Appendix: Statistical tables

Table 1 Simple random numbers

Line/col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
2	22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
3	24130	48390	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
4	42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
5	37570	39975	81837	16656	06121	91782	60468	81305	49684	60072	14110	06927	01263	54613
6	77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
7	99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
8	96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
9	89579	14342	63661	10281	17453	18103	57740	84378	25331	12568	58678	44947	05585	56941
10	85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
11	28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
12	63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12234	90511	33703	90322
13	09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
14	10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
15	07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
16	51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
17	02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
18	01011	54092	33362	94904	31273	04146	18594	29852	71685	85030	51132	01915	92747	64951
19	52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
20	07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
21	48663	91245	85828	14346	09172	30163	90229	04734	59193	22178	30421	61666	99904	32812
22	54164	58492	22421	74103	47070	25306	76468	26384	58151	06646	21524	15227	96909	44592
23	32639	32363	05597	24200	13363	38005	94342	28728	35806	06912	17012	64161	18296	22851
24	29334	27001	87637	87308	58731	00256	45834	15398	46557	41135	10307	07684	36188	18510
25	02488	33062	28834	07351	19731	92420	60952	61280	50001	67658	32586	86679	50720	94953
26	81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
27	29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
28	00742	57392	39064	66432	84673	40027	32832	61362	98947	96067	64760	64584	96096	98253
29	05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
30	91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
31	00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
32	00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
33	69011	65795	95876	55293	18988	27354	26575	08625	40801	59920	29841	80150	12777	48501
34	25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
35	09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
36	91567	42595	27959	30134	04024	86385	29880	99730	55536	84855	29088	09250	79656	73211
37	17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
38	46503	18584	18845	49618	02304	51038	20655	58727	28168	15475	56942	53389	20562	87338
39	92157	89634	94824	78171	84610	82834	09922	25417	44137	48413	25555	21246	35509	20468
40	14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
41	98427	07523	33362	64270	01638	92477	66969	98420	04880	45585	46565	04102	46880	45709
42	34914	63976	88720	82765	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
43	70060	28277	39475	46473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
44	53976	54914	06990	67245	68350	82948	11398	42878	80287	88267	47363	46634	06541	97809
45	76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41151	14222	60697	59583

Table 1 (continued)

Line/col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
46	90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
47	64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
48	08962	00358	31662	25388	61642	34072	81249	35648	56891	69352	48373	45578	78547	81788
49	95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
50	15664	10493	20492	38301	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653
51	16408	81899	04153	53381	79401	21438	83035	92350	36693	31238	59649	91754	72772	02338
52	18629	81953	05520	91962	04739	13092	97662	24822	94730	06496	35090	04822	86774	98289
53	73115	35101	47498	87637	99016	71060	88824	71013	18735	20286	23153	72924	35165	43040
54	57491	16703	23167	49323	45021	33132	12544	41035	80780	45393	44812	12515	98931	91202
55	30405	83946	23792	14422	15059	45799	22716	19792	09983	74353	68668	30429	70735	25499
56	16631	35006	85900	98275	32388	52390	16815	69293	82732	38480	73817	32523	41961	44437
57	96773	20206	42559	78985	05300	22164	24369	54224	35083	19687	11052	91491	60383	19746
58	38935	64202	14349	82674	66523	44133	00697	35552	35970	19124	63318	29686	03387	59846
59	31624	76384	17403	53363	44167	64486	64758	75366	76554	31601	12614	33072	60332	92325
60	78919	19474	23632	27889	47914	02584	37680	20801	72152	39339	34806	08930	85001	87820
61	03931	33309	57047	74211	63445	17361	62825	39908	05607	91284	68833	25570	38818	46920
62	74426	33278	43972	10119	89917	15665	52872	73823	73144	88662	88970	74492	51805	99378
63	09066	00903	20795	95452	92648	45454	69552	88815	16553	51125	79375	97596	16296	66092
64	42238	12426	87025	14267	20979	04508	64535	31355	86064	29472	47689	05974	52468	16834
65	16153	08002	26504	41744	81959	65642	74240	56302	00033	67107	77510	70625	28725	34191
66	21457	40742	29820	96783	29400	21840	15035	34537	33310	06116	95240	15957	16572	06004
67	21581	57802	02050	89728	17937	37621	47075	42080	97403	48626	68995	43805	33386	21597
68	55612	78095	83197	33732	05810	24813	86902	60397	16489	03264	88525	42786	05269	92532
69	44657	66999	99324	51281	84463	60563	79312	93454	68876	25471	93911	25650	12682	73572
70	91340	84979	46949	81973	37949	61023	43997	15263	80644	43942	89203	71795	99533	50501
71	91227	21199	31935	27022	84067	05462	35216	14486	29891	68607	41867	14951	91696	85065
72	50001	38140	66321	19924	72163	09538	12151	06878	91903	18749	34405	56087	82790	70925
73	65390	05224	72958	28609	81406	39147	25549	48542	42627	45233	57202	94617	23772	07896
74	27504	96131	83944	41575	10573	03619	64482	73923	36152	05184	94142	25299	94387	34925
75	37169	94851	39117	89632	00959	16487	65536	49071	39782	17095	02330	74301	00275	48280
76	11508	70225	51111	38351	19444	66499	71945	05422	13442	78675	84031	66938	93654	59894
77	37449	30362	06694	54690	04052	53115	62757	95348	78662	11163	81651	50245	34971	52974
78	46515	70331	85922	38329	57015	15765	97161	17869	45349	61796	66345	81073	49106	79860
79	30986	81223	42416	58353	21532	30502	32305	86482	05174	07901	54339	58861	74818	46942
80	63798	64995	46583	09785	44160	78128	83991	42865	92520	83531	80377	35909	81250	54238
81	82486	84846	99254	67632	43218	50076	21361	64816	51202	88124	41870	52689	51275	83556
82	21885	32906	92431	09060	64297	51674	64126	62570	26123	05155	59194	52799	28225	85762
83	60336	98782	07408	53458	13564	59089	26445	29789	85205	41001	12535	12133	14645	23541
84	43937	46891	24010	25560	86355	33941	25786	54990	71899	15475	95434	98227	21824	19535
85	97656	63175	89303	16275	07100	92063	21942	18611	47348	20203	18534	03862	78095	50136
86	03299	01221	05418	38982	55758	92237	26759	86367	21216	98442	08303	56613	91511	75928
87	79626	06486	03574	17668	07785	76020	79924	25651	83325	88428	85076	72811	22717	50585
88	85636	68335	47539	03129	65651	11977	02510	26113	99447	68645	34327	15152	55230	93448
89	18039	14367	61337	06177	12143	46609	32989	74014	64708	00533	35398	58408	13261	47908
90	08362	15656	60627	36478	65648	16764	53412	09013	07832	41574	17639	82163	60859	75567
91	79556	29068	04142	16268	15387	12856	66227	38358	22478	73373	88732	09443	82558	05250
92	92608	82674	27072	32534	17075	27698	98204	63863	11951	34648	88022	56148	34925	57031
93	23982	25835	40055	67006	12293	02753	14827	23235	35071	99704	37543	11601	35503	85171
94	09915	96306	05908	97901	28395	14186	00821	80703	70426	75647	76310	88717	37890	40129
95	59037	33300	26695	62247	69927	76123	50842	43834	86654	70959	79725	93872	28117	19233
96	42488	78077	69882	61657	34136	79180	97526	43092	04098	73571	80799	76536	71255	64239
97	46764	86273	63003	93017	31204	36692	40202	35275	57306	55543	53203	18098	47625	88684
98	03237	45430	55417	63282	90816	17349	88298	90183	36600	78406	06216	95787	42579	90730
99	86591	81482	52667	61582	14972	90053	89534	76036	49199	43716	97548	04379	46370	28672
100	38534	01715	94964	87288	65680	43772	39560	12918	80537	62738	19636	51132	25739	56947
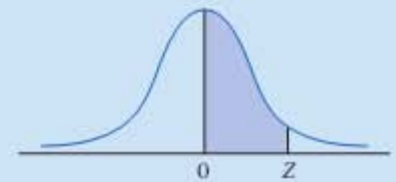
Table 2 Area under the normal curve

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.49865	.49869	.49874	.49878	.49882	.49886	.49889	.49893	.49897	.49900
3.1	.49903	.49906	.49910	.49913	.49916	.49918	.49921	.49924	.49926	.49929
3.2	.49931	.49934	.49936	.49938	.49940	.49942	.49944	.49946	.49948	.49950
3.3	.49952	.49953	.49955	.49957	.49958	.49960	.49961	.49962	.49964	.49965
3.4	.49966	.49968	.49969	.49970	.49971	.49972	.49973	.49974	.49975	.49976
3.5	.49977	.49978	.49978	.49979	.49980	.49981	.49981	.49982	.49983	.49983
3.6	.49984	.49985	.49985	.49986	.49986	.49987	.49987	.49988	.49988	.49989
3.7	.49989	.49990	.49990	.49990	.49991	.49991	.49992	.49992	.49992	.49992
3.8	.49993	.49993	.49993	.49994	.49994	.49994	.49994	.49995	.49995	.49995
3.9	.49995	.49995	.49996	.49996	.49996	.49996	.49996	.49996	.49997	.49997

Each entry represents the area under the standard normal distribution from the mean to Z.
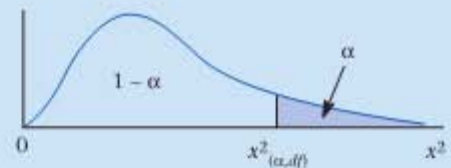
Table 3 Chi-square distribution

