Table S1

Generated item parameters for 120 items in the simulation study

item	loading	tau_m1	delta_m12	delta_m23	tau_e1	delta_e12	delta_e23
1	0.6041178	0.3437225	1.0526490	0.8243726	-1.5146749	0.8924276	1.1275917
2	0.2840618	0.4790786	1.0220842	0.1798673	-1.2060694	0.6643730	0.7518570
3	0.5278476	-0.6611262	1.2391527	0.1818256	-2.0041441	0.7006579	1.1475365
4	0.4830502	-0.2618326	1.1466619	0.3417800	-2.4787415	0.8023230	1.0179239
5	0.3666721	-1.8432756	0.9990977	0.8143983	-0.7877206	0.6087879	1.1014837
6	-0.0032178	-0.5186912	0.9957569	0.7789740	-0.8893809	0.6578192	0.5493987
7	0.3529706	-1.1264886	1.0277003	0.4314735	-1.2656127	0.5854890	0.7453136
8	0.2959755	-0.8992485	0.7859746	0.6092595	-1.4112630	0.6293328	0.8226529
9	0.5227109	-0.4687001	1.2472124	0.7246736	-2.6167582	0.4900688	0.9376695
10	0.4052418	-0.1800019	0.8920380	0.6970184	-3.1173140	0.8576771	0.8876112
11	0.4183571	-0.8277073	0.9407542	0.7063889	-0.6255481	0.8238463	0.8703224
12	0.3539133	0.7832244	1.1376438	0.6394845	-1.7204686	0.5428463	1.0198211
13	0.4557127	-0.4465966	0.9201985	0.6653134	-2.3947858	1.0563208	1.0827696
14	0.4548367	-0.9214264	0.9793030	0.3119536	-0.9853926	0.6500143	1.2333200
15	-0.0093763	-0.5350639	1.3059068	1.0229418	-2.2688922	0.6397805	1.0207276
16	0.7694003	-0.8601546	0.8730727	0.5630655	-2.1758564	0.4001336	0.6675977
17	0.6232816	-1.4560424	0.9546291	0.6984209	-1.6338154	0.7068411	0.6255536
18	0.5435129	-0.4980516	1.3002168	0.3277346	-2.7375889	0.5177906	1.1668083
19	0.3390562	-0.2304559	0.9315073	0.5269565	-2.2014867	0.7702771	0.8212915
20	0.6379494	-0.5703188	0.8892545	0.7512253	-2.5363593	0.7390829	0.9707170
21	0.4342656	-0.5770531	1.0515254	0.6293006	-1.1952357	0.8719260	0.9800111
22	0.4670637	-0.7056702	1.1226244	0.6523894	-1.7017771	0.5651690	1.0333480
23	0.2215942	-0.2912361	0.8695425	0.3387682	-2.0730599	0.3674829	0.8159517
24	0.7931650	-1.5700356	0.9723438	0.6984328	-1.1070627	0.7780092	0.8343651
25	0.5096414	-0.1050328	0.9752724	0.4977792	-1.9272844	0.7882731	0.9875847
26	0.8816168	-1.3454637	0.8070590	0.2678851	-2.0288763	0.9567932	0.7431911
27	0.8461889	-0.5990056	1.0038086	0.7244753	-1.8191173	0.6673628	0.8546326
28	0.5116292	-0.3344876	1.3383385	0.6031462	-2.2869985	0.7999138	0.7835579
29	0.6290656	-0.6577159	1.1771618	0.4532226	-1.8657569	0.7920288	0.6803779
30	0.8451258	-1.7359221	0.8540140	0.6550422	-1.3412892	0.6047436	0.9324705
31	0.3942066	-0.7854039	1.0703769	0.2282523	-1.7778019	0.3886715	0.9901239
32	0.5332784	-0.5992189	0.9505338	1.0157781	-0.9245223	0.5621955	0.9196599
33	0.4490553	-0.2063534	0.9672816	0.1278239	-2.2560136	0.7296815	0.9668111
34	0.5665565	-0.4997749	1.1744721	0.6654271	-2.0851414	0.7270859	0.8819255
35	0.5364866	-0.4538553	1.1211876	0.5544955	-1.0981310	0.4255316	0.8649125
36	0.7329187	-0.1143854	1.1854482	0.3638809	-2.6238785	0.6813793	0.5858557
37	0.6186986	-1.2244687	1.0916089	0.6660843	-2.7453291	0.4763584	1.1423186
38	0.3216441	-1.1711358	0.8397772	0.5186130	-1.5133452	0.8489655	1.1915877
39	0.6154507	-0.8049885	0.9005754	0.9050446	-2.1453205	0.7155365	1.0730151
40	0.3350189	-0.5966482	0.7574064	0.3793632	-2.4875418	0.6000142	1.0179751
41	0.2685492	0.0432438	1.1239425	0.8673785	-2.4563387	0.8223487	0.9165641
42	0.6555998	-1.3191619	1.2719327	0.7105421	-1.4243775	0.5261930	0.8192630
43	0.2591556	-1.3243724	0.6757870	0.3886947	-2.3134594	0.9332316	0.9387556
44	0.5613428	-0.3354091	1.0159119	0.5619634	-1.9249910	0.5460537	0.7893715
45	0.3332683	-1.0411341	1.1025186	0.4181552	-2.3713713	0.3385511	1.0406929
46	0.7836282	-0.9290827	0.9561796	0.1998169	-1.6393267	0.5165069	0.9795337
47	0.6423572	-0.4368463	0.8348123	0.9817942	-2.2993401	0.6287087	0.9020011
48	0.4195005	-1.1687406	0.7972844	0.9137960	-1.6300383	0.6646893	0.8488925
49	0.6598724	-1.2346538	1.2564132	0.6280602	-2.2288243	0.5401377	0.9603598
50	0.5852969	-0.9541656	0.9575711	0.3158881	-0.7858379	0.6214407	1.0447168

51	0.2660203	-1.0352436	1.2369754	0.7026134	-1.6587531	0.7547450	1.1830340
52	0.4587600	-1.2120212	0.8698775	0.4025078	-3.0187619	0.7516284	0.6253241
53	0.3138779	-0.2744958	1.2574735	0.7194448	-1.0750417	0.7220824	0.7800904
54	0.5898795	-1.0886348	1.1077866	0.7735721	-1.9447621	0.5169678	1.2420312
55	0.3710387	-0.7589854	1.0051081	0.6378516	-1.7633237	0.7425873	0.8672125
56	0.4537155	-0.7177851	1.2327895	0.5861387	-1.0668063	0.9806671	1.2209203
57	0.2527264	-1.9152611	0.9264749	0.8152519	-1.6565067	0.5383130	0.7402650
58	0.3078089	-0.5922341	0.9273261	0.8141783	-0.3631794	1.0839067	1.1360748
59	0.5267913	0.1009803	0.9986493	0.6843267	-2.2158007	0.8731338	0.7280820
60	0.3001895	-0.8082429	0.9799055	0.5750900	-1.6885556	0.4472185	0.7260501
61	0.4717059	-1.2651471	0.9702816	0.7874384	-1.6149033	0.5086748	0.9591169
62	0.5334660	-0.0133051	0.9634094	0.6401238	-1.4248569	0.6393260	0.8450324
63	0.4602423	-0.6436853	0.8283704	0.8896358	-1.4012374	0.6995593	0.6775239
64	0.4417586	-0.1915898	1.1916318	0.3435635	-1.5707812	0.5173857	0.6787776
65	0.1531206	-0.6706435	0.8321846	0.5830892	-2.6453650	0.5700714	0.9616057
66	0.4454543	-0.4319572	0.8480551	0.8203228	-2.1480222	0.7752622	0.6828624
67	0.1400141	0.0675931	0.8266970	0.4618601	-1.8573768	0.7555993	1.1033679
68	0.7305482	-0.4051485	1.3318051	0.2549169	-2.1965631	0.5490558	1.1587965
69	0.2993361	-0.5748593	1.1113885	0.7131771	-1.7067140	0.6053831	0.6586142
70	0.5296420	-1.2048130	1.1202772	0.4807683	-2.3778575	0.5172099	0.5500058
71	0.6038993	-0.4517117	0.6060426	0.5021310	-1.3557302	0.1793401	0.4609545
72	0.5010873	-1.0485376	0.9239785	0.7537787	-1.7754765	0.5813065	1.0560180
73	0.7694042	0.5083024	1.2315547	1.0229224	-1.5712946	0.5722040	0.6829070
74	0.3305933	-0.5942854	1.2779269	0.6089562	-2.0330172	0.6788166	1.1032257
75	0.5886796	-1.2788148	0.5976983	0.7894482	-2.3090783	0.5039418	0.8579187
76	0.3045701	0.1846217	0.5327383	0.1750983	-1.0240858	0.7952471	0.6322667
77	0.9248982	-1.0760031	0.7263080	0.6180857	-2.4175047	0.4175217	0.7247721
78	0.6375398	-1.7518826	0.7253811	0.2521702	-2.3802303	1.0262006	0.9094346
79	0.4313264	-1.4269494	1.1474777	0.2595423	-2.3110852	0.4744028	1.3033905
80	0.6570339	-0.7750078	1.0909419	0.8816593	-0.8072064	0.7876902	0.9745398
81	0.2688845	-1.0592158	1.3553363	0.7396336	-1.9628465	1.0801300	0.5789477
82	0.8017833	-0.5248453	1.0389971	0.7152171	-1.2331153	0.5598479	0.7995004
83	0.2689008	-0.9376112	0.9310775	0.4931328	-2.5165133	0.6256521	0.6608285
84	0.1886376	-1.9141773	1.3225353	0.3436027	-2.1544741	0.5642994	0.6857865
85	0.4889504	-0.9738045	1.1551419	0.6859228	-1.9954897	0.7202903	1.0492373
86	0.6698386	0.2602847	1.1408558	0.3741125	-1.5050975	0.8106560	0.8126227
87	0.4977807	-1.0656097	1.2144308	1.0839527	-2.0820787	0.3955558	1.1154735
88	0.3479372	-1.1533186	0.9571738	0.6156552	-1.4820623	0.4956901	0.9485574
89	0.7351599	-0.8723530	1.0727262	0.6632450	-1.8323366	0.4218636	0.9100435
90	0.9828899	0.1918368	1.2167128	0.2841200	-1.7918461	0.7866680	1.2307408
91	0.1082974	-1.3228127	0.6095448	0.7037811	-0.6272773	0.7739397	0.7935309
92	0.7947180	-0.3315990	1.0031020	0.8270785	-2.3063471	0.5581013	0.9656424
93	0.4050232	-1.1683267	0.8258038	0.6624809	-1.3148322	0.4962101	1.5832959
94	0.6962342	-0.9965548	0.8198132	0.6111088	-1.2415968	0.3718507	0.8289069
95	0.1351290	-1.0131296	0.8447776	0.9130906	-0.8995685	0.8365421	1.2575746
96	0.4478778	-0.3314396	1.0722862	0.7437662	-1.7055281	0.5496247	0.5829070
97	0.3082309	-0.4347979	0.9965301	0.7268651	-1.7495290	0.8432474	0.9550503
98	0.4019409	-0.1542926	0.7763609	0.8131813	-1.8080145	1.0990003	0.7905574
99	0.2845407	-0.1606654	1.1173383	0.6683777	-1.4708624	0.9692273	0.5954765
100	0.5738852	0.4969878	1.0972390	1.2286734	-1.5336750	0.5346186	0.7762855
101	0.7432533	-0.7577261	1.0947789	0.6699902	-2.0690901	0.9276930	1.3650712
102	0.4012314	-2.3211351	1.0722855	0.8146671	-1.3684011	0.5658513	0.8615627
103	0.4544431	-1.1248005	1.2435367	0.7832876	-1.5435238	0.7576611	0.7869873
104	0.2776702	-1.2655637	0.8653766	0.7435314	-1.4799290	0.7327680	1.1107182

