

What is Appropriate? On the Assessment of Human-Robot Proxemics for Casual Encounters in Closed Environments

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Online Resource 1

Supplementary Figures (Appendix A) and Tables (Appendix B)

Appendix A

Fig. 1

Interaction plot robot and distance for lateral passing.

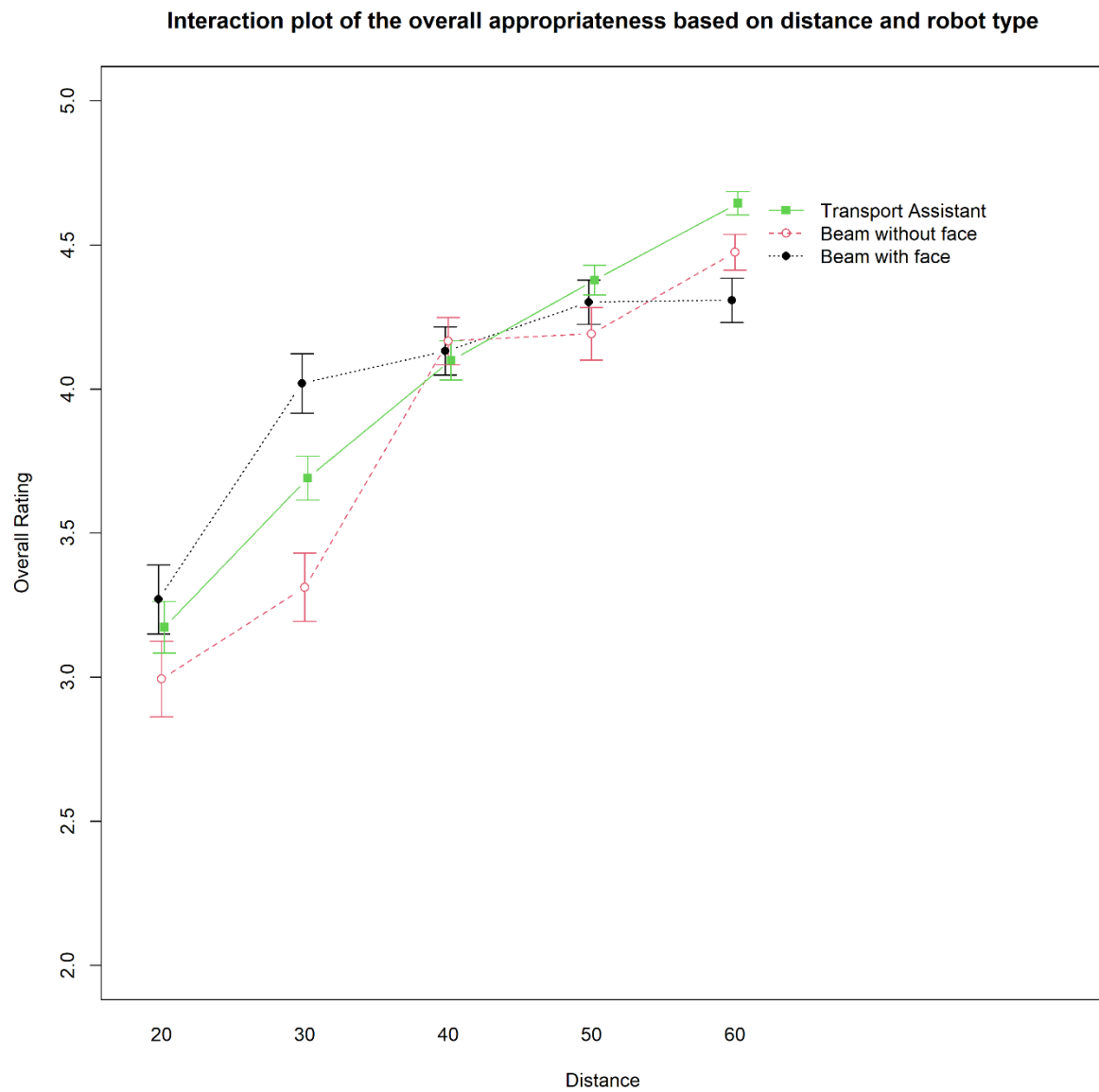
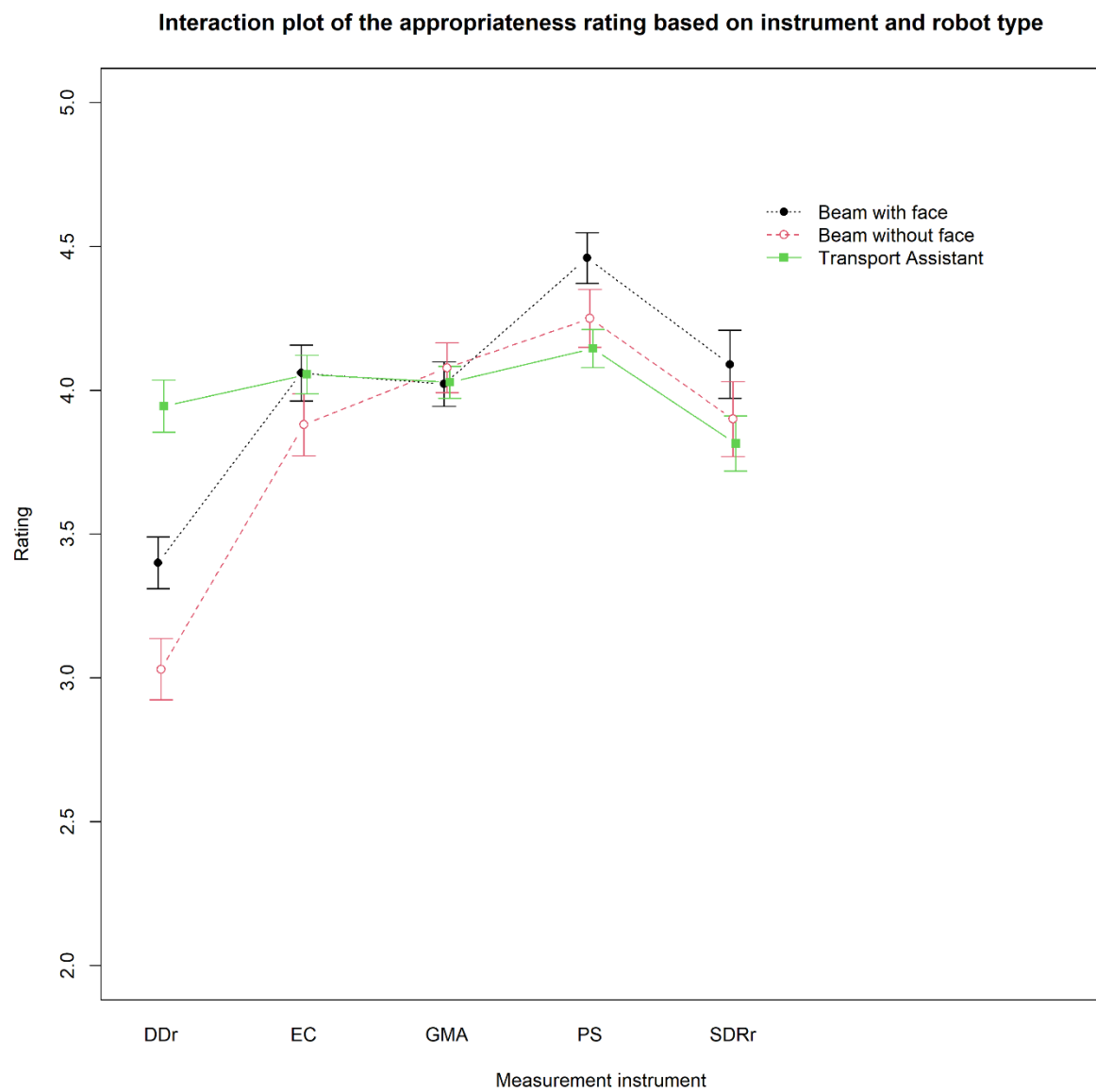