Degrees of freedom	Upper tail area (α)											
	.995	.99	.975	.95	.90	.75	.25	.10	.05	.025	.01	.005
1			0.001	0.004	0.016	0.102	1.323	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	0.575	2.773	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	1.213	4.108	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	1.923	5.385	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	2.675	6.626	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	3.455	7.841	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	4.255	9.037	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	5.071	10.219	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	5.899	11.389	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	6.737	12.549	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	7.584	13.701	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	8.438	14.845	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	9.299	15.984	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	10.165	17.117	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	11.037	18.245	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	11.912	19.369	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	12.792	20.489	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	13.675	21.605	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	14.562	22.718	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	15.452	23.828	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	16.344	24.935	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	17.240	26.039	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	18.137	27.141	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	19.037	28.241	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	19.939	29.339	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	20.843	30.435	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	21.749	31.528	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	22.657	32.620	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	23.567	33.711	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	24.478	34.800	40.256	43.773	46.979	50.892	53.672
31	14.458	15.655	17.539	19.281	21.434	25.390	35.887	41.422	44.985	48.232	52.191	55.003
32	15.134	16.362	18.291	20.072	22.271	26.304	36.973	42.585	46.194	49.480	53.486	56.328
33	15.815	17.074	19.047	20.867	23.110	27.219	38.058	43.745	47.400	50.725	54.776	57.648
34	16.501	17.789	19.806	21.664	23.952	28.136	39.141	44.903	48.602	51.966	56.061	58.964
35	17.192	18.509	20.569	22.465	24.797	29.054	40.223	46.059	49.802	53.203	57.342	60.275
36	17.887	19.233	21.336	23.269	25.643	29.973	41.304	47.212	50.998	54.437	58.619	61.581
37	18.586	19.960	22.106	24.075	26.492	30.893	42.383	48.363	52.192	55.668	59.892	62.883
38	19.289	20.691	22.878	24.884	27.343	31.815	43.462	49.513	53.384	56.896	61.162	64.181
39	19.996	21.426	23.654	25.695	28.196	32.737	44.539	50.660	54.572	58.120	62.428	65.476
40	20.707	22.164	24.433	26.509	29.051	33.660	45.616	51.805	55.758	59.342	63.691	66.766
41	21.421	22.906	25.215	27.326	29.907	34.585	46.692	52.949	56.942	60.561	64.950	68.053
42	22.138	23.650	25.999	28.144	30.765	35.510	47.766	54.090	58.124	61.777	66.206	69.336

(continued)

Table 3 (continued)

Degrees of freedom	Upper tail areas (α)											
	.995	.99	.975	.95	.90	.75	.25	.10	.05	.025	.01	.005
43	22.859	24.398	26.785	28.965	31.625	36.436	48.840	55.230	59.304	62.990	67.459	70.616
44	23.584	25.148	27.575	29.787	32.487	37.363	49.913	56.369	60.481	64.201	68.710	71.893
45	24.311	25.901	28.366	30.612	33.350	38.291	50.985	57.505	61.656	65.410	69.957	73.166
46	25.041	26.657	29.160	31.439	34.215	39.220	52.056	58.641	62.830	66.617	71.201	74.437
47	25.775	27.416	29.956	32.268	35.081	40.149	53.127	59.774	64.001	67.821	72.443	75.704
48	26.511	28.177	30.755	33.098	35.949	41.079	54.196	60.907	65.171	69.023	73.683	76.969
49	27.249	28.941	31.555	33.930	36.818	42.010	55.265	62.038	66.339	70.222	74.919	78.231
50	27.991	29.707	32.357	34.764	37.689	42.942	56.334	63.167	67.505	71.420	76.154	79.490
51	28.735	30.475	33.162	35.600	38.560	43.874	57.401	64.295	68.669	72.616	77.386	80.747
52	29.481	31.246	33.968	36.437	39.433	44.808	58.468	65.422	69.832	73.810	78.616	82.001
53	30.230	32.018	34.776	37.276	40.308	45.741	59.534	66.548	70.993	75.002	79.843	83.253
54	30.981	32.793	35.586	38.116	41.183	46.676	60.600	67.673	72.153	76.192	81.069	84.502
55	31.735	33.570	36.398	38.958	42.060	47.610	61.665	68.796	73.311	77.380	82.292	85.749
56	32.490	34.350	37.212	39.801	42.937	48.546	62.729	69.919	74.468	78.567	83.513	86.994
57	33.248	35.131	38.027	40.646	43.816	49.482	63.793	71.040	75.624	79.752	84.733	88.236
58	34.008	35.913	38.844	41.492	44.696	50.419	64.857	72.160	76.778	80.936	85.950	89.477
59	34.770	36.698	39.662	42.339	45.577	51.356	65.919	73.279	77.931	82.117	87.166	90.715
60	35.534	37.485	40.482	43.188	46.459	52.294	66.981	74.397	79.082	83.298	88.379	91.952

For a particular number of degrees of freedom, each entry represents the critical value of χ^2 corresponding to a specified upper tail area, α.

For larger values of degrees of freedom (df), the expression $z = \sqrt{2\chi^2} - \sqrt{2(df) - 1}$ may be used and the resulting upper tail area can be obtained from the table of the standardised normal distribution.
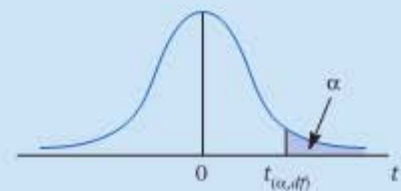
Table 4 *t* distribution

Degrees of freedom	Upper tail area					
	.25	.10	.05	.025	.01	.005
1	1.0000	3.0777	6.3138	12.7062	31.8207	63.6574
2	0.8165	1.8856	2.9200	4.3027	6.9646	9.9248
3	0.7649	1.6377	2.3534	3.1824	4.5407	5.8409
4	0.7407	1.5332	2.1318	2.7764	3.7469	4.6041
5	0.7267	1.4759	2.0150	2.5706	3.3649	4.0322
6	0.7176	1.4398	1.9432	2.4469	3.1427	3.7074
7	0.7111	1.4149	1.8946	2.3646	2.9980	3.4995
8	0.7064	1.3968	1.8595	2.3060	2.8965	3.3554
9	0.7027	1.3830	1.8331	2.2622	2.8214	3.2498
10	0.6998	1.3722	1.8125	2.2281	2.7638	3.1693
11	0.6974	1.3634	1.7959	2.2010	2.7181	3.1058
12	0.6955	1.3562	1.7823	2.1788	2.6810	3.0545
13	0.6938	1.3502	1.7709	2.1604	2.6503	3.0123
14	0.6924	1.3450	1.7613	2,1448	2.6245	2.9768
15	0.6912	1.3406	1.7531	2.1315	2.6025	2.9467
16	0.6901	1.3368	1.7459	2.1199	2.5835	2.9208
17	0.6892	1.3334	1.7396	2.1098	2.5669	2.8982
18	0.6884	1.3304	1.7341	2.1009	2.5524	2.8784
19	0.6876	1.3277	1.7291	2.0930	2.5395	2.8609
20	0.6870	1.3253	1.7247	2.0860	2.5280	2.8453
21	0.6864	1.3232	1.7207	2.0796	2.5177	2.8314
22	0.6858	1.3212	1.7171	2.0739	2.5083	2.8188
23	0.6853	1.3195	1.7139	2.0687	2.4999	2.8073
24	0.6848	1.3178	1.7109	2.0639	2.4922	2.7969
25	0.6844	1.3163	1.7081	2.0595	2.4851	2.7874
26	0.6840	1.3150	1.7056	2.0555	2.4786	2.7787
27	0.6837	1.3137	1.7033	2.0518	2.4727	2.7707
28	0.6834	1.3125	1.7011	2.0484	2.4671	2.7633
29	0.6830	1.3114	1.6991	2.0452	2.4620	2.7564
30	0.6828	1.3104	1.6973	2.0423	2.4573	2.7500
31	0.6825	1.3095	1.6955	2.0395	2.4528	2.7440
32	0.6822	1.3086	1.6939	2.0369	2.4487	2.7385
33	0.6820	1.3077	1.6924	2.0345	2.4448	2.7333
34	0.6818	1.3070	1.6909	2.0322	2.4411	2.7284
35	0.6816	1.3062	1.6896	2.0301	2.4377	2.7238
36	0.6814	1.3055	1.6883	2.0281	2.4345	2.7195
37	0.6812	1.3049	1.6871	2.0262	2.4314	2.7154
38	0.6810	1.3042	1.6860	2.0244	2.4286	2.7116
39	0.6808	1.3036	1.6849	2.0227	2.4258	2.7079
40	0.6807	1.3031	1.6839	2.0211	2.4233	2.7045
41	0.6805	1.3025	1.6829	2.0195	2.4208	2.7012
42	0.6804	1.3020	1.6820	2.0181	2.4185	2.6981
43	0.6802	1.3016	1.681 1	2.0167	2.4163	2.6951

(*continued*)

Table 4 *(continued)*

Degrees of freedom	Upper tail area					
	.25	.10	.05	.025	.01	.005
44	0.6801	1.3011	1.6802	2.0154	2.4141	2.6923
45	0.6800	1.3006	1.6794	2.0141	2.4121	2.6896
46	0.6799	1.3002	1.6787	2.0129	2.4102	2.6870
47	0.6797	1.2998	1.6779	2.0117	2.4083	2.6846
48	0.6796	1.2994	1.6772	2.0106	2.4066	2.6822
49	0.6795	1.2991	1.6766	2.0096	2.4049	2.6800
50	0.6794	1.2987	1.6759	2.0086	2.4033	2.6778
51	0.6793	1.2984	1.6753	2.0076	2.4017	2.6757
52	0.6792	1.2980	1.6747	2.0066	2.4002	2.6737
53	0.6791	1.2977	1.6741	2.0057	2.3988	2.6718
54	0.6791	1.2974	1.6736	2.0049	2.3974	2.6700
55	0.6790	1.2971	1.6730	2.0040	2.3961	2.6682
56	0.6789	1.2969	1.6725	2.0032	2.3948	2.6665
57	0.6788	1.2966	1.6720	2.0025	2.3936	2.6649
58	0.6787	1.2963	1.6716	2.0017	2.3924	2.6633
59	0.6787	1.2961	1.6711	2.0010	2.3912	2.6618
60	0.6786	1.2958	1.6706	2.0003	2.3901	2.6603
61	0.6785	1.2956	1.6702	1.9996	2.3890	2.6589
62	0.6785	1.2954	1.6698	1.9990	2.3880	2.6575
63	0.6784	1.2951	1.6694	1.9983	2.3870	2.6561
64	0.6783	1.2949	1.6690	1.9977	2.3860	2.6549
65	0.6783	1.2947	1.6686	1.9971	2.3851	2.6536
66	0.6782	1.2945	1.6683	1.9966	2.3842	2.6524
67	0.6782	1.2943	1.6679	1.9960	2.3833	2.6512
68	0.6781	1.2941	1.6676	1.9955	2.3824	2.6501
69	0.6781	1.2939	1.6672	1.9949	2.3816	2.6490
70	0.6780	1.2938	1.6669	1.9944	2.3808	2.6479
71	0.6780	1.2936	1.6666	1.9939	2.3800	2.6469
72	0.6779	1.2934	1.6663	1.9935	2.3793	2.6459
73	0.6779	1.2933	1.6660	1.9930	2.3785	2.6449
74	0.6778	1.2931	1.6657	1.9925	2.3778	2.6439
75	0.6778	1.2929	1.6654	1.9921	2.3771	2.6430
76	0.6777	1.2928	1.6652	1.9917	2.3764	2.6421
77	0.6777	1.2926	1.6649	1.9913	2.3758	2.6412
78	0.6776	1.2925	1.6646	1.9908	2.3751	2.6403
79	0.6776	1.2924	1.6644	1.9905	2.3745	2.6395
80	0.6776	1.2922	1.6641	1.9901	2.3739	2.6387
81	0.6775	1.2921	1.6639	1.9897	2.3733	2.6379
82	0.6775	1.2920	1.6636	1.9893	2.3727	2.6371
83	0.6775	1.2918	1.6634	1.9890	2.3721	2.6364
84	0.6774	1.2917	1.6632	1.9886	2.3716	2.6356
85	0.6774	1.2916	1.6630	1.9883	2.3710	2.6349
86	0.6774	1.2915	1.6628	1.9879	2.3705	2.6342
87	0.6773	1.2914	1.6626	1.9876	2.3700	2.6335
88	0.6773	1.2912	1.6624	1.9873	2.3695	2.6329
89	0.6773	1.2911	1.6622	1.9870	2.3690	2.6322
90	0.6772	1.2910	1.6620	1.9867	2.3685	2.6316
91	0.6772	1.2909	1.6618	1.9864	2.3680	2.6309
92	0.6772	1.2908	1.6616	1.9861	2.3676	2.6303
93	0.6771	1.2907	1.6614	1.9858	2.3671	2.6297
94	0.6771	1.2906	1.6612	1.9855	2.3667	2.6291
95	0.6771	1.2905	1.6611	1.9853	2.3662	2.6286