105	0.6991666	-0.9775733	0.8802304	0.8110970	-0.2110523	0.8087412	0.7610812
106	0.6123658	-0.1091763	1.1471746	0.6701184	-1.7337531	0.7017922	0.9472162
107	0.1871443	-1.1413327	1.1203479	0.2127923	-2.2082447	0.7582879	0.9560346
108	0.7962154	-1.2834718	1.2217784	0.4398516	-1.6466715	0.8264200	0.8161959
109	0.2661590	-0.5044437	0.9977219	1.0685879	-2.0593386	0.2755411	0.8247518
110	0.2895973	-0.3795450	1.1210072	0.9841757	-2.3622125	0.6453768	1.2330518
111	0.2056309	-0.9458752	1.2247056	0.5780923	-2.1259004	0.7758539	0.8679359
112	0.2613126	-0.5525113	0.8589276	0.0974358	-1.8338662	0.7414823	1.3350223
113	0.4304041	-0.5011008	1.3524944	0.4480753	-1.3164631	0.7260151	0.8593695
114	0.6065645	-0.5793925	0.8539959	0.2989074	-1.6858036	1.0458030	0.8504234
115	0.3578023	-1.1423617	0.6731685	0.2643509	-2.3945004	0.6736445	0.7776233
116	0.4602022	-0.3567101	0.9752012	0.7900197	-1.9933784	0.7180360	0.3227981
117	0.4437253	-2.1609748	1.0408279	0.6249907	-2.8178300	0.6754688	0.5200860
118	0.7341853	-0.4315754	0.8633522	0.8876784	-2.0213365	1.1695972	0.8807603
119	0.9577466	-0.5578185	0.7967275	0.3349298	-2.6869103	0.5755276	0.7521466
120	0.2862287	0.4309476	0.8657132	0.3992131	-2.7340474	0.9192160	1.2123712

Table S2

Omega squared (partial) values for simulation factors and their interactions by CRM fit index (means across 100 replications)

Factor	Chi^2/df	RMSEA	CFI	SRMR
multidim	0.69	0.82	0.82	0.44
testlet_n	0.07	0.15	0.08	0.80
testlet_size	0.48	0.64	0.47	0.00
testlet_load	0.16	0.24	0.02	0.04
categories	0.07	0.15	0.00	0.00
easy	0.00	0.02	0.57	0.76
multidim:testlet_n	0.07	0.00	0.05	0.00
multidim:testlet_size	0.44	0.56	0.56	0.29
multidim:testlet_load	0.06	0.08	0.04	0.02
multidim:categories	0.00	0.00	0.00	0.00
multidim:easy	0.07	0.15	0.35	0.10
testlet_n:testlet_size	0.05	0.02	0.00	0.08
testlet_n:testlet_load	0.00	0.00	0.00	0.00
testlet_n:categories	0.00	0.00	0.00	0.00
testlet_n:easy	0.03	0.05	0.04	0.00
testlet_size:testlet_load	0.03	0.03	0.02	0.00
testlet_size:categories	0.00	0.02	0.00	0.10
testlet_size:easy	0.00	0.00	0.05	0.15
testlet_load:categories	0.03	0.03	0.02	0.00
testlet_load:easy	0.00	0.01	0.00	0.00
categories:easy	0.21	0.33	0.35	0.20