Fig. 2

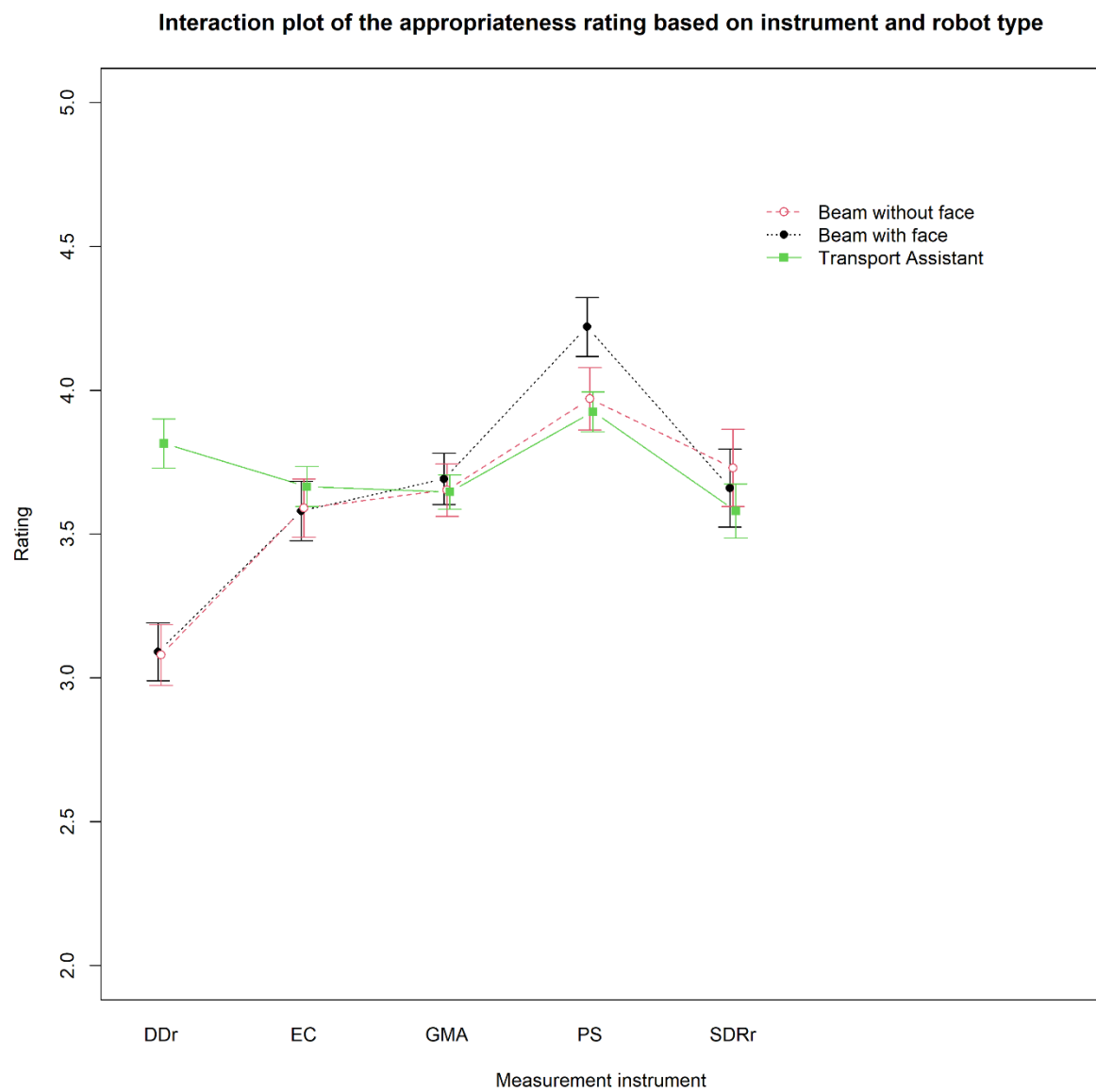
Interaction plot robot and measurement instrument for lateral passing.