Table 4 (continued)

Degrees of freedom	Upper tail area					
	.25	.10	.05	.025	.01	.005
96	0.6771	1.2904	1.6609	1.9850	2.3658	2.6280
97	0.6770	1.2903	1.6607	1.9847	2.3654	2.6275
98	0.6770	1.2902	1.6606	1.9845	2.3650	2.6269
99	0.6770	1.2902	1.6604	1.9842	2.3646	2.6264
100	0.6770	1.2901	1.6602	1.9840	2.3642	2.6259
110	0.6767	1.2893	1.6588	1.9818	2.3607	2.6213
120	0.6765	1.2886	1.6577	1.9799	2.3578	2.6174
130	0.6764	1.2881	1.6567	1.9784	2.3554	2.6142
140	0.6762	1.2876	1.6558	1.9771	2.3533	2.6114
150	0.6761	1.2872	1.6551	1.9759	2.3515	2.6090
∞	0.6745	1.2816	1.6449	1.9600	2.3263	2.5758

For a particular number of degrees of freedom, each entry represents the critical value of t corresponding to a specified upper tail area a.

$\alpha = .05$
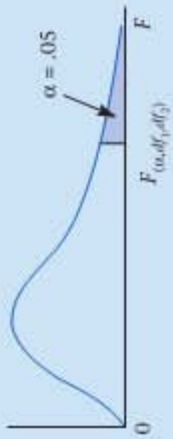
Table 5 F distribution

Numerator df_1

Denominator df_2	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	161.4	199.5	215.7	224.6	230.2	234.0	236.8	238.9	240.5	241.9	243.9	245.9	248.0	249.1	250.1	251.1	252.2	253.3	254.3
2	18.51	19.00	19.16	19.25	19.30	19.33	19.35	19.37	19.38	19.40	19.41	19.43	19.45	19.45	19.46	19.47	19.48	19.49	19.50
3	10.13	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.64	8.62	8.59	8.57	8.55	8.53
4	7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.77	5.75	5.72	5.69	5.66	5.63
5	6.61	5.79	5.41	5.19	5.05	4.95	4.88	4.82	4.77	4.74	4.68	4.62	4.56	4.53	4.50	4.46	4.43	4.40	4.36
6	5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.84	3.81	3.77	3.74	3.70	3.67
7	5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.41	3.38	3.34	3.30	3.27	3.23
8	5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.12	3.08	3.04	3.01	2.97	2.93
9	5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.90	2.86	2.83	2.79	2.75	2.71
10	4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.85	2.77	2.74	2.70	2.66	2.62	2.58	2.54
11	4.84	3.98	3.59	3.36	3.20	3.09	3.01	2.95	2.90	2.85	2.79	2.72	2.65	2.61	2.57	2.53	2.49	2.45	2.40
12	4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.51	2.47	2.43	2.38	2.34	2.30
13	4.67	3.81	3.41	3.18	3.03	2.92	2.83	2.77	2.71	2.67	2.60	2.53	2.46	2.42	2.38	2.34	2.30	2.25	2.21
14	4.60	3.74	3.34	3.11	2.96	2.85	2.76	2.70	2.65	2.60	2.53	2.46	2.39	2.35	2.31	2.27	2.22	2.18	2.13
15	4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.29	2.25	2.20	2.16	2.11	2.07
16	4.49	3.63	3.24	3.01	2.85	2.74	2.66	2.59	2.54	2.49	2.42	2.35	2.28	2.24	2.19	2.15	2.11	2.06	2.01
17	4.45	3.59	3.20	2.96	2.81	2.70	2.61	2.55	2.49	2.45	2.38	2.31	2.23	2.19	2.15	2.10	2.06	2.01	1.96
18	4.41	3.55	3.16	2.93	2.77	2.66	2.58	2.51	2.46	2.41	2.34	2.27	2.19	2.15	2.11	2.06	2.02	1.97	1.92
19	4.38	3.52	3.13	2.90	2.74	2.63	2.54	2.48	2.42	2.38	2.31	2.23	2.16	2.11	2.07	2.03	1.98	1.93	1.88
20	4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.08	2.04	1.99	1.95	1.90	1.84
21	4.32	3.47	3.07	2.84	2.68	2.57	2.49	2.42	2.37	2.32	2.25	2.18	2.10	2.05	2.01	1.96	1.92	1.87	1.81
22	4.30	3.44	3.05	2.82	2.66	2.55	2.46	2.40	2.34	2.30	2.23	2.15	2.07	2.03	1.98	1.94	1.89	1.84	1.78
23	4.28	3.42	3.03	2.80	2.64	2.53	2.44	2.37	2.32	2.27	2.20	2.13	2.05	2.01	1.96	1.91	1.86	1.81	1.76
24	4.26	3.40	3.01	2.78	2.62	2.51	2.42	2.36	2.30	2.25	2.18	2.11	2.03	1.98	1.94	1.89	1.84	1.79	1.73
25	4.24	3.39	2.99	2.76	2.60	2.49	2.40	2.34	2.28	2.24	2.16	2.09	2.01	1.96	1.92	1.87	1.82	1.77	1.71
26	4.23	3.37	2.98	2.74	2.59	2.47	2.39	2.32	2.27	2.22	2.15	2.07	1.99	1.95	1.90	1.85	1.80	1.75	1.69
27	4.21	3.35	2.96	2.73	2.57	2.46	2.37	2.31	2.25	2.20	2.13	2.06	1.97	1.93	1.88	1.84	1.79	1.73	1.67
28	4.20	3.34	2.95	2.71	2.56	2.45	2.36	2.29	2.24	2.19	2.12	2.04	1.96	1.91	1.87	1.82	1.77	1.71	1.65
29	4.18	3.33	2.93	2.70	2.55	2.43	2.35	2.28	2.22	2.18	2.10	2.03	1.94	1.90	1.85	1.81	1.75	1.70	1.64
30	4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.89	1.84	1.79	1.74	1.68	1.62
40	4.08	3.23	2.84	2.61	2.45	2.34	2.25	2.18	2.12	2.08	2.00	1.92	1.84	1.79	1.74	1.69	1.64	1.58	1.51
60	4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.70	1.65	1.59	1.53	1.47	1.39
120	3.92	3.07	2.68	2.45	2.29	2.17	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.61	1.55	1.50	1.43	1.35	1.25
∞	3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.52	1.46	1.39	1.32	1.22	1.00

(continued)

$\alpha = .025$

$F_{(\alpha, df_1, df_2)}$
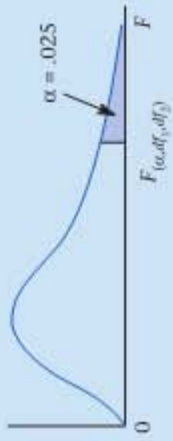
Table 5 *(continued)*