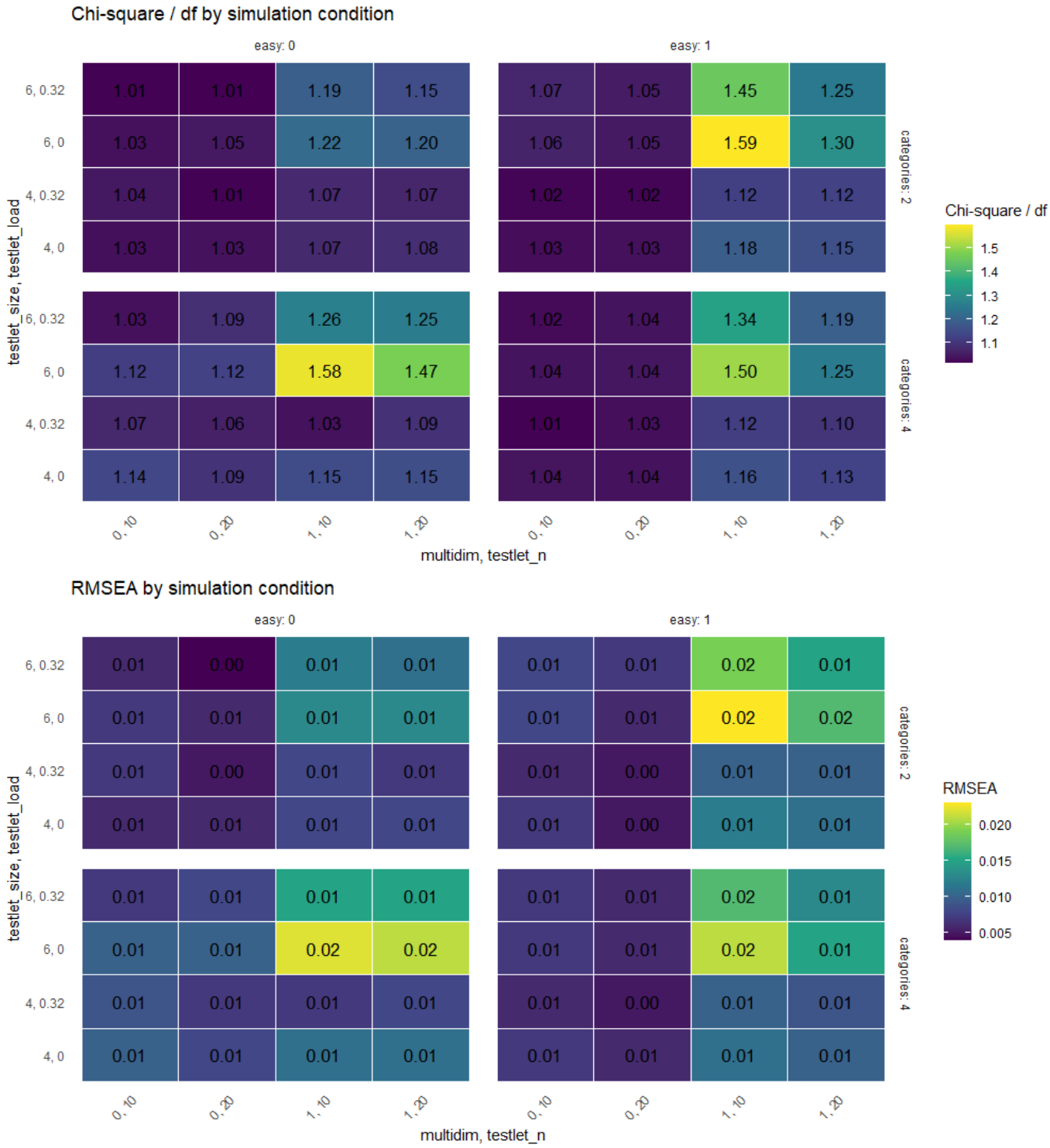
Table S3

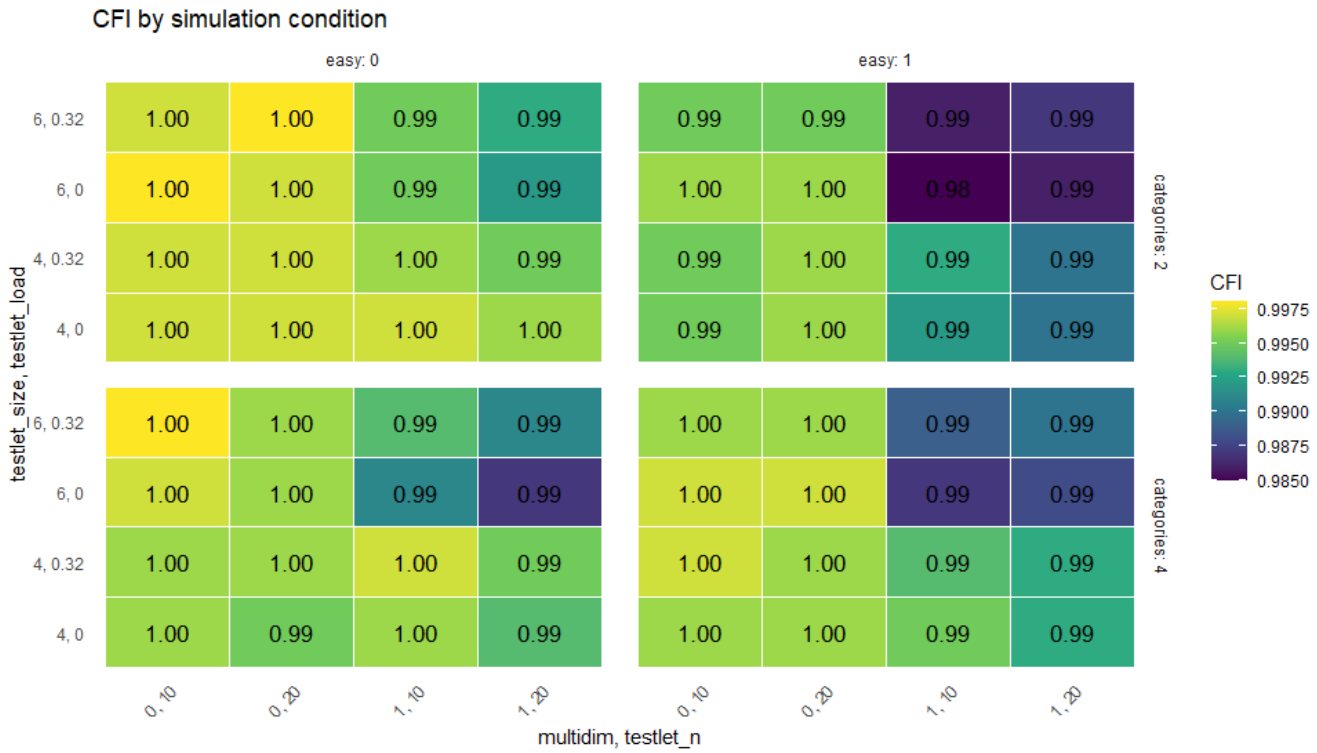
Omega squared (partial) values for simulation factors and their interactions by true score recovery indicator (in one giant sample)

Factor	RMSE	Mean abs cond. bias	Max abs cond. bias	AIC	Spearman rho
multidim	0.99	0.81	0.78	0.98	1.00
testlet_n	0.96	0.55	0.59	0.92	0.98
testlet_size	0.82	0.13	0.11	0.70	0.95
testlet_load	0.68	0.04	0.05	0.54	0.89
categories	0.88	0.08	0.55	0.79	0.98
easy	0.92	0.44	0.89	0.85	0.97
multidim: testlet_n	0.62	0.00	0.00	0.70	0.49
multidim: testlet_size	0.26	0.00	0.00	0.35	0.19
multidim: testlet_load	0.17	0.00	0.00	0.23	0.16
multidim: categories	0.20	0.00	0.01	0.37	0.01
multidim: easy	0.21	0.04	0.04	0.43	0.00
testlet_n: testlet_size	0.07	0.01	0.00	0.00	0.57
testlet_n: testlet_load	0.02	0.00	0.00	0.00	0.31
testlet_n: categories	0.08	0.01	0.01	0.00	0.69
testlet_n: easy	0.17	0.00	0.01	0.00	0.75
testlet_size: testlet_load	0.00	0.00	0.00	0.01	0.00
testlet_size: categories	0.02	0.00	0.03	0.08	0.01
testlet_size: easy	0.00	0.01	0.12	0.02	0.35
testlet_load: categories	0.01	0.00	0.00	0.02	0.00
testlet_load: easy	0.01	0.00	0.00	0.03	0.00
categories: easy	0.00	0.00	0.00	0.01	0.61

Figure S1

Heatmaps of fit indices (averaged across 100 replications) for the 64 simulation conditions

