.35, 1.33)	Overall = (1.16, 1.17)	Overall = (0.83, 1.15)	Overall = (1.08, 1.05)
<b>Measure</b>	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(3, 456)} = 0.19, p = 0.97$	$F_{(3, 456)} = 2.02, p = 0.39$	$F_{(3, 456)} = 0.56, p = 0.75$	$F_{(3, 456)} = 1.12, p = 0.43$	$F_{(3, 456)} = 0.46, p = 0.71$
<b>Means &amp; STDs</b>	Overall = (1, 0.88)	Overall = (0.95, 0.9)	Overall = (1.24, 0.95)	Overall = (0.8, 1.13)	Overall = (-0.46, 1.95)

Table 7: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Intensity Experiment: Popping Graphs

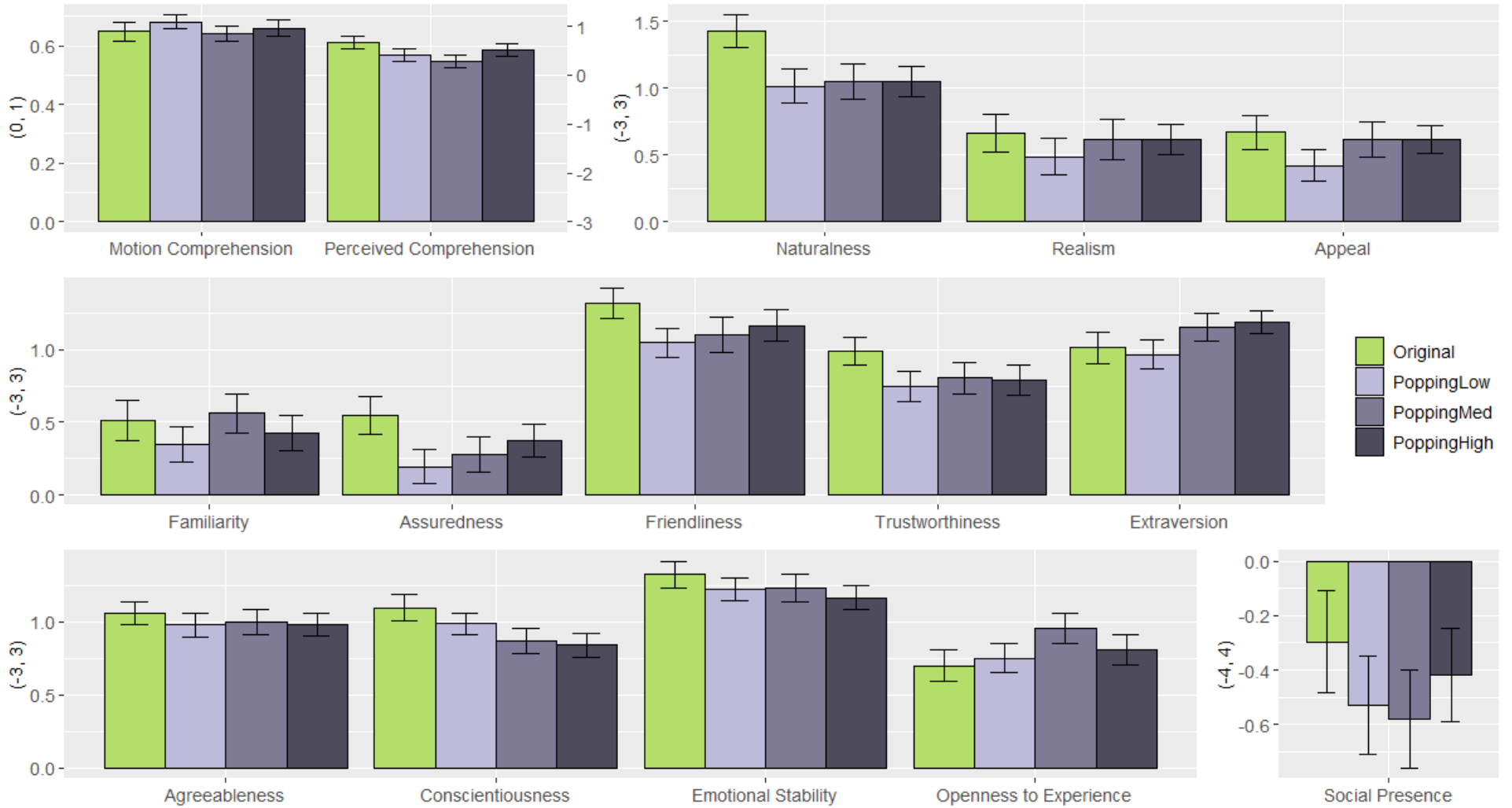


Figure 5: All graphs for the Popping Intensity Levels of the Intensity Experiment. Bolded measures had significant differences between levels. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Intensity Experiment: Smoothing Intensity Results