Numerator df_1

Denominator df_2	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	647.8	799.5	864.2	899.6	921.8	937.1	948.2	956.7	963.3	968.6	976.7	984.9	993.1	997.2	1001	1006	1010	1014	1018
2	38.51	39.00	39.17	39.25	39.30	39.33	39.36	39.37	39.39	39.40	39.41	39.43	39.45	39.46	39.46	39.47	39.48	39.49	39.50
3	17.44	16.04	15.44	15.10	14.88	14.73	14.62	14.54	14.47	14.42	14.34	14.25	14.17	14.12	14.08	14.04	13.99	13.95	13.90
4	12.22	10.65	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.75	8.66	8.56	8.51	8.46	8.41	8.36	8.31	8.26
5	10.01	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.52	6.43	6.33	6.28	6.23	6.18	6.12	6.07	6.02
6	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.37	5.27	5.17	5.12	5.07	5.01	4.96	4.90	4.85
7	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.67	4.57	4.47	4.42	4.36	4.31	4.25	4.20	4.14
8	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4.20	4.10	4.00	3.95	3.89	3.84	3.78	3.73	3.67
9	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.87	3.77	3.67	3.61	3.56	3.51	3.45	3.39	3.33
10	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.62	3.52	3.42	3.37	3.31	3.26	3.20	3.14	3.08
11	6.72	5.26	4.63	4.28	4.04	3.88	3.76	3.66	3.59	3.53	3.43	3.33	3.23	3.17	3.12	3.06	3.00	2.94	2.88
12	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.28	3.18	3.07	3.02	2.96	2.91	2.85	2.79	2.72
13	6.41	4.97	4.35	4.00	3.77	3.60	3.48	3.39	3.31	3.25	3.15	3.05	2.95	2.89	2.84	2.78	2.72	2.66	2.60
14	6.30	4.86	4.24	3.89	3.66	3.50	3.38	3.29	3.21	3.15	3.05	2.95	2.84	2.79	2.73	2.67	2.61	2.55	2.49
15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.96	2.86	2.76	2.70	2.64	2.59	2.52	2.46	2.40
16	6.12	4.69	4.08	3.73	3.50	3.34	3.22	3.12	3.05	2.99	2.89	2.79	2.68	2.63	2.57	2.51	2.45	2.38	2.32
17	6.04	4.62	4.01	3.66	3.44	3.28	3.16	3.06	2.98	2.92	2.82	2.72	2.62	2.56	2.50	2.44	2.38	2.32	2.25
18	5.98	4.56	3.95	3.61	3.38	3.22	3.10	3.01	2.93	2.87	2.77	2.67	2.56	2.50	2.44	2.38	2.32	2.26	2.19
19	5.92	4.51	3.90	3.56	3.33	3.17	3.05	2.96	2.88	2.82	2.72	2.62	2.51	2.45	2.39	2.33	2.27	2.20	2.13
20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.41	2.35	2.29	2.22	2.16	2.09
21	5.83	4.42	3.82	3.48	3.25	3.09	2.97	2.87	2.80	2.73	2.64	2.53	2.42	2.37	2.31	2.25	2.18	2.11	2.04
22	5.79	4.38	3.78	3.44	3.22	3.05	2.93	2.84	2.76	2.70	2.60	2.50	2.39	2.33	2.27	2.21	2.14	2.08	2.00
23	5.75	4.35	3.75	3.41	3.18	3.02	2.90	2.81	2.73	2.67	2.57	2.47	2.36	2.30	2.24	2.18	2.11	2.04	1.97
24	5.72	4.32	3.72	3.38	3.15	2.99	2.87	2.78	2.70	2.64	2.54	2.44	2.33	2.27	2.21	2.15	2.08	2.01	1.94
25	5.69	4.29	3.69	3.35	3.13	2.97	2.85	2.75	2.68	2.61	2.51	2.41	2.30	2.24	2.18	2.12	2.05	1.98	1.91
26	5.66	4.27	3.67	3.33	3.10	2.94	2.82	2.73	2.65	2.59	2.49	2.39	2.28	2.22	2.16	2.09	2.03	1.95	1.88
27	5.63	4.24	3.65	3.31	3.08	2.92	2.80	2.71	2.63	2.57	2.47	2.36	2.25	2.19	2.13	2.07	2.00	1.93	1.85
28	5.61	4.22	3.63	3.29	3.06	2.90	2.78	2.69	2.61	2.55	2.45	2.34	2.23	2.17	2.11	2.05	1.98	1.91	1.83
29	5.59	4.20	3.61	3.27	3.04	2.88	2.76	2.67	2.59	2.53	2.43	2.32	2.21	2.15	2.09	2.03	1.96	1.89	1.81
30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.14	2.07	2.01	1.94	1.87	1.79
40	5.42	4.05	3.46	3.13	2.90	2.74	2.62	2.53	2.45	2.39	2.29	2.18	2.07	2.01	1.94	1.88	1.80	1.72	1.64
60	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33	2.27	2.17	2.06	1.94	1.88	1.82	1.74	1.67	1.58	1.48
120	5.15	3.80	3.23	2.89	2.67	2.52	2.39	2.30	2.22	2.16	2.05	1.94	1.82	1.76	1.69	1.61	1.53	1.43	1.31
∞	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11	2.05	1.94	1.83	1.71	1.64	1.57	1.48	1.39	1.27	1.00

(continued)
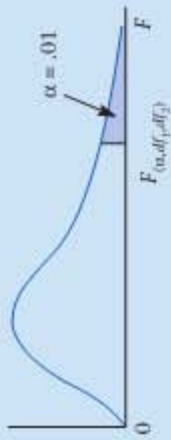
Table 5 (continued)

Numerator df_1

Denominator df_2	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	∞
1	4052	4999.5	5403	5625	5764	5859	5928	5982	6022	6056	6106	6157	6209	6235	6261	6287	6313	6339	6366
2	98.50	99.00	99.17	99.25	99.30	99.33	99.36	99.37	99.39	99.40	99.42	99.43	99.45	99.46	99.47	99.47	99.48	99.49	99.50
3	34.12	30.82	29.46	28.71	28.24	27.91	27.67	27.49	27.35	27.23	27.05	26.87	26.69	26.60	26.50	26.41	26.32	26.22	26.13
4	21.20	18.00	16.69	15.98	15.52	15.21	14.98	14.80	14.66	14.55	14.37	14.20	14.02	13.93	13.84	13.75	13.65	13.56	13.46
5	16.26	13.27	12.06	11.39	10.97	10.67	10.46	10.29	10.16	10.05	9.89	9.72	9.55	9.47	9.38	9.29	9.20	9.11	9.02
6	13.75	10.92	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.31	7.23	7.14	7.06	6.97	6.88
7	12.25	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	6.07	5.99	5.91	5.82	5.74	5.65
8	11.26	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.28	5.20	5.12	5.03	4.95	4.86
9	10.56	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.73	4.65	4.57	4.48	4.40	4.31
10	10.04	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.33	4.25	4.17	4.08	4.00	3.91
11	9.65	7.21	6.22	5.67	5.32	5.07	4.89	4.74	4.63	4.54	4.40	4.25	4.10	4.02	3.94	3.86	3.78	3.69	3.60
12	9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.78	3.70	3.62	3.54	3.45	3.36
13	9.07	6.70	5.74	5.21	4.86	4.62	4.44	4.30	4.19	4.10	3.96	3.82	3.66	3.59	3.51	3.43	3.34	3.25	3.17
14	8.86	6.51	5.56	5.04	4.69	4.46	4.28	4.14	4.03	3.94	3.80	3.66	3.51	3.43	3.35	3.27	3.18	3.09	3.00
15	8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.29	3.21	3.13	3.05	2.96	2.87
16	8.53	6.23	5.29	4.77	4.44	4.20	4.03	3.89	3.78	3.69	3.55	3.41	3.26	3.18	3.10	3.02	2.93	2.84	2.75
17	8.40	6.11	5.18	4.67	4.34	4.10	3.93	3.79	3.68	3.59	3.46	3.31	3.16	3.08	3.00	2.92	2.83	2.75	2.65
18	8.29	6.01	5.09	4.58	4.25	4.01	3.84	3.71	3.60	3.51	3.37	3.23	3.08	3.00	2.92	2.84	2.75	2.66	2.57
19	8.18	5.93	5.01	4.50	4.17	3.94	3.77	3.63	3.52	3.43	3.30	3.15	3.00	2.92	2.84	2.76	2.67	2.58	2.49
20	8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.86	2.78	2.69	2.61	2.52	2.42
21	8.02	5.78	4.87	4.37	4.04	3.81	3.64	3.51	3.40	3.31	3.17	3.03	2.88	2.80	2.72	2.64	2.55	2.46	2.36
22	7.95	5.72	4.82	4.31	3.99	3.76	3.59	3.45	3.35	3.26	3.12	2.98	2.83	2.75	2.67	2.58	2.50	2.40	2.31
23	7.88	5.66	4.76	4.26	3.94	3.71	3.54	3.41	3.30	3.21	3.07	2.93	2.78	2.70	2.62	2.54	2.45	2.35	2.26
24	7.82	5.61	4.72	4.22	3.90	3.67	3.50	3.36	3.26	3.17	3.03	2.89	2.74	2.66	2.58	2.49	2.40	2.31	2.21
25	7.77	5.57	4.68	4.18	3.85	3.63	3.46	3.32	3.22	3.13	2.99	2.85	2.70	2.62	2.54	2.45	2.36	2.27	2.17
26	7.72	5.53	4.64	4.14	3.82	3.59	3.42	3.29	3.18	3.09	2.96	2.81	2.66	2.58	2.50	2.42	2.33	2.23	2.13
27	7.68	5.49	4.60	4.11	3.78	3.56	3.39	3.26	3.15	3.06	2.93	2.78	2.63	2.55	2.47	2.38	2.29	2.20	2.10
28	7.64	5.45	4.57	4.07	3.75	3.53	3.36	3.23	3.12	3.03	2.90	2.75	2.60	2.52	2.44	2.35	2.26	2.17	2.06
29	7.60	5.42	4.54	4.04	3.73	3.50	3.33	3.20	3.09	3.00	2.87	2.73	2.57	2.49	2.41	2.33	2.23	2.14	2.03
30	7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.47	2.39	2.30	2.21	2.11	2.01
40	7.31	5.18	4.31	3.83	3.51	3.29	3.12	2.99	2.89	2.80	2.66	2.52	2.37	2.29	2.20	2.11	2.02	1.92	1.80
60	7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.12	2.03	1.94	1.84	1.73	1.60
120	6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.95	1.86	1.76	1.66	1.53	1.38
∞	6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.79	1.70	1.59	1.47	1.32	1.00

For a particular combination of numerator and denominator degrees of freedom, each entry represents the critical value of F corresponding to a specified upper tail area α.

Glossary

A posteriori contrasts Contrasts made after conducting the analysis. These are generally multiple comparison tests.

A priori contrasts Contrasts determined before conducting the analysis, based on the researcher's theoretical framework.

Access panel A general 'pool' of individuals or households who have agreed to be available for surveys of widely varying types and topics.

Action research A team research process, facilitated by a professional researcher(s), linking with decision-makers and other stakeholders who together wish to improve particular situations.

Agglomerative clustering A hierarchical clustering procedure where each object starts out in a separate cluster. Clusters are formed by grouping objects into bigger and bigger clusters.

Alpha error (α) See Type I error.

Alternative hypothesis A statement that some difference or effect is expected. Accepting the alternative hypothesis will lead to changes in opinions or actions.

Alternative-forms reliability An approach for assessing reliability that requires two equivalent forms of the scale to be constructed and then the same respondents to be measured at two different times.

Analysis of covariance (ANCOVA) An advanced ANOVA procedure in which the effects of one or more metric-scaled extraneous variables are removed from the dependent variable before conducting the ANOVA.

Analysis of variance (ANOVA) A statistical technique for examining the differences among means for two or more populations.

Analysis sample Part of the total sample used to check the results of the discriminant function.

Analytical model An explicit specification of a set of variables and their interrelationships designed to represent some real system or process in whole or in part.