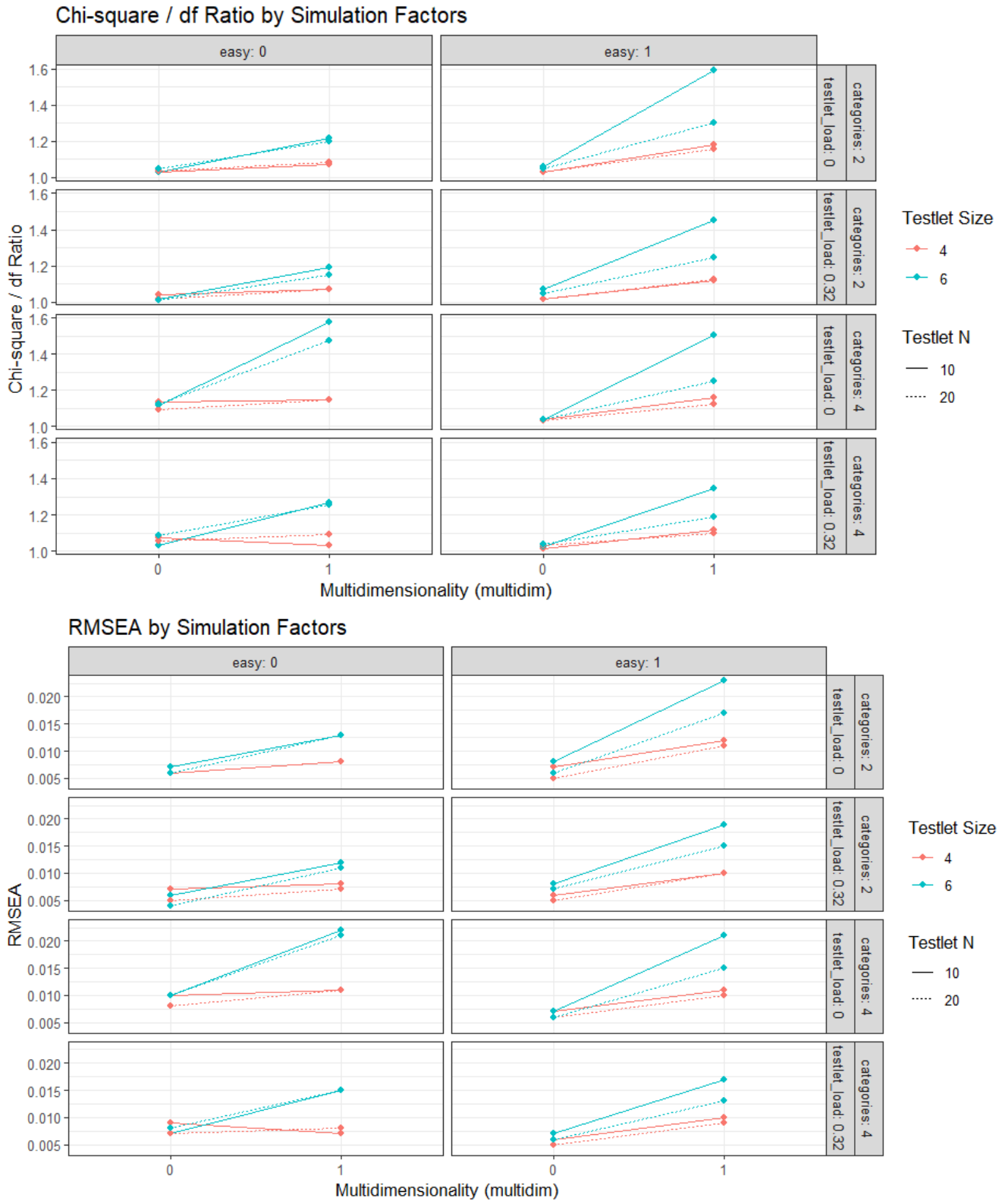


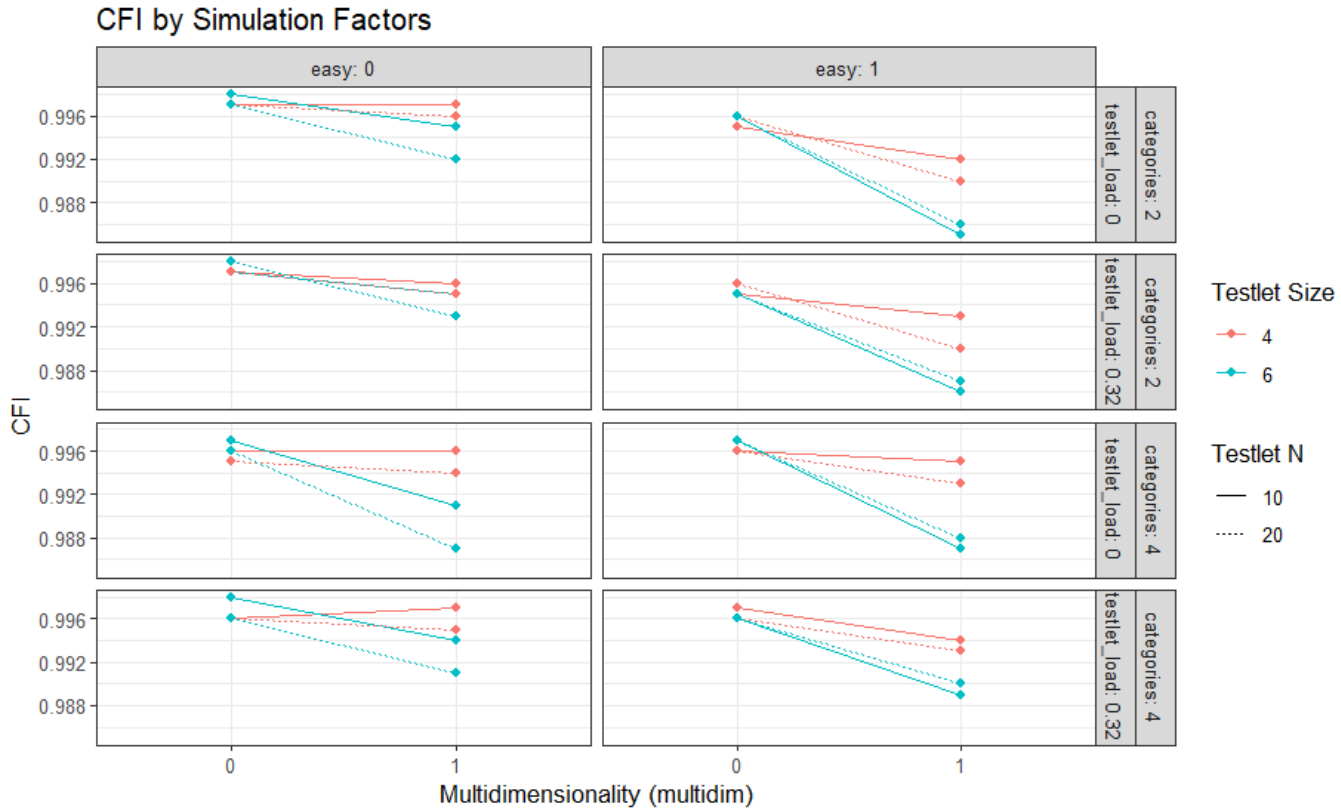

CFI by simulation condition
easy: 0
easy: 1
testlet_size, testlet_load
6, 0.32
6, 0
4, 0.32
4, 0
categories: 2
categories: 4
CFI
0.9975
0.9950
0.9925
0.9900
0.9875
0.9850
0, 10
0, 20
1, 10
1, 20
multidim, testlet_n


SRMR by simulation condition
easy: 0
easy: 1
testlet_size, testlet_load
6, 0.32
6, 0
4, 0.32
4, 0
categories: 2
categories: 4
SRMR
0.0250
0.0225
0.0200
0.0175
0.0150
0, 10
0, 20
1, 10
1, 20
multidim, testlet_n

Figure S2

Interaction plots of fit indices (averaged across 100 replications) for the 64 simulation conditions




CFI by Simulation Factors
easy: 0
easy: 1
testlet_load: 0
testlet_load: 0.32
categories: 2
categories: 4
CFI
0.996
0.992
0.988
0
1
Multidimensionality (multidim)
Testlet Size
4
6
Testlet N
10
20