Note. DDr = Direct Distance reversed, EC = Expectation Conformity, GMA = General Motion Acceptance, PS = Perceived Safety, SDRr = Spatial Discomfort Rating reversed

Fig. 3

Interaction plot robot and measurement instrument for frontal approaches.



Note. DDr = Direct Distance reversed, EC = Expectation Conformity, GMA = General Motion Acceptance, PS = Perceived Safety, SDRr = Spatial Discomfort Rating reversed

Figure 4

Correlation heat map.



Note. These are the mean correlations between the instruments across all three robots and all lateral and frontal distances.

Appendix B

Supplementary Tables

Table 1

FDR-corrected pairwise comparisons between measures, grouped by lateral distances.

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5%)	Magnitude
20	Spatial Discomfort Rating	Direct Distance	3.57	79	0.001	0.001	0.384	0.17	0.63	small
	Spatial Discomfort Rating	Expectation Conformity	-4.81	79	< 0.001	< 0.001	-0.533	-0.8	-0.3	moderate
	Spatial Discomfort Rating	General Motion Acceptance	-6.73	79	< 0.001	< 0.001	-0.745	-0.99	-0.54	moderate
	Spatial Discomfort Rating	Perceived Safety	-7.9	79	< 0.001	< 0.001	-0.875	-1.13	-0.67	large
	Direct Distance	Expectation Conformity	-7.59	79	< 0.001	< 0.001	-0.841	-1.21	-0.54	large
	Direct Distance	General Motion Acceptance	-9.46	79	< 0.001	< 0.001	-1.048	-1.36	-0.81	large
	Direct Distance	Perceived Safety	-10.2	79	< 0.001	< 0.001	-1.129	-1.42	-0.92	large
	Expectation Conformity	General Motion Acceptance	-0.14	79	0.887	0.887	-0.016	-0.23	0.23	negligible
	Expectation Conformity	Perceived Safety	-0.74	79	0.462	0.513	-0.082	-0.31	0.15	negligible

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5%)	Magnitude
	General Motion Acceptance	Perceived Safety	-0.87	79	0.389	0.486	-0.096	-0.33	0.11	negligible
30	Spatial Discomfort Rating	Direct Distance	2.98	79	0.004	0.005	0.33	0.11	0.57	small
	Spatial Discomfort Rating	Expectation Conformity	-3.18	79	0.002	0.004	-0.352	-0.56	-0.13	small
	Spatial Discomfort Rating	General Motion Acceptance	-3.65	79	< 0.001	0.001	-0.404	-0.64	-0.17	small
	Spatial Discomfort Rating	Perceived Safety	-5.79	79	< 0.001	< 0.001	-0.642	-0.83	-0.47	moderate
	Direct Distance	Expectation Conformity	-5.65	79	< 0.001	< 0.001	-0.626	-0.94	-0.37	moderate
	Direct Distance	General Motion Acceptance	-6.67	79	< 0.001	< 0.001	-0.738	-1.01	-0.53	moderate
	Direct Distance	Perceived Safety	-8.65	79	< 0.001	< 0.001	-0.958	-1.24	-0.73	large
	Expectation Conformity	General Motion Acceptance	0.45	79	0.654	0.654	0.05	-0.16	0.31	negligible
	Expectation Conformity	Perceived Safety	-1.95	79	0.055	0.061	-0.215	-0.46	0	small
	General Motion Acceptance	Perceived Safety	-2.95	79	0.004	0.005	-0.327	-0.57	-0.11	small
40	Spatial Discomfort Rating	Direct Distance	2.39	79	0.019	0.032	0.265	0.05	0.51	small