Analytical services Companies that provide guidance in the development of research design.

Area sampling A common form of cluster sampling in which the clusters consist of geographical areas such as counties, housing tracts, blocks or other area descriptions.

Association techniques A type of projective technique in which participants are presented with a stimulus and are asked to respond with the first thing that comes to mind.

Asymmetric lambda A measure of the percentage improvement in predicting the value of the dependent variable given the value of the independent variable in contingency table analysis. Lambda also varies between 0 and 1.

Audit A data collection process derived from physical records or performing inventory analysis. Data are collected personally by the researcher, or by representatives of the researcher, and are based on counts usually of physical objects rather than people.

Average linkage A linkage method based on the average distance between all pairs of objects, where one member of the pair is from each of the clusters.

Back translation A translation technique that translates a questionnaire from the base language by a translator whose native language is the one into which the questionnaire is being translated. This version is then retranslated back into the original language by someone whose native language is the base language. Translation errors can then be identified.

Balanced scale A scale with an equal number of favourable and unfavourable categories.

Bar chart A chart that displays data in bars positioned horizontally or vertically.

Bayesian approach A selection method where the elements are selected sequentially. The Bayesian approach explicitly incorporates prior information about population parameters as well as the costs and probabilities associated with making wrong decisions.

Beta error (β) See Type II error.

Bibliographic databases Databases composed of citations to articles in journals, magazines, newspapers, marketing research studies, technical reports, government documents, and the like. They often provide summaries or abstracts of the material cited.

Binominal test A goodness-of-fit statistical test for dichotomous variables. It tests the goodness of fit of the observed number of observations in each category to the number expected under a specified binominal distribution.

Bivariate regression A procedure for deriving a mathematical relationship, in the form of an equation, between a single metric-dependent variable and a single metric-independent variable.

Branching question A question used to guide an interviewer (or respondent) through a survey by directing the interviewer (or respondent) to different spots on the questionnaire depending on the answers given.

Branded market research products Specialised data collection and analysis procedures developed to address specific types of marketing research problems.

Broad statement of the problem The initial statement of the marketing research problem that provides an appropriate perspective on the problem.

Call disposition Call disposition records the outcome of an interview call.

Carryover effects Where the evaluation of a particular scaled item significantly affects the respondent's judgement of subsequent scaled items.

Cartoon tests Cartoon characters are shown in a specific situation related to the problem. Participants are asked to indicate the dialogue that one cartoon character might make in response to the comment(s) of another character.

Case study A detailed study based upon the observation of the intrinsic details of individuals, groups of individuals and organisations.

Casewise deletion A method for handling missing responses in which cases or respondents with any missing responses are discarded from the analysis.

Category equivalence A construct equivalence issue that deals specifically with whether the categories in which brands, products and behaviour are grouped are the same in different countries.

Causal research A type of conclusive research where the major objective is to obtain evidence regarding cause-and-effect (causal) relationships.

Causality Causality applies when the occurrence of X increases the probability of the occurrence of Y.

Census A complete enumeration of the elements of a population or study objects.

Centroid method A variance method of hierarchical clustering in which the distance between two clusters is the distance between their centroids (means for all the variables).

Characteristic profile An aid to interpreting discriminant analysis results by describing each group in terms of the group means for the predictor variables.

Chi-square distribution A skewed distribution whose shape depends solely on the number of degrees of freedom. As the number of degrees of freedom increases, the chi-square distribution becomes more symmetrical.

Chi-square statistic The statistic used to test the statistical significance of the observed association in a cross-tabulation. It assists us in determining whether a systematic association exists between the two variables.

Classification information Socio-economic and demographic characteristics used to classify respondents.

Cluster sampling A two-step probability sampling technique where the target population is first divided into mutually exclusive and collectively exhaustive subpopulations called clusters, and then a random sample of clusters is selected based on a probability sampling technique such as SRS. For each selected cluster, either all the elements are included in the sample, or a sample of elements is drawn probabilistically.

Codebook A book containing coding instructions and the necessary information about the questions and potential answers in a survey.

Coding Assigning a code to represent a specific response to a specific question along with the data record and column position that the code will occupy.

Coding and data entry services Companies whose primary service offering is their expertise in converting completed surveys or interviews into a usable database for conducting statistical analysis.

Coding data Breaking down qualitative data into discrete chunks and attaching a reference to those chunks of data.

Coding data in grounded theory A form of shorthand that distills events and meanings without losing their essential properties.

Coefficient alpha A measure of internal consistency reliability that is the average of all possible split-half coefficients resulting from different splittings of the scale items.

Coefficient of variation A useful expression in sampling theory for the standard deviation as a percentage of the mean.

Cohort analysis A multiple cross-sectional design consisting of surveys conducted at appropriate time intervals. The cohort refers to the group of respondents who experience the same event within the same interval.

Common factor analysis An approach to factor analysis that estimates the factors based only on the common variance. Also called principal axis factoring.

Comparative scales One of two types of scaling technique in which there is direct comparison of stimulus objects with one another.

Complete linkage A linkage method that is based on maximum distance of the farthest neighbour approach.

Completion rate The percentage of qualified respondents who complete the interview. It enables researchers to take into account anticipated refusals by people who qualify.

Completion technique A projective technique that requires particpants to complete an incomplete stimulus situation.

Conceptual equivalence A construct equivalence issue that deals with whether the interpretation of brands, products, consumer behaviour and the marketing effort are the same in different countries.

Conclusive research A research design characterised by the measurement of clearly defined marketing phenomena.

Concomitant variation A condition for inferring causality that requires that the extent to which a cause, X, and an effect, Y, occur together or vary together is predicted by the hypothesis under consideration.

Concurrent validity A type of validity that is assessed when the data on the scale being evaluated and on the criterion variables are collected at the same time.

Confidence intervals The range into which the true population parameter will fall, assuming a given level of confidence.

Confounding variables Variables used to illustrate that extraneous variables can confound the results by influencing the dependent variable; synonymous with extraneous variables.

Conjoint analysis A technique that attempts to determine the relative importance consumers attach to salient attributes and the utilities they attach to the levels of attributes.

Conjoint analysis model The mathematical model expressing the fundamental relationship between attributes and utility in conjoint analysis.

Consistency checks A part of the data cleaning process that identifies data that are out of range, logically inconsistent or have extreme values. Data with values not defined by the coding scheme are inadmissible.

Constant sum scaling A comparative scaling technique in which respondents are required to allocate a constant sum of units such as points, euros, chits, stickers or chips among a set of stimulus objects with respect to some criterion.

Construct equivalence A type of equivalence that deals with the question of whether the marketing constructs have the same meaning and significance in different countries.

Construct validity A type of validity that addresses the question of what construct or characteristic the scale is measuring. An attempt is made to answer theoretical questions of why a scale works and what deductions can be made concerning the theory underlying the scale.

Construction technique A projective technique in which participants are required to construct a response in the form of a story, dialogue or description.

Content analysis The objective, systematic and quantitative description of the manifest content of a communication.

Content validity A type of validity, sometimes called face validity, that consists of a subjective but systematic evaluation of the representativeness of the content of a scale for the measuring task at hand.

Contingency coefficient A measure of the strength of association in a table of any size.

Contingency table A cross-tabulation table. It contains a cell for every combination of categories of the two variables.

Continuous rating scale A measurement scale that has respondents rate the objects by placing a mark at the appropriate position on a line that runs from one extreme of the criterion variable to the other. The form may vary considerably. Also called graphic rating scale.

Contrasts In ANOVA, a method of examining differences among two or more means of the treatment groups.

Contrived observation Observing behaviour in an artificial environment.

Controlled test market A test-marketing programme conducted by an outside research company in field experimentation. The research company guarantees distribution of the product in retail outlets that represent a predetermined percentage of the market.

Convenience sampling A non-probability sampling technique that attempts to obtain a sample of convenient elements. The selection of sampling units is left primarily to the interviewer.

Convergent validity A measure of construct validity that measures the extent to which the scale correlates positively with other measures of the same construct.

Cookie technology A group of letters and numbers stored in a web surfer's browser that identify the browser's computer.

Correspondence analysis An MDS technique for scaling qualitative data that scales the rows and columns of the input contingency table in corresponding units so that each can be displayed in the same low-dimensional space.

Covariance A systematic relationship between two variables in which a change in one implies a corresponding change in the other (COV_{xy}).

Covariate A metric-independent variable used in ANCOVA.

Cramer's V A measure of the strength of association used in tables larger than 2×2.

Criterion validity A type of validity that examines whether the measurement scale performs as expected in relation to other selected variables as meaningful criteria.

Critical request The target behaviour being researched.

Cross-cultural analysis A type of across-countries analysis in which the data could be aggregated for each country and these aggregate statistics analysed.

Cross-sectional design A type of research design involving the collection of information from any given sample of population elements only once.

Cross-tabulation A statistical technique that describes two or more variables simultaneously and results in tables that reflect the joint distribution of two or more variables that have a limited number of categories or distinct values.

Cross-validation A test of validity that examines whether a model holds on comparable data not used in the original estimation.

Customer database A database that details characteristics of customers and prospects that can include names and addresses, geographic, demographic and buying behaviour data.

Customised services Companies that tailor research procedures to best meet the needs of each client.

Data analysis services Firms whose primary service is to conduct statistical analysis of quantative data.

Data assembly The gathering of data from a variety of disparate sources.

Data cleaning Thorough and extensive checks for consistency and treatment of missing responses.

Data display Involves summarising and presenting the structure that is seen in collected qualitative data.

Data mining The process of discovering meaningful correlations, patterns and trends by sifting through large amounts of data stored in repositories, using pattern recognition as well as statistical and mathematical techniques.

Data reduction The organising and structuring of qualitative data.

Data verification Involves seeking alternative explanations of the interpretations of qualitative data, through other data sources.

Datawarehouse This may be seen as a 'super-database', but more specifically it may be defined as a process of gathering disparate data from database and survey sources, and converting the data into a consistent format that can aid business decision making.

Debriefing After a disguised experiment, informing test subjects what the experiment was about and how the experimental manipulations were performed.

Decision support system (DSS) An information system that enables decision-makers to interact directly with both databases and analysis models. The important components of a DSS include hardware and a communication network, database, model base, software base and the DSS user (decision-maker).

Decomposition of the total variation In one-way ANOVA, separation of the variation observed in the dependent variable into the variation due to the independent variables plus the variation due to error.