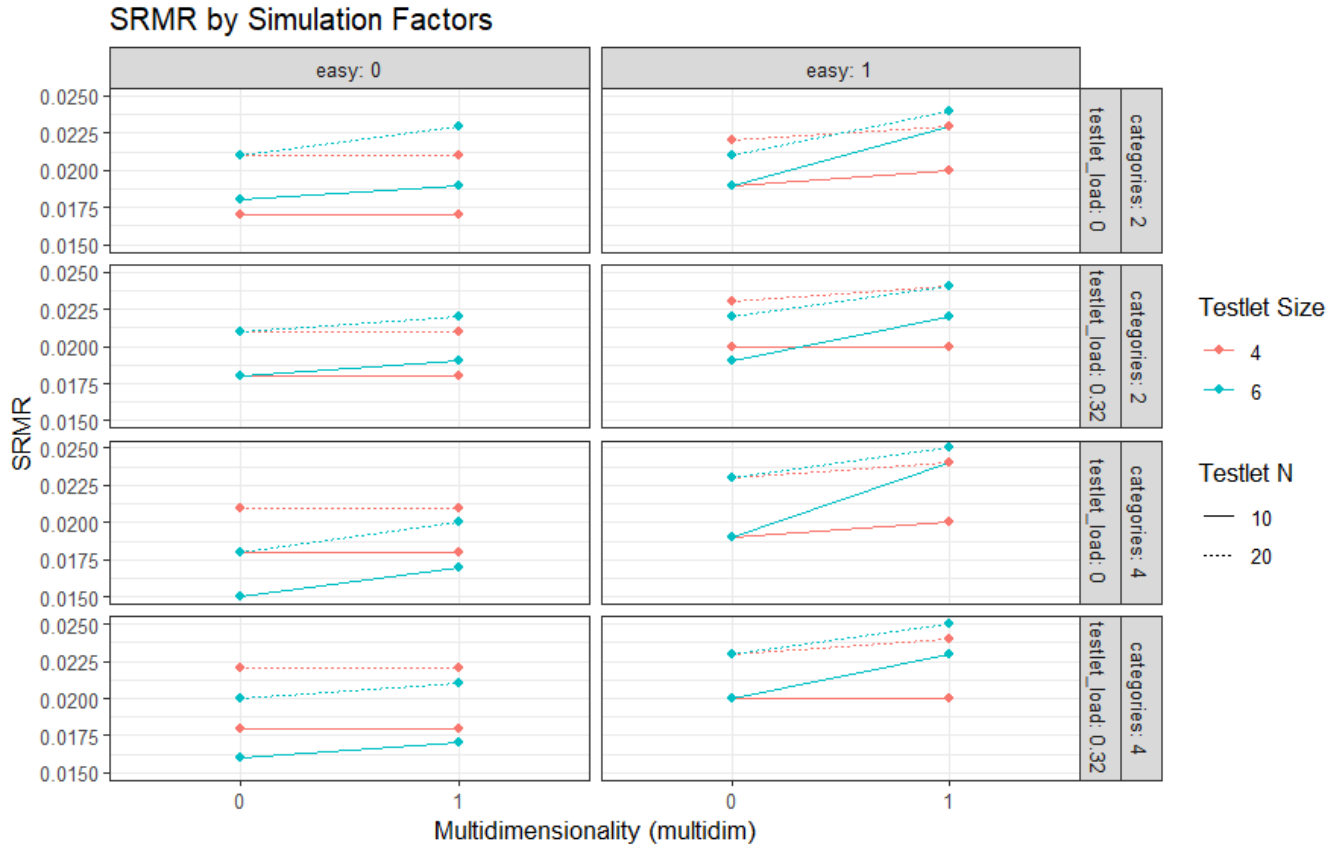
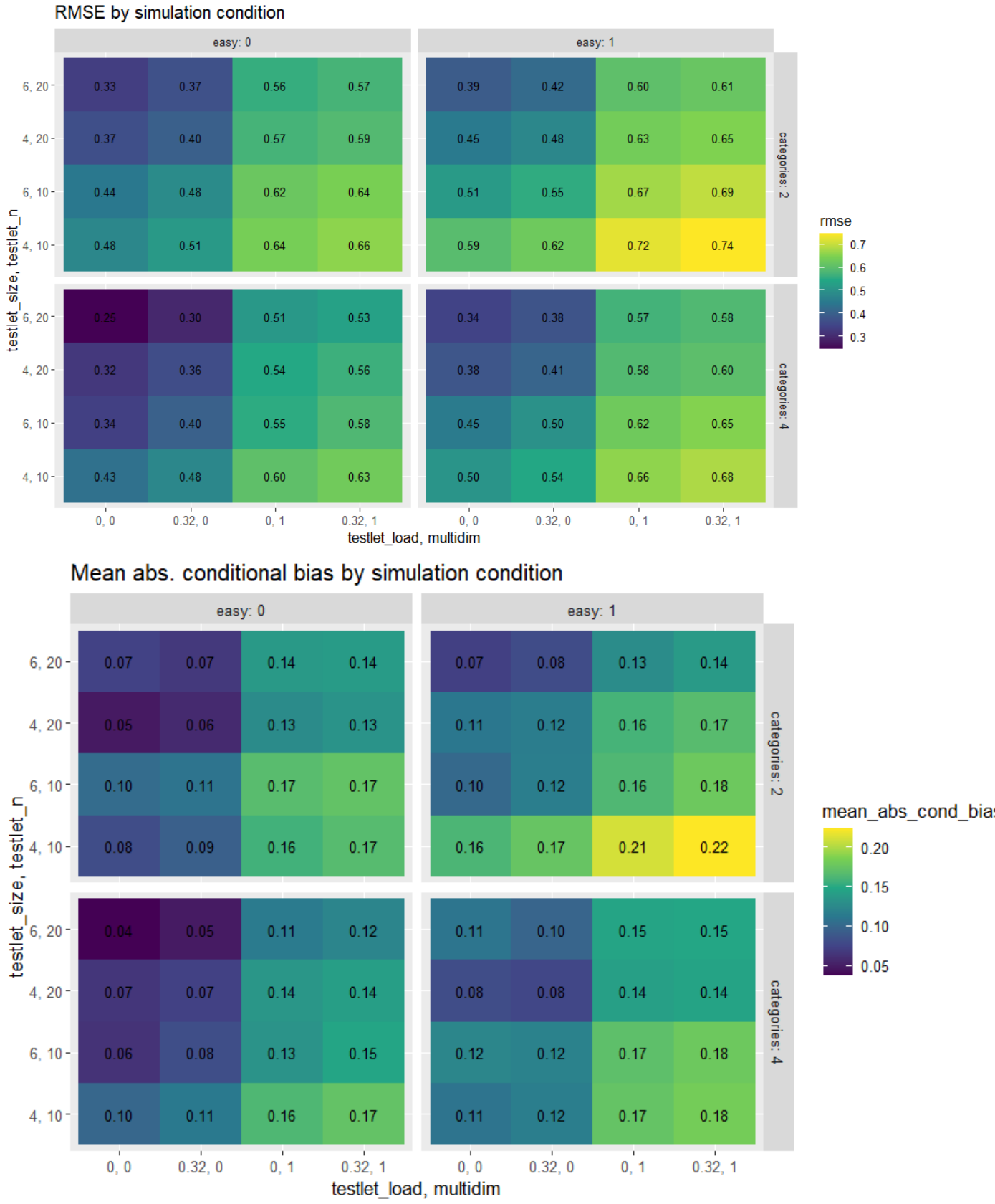
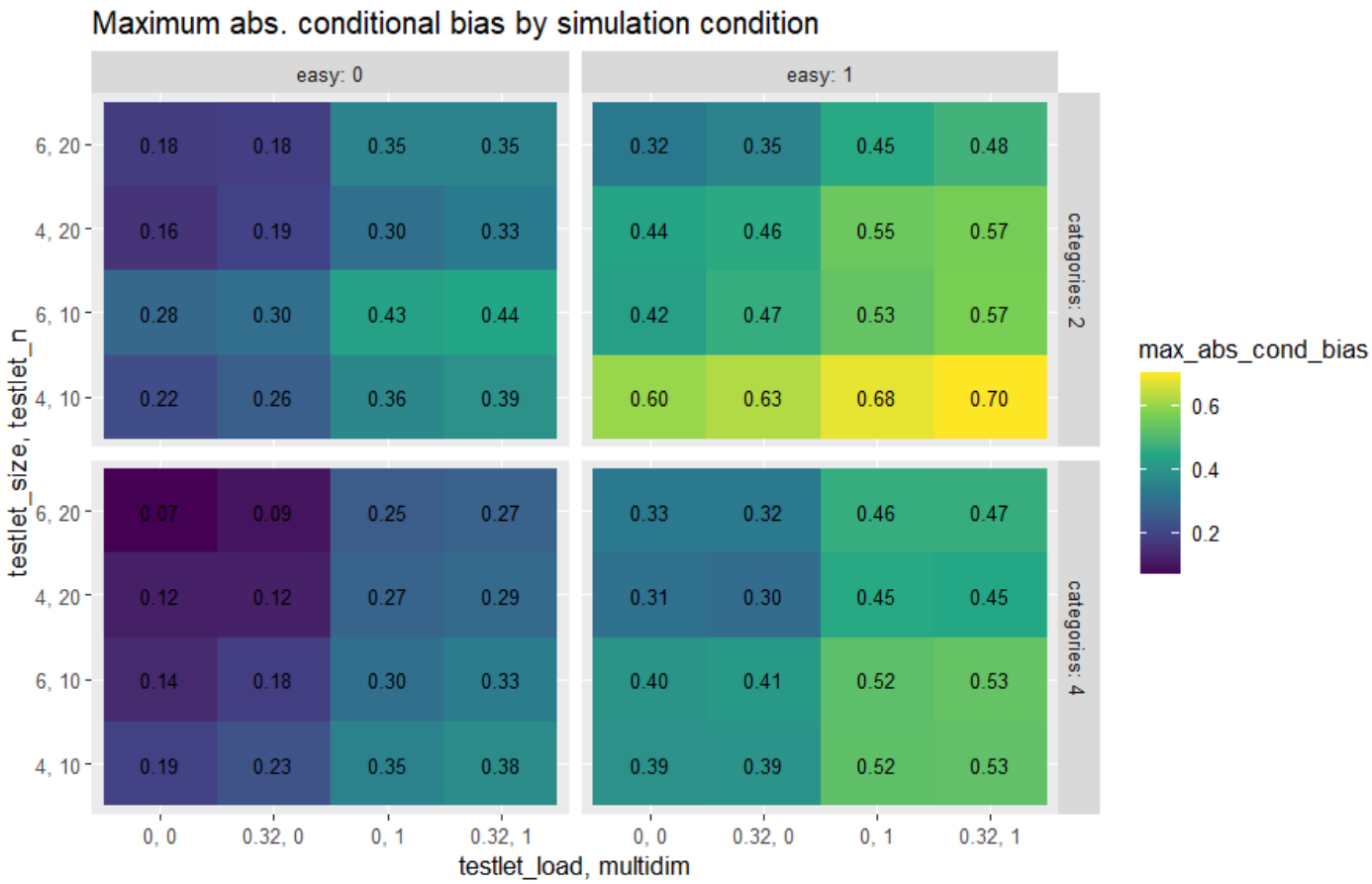
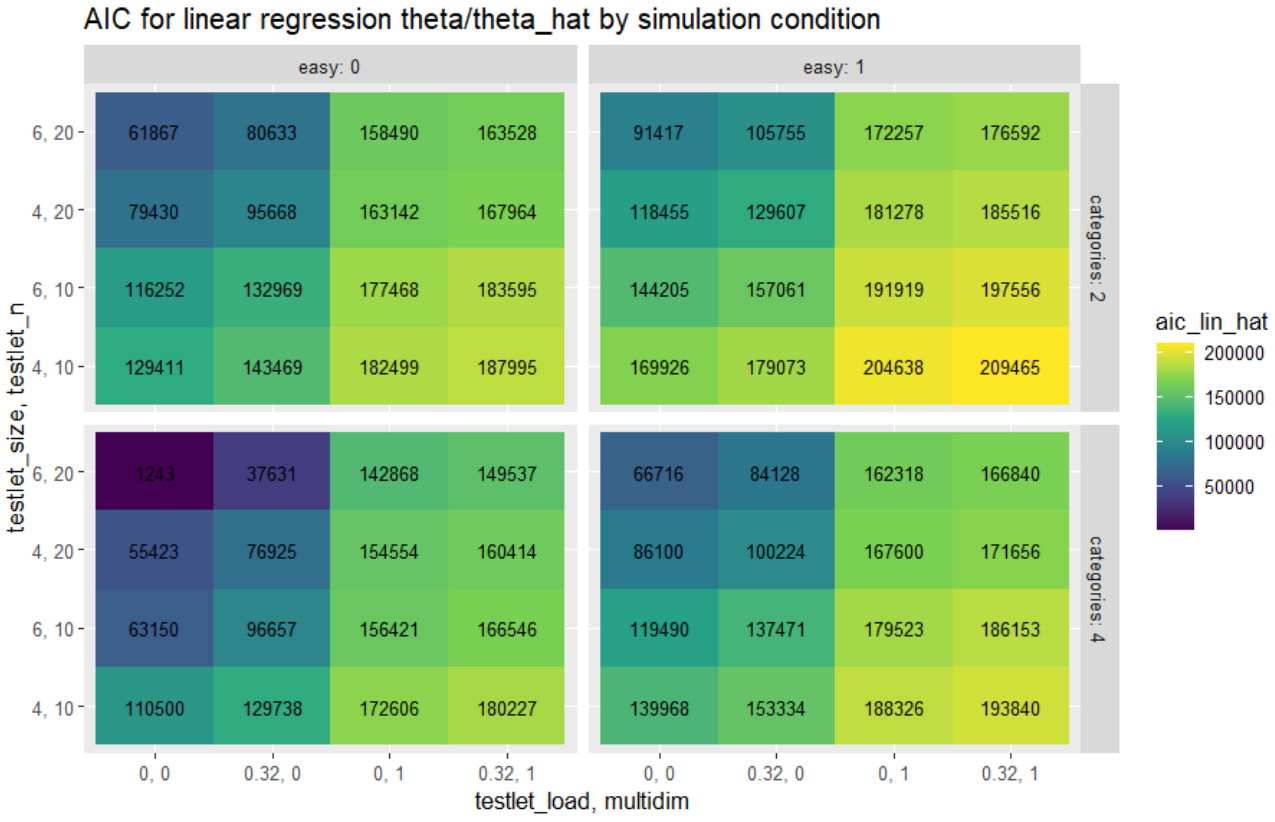