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5%)	Magnitude
	Spatial Discomfort Rating	Expectation Conformity	-0.49	79	0.629	0.699	-0.054	-0.28	0.19	negligible
	Spatial Discomfort Rating	General Motion Acceptance	-0.74	79	0.461	0.576	-0.082	-0.28	0.16	negligible
	Spatial Discomfort Rating	Perceived Safety	-3.16	79	0.002	0.008	-0.35	-0.53	-0.15	small
	Direct Distance	Expectation Conformity	-2.40	79	0.019	0.032	-0.266	-0.52	-0.04	small
	Direct Distance	General Motion Acceptance	-3.15	79	0.002	0.008	-0.349	-0.59	-0.15	small
	Direct Distance	Perceived Safety	-5.05	79	< 0.001	< 0.001	-0.559	-0.8	-0.34	moderate
	Expectation Conformity	General Motion Acceptance	-0.14	79	0.888	0.888	-0.016	-0.23	0.22	negligible
	Expectation Conformity	Perceived Safety	-1.90	79	0.062	0.088	-0.21	-0.44	0.01	small
	General Motion Acceptance	Perceived Safety	-2.70	79	0.009	0.021	-0.299	-0.58	-0.07	small
50	Spatial Discomfort Rating	Direct Distance	2.85	79	< 0.001	0.001	0.426	0.2	0.71	small
	Spatial Discomfort Rating	Expectation Conformity	2.96	79	0.004	0.007	0.328	0.13	0.54	small

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5%)	Magnitude
	Spatial Discomfort Rating	General Motion Acceptance	3.23	79	0.002	0.004	0.358	0.11	0.7	small
	Spatial Discomfort Rating	Perceived Safety	-0.54	79	0.593	0.64	-0.059	-0.24	0.17	negligible
	Direct Distance	Expectation Conformity	-0.47	79	0.64	0.64	-0.052	-0.29	0.16	negligible
	Direct Distance	General Motion Acceptance	-1.72	79	0.09	0.129	-0.19	-0.4	0.03	negligible
	Direct Distance	Perceived Safety	-3.82	79	< 0.001	0.001	-0.423	-0.68	-0.2	small
	Expectation Conformity	General Motion Acceptance	-1.38	79	0.172	0.215	-0.153	-0.36	0.07	negligible
	Expectation Conformity	Perceived Safety	-3.66	79	< 0.001	0.001	-0.405	-0.61	-0.2	small
	General Motion Acceptance	Perceived Safety	-4.34	79	< 0.001	< 0.001	-0.481	-0.69	-0.27	small
60	Spatial Discomfort Rating	Direct Distance	4.53	79	< 0.001	< 0.001	0.502	0.29	0.77	moderate
	Spatial Discomfort Rating	Expectation Conformity	3.76	79	< 0.001	0.001	0.417	0.2	0.66	small
	Spatial Discomfort Rating	General Motion Acceptance	5.04	79	< 0.001	< 0.001	0.558	0.34	0.8	moderate

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5%)	Magnitude
	Spatial Discomfort Rating	Perceived Safety	0.36	79	0.717	0.819	0.04	-0.18	0.28	negligible
	Direct Distance	Expectation Conformity	0.13	79	0.901	0.901	0.014	-0.19	0.24	negligible
	Direct Distance	General Motion Acceptance	-0.34	79	0.737	0.819	-0.037	-0.27	0.18	negligible
	Direct Distance	Perceived Safety	-3.96	79	< 0.001	< 0.001	-0.439	-0.7	-0.21	small
	Expectation Conformity	General Motion Acceptance	-0.57	79	0.574	0.819	-0.063	-0.29	0.17	negligible
	Expectation Conformity	Perceived Safety	-4.5	79	< 0.001	< 0.001	-0.499	-0.68	-0.32	small
	General Motion Acceptance	Perceived Safety	-6.02	79	< 0.001	< 0.001	-0.667	-0.88	-0.47	moderate

Note. Spatial Discomfort Rating and Direct Distance were reverse-coded. FDR correction method: Benjamini-Hochberg correction [1].