Deduction A form of reasoning in which a conclusion is validly inferred from some premises, and must be true if those premises are true.

Demand artefacts Responses given because the respondents attempt to guess the purpose of the experiment and respond accordingly.

Dependence techniques Multivariate techniques appropriate when one or more of the variables can be identified as dependent variables and the remaining ones as independent variables.

Dependent variables Variables that measure the effect of the independent variables on the test units.

Depth interview An unstructured, direct, personal interview in which a single respondent is probed by an experienced interviewer to uncover underlying motivations, beliefs, attitudes and feelings on a topic.

Derived approaches In MDS, attribute-based approaches to collecting perception data requiring respondents to rate the stimuli on the identified attributes using semantic differential or Likert scales.

Descriptive research A type of conclusive research that has as its major objective the description of something, usually market characteristics or functions.

Design control A method of controlling extraneous variables that involves using specific experimental designs.

Determinism A doctrine espousing that everything that happens is determined by a necessary chain of causation.

Diary media panels A data gathering technique composed of samples of respondents whose television viewing behaviour is automatically recorded by electronic devices, supplementing the purchase information recorded in a diary.

Diary purchase panels A data gathering technique in which respondents record their purchases in a diary.

Dichotomous question A structured question with only two response alternatives, such as yes and no.

Direct approach A type of qualitative research in which the purposes of the project are disclosed to the participant or are obvious given the nature of the interview.

Direct method An approach to discriminant analysis that involves estimating the discriminant function so that all the predictors are included simultaneously.

Directory databases Databases that provide information on individuals, organisations and services.

Discriminant analysis A technique for analysing marketing research data when the criterion or dependent variable is categorical and the predictor or independent variables are interval in nature.

Discriminant analysis model The statistical model on which discriminant analysis is based.

Discriminant function The linear combination of independent variables developed by discriminant analysis that will best discriminate between the categories of the dependent variable.

Discriminant validity A type of construct validity that assesses the extent to which a measure does not correlate with other constructs from which it is supposed to differ.

Disordinal interaction The change in the rank order of the effects of one factor across the levels of another.

Divisive clustering A hierarchical clustering procedure where all objects start out in one giant cluster. Clusters are formed by dividing this cluster into smaller and smaller clusters.

Double-barrelled question A single question that attempts to cover two issues. Such questions can be confusing to respondents and result in ambiguous responses.

Double cross-validation A special form of validation in which the sample is split into halves. One half serves as the estimation sample and the other as a validation sample. The roles of the estimation and validation halves are then reversed and the cross-validation process is repeated.

Double sampling A sampling technique in which certain population elements are sampled twice.

Dummy variables A respecification procedure using variables that take on only two values, usually 0 or 1.

Editing A review of the questionnaires with the objective of increasing accuracy and precision.

Elbow criterion A plot of stress versus dimensionality used in MDS. The point at which an elbow or a sharp bend occurs indicates an appropriate dimensionality.

Electronic observation An observational research strategy in which electronic devices, rather than human observers, record the phenomenon being observed.

Element An object that possesses the information sought by the researcher and about which inferences are to be made.

Empiricism A theory of knowledge. A broad category of the philosophy of science that locates the source of all knowledge in experience.

Estimated or predicted value The value $Y_i = a + b_x$, where a and b are, respectively, estimators of β_0 and β_1, the corresponding population parameters.

Ethnography A research approach based upon the observation of the customs, habits and differences between people in everyday situations.

Euclidean distance The square root of the sum of the squared differences in values for each variable.

Evolving research design A research design where particular research techniques are chosen as the researcher develops an understanding of the issues and respondents.

Experiment The process of manipulating one or more independent variables and measuring their effect on one or more dependent variables, while controlling for the extraneous variables.

Experimental design The set of experimental procedures specifying (1) the test units and sampling procedures, (2) the independent variables, (3) the dependent variables, and (4) how to control the extraneous variables.

Experimental group An initial focus group run to test the setting of the interview, the opening question, the topic guide and the mix of participants that make up the group.

Exploratory research A research design characterised by a flexible and evolving approach to understand marketing phenomena that are inherently difficult to measure.

Expressive technique A projective technique in which participants are presented with a verbal or visual situation and are asked to relate the feelings and attitudes of other people to the situation.

External analysis of preferences A method of configuring a spatial map such that the ideal points or vectors based on preference data are fitted in a spatial map derived from the perception data.

External data Data that originate outside the organisation.

External suppliers Outside marketing research companies hired to supply marketing research services.

External validity A determination of whether the cause-and-effect relationships found in the experiment can be generalised.

Extraneous variables Variables, other than dependent and independent variables, which may influence the results of an experiment.

Eye tracking equipment Instruments that record the gaze movements of the eye.

F distribution A frequency distribution that depends upon two sets of degrees of freedom: the degrees of freedom in the numerator and the degrees of freedom in the denominator.

F statistic The ratio of two sample variances.

F test A statistical test of the equality of the variances of two populations.

Factor An underlying dimension that explains the correlations among a set of variables.

Factor analysis A class of procedures primarily used for data reduction and summarisation.

Factor scores Composite scores estimated for each respondent on the derived factors.

Factorial design A statistical experimental design used to measure the effects of two or more independent variables at various levels and to allow for interactions between variables.

Factors Categorical independent variables in ANOVA. The independent variables must all be categorical (non-metric) to use ANOVA.

Field environment An experimental location set in actual market conditions.

Field force Both the actual interviewers and the supervisors involved in data collection.

Field notes A log or diary of observations, events and reflections made by a researcher as a study is planned, implemented and analysed.

Field services Companies whose primary service is offering their expertise in collecting data for research projects.

Filter question An initial question in a questionnaire that screens potential respondents to ensure they meet the requirements of the sample.

Fixed-response alternative questions Questions that require respondents to choose from a set of predetermined answers.

Focus group A discussion conducted by a trained moderator among a small group of participants in an unstructured and natural manner.

Forced rating scale A rating scale that forces respondents to express an opinion because a 'no opinion' or 'no knowledge' option is not provided.

Frequency distribution A mathematical distribution whose objective is to obtain a count of the number of responses associated with different values of one variable and to express these counts in percentage terms.

Friendship pair A technique used to interview children as two friends or classmates together.

Frugging The use of marketing research to deliberately disguise fundraising activities.

Full-service suppliers Companies that offer a full range of marketing research activities.

Full-text databases Databases that contain the complete text of secondary source documents comprising the database.

Functional equivalence A construct equivalence issue that deals specifically with whether a given concept or behaviour serves the same role or function in different countries.

Funnel approach A strategy for ordering questions in a questionnaire in which the sequence starts with the general questions, which are followed by progressively specific questions, to prevent specific questions from biasing general questions.

Galvanic skin response Changes in the electrical resistance of the skin that relate to a respondent's affective state.

Gamma A test statistic that measures the association between two ordinal-level variables. It does not make an adjustment for ties.

Generalisability The degree to which a study based on a sample applies to the population as a whole.

Geodemographic classification This groups consumers together based on the types of neighbourhood in which they live. If a set of neighbourhoods are similar across a wide range of demographic measures, they may also offer similar potential across most products, brands, services and media.

Geodemographic information system (GIS) At a base level, a GIS matches geographic information with demographic information. This match allows subsequent data analyses to be presented on maps.

Graphic rating scale See Continuous rating scale.

Graphical models Analytical models that provide a visual picture of the relationships between variables.

Grounded theory Theory derived from data, systematically gathered and analysed. Or, a qualitative approach to generating theory through the systematic and simultaneous process of data collection and analysis.

Hierarchical clustering A clustering procedure characterised by the development of a hierarchy or treelike structure.

Histogram A vertical bar chart in which the height of the bar represents the relative or cumulative frequency of occurrence.

History Specific events that are external to the experiment but that occur at the same time as the experiment.

Hit ratio The percentage of cases correctly classified by discriminant analysis.

Hybrid conjoint analysis A form of conjoint analysis that can simplify the data collection task and estimate selected interactions as well as all main effects.

Hypertext markup language (HTML) The language of the Web.

Hypothesis An unproven statement or proposition about a factor or phenomenon that is of interest to a researcher.

Identification information A type of information obtained in a questionnaire that includes name, address and phone number.

Implicit alternative An alternative that is not explicitly expressed.

Implicit assumptions An assumption that is not explicitly stated in a question.

Imputation A method to adjust for non-response by assigning the characteristic of interest to the non-respondents based on the similarity of the variables available for both non-respondents and respondents.

Incidence rate The rate of occurrence of persons eligible to participate in the study expressed as a percentage.

Independent samples The samples are independent if they are drawn randomly from different populations.

Independent variables Variables that are manipulated by the researcher and whose effects are measured and compared.

In-depth interview An unstructured, direct, personal interview in which a single participant is probed by an experienced interviewer to uncover underlying motivations, beliefs, attitudes and feelings on a topic.

Indirect approach A type of qualitative research in which the purposes of the project are disguised from the participants.

Induction A form of reasoning that usually involves the inference that an instance or repeated combination of events may be universally generalised.

Instrumentation An extraneous variable involving changes in the measuring instrument, in the observers, or in the scores themselves.

Integrating analysis Creating an order and connectivity that is seen to be emerging from memos.

Interaction When assessing the relationship between two variables, an interaction occurs if the effect of X_1 depends on the level of X_2, and vice versa.

Interactive testing effect An effect in which a prior measurement affects the test unit's response to the independent variable.

Interdependence technique A multivariate statistical technique in which the whole set of inter-dependent relationships is examined.

Interdependence techniques Multivariate statistical techniques that attempt to group data based on underlying similarity and thus allow for interpretation of the data structures. No distinction is made as to which variables are dependent and which are independent.

Internal analysis of preferences A method of configuring a spatial map such that the spatial map represents both

brands or stimuli and respondent points or vectors and is derived solely from the preference data.

Internal consistency reliability An approach for assessing the internal consistency of a set of items, where several items are summated in order to form a total score for the scale.

Internal data Data available within the organisation for whom the research is being conducted.

Internal supplier Marketing research department located within a firm.

Internal validity A measure of accuracy of an experiment. It measures whether the manipulation of the independent variables, or treatments, actually caused the effects on the dependent variable(s).

Internet databases Databases that can be accessed, searched and analysed on the Internet. It is also possible to download data from the Internet and store it on the computer or an auxiliary device.

Internet services Companies which specialise in the use of the Internet to collect, analyse and distribute marketing research information.