<b>Measure</b>	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(3, 263)} = 0.37, p = 0.90$	$F_{(3, 466)} = 1.54, p = 0.41$	$F_{(3, 466)} = 3.44, p = 0.11$	$F_{(3, 466)} = 2.02, p = 0.19$	$F_{(3, 466)} = 2.52, p = 0.13$
<b>Means &amp; STDs</b>	Overall = (0.65, 0.23)	Overall = (0.55, 1.33)	Overall = (1.15, 1.34)	Overall = (0.61, 1.44)	Overall = (0.55, 1.4)
<b>Measure</b>	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(3, 466)} = 0.34, p = 0.88$	$F_{(3, 466)} = 0.69, p = 0.70$	$F_{(3, 466)} = 1.04, p = 0.69$	$F_{(3, 466)} = 1.08, p = 0.46$	$F_{(3, 466)} = 0.25, p = 0.86$
<b>Means &amp; STDs</b>	Overall = (0.51, 1.43)	Overall = (0.41, 1.38)	Overall = (1.21, 1.2)	Overall = (0.87, 1.17)	Overall = (1.06, 1.11)
<b>Measure</b>	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(3, 466)} = 0.05, p = 0.99$	$F_{(3, 466)} = 0.47, p = 0.82$	$F_{(3, 466)} = 0.22, p = 0.88$	$F_{(3, 466)} = 1.48, p = 0.37$	$F_{(3, 466)} = 1.79, p = 0.35$
<b>Means &amp; STDs</b>	Overall = (1.07, 0.84)	Overall = (1.02, 0.91)	Overall = (1.33, 0.92)	Overall = (0.85, 1.13)	Overall = (-0.52, 1.98)

Table 8: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### Intensity Experiment: Smoothing Graphs