SRMR by Simulation Factors
easy: 0
easy: 1
testlet_load: 0
testlet_load: 0.32
categories: 2
categories: 4
SRMR
0.0250
0.0225
0.0200
0.0175
0.0150
0
1
Multidimensionality (multidim)
Testlet Size
4
6
Testlet N
10
20

Figure S3

Heatmaps of true score recovery indices (in one giant sample) for the 64 simulation conditions




Maximum abs. conditional bias by simulation condition
easy: 0
easy: 1
categories: 2
categories: 4
testlet_size, testlet_n
6, 20
4, 20
6, 10
4, 10
0.18 0.18 0.35 0.35
0.16 0.19 0.30 0.33
0.28 0.30 0.43 0.44
0.22 0.26 0.36 0.39
0.32 0.35 0.45 0.48
0.44 0.46 0.55 0.57
0.42 0.47 0.53 0.57
0.60 0.63 0.68 0.70
0.07 0.09 0.25 0.27
0.12 0.12 0.27 0.29
0.14 0.18 0.30 0.33
0.19 0.23 0.35 0.38
0.33 0.32 0.46 0.47
0.31 0.30 0.45 0.45
0.40 0.41 0.52 0.53
0.39 0.39 0.52 0.53
0, 0
0.32, 0
0, 1
0.32, 1
testlet_load, multidim
max_abs_cond_bias
0.6
0.4
0.2


AIC for linear regression theta/theta_hat by simulation condition
easy: 0
easy: 1
categories: 2
categories: 4
testlet_size, testlet_n
6, 20
4, 20
6, 10
4, 10
61867 80633 158490 163528
79430 95668 163142 167964
116252 132969 177468 183595
129411 143469 182499 187995
91417 105755 172257 176592
118455 129607 181278 185516
144205 157061 191919 197556
169926 179073 204638 209465
1243 37631 142868 149537
55423 76925 154554 160414
63150 96657 156421 166546
110500 129738 172606 180227
66716 84128 162318 166840
86100 100224 167600 171656
119490 137471 179523 186153
139968 153334 188326 193840
0, 0
0.32, 0
0, 1
0.32, 1
testlet_load, multidim
aic_lin_hat
200000
150000
100000
50000

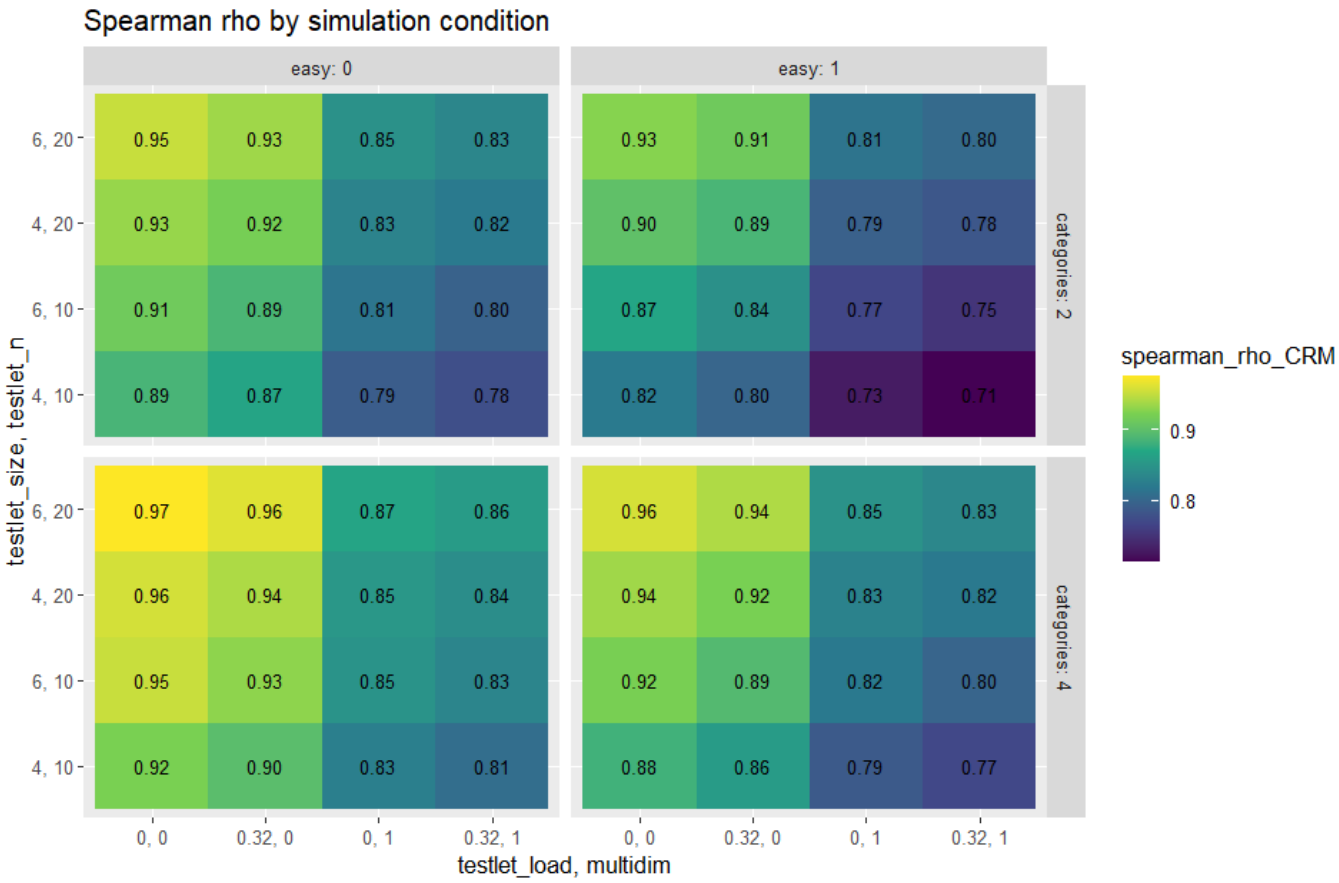
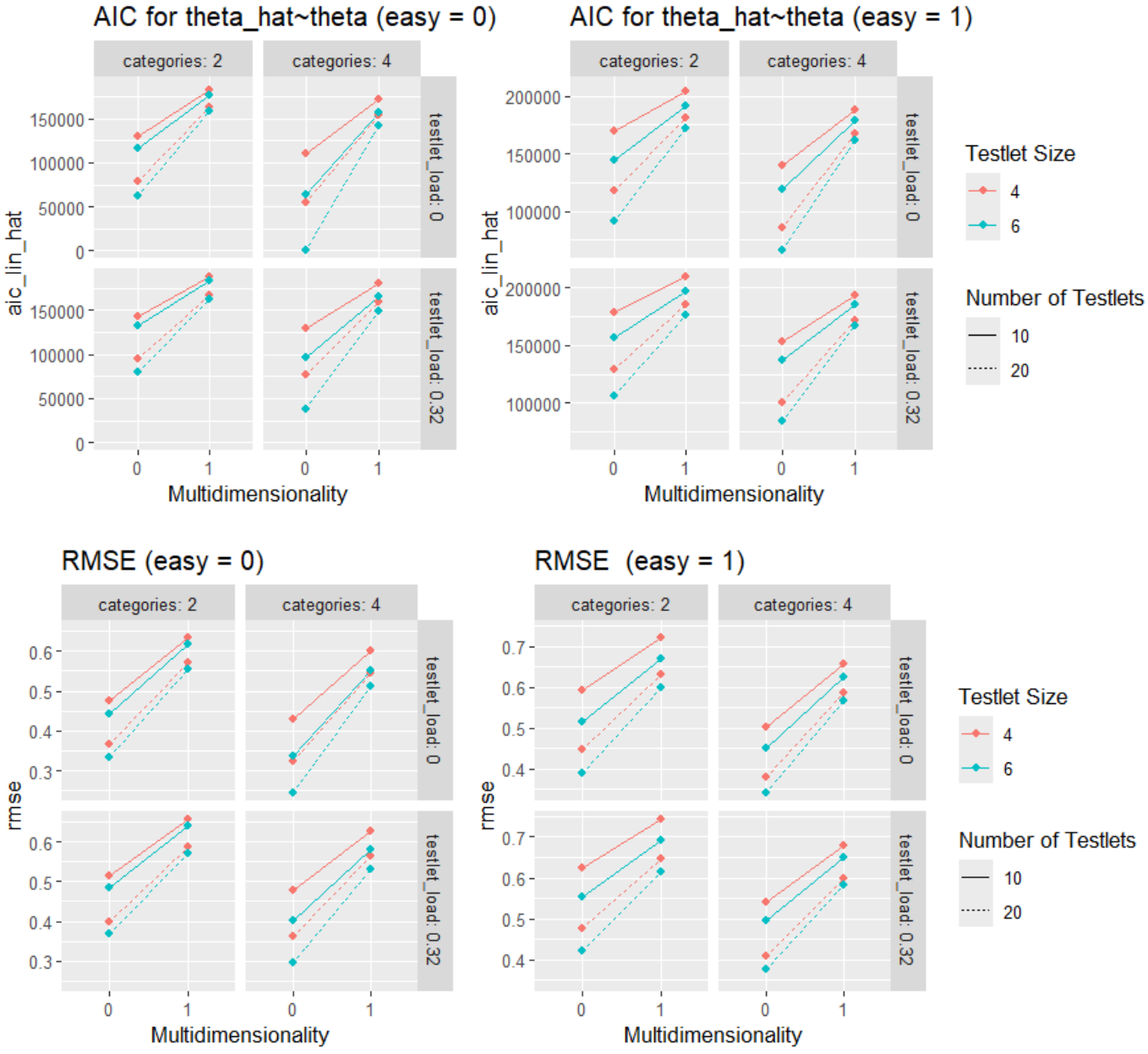