Interquartile range The range of a distribution encompassing the middle 50% of the observations.

Interval scale A scale in which the numbers are used to rank objects such that numerically equal distances on the scale represent equal distances in the characteristic being measured.

Intra-cultural analysis Within-country analysis of international data.

Item equivalence Use of the same instrument in different countries.

Itemised rating scale A measurement scale having numbers or brief descriptions associated with each category. The categories are ordered in terms of scale position.

Judgemental sampling A form of convenience sampling in which the population elements are purposely selected based on the judgement of the researcher.

_k_-sample median test A non-parametric test used to examine differences among more than two groups when the dependent variable is measured on an ordinal scale.

Kolmogorov–Smirnov (K–S) one-sample test A one-sample non-parametric goodness-of-fit test that compares the cumulative distribution function for a variable with a specified distribution.

Kolmogorov–Smirnov (K–S) two-sample test Non-parametric test statistic that determines whether two distributions are the same. It takes into account any differences in the two distributions, including median, dispersion and skewness.

Kruskal–Wallis one-way ANOVA A non-metric ANOVA test that uses the rank value of each case, not merely its location relative to the median.

Kurtosis A measure of the relative peakedness of the curve defined by the frequency distribution.

Laboratory environment An artificial setting for experimentation in which the researcher constructs the desired conditions.

Laddering A technique for conducting depth interviews in which a line of questioning proceeds from product characteristics to user characteristics.

Latin square design A statistical design that allows for the statistical control of two non-interacting external variables in addition to the manipulation of the independent variable.

Leading question A question that gives the respondent a clue as to what the answer should be.

Least squares procedure A technique for fitting a straight line into a scattergram by minimising the vertical distances of all the points from the line.

Level of significance The probability of making a Type I error.

Lifestyles Distinctive patterns of living described by the activities people engage in, the interests they have, and the opinions they hold of themselves and the world around them.

Likert scale A measurement scale with five response categories ranging from 'strongly disagree' to 'strongly agree' that requires respondents to indicate a degree of agreement or disagreement with each of a series of statements related to the stimulus objects.

Limited-service suppliers Companies that specialise in one or a few phases of a marketing research project.

Line chart A chart that connects a series of data points using continuous lines.

Linguistic equivalence The equivalence of both spoken and written language forms used in scales and questionnaires.

Linkage methods Agglomerative methods of hierarchical clustering that cluster objects based on a computation of the distance between them.

Longitudinal design A type of research design involving a fixed sample of population elements measured repeatedly. The sample remains the same over time, thus providing a series of pictures that, when viewed together, vividly illustrate the situation and the changes that are taking place.

Loyalty card At face value, a sales promotion device used by supermarkets, pharmacists, department stores, petrol stations and even whole shopping centres and towns to encourage repeat purchases. For the marketing researcher, the loyalty card is a device that can link customer characteristics to actual product purchases.

Mahalanobis procedure A stepwise procedure used in discriminant analysis to maximise a generalised measure of the distance between the two closest groups.

Mail panel A large and nationally representative sample of households that have agreed to participate in periodic mail questionnaires and product tests.

Main testing effect An effect of testing occurring when a prior observation affects a later observation.

Mann–Whitney *U* test A statistical test for a variable measured on an ordinal scale, comparing the differences in the location of two populations based on observations from two independent samples.

Marketing decision problem The problem confronting the marketing decision-maker, which asks what the decision-maker has to do.

Marketing information systems (MkIS) A formalised set of procedures for generating, analysing, sorting and distributing pertinent information to marketing decision-makers on an ongoing basis.

Marketing intelligence Qualified observations of events and developments in the marketing environment.

Marketing research A key element within the total field of marketing information. It links the consumer, customer and public to the marketer through information which is used to identify and define marketing opportunities and problems; to generate, refine and evaluate marketing actions; and to improve understanding of marketing as a process and of the ways in which specific marketing activities can be made more effective.

Marketing research problem A problem that entails determining what information is needed and how it can be obtained in the most feasible way.

Marketing research process A set of six steps which define the tasks to be accomplished in conducting a marketing research study. These include problem definition, developing an approach to the problem, research design formulation, fieldwork, data preparation and analysis, and report generation and presentation.

Matching A method of controlling extraneous variables that involves matching test units on a set of key background variables before assigning them to the treatment conditions.

Mathematical models Analytical models that explicitly describe the relationship between variables, usually in equation form.

Maturation An extraneous variable attributable to changes in the test units themselves that occur with the passage of time.

Mean The average; that value obtained by summing all elements in a set and dividing by the number of elements.

Measure of location A statistic that describes a location within a dataset. Measures of central tendency describe the centre of the distribution.

Measure of variability A statistic that indicates the distribution's dispersion.

Measurement The assignment of numbers or other symbols to characteristics of objects according to certain pre-specified rules.

Measurement error The variation in the information sought by the researcher and the information generated by the measurement process employed.

Media panels A data gathering technique composed of samples of respondents whose TV viewing behaviour is automatically recorded by electronic devices, supplementing the purchase information recorded in a diary.

Median A measure of central tendency given as the value above which half of the values fall and below which half of the values fall.

Memo writing Loosely written notes through to fully formed analytical arguments which are added to the original data and interpretations.

Metric data Data that are interval or ratio in nature.

Metric equivalence See Scalar equivalence.

Metric MDS An MDS scaling method that assumes the input data are metric.

Metric scale A scale that is either interval or ratio in nature.

Missing responses Values of a variable that are unknown because the respondents concerned provided ambiguous answers to the question or because their answers were not properly recorded.

Mode A measure of central tendency given as the value that occurs with the most frequency in a sample distribution.

Moderator An individual who conducts a focus group interview, by setting the purpose of the interview, questioning, probing and handling the process of discussion.

Monadic scale See Non-comparative scale.

Mood board A collage created in a focus group setting. Focus group participants are asked to snip words and pictures from magazines that they see as representing the values a particular brand is perceived to have. In some circumstances, collages can also be made up from audio- and videotapes.

Mortality An extraneous variable attributable to the loss of test units while the experiment is in progress.

Multicollinearity A state of high intercorrelations among independent variables.

Multidimensional scaling (MDS) A class of procedures for representing perceptions and preferences of respondents spatially by means of a visual display.

Multiple comparison tests A posteriori contrasts that enable the researcher to construct generalised confidence intervals that can be used to make pairwise comparisons of all treatment means.

Multiple cross-sectional design A cross-sectional design in which there are two or more samples of respondents, and information from each sample is obtained only once.

Multiple discriminant analysis Discriminant analysis technique where the criterion variable involves three or more categories.

Multiple regression A statistical technique that simultaneously develops a mathematical relationship between two or more independent variables and an interval-scaled dependent variable.

Multiple regression model An equation used to explain the results of multiple regression analysis.

Multiple time series design A time series design that includes another group of test units to serve as a control group.

Multiple η^2 The strength of the joint effect of two (or more) factors, or the overall effect.

Multivariate ANOVA (MANOVA) An ANOVA technique using two or more metric dependent variables.

Multivariate techniques Statistical techniques suitable for analysing data when there are two or more measurements on each element and the variables are analysed simultaneously. Multivariate techniques are concerned with the simultaneous relationships among two or more phenomena.

Mystery shopper An observer visiting providers of goods and services as if he or she was really a customer, and recording characteristics of the service delivery.

n-way analysis of variance An ANOVA model where two or more factors are involved.

Natural observation Observing behaviour as it takes place in the environment.

Neuromarketing The application of neuroscience in marketing, primarily to measure emotions through brain imaging.

Nominal scale A scale whose numbers serve only as labels or tags for identifying and classifying objects with a strict one-to-one correspondence between the numbers and the objects.

Nomological validity A type of validity that assesses the relationship between theoretical constructs. It seeks to confirm significant correlations between the constructs as predicted by a theory.

Non-comparative scale One of two types of scaling techniques in which each stimulus object is scaled independently of the other objects in the stimulus set. Also called monadic scale.

Non-hierarchical clustering A procedure that first assigns or determines a cluster centre and then groups all objects within a pre-specified threshold value from the centre.

Non-metric ANOVA An ANOVA technique for examining the difference in the central tendencies of more than two groups when the dependent variable is measured on an ordinal scale.

Non-metric correlation A correlation measure for two non-metric variables that relies on rankings to compute the correlation.

Non-metric data Data derived from a nominal or ordinal scale.

Non-metric MDS A type of MDS which assumes that the input data are ordinal.

Non-metric scale A scale that is either nominal or ordinal in nature.

Non-parametric tests Hypothesis testing procedures that assume that the variables are measured on a nominal or ordinal scale.

Non-probability sampling Sampling techniques that do not use chance selection procedures but rather rely on the personal judgement of the researcher.

Non-response bias Bias caused when actual respondents differ from those who refuse to participate.

Non-response error A type of non-sampling error that occurs when some of the respondents included in the sample do not respond. This error may be defined as the variation between the true mean value of the variable in the original sample and the true mean value in the net sample.

Non-sampling error An error that can be attributed to sources other than sampling and that can be random or non-random.

Null hypothesis A statement in which no difference or effect is expected. If the null hypothesis is not rejected, no changes will be made.

Numeric databases Databases containing numerical and statistical information that may be important sources of secondary data.

Objective evidence Perceived to be unbiased evidence, supported by empirical findings.

Oblique rotation Rotation of factors when the axes are not maintained at right angles.

Offline databases Databases that are available on diskette or CD-ROM.

Omega squared (ω^2) A measure indicating the proportion of the variation in the dependent variable that is related to a particular independent variable or factor.

Omnibus survey A distinctive form of survey that serves the needs of a syndicated group. The omnibus survey targets particular types of respondents such as those in specific geographic locations, e.g. Luxembourg residents, or consumers of particular types of products, e.g. business air travellers. With that target group of respondents, a core set of questions can be asked, with other questions added as syndicate members wish.

One-group pretest–posttest design A pre-experimental design in which a group of test units is measured twice.

One-shot case study A pre-experimental design in which a single group of test units is exposed to a treatment **X**, and then a single measurement of the dependent variable is taken.

One-tailed test A test of the null hypothesis where the alternative hypothesis is expressed directionally.

One-way analysis of variance An ANOVA technique in which there is only one factor.

Online databases Databases, stored in computers, that require a telecommunications network to access.

Operational data Data generated about an organisation's customers, through day-to-day transactions.