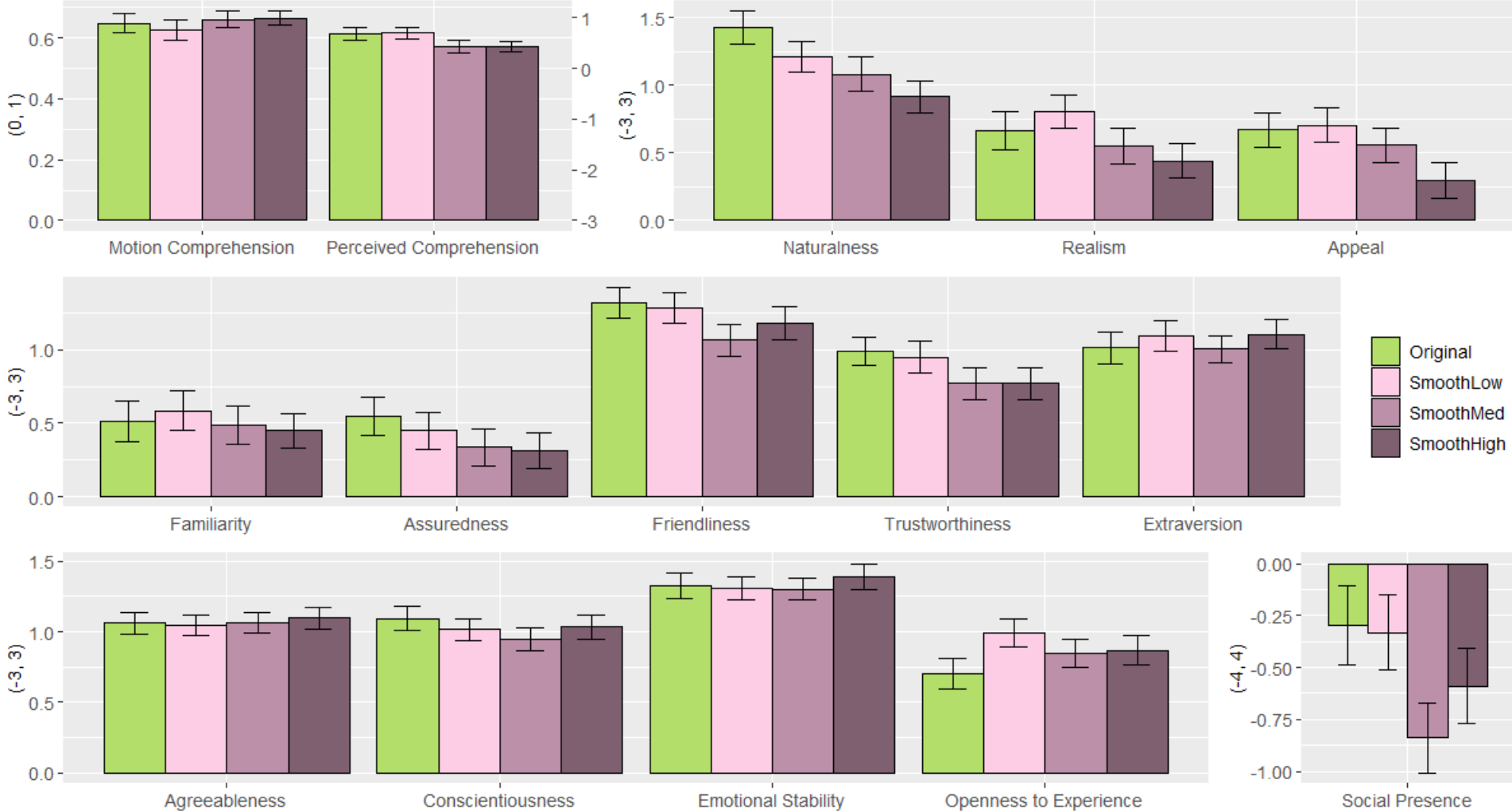


Figure 6: All graphs for the Smoothing Intensity Levels of the Intensity Experiment. Bolded measures had significant differences between levels. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### VR Compare Experiment Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(1, 31)} = 58.52, p < 0.001$	$F_{(1, 31)} = 4.15, p = 0.05$	$F_{(1, 31)} = 0.59, p = 0.45$	$F_{(1, 31)} = 3.95, p = 0.06$	$F_{(1, 31)} = 0.00, p = 0.99$
<b>Means &amp; STDs</b>	Original = (0.78, 0.18) Static = (0.38, 0.11)	Overall = (0.58, 1.31)	Overall = (0.82, 1.31)	Overall = (0.91, 1.18)	Overall = (1.06, 1.2)
<b>Post-Hoc</b>	$p < 0.001$				

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Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(1, 31)} = 1.67, p = 0.21$	$F_{(1, 31)} = 0.05, p = 0.82$	$F_{(1, 31)} = 0.01, p = 0.93$	$F_{(1, 31)} = 1.59, p = 0.22$	$F_{(1, 31)} = 0.17, p = 0.69$
<b>Means &amp; STDs</b>	Overall = (1, 1.09)	Overall = (0.3, 1.26)	Overall = (1.39, 1.12)	Overall = (0.67, 1.02)	Overall = (0.38, 0.79)
<b>Post-Hoc</b>					

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Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(1, 31)} = 0.02, p = 0.89$	$F_{(1, 31)} = 5.06, p < 0.05$	$F_{(1, 31)} = 0.99, p = 0.33$	$F_{(1, 31)} = 0.04, p = 0.84$	$F_{(1, 31)} = 0.16, p = 0.69$
<b>Means &amp; STDs</b>	Overall = (0.17, 0.82)	Original = (0.38, 0.81) Static = (-0.24, 0.75)	Overall = (0.14, 0.94)	Overall = (0, 0.84)	Overall = (-0.38, 1.99)
<b>Post-Hoc</b>		$p < 0.05$			

Table 9: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### VR Compare vs. Alteration Experiment Results