Spearman rho by simulation condition
easy: 0
easy: 1
categories: 2
categories: 4
testlet_size, testlet_n
6, 20
4, 20
6, 10
4, 10
0.95 0.93 0.85 0.83
0.93 0.92 0.83 0.82
0.91 0.89 0.81 0.80
0.89 0.87 0.79 0.78
0.93 0.91 0.81 0.80
0.90 0.89 0.79 0.78
0.87 0.84 0.77 0.75
0.82 0.80 0.73 0.71
0.97 0.96 0.87 0.86
0.96 0.94 0.85 0.84
0.95 0.93 0.85 0.83
0.92 0.90 0.83 0.81
0.96 0.94 0.85 0.83
0.94 0.92 0.83 0.82
0.92 0.89 0.82 0.80
0.88 0.86 0.79 0.77
0, 0
0.32, 0
0, 1
0.32, 1
testlet_load, multidim
spearman_rho_CRM
0.9
0.8

Figure S4

Interaction plots of true score recovery indices (in one giant sample) for the 64 simulation conditions



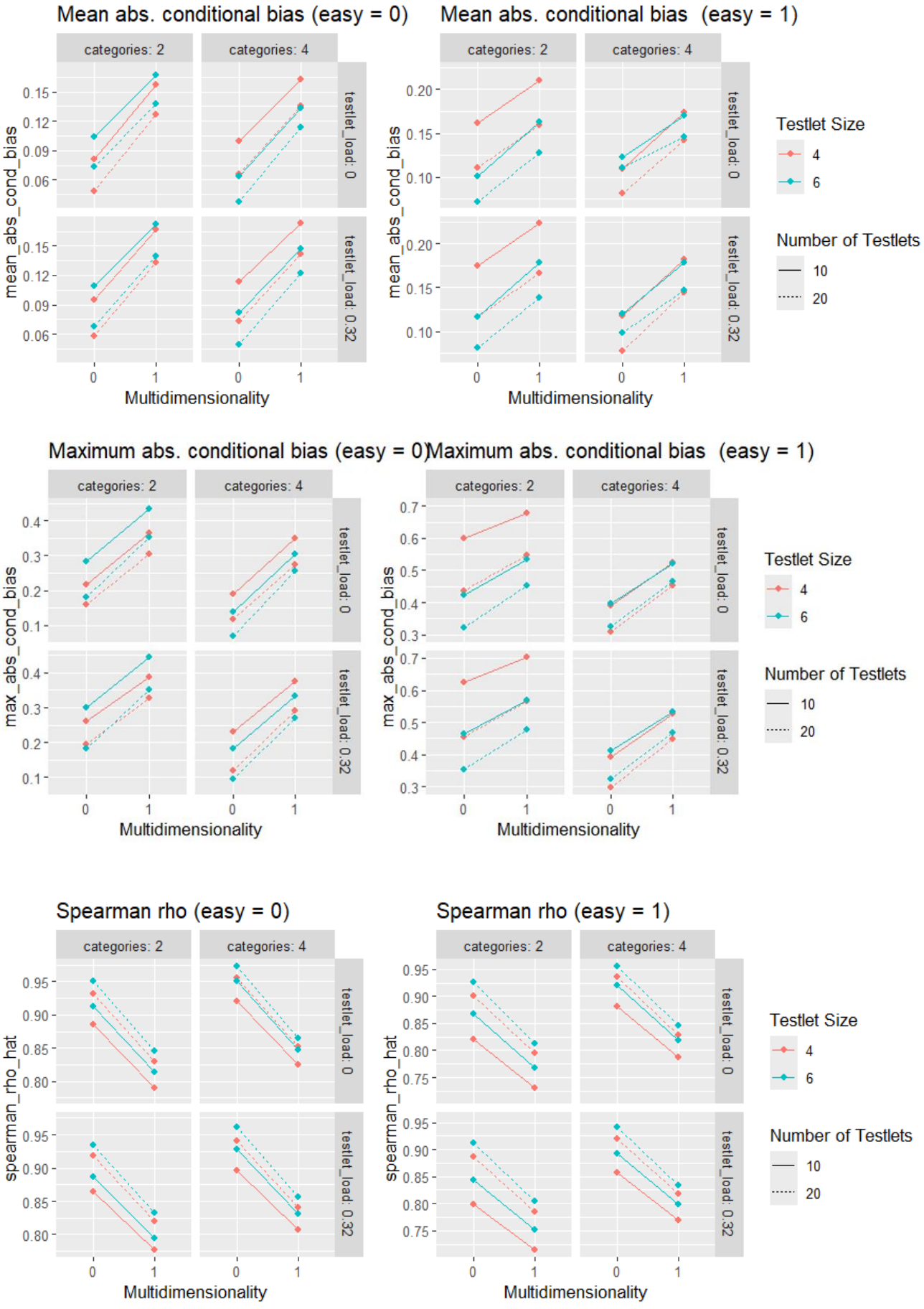

Mean abs. conditional bias (easy = 0)
Mean abs. conditional bias (easy = 1)
Maximum abs. conditional bias (easy = 0)
Maximum abs. conditional bias (easy = 1)
Spearman rho (easy = 0)
Spearman rho (easy = 1)
categories: 2
categories: 4
testlet_load: 0
testlet_load: 0.32
mean_abs_cond_bias
max_abs_cond_bias
spearman_rho_hat
Multidimensionality
Testlet Size
4
6
Number of Testlets
10
20

Figure S5

Average conditional bias with standard errors in one giant sample across for the 64 simulation conditions