Table 2

FDR-corrected pairwise comparisons between measures, grouped by frontal distances.

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5)	Magnitude
50	Spatial Discomfort Rating	Direct Distance	2.46	79	0.016	0.02	0.272	0.07	0.47	small
	Spatial Discomfort Rating	Expectation Conformity	-4.71	79	< 0.001	< 0.001	-0.522	-0.76	-0.3	moderate
	Spatial Discomfort Rating	General Motion Acceptance	-5.26	79	< 0.001	< 0.001	-0.582	-0.85	-0.35	moderate
	Spatial Discomfort Rating	Perceived Safety	-7.88	79	< 0.001	< 0.001	-0.873	-1.1	-0.69	large
	Direct Distance	Expectation Conformity	-7.27	79	< 0.001	< 0.001	-0.805	-1.07	-0.61	large
	Direct Distance	General Motion Acceptance	-8.3	79	< 0.001	< 0.001	-0.919	-1.16	-0.72	large
	Direct Distance	Perceived Safety	-9.36	79	< 0.001	< 0.001	-1.036	-1.3	-0.82	large
	Expectation Conformity	General Motion Acceptance	0.52	79	0.601	0.601	0.058	-0.16	0.28	negligible
	Expectation Conformity	Perceived Safety	-2.31	79	0.024	0.026	-0.255	-0.51	-0.06	small
	General Motion Acceptance	Perceived Safety	-3.47	79	0.001	0.001	-0.384	-0.64	-0.15	small

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5)	Magnitude
65	Spatial Discomfort Rating	Direct Distance	1.37	79	0.176	0.196	0.151	-0.05	0.39	negligible
	Spatial Discomfort Rating	Expectation Conformity	-2.14	79	0.036	0.045	-0.237	-0.48	-0.01	small
	Spatial Discomfort Rating	General Motion Acceptance	-2.35	79	0.021	0.031	-0.26	-0.49	-0.04	small
	Spatial Discomfort Rating	Perceived Safety	-5.17	79	< 0.001	< 0.001	-0.572	-0.8	-0.35	moderate
	Direct Distance	Expectation Conformity	-3.48	79	0.001	0.002	-0.386	-0.63	-0.17	small
	Direct Distance	General Motion Acceptance	-3.59	79	0.001	0.001	-0.397	-0.63	-0.17	small
	Direct Distance	Perceived Safety	-5.82	79	< 0.001	< 0.001	-0.644	-0.89	-0.44	moderate
	Expectation Conformity	General Motion Acceptance	0.49	79	0.626	0.626	0.054	-0.18	0.26	negligible
	Expectation Conformity	Perceived Safety	-2.47	79	0.016	0.026	-0.273	-0.53	-0.05	small
	General Motion Acceptance	Perceived Safety	-4.21	79	< 0.001	< 0.001	-0.466	-0.71	-0.24	small
80	Spatial Discomfort Rating	Direct Distance	1.47	79	0.146	0.243	0.163	-0.04	0.4	negligible