Measure	<i>Motion Comprehension</i>	<i>Perceived Comprehension</i>	<i>Naturalness</i>	<i>Realism</i>	<i>Appeal</i>
<b>Values</b>	$F_{(1, 62)} = 0.35, p = 0.83$	$F_{(1, 85)} = 2.35, p = 0.19$	$F_{(1, 85)} = 0.16, p = 0.69$	$F_{(1, 85)} = 1.78, p = 0.28$	$F_{(1, 85)} = 5.87, p = 0.05$
<b>Means &amp; STDs</b>	Overall = (0.59, 0.26)	Overall = (0.37, 1.48)	Overall = (0.8, 1.62)	Overall = (0.72, 1.42)	Overall = (0.64, 1.43)
<b>Post-Hoc</b>					

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Measure	<i>Familiarity</i>	<i>Assuredness</i>	<i>Friendliness</i>	<i>Trustworthiness</i>	<i>Extraversion</i>
<b>Values</b>	$F_{(1, 85)} = 3.36, p = 0.13$	$F_{(1, 85)} = 0.35, p = 0.55$	$F_{(1, 85)} = 2.35, p = 0.31$	$F_{(1, 85)} = 0.17, p = 0.91$	$F_{(1, 85)} = 3.71, p = 0.17$
<b>Means &amp; STDs</b>	Overall = (0.71, 1.29)	Overall = (0.44, 1.32)	Overall = (1.13, 1.33)	Overall = (0.61, 1.01)	Overall = (0.66, 1)
<b>Post-Hoc</b>					

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Measure	<i>Agreeableness</i>	<i>Conscientiousness</i>	<i>Emotional Stability</i>	<i>Openness to Experience</i>	<i>Social Presence</i>
<b>Values</b>	$F_{(1, 85)} = 28.37, p < 0.001$	$F_{(1, 85)} = 22.51, p < 0.001$	$F_{(1, 85)} = 30.11, p < 0.001$	$F_{(1, 85)} = 9.77, p < 0.01$	$F_{(1, 85)} = 0.14, p = 0.71$
<b>Means &amp; STDs</b>	VR Compare = (0.17, 0.82) Alteration = (1.13, 0.8)	VR Compare = (0.06, 0.83) Alteration = (0.99, 0.9)	VR Compare = (0.14, 0.94) Alteration = (1.32, 1)	VR Compare = (0, 0.84) Alteration = (0.68, 1.04)	Overall = (-0.44, 2.2)
<b>Post-Hoc</b>	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.01$	

Table 10: Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### VR Compare: Motion Alteration Graphs