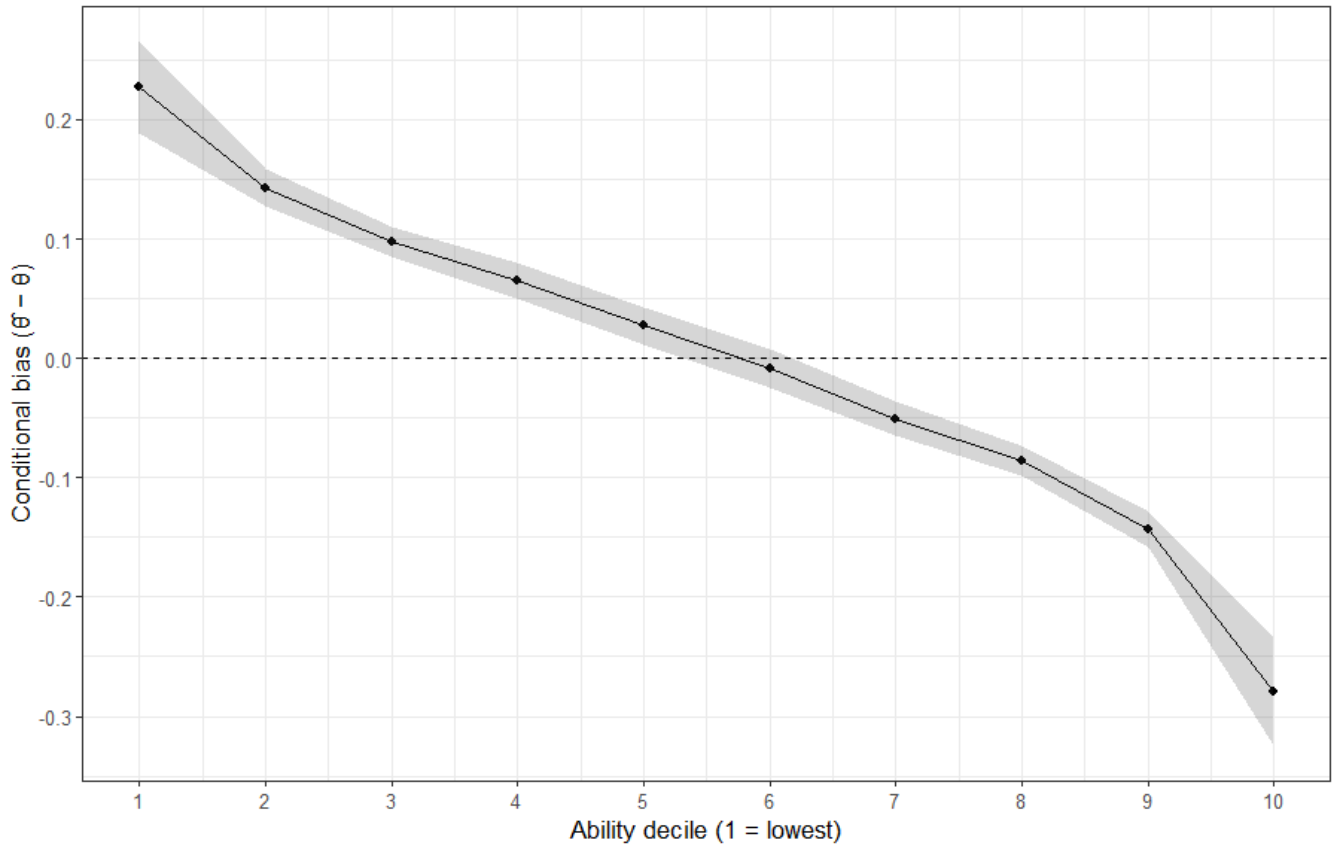
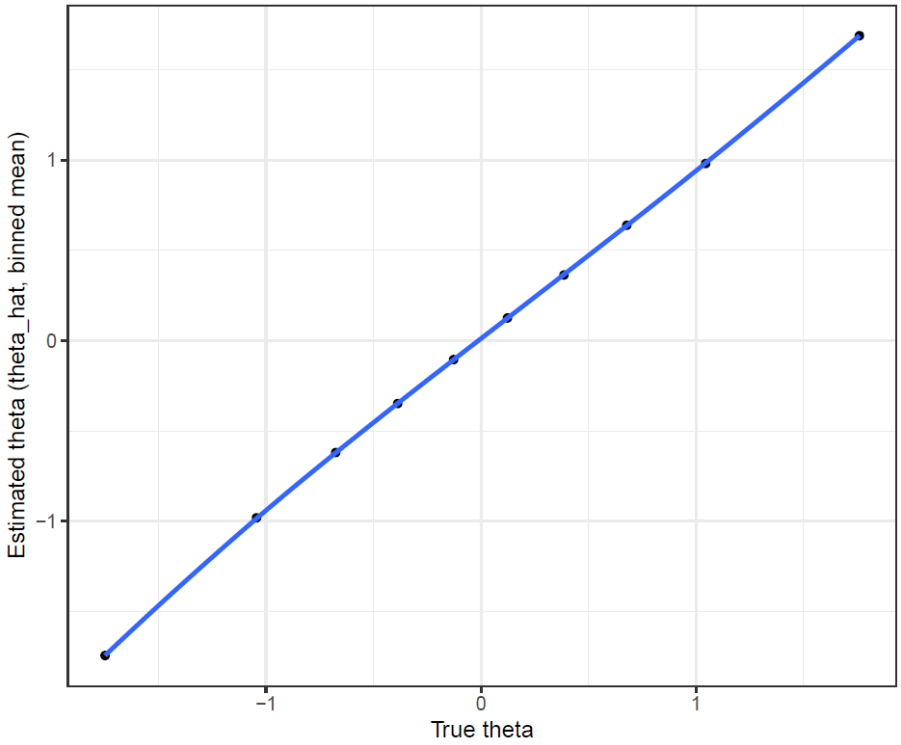


Figure S6

Relationship between theta and theta_hat at the midpoint of each decile of theta in best and worst simulation conditions for true score recovery

a) Best condition for true score recovery (1D, testlet load = 0, 20 testlets, 6 items per testlet, 4 categories, moderate difficulty items)



b) Worst condition for true score recovery (4D, testlet load = 0.32, 10 testlets, 4 items per testlet, 2 categories, overly easy items)

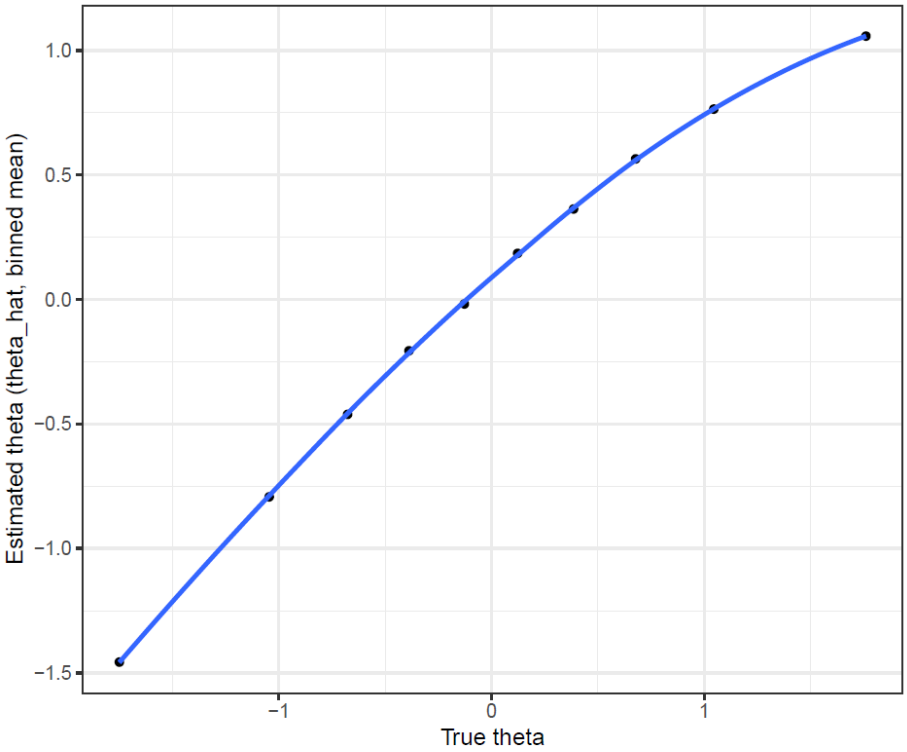
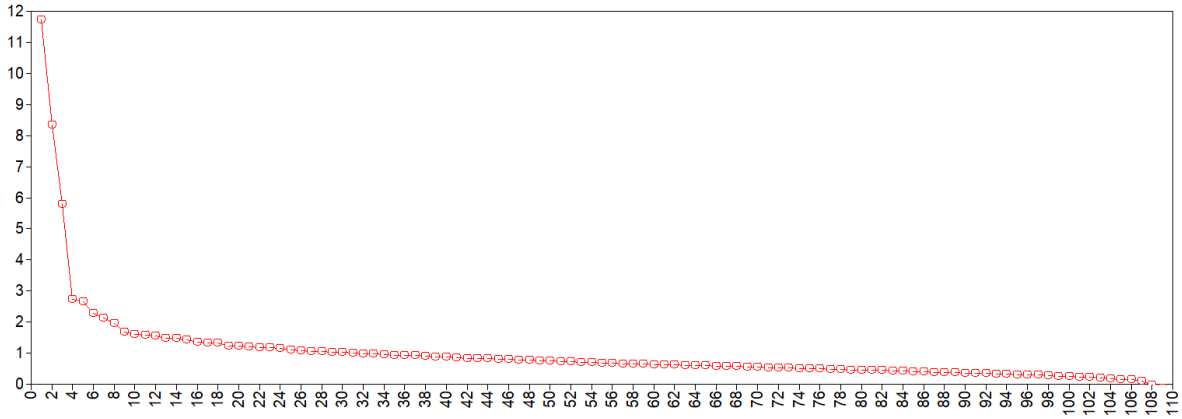


Figure S7

Eigenvalues for expert-scored and raw item responses in the empirical example

A. Eigenvalues for expert-scored item responses



B. Eigenvalues for raw item responses

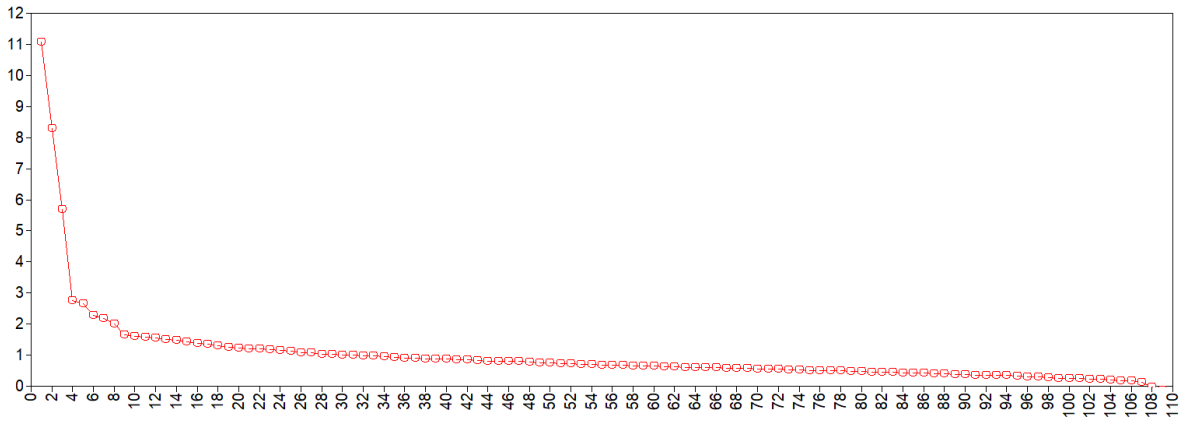


Figure S8

Eigenvalues for scenario scores derived as sums of expert-scored rating items in the empirical example