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5)	Magnitude
	Spatial Discomfort Rating	Expectation Conformity	-0.39	79	0.695	0.695	-0.044	-0.28	0.17	negligible
	Spatial Discomfort Rating	General Motion Acceptance	0.48	79	0.632	0.695	0.053	-0.18	0.25	negligible
	Spatial Discomfort Rating	Perceived Safety	-3.18	79	0.002	0.007	-0.352	-0.57	-0.14	small
	Direct Distance	Expectation Conformity	-1.55	79	0.125	0.243	-0.172	-0.4	0.04	negligible
	Direct Distance	General Motion Acceptance	-0.88	79	0.381	0.476	-0.097	-0.35	0.12	negligible
	Direct Distance	Perceived Safety	-4.11	79	< 0.001	< 0.001	-0.455	-0.67	-0.27	small
	Expectation Conformity	General Motion Acceptance	1.27	79	0.206	0.294	0.141	-0.08	0.39	negligible
	Expectation Conformity	Perceived Safety	-2.62	79	0.011	0.026	-0.29	-0.52	-0.07	small
	General Motion Acceptance	Perceived Safety	-4.27	79	0	0	-0.473	-0.69	-0.26	small
95	Spatial Discomfort Rating	Direct Distance	1.95	79	0.054	0.09	0.216	0	0.47	small
	Spatial Discomfort Rating	Expectation Conformity	3.08	79	0.003	0.007	0.341	0.12	0.57	small

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5)	Magnitude
	Spatial Discomfort Rating	General Motion Acceptance	3.34	79	0.001	0.004	0.37	0.14	0.66	small
	Spatial Discomfort Rating	Perceived Safety	-0.45	79	0.653	0.653	-0.05	-0.26	0.18	negligible
	Direct Distance	Expectation Conformity	1.74	79	0.086	0.123	0.192	-0.03	0.41	negligible
	Direct Distance	General Motion Acceptance	1.41	79	0.162	0.202	0.156	-0.07	0.39	negligible
	Direct Distance	Perceived Safety	-1.96	79	0.053	0.09	-0.217	-0.47	-0.01	small
	Expectation Conformity	General Motion Acceptance	-0.92	79	0.359	0.399	-0.102	-0.33	0.11	negligible
	Expectation Conformity	Perceived Safety	-4.46	79	< 0.001	< 0.001	-0.494	-0.72	-0.28	small
	General Motion Acceptance	Perceived Safety	-4.84	79	< 0.001	< 0.001	-0.536	-0.8	-0.32	moderate
110	Spatial Discomfort Rating	Direct Distance	1.77	79	0.08	0.1	0.196	0	0.46	negligible
	Spatial Discomfort Rating	Expectation Conformity	5.49	79	< 0.001	< 0.001	0.608	0.4	0.84	moderate
	Spatial Discomfort Rating	General Motion Acceptance	4.30	79	< 0.001	< 0.001	0.476	0.24	0.75	small

Distance (in cm)	Measure 1	Measure 2	<i>t</i>	<i>df</i>	<i>p</i>	<i>p</i> adj.	Effect size	CI (2.5%)	CI (97.5)	Magnitude
	Spatial Discomfort Rating	Perceived Safety	0.56	79	0.575	0.575	0.062	-0.15	0.31	negligible
	Direct Distance	Expectation Conformity	3.88	79	< 0.001	< 0.001	0.429	0.22	0.66	small
	Direct Distance	General Motion Acceptance	2.04	79	0.044	0.063	0.226	0.0072	0.48	small
	Direct Distance	Perceived Safety	-1.22	79	0.227	0.252	-0.135	-0.37	0.09	negligible
	Expectation Conformity	General Motion Acceptance	-3.41	79	0.001	0.002	-0.378	-0.59	-0.16	small
	Expectation Conformity	Perceived Safety	-5.55	79	< 0.001	< 0.001	-0.615	-0.85	-0.4	moderate
	General Motion Acceptance	Perceived Safety	-4.38	79	< 0.001	< 0.001	-0.485	-0.77	-0.26	small

Note. Spatial Discomfort Rating and Direct Distance were reverse-coded. FDR correction method: Benjamini-Hochberg correction.

References

1. Benjamini Y, Hochberg Y (1995) Controlling the False Discovery Rate: A Practical and Powerful Approach to Multiple Testing. *Journal of the Royal Statistical Society: Series B (Methodological)* 57:289–300. <https://doi.org/10.1111/j.2517-6161.1995.tb02031.x>