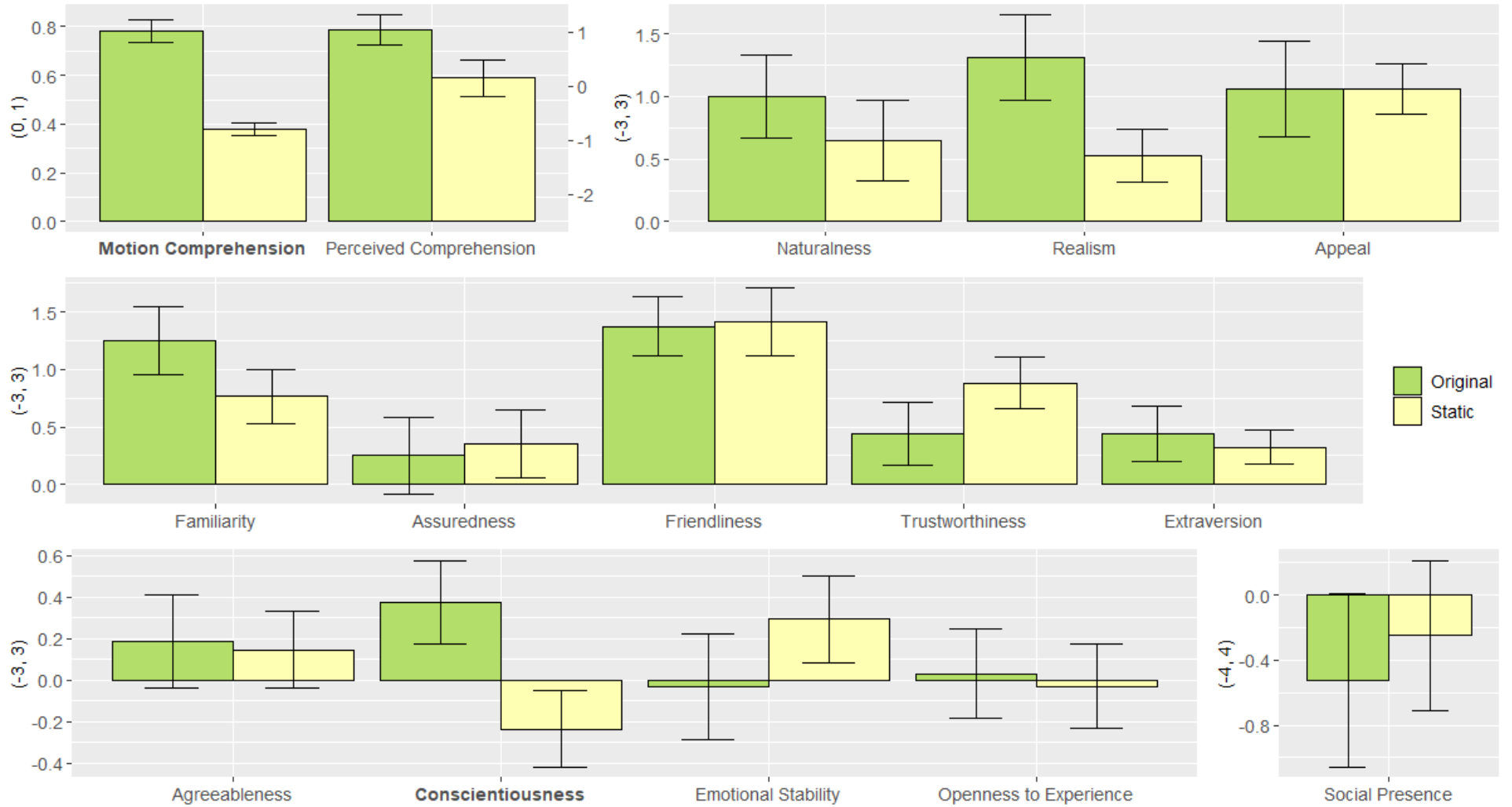


Figure 7: All graphs for the Motion Alterations Original and Static for VR Compare. Bolded measures had significant differences between levels. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).



### VR Compare vs Alteration Graphs

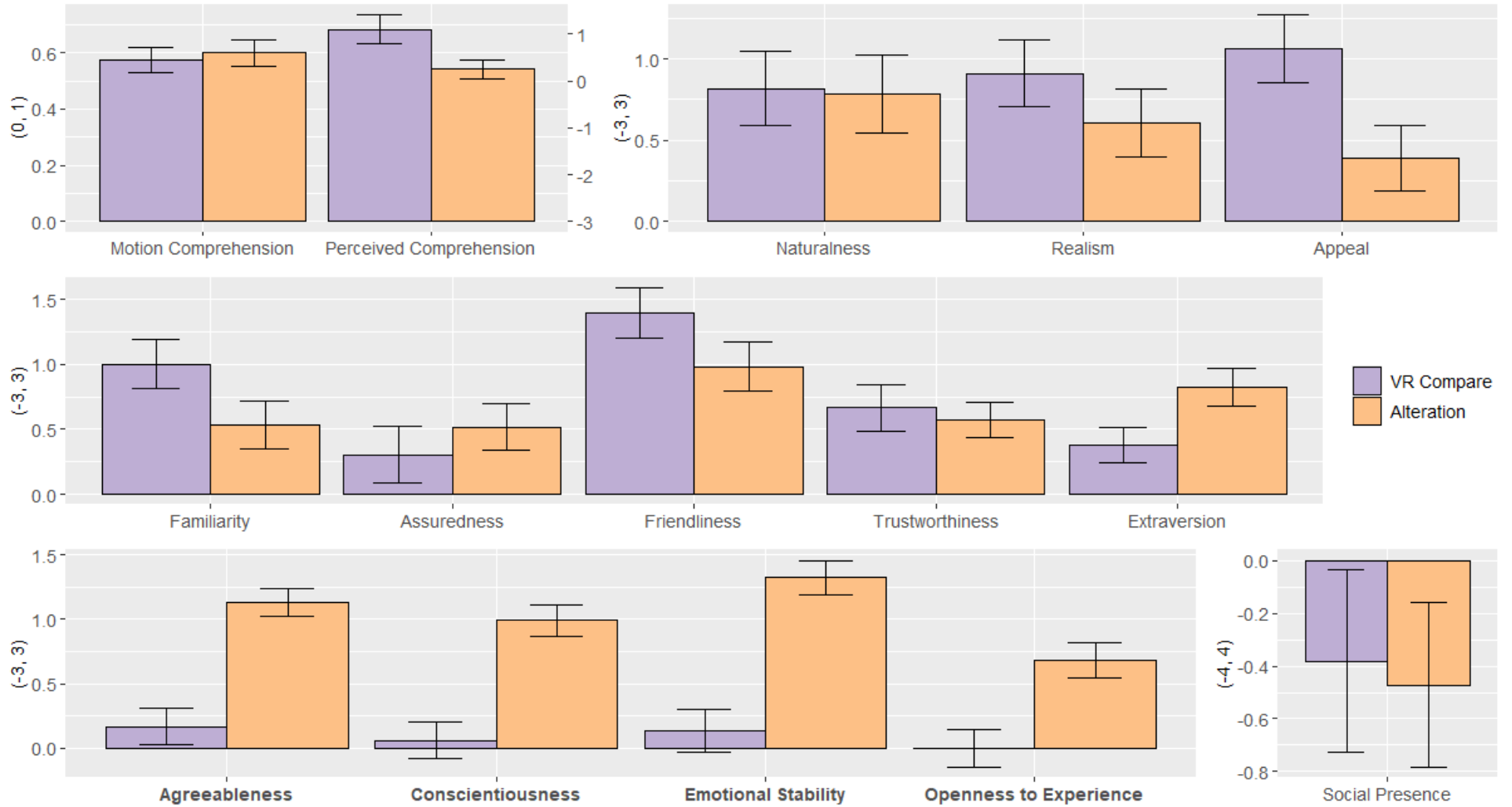


Figure 8: All graphs of VR Compare vs. Alteration experiment. Bolded measures had significant differences between levels. Motion Comprehension is on a scale of (0, 1); Social Presence is on a scale of (-4, 4). All other measures are on a scale of (-3, 3).

### VR Comfort: Motion Condition Results

Measure	Comfort	Naturalness
<b>Values</b>	$F_{(13, 448)} = 6.68, p < 0.001$	$F_{(13, 448)} = 12.76, p < 0.001$
<b>Means &amp; STDs</b>	Original = (0.82, 1.18) Reduced = (0.94, 1.36) JitterLow = (0.14, 1.34) JitterMed = (-0.56, 1.49) JitterHigh = (-1.03, 1.54) PoppingLow = (0.64, 1.28) PoppingMed = (0.68, 1.15) PoppingHigh = (0.52, 1.35) SmoothLow = (0.89, 1.17) SmoothMed = (0.8, 1.37) SmoothHigh = (0.85, 1.22) Random = (0.71, 1.4) Passive = (0.79, 1.08) Static = (0.56, 1.17)	Original = (1.18, 1.16) Reduced = (1.14, 1.29) JitterLow = (-0.08, 1.49) JitterMed = (-1.05, 1.67) JitterHigh = (-1.48, 1.37) PoppingLow = (0.82, 1.37) PoppingMed = (0.67, 1.36) PoppingHigh = (0.24, 1.52) SmoothLow = (1.12, 1.21) SmoothMed = (1.23, 1.28) SmoothHigh = (1.08, 1.14) Random = (0.92, 1.21) Passive = (0.79, 1.29) Static = (0.45, 1.51)

Table 11: Comfort and Naturalness are both on a scale of (-3, 3).

### VR Comfort Graphs

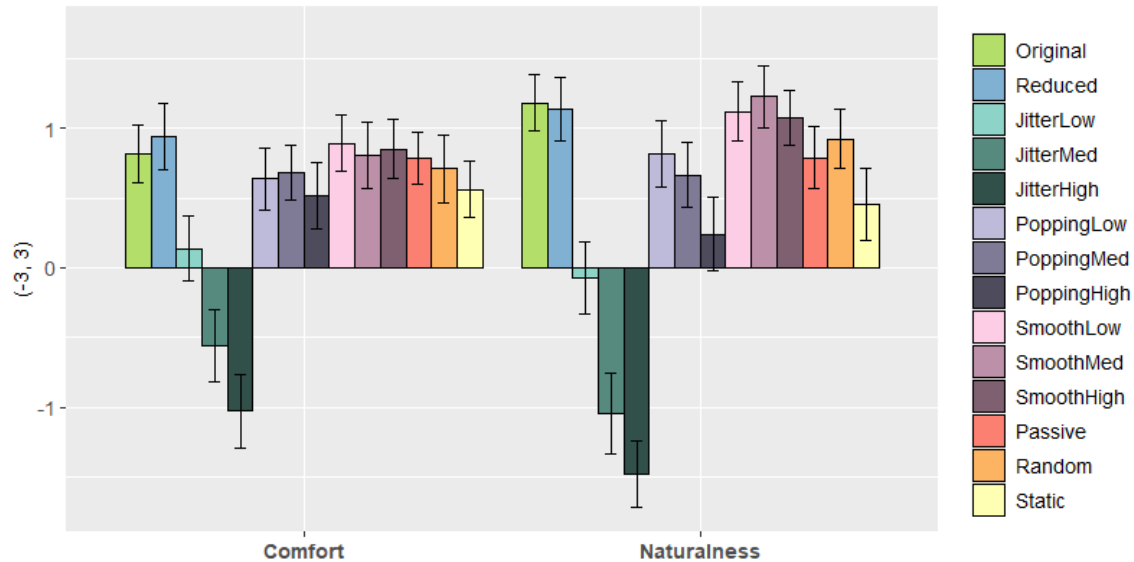


Figure 9: Measures of Comfort and Naturalness for all Motion Condition conditions. Both measures had significant differences between levels. Comfort and Naturalness are on a scale of (-3, 3).

VR Comfort: Motion Condition Post-Hoc Comparisons

Measure	Original													Reduced												
	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St	O	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St
Comfort	1.0	0.68	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4	***	***	1.0	1.0	0.99	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	1.0	*	***	***	1.0	0.96	0.22	1.0	1.0	1.0	1.0	1.0	0.64	1.0	*	***	***	1.0	0.98	0.29	1.0	1.0	1.0	1.0	1.0	0.74
Measure	JitterLow													JitterMed												
	O	Re	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St	O	Re	JL	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St
Comfort	0.68	0.4	0.65	*	0.95	0.91	1.0	0.51	0.71	0.61	0.74	0.88	0.99	**	***	0.65	0.97	*	**	0.05	***	**	**	**	**	*
Naturalness	*	*	0.18	**	0.29	0.61	1.0	*	**	*	0.35	0.14	0.95	***	***	0.18	0.99	***	***	**	***	***	***	***	***	***
Measure	JitterHigh													PoppingLow												
	O	Re	JL	JM	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St	O	Re	JL	JM	JH	PoL	PoH	SmL	SmM	SmH	Pa	Ra	St
Comfort	***	***	*	0.97	***	***	***	***	***	***	***	***	***	1.0	1.0	0.95	*	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	***	***	**	0.99	***	***	***	***	***	***	***	***	***	1.0	1.0	0.29	***	***	1.0	0.91	1.0	0.99	1.0	1.0	1.0	1.0
Measure	PoppingMed													PoppingHigh												
	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra	St	O	Re	JL	JM	JH	PoL	PoM	SmL	SmM	SmH	Pa	Ra
Comfort	1.0	1.0	0.91	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.99	1.0	0.05	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	0.96	0.98	0.61	***	***	1.0	0.99	0.99	0.92	0.99	1.0	1.0	1.0	0.22	0.29	1.0	**	***	0.91	0.99	0.32	0.16	0.41	0.94	0.74	1.0
Measure	SmoothLow													SmoothMed												
	O	Re	JL	JM	JH	PoL	PoM	PoH	SmM	SmH	Pa	Ra	St	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra
Comfort	1.0	1.0	0.51	***	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.71	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	1.0	1.0	*	***	***	1.0	0.99	0.32	1.0	1.0	1.0	1.0	0.77	1.0	1.0	**	***	***	0.99	0.92	0.16	1.0	1.0	0.99	1.0	0.54
Measure	SmoothHigh													Passive												
	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	Pa	Ra	St	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Ra	St
Comfort	1.0	1.0	0.61	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.74	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	1.0	1.0	*	***	***	1.0	0.99	0.41	1.0	1.0	1.0	1.0	0.85	1.0	1.0	0.35	***	***	1.0	1.0	0.94	1.0	0.99	1.0	1.0	1.0
Measure	Random													Static												
	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	St	O	Re	JL	JM	JH	PoL	PoM	PoH	SmL	SmM	SmH	Pa	Ra
Comfort	1.0	1.0	0.88	**	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.99	*	***	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Naturalness	1.0	1.0	0.14	***	***	1.0	1.0	0.74	1.0	1.0	1.0	1.0	0.98	0.64	0.74	0.95	***	***	1.0	1.0	1.0	0.77	0.54	0.85	1.0	0.98

Table 12: \* indicates a post-hoc p-value of <0.05, \*\* of <0.01, and \*\*\* values are <0.001. Conditions are abbreviated: Original = O, Reduced = Re, JitterLow = JL, JitterMed = JM, JitterHigh = JH, PoppingLow = PoL, PoppingMed = PoM, PoppingHigh = PoH, SmoothLow = SmL, SmoothMed = SmM, SmoothHigh = SmH, Passive = Pa, Random = Ra, Static = St.

### VR Rank: Results

$\chi^2(7) = 95.77, p < 0.005; \text{Critical Difference} = 62.16$

Original							Reduced							Jitter							Popping						
Re	J	Po	Sm	Ps	Ra	St	O	J	Po	Sm	Pa	Ra	St	O	Re	Po	Sm	Pa	Ra	St	O	Re	J	Sm	Pa	Ra	St
18	<b>141</b>	6	5	<b>71</b>	48	<b>93</b>	18	<b>123</b>	12	23	53	30	<b>75</b>	<b>141</b>	<b>123</b>	<b>135</b>	<b>146</b>	<b>70</b>	<b>93</b>	48	6	12	<b>135</b>	11	<b>65</b>	42	<b>87</b>
Smooth							Passive							Random							Static						
O	Re	J	Po	Pa	Ra	St	O	Re	J	Po	Sm	Ra	St	O	Re	J	Po	Sm	Pa	St	O	Re	J	Po	Sm	Pa	Ra
5	23	<b>146</b>	11	<b>76</b>	53	<b>98</b>	<b>71</b>	53	<b>70</b>	<b>65</b>	<b>76</b>	23	22	48	30	<b>93</b>	42	53	23	45	<b>93</b>	<b>75</b>	48	<b>87</b>	<b>98</b>	22	45

Table 13: Bolded measures indicate significant differences between conditions. Conditions are abbreviated: Original = O, Reduced = Re, Jitter = J, Popping = Po, Smooth = Sm, Passive = Pa, Random = Ra, Static = St.

### VR Rank Graphs

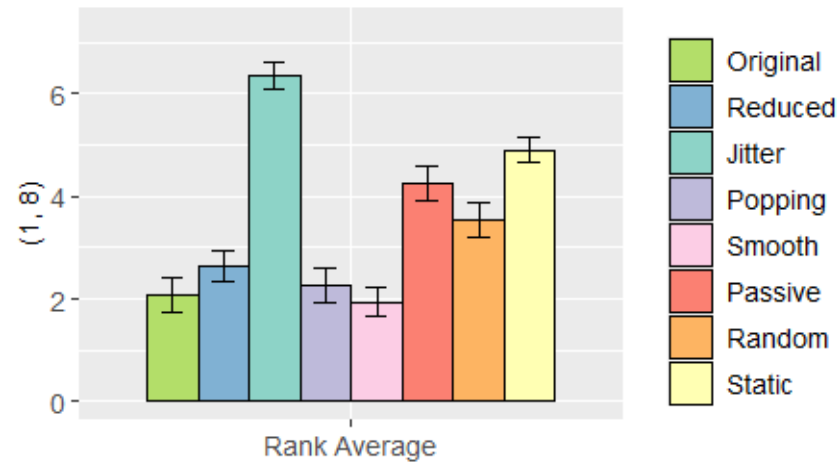


Figure 10: Ranking measures from Most Comfortable (1) to Least Comfortable (8).