Operational equivalence A type of equivalence that measures how theoretical constructs are operationalised in different countries to measure marketing variables.

Operationalised The derivation of measurable characteristics to encapsulate marketing phenomena, e.g. the concept of 'customer loyalty' can be operationalised through measurements such as frequency of repeat purchases or the number of years that a business relationship has existed.

Optimising partitioning method A non-hierarchical clustering method that allows for later reassignment of objects to clusters to optimise an overall criterion.

Order bias (position bias) A respondent's tendency to choose an alternative merely because it occupies a certain position or is listed in a certain order.

Ordinal interaction An interaction where the rank order of the effects attributable to one factor does not change across the levels of the second factor.

Ordinal scale A ranking scale in which numbers are assigned to objects to indicate the relative extent to which some characteristic is possessed. Thus, it is possible to determine whether an object has more or less of a characteristic than some other object.

Orthogonal rotation Rotation of factors in which the axes are maintained at right angles.

Paired comparison scaling A comparative scaling technique in which a respondent is presented with two objects at a time and asked to select one object in the pair according to some criterion. The data obtained are ordinal in nature.

Paired samples The samples are paired when the data for the two samples relate to the same group of respondents.

Paired samples _t_ test A test for differences in the means of paired samples.

Pairwise deletion A method for handling missing responses in which all cases or respondents with any missing responses are not automatically discarded; rather, for each calculation, only the cases or respondents with complete responses are considered.

Pan-cultural analysis Across-countries analysis in which the data for all respondents from all the countries are pooled and analysed.

Panel A sample of respondents who have agreed to provide information at specified intervals over an extended period.

Pantry audit A type of audit where the researcher inventories the brands, quantities and package sizes of products in a consumer's home.

Paradigm A set of assumptions consisting of agreed-upon knowledge, criteria of judgement, problem fields and ways to consider them.

Parallel threshold method A non-hierarchical clustering method that specifies several cluster centres at once. All objects that are within a pre-specified threshold value from the centre are grouped together.

Parallel translation A translation method in which a committee of translators, each of whom is fluent in at least two languages, discuss alternative versions of a questionnaire and make modifications until consensus is reached

Parametric tests Hypothesis testing procedures that assume that the variables of interest are measured on at least an interval scale.

Part correlation coefficient A measure of the correlation between Y and X when the linear effects of the other independent variables have been removed from X (but not from Y).

Partial correlation coefficient A measure of the association between two variables after controlling or adjusting for the effects of one or more additional variables.

Perceived respondent anonymity The respondents' perceptions that their identities will not be discerned by the interviewer or researcher.

Personal observation An observational research strategy in which human observers record the phenomenon being observed as it occurs.

Personification technique Participants are asked to imagine that the brand is a person and then describe characteristics of that person.

Phi coefficient (ϕ) A measure of the strength of association in the special case of a table with two rows and two columns (a 2×2 table).

Picture response technique A projective technique in which participants are shown a picture and are asked to tell a story describing it.

Pie chart A round chart divided into sections.

Pilot-testing Testing the questionnaire on a small sample of particpants for the purpose of improving the questionnaire by identifying and eliminating potential problems.

Population The aggregate of all the elements, sharing some common set of characteristics, that comprise the universe for the purpose of the marketing research problem.

Position bias See Order bias.

Positivism A philosophy of language and logic consistent with an empiricist philosophy of science.

Posttest-only control group design Experimental design in which the experimental group is exposed to the treatment but the control group is not and no pretest measure is taken.

Power of a statistical test The probability of rejecting the null hypothesis when it is in fact false and should be rejected.

Pre-coding In questionnaire design, assigning a code to every conceivable response before data collection.

Predictive validity A type of validity that is concerned with how well a scale can forecast a future criterion.

Pre-experimental designs Designs that do not control for extraneous factors by randomisation.

Pretest–posttest control group design An experimental design in which the experimental group is exposed to the treatment but the control group is not. Pretest and posttest measures are taken on both groups.

Primary data Data originated by the researcher specifically to address the research problem.

Principal axis factoring See Common factor analysis.

Principal components analysis An approach to factor analysis that considers the total variance in the data.

Probability proportionate to size (PPS) A selection method where the probability of selecting a sampling unit in a selected cluster varies inversely with the size of the cluster. Therefore, the size of all the resulting clusters is approximately equal.

Probability sampling A sampling procedure in which each element of the population has a fixed probabilistic chance of being selected for the sample.

Probing A motivational technique used when asking questions to induce the participants to enlarge on, clarify or explain their answers.

Problem audit A comparative examination of a marketing problem to understand its origin and nature.

Problem definition A broad statement of the general problem and identification of the specific components of the marketing research problem.

Problem identification research Research undertaken to help identify problems that are not necessarily apparent on the surface, yet exist or are likely to arise in the future.

Problem-solving research Research undertaken to help solve marketing problems.

Product moment correlation (r) A statistic summarising the strength of association between two metric variables.

Projective technique An unstructured and indirect form of questioning that encourages participants to project their underlying motivations, beliefs, attitudes or feelings regarding the issues of concern.

Psycho-galvanometer An instrument that measures a respondent's galvanic skin response.

Psychographics Quantified profiles of individuals based upon lifestyle characteristics.

Pupilometer An instrument that measures changes in the eye pupil diameter.

Purchase panels A data gathering technique in which respondents record their purchases in a diary.

Q-sort scaling A comparative scaling technique that uses a rank order procedure to sort objects based on similarity with respect to some criterion.

Qualitative research An unstructured, primarily exploratory design based on small samples, intended to provide insight and understanding.

Quantitative observation The recording and counting of behavioural patterns of people, objects and events in a systematic manner to obtain information about the phenomenon of interest.

Quantitative research Research techniques that seek to quantify data and, typically, apply some form of statistical analysis.

Quasi-experimental designs Designs that apply part of the procedures of true experimentation yet lack full experimental control.

Questionnaire A structured technique for data collection consisting of a series of questions, written or verbal, that a respondent answers.

Quota sampling A non-probability sampling technique that is two-stage restricted judgemental sampling. The first stage consists of developing control categories or quotas of population elements. In the second stage, sample elements are selected based on convenience or judgement.

Random error An error that arises from random changes or differences in respondents or measurement situations.

Random sampling error The error because the particular sample selected is an imperfect repesentation of the population of interest. It may be defined as the variation between the true mean value for the sample and the true mean value of the population.

Randomisation A method of controlling extraneous variables that involves randomly assigning test units to experimental groups by using random numbers. Treatment conditions are also randomly assigned to experimental groups.

Randomised block design A statistical design in which the test units are blocked on the basis of an external variable to ensure that the various experimental and control groups are matched closely on that variable.

Range The difference between the smallest and largest values of a distribution.

Rank order scaling A comparative scaling technique in which respondents are presented with several objects simultaneously and asked to order or rank them according to some criterion.

Ratio scale The highest scale. This scale allows the researcher to identify or classify objects, rank order the objects, and compare intervals or differences. It is also meaningful to compute ratios of scale values.

Regression analysis A statistical procedure for analysing associative relationships between a metric-dependent variable and one or more independent variables.

Reliability The extent to which a scale produces consistent results if repeated measurements are made on the characteristic.

Repeated measures ANOVA An ANOVA technique used when respondents are exposed to more than one treatment condition and repeated measurements are obtained.

Research brief A document produced by the users of research findings or the buyers of a piece of marketing research. The brief is used to communicate the perceived requirements of a marketing research project.

Research design A framework or blueprint for conducting the marketing research project. It specifies the details of the procedures necessary for obtaining the information needed to structure or solve marketing research problems.

Research proposal The official layout of the planned marketing research activity.

Research questions Refined statements of the specific components of the problem.

Residual The difference between the observed value of Y_i and the value predicted by the regression equation $\hat{Y}_i$.

Response error A type of non-sampling error arising from respondents who do respond but who give inaccurate answers or whose answers are mis-recorded or mis-analysed. It may be defined as a variation between the true mean value of the variable in the net sample and the observed mean value obtained in the market research project.

Response latency The amount of time it takes to respond to a question.

Response rate The percentage of the total attempted interviews that are completed.

Role playing Participants are asked to assume the behaviour of someone else.

Runs test A test of randomness for a dichotomous variable.

Sample A subgroup of the elements of the population selected for participation in the study.

Sample control The ability of the survey mode to reach the units specified in the sample effectively and efficiently.

Sample size The number of elements to be included in a study.

Sampling control An aspect of supervising that ensures that the interviewers strictly follow the sampling plan rather than select sampling units based on convenience or accessibility.

Sampling distribution The distribution of the values of a sample statistic computed for each possible sample that could be drawn from the target population under a specified sampling plan.

Sampling frame A representation of the elements of the target population that consists of a list or set of directions for identifying the target population.

Sampling unit An element, or a unit containing the element, that is available for selection at some stage of the sampling process.

Sampling with replacement A sampling technique in which an element can be included in the sample more than once.

Sampling without replacement A sampling technique in which an element cannot be included in the sample more than once.

Scalar equivalence The demonstration that two individuals from different countries with the same value on some variable will score at the same level on the same test. Also called metric equivalence

Scale transformation A manipulation of scale values to ensure compatibility with other scales or otherwise to make the data suitable for analysis.

Scaling The generation of a continuum upon which measured objects are located.

Scanner data Data obtained by passing merchandise over a laser scanner that reads the UPC from the packages.

Scanner diary panels Scanner data where panel members are identified by an ID card, allowing information about each panel member's purchases to be stored with respect to the the individual shopper.

Scanner diary panels with cable TV The combination of a scanner diary panel with manipulations of the advertising that is being broadcast by cable TV companies.

Scanning device Technology that reads the UPC from merchandise by passing it over a laser scanner.

Secondary data Data collected for some purpose other than the problem at hand.

Selection bias An extraneous variable attributable to the improper assignment of test units to treatment conditions.

Semantic differential A seven-point rating scale with end points associated with bipolar labels.

Semiotics The study of signs in the context of consumer experience.

Sentence completion A projective technique in which participants are presented with a number of incomplete sentences and are asked to complete them.

Sequential sampling A probability sampling technique in which the population elements are sampled sequentially, data collection and analysis are done at each stage, and a decision is made as to whether additional population elements should be sampled.

Shadow team A small cross-functional boundary spanning group that learns everything about a competitive unit.

Sign test A non-parametric test for examining differences in the location of two populations, based on paired populations, that compares only the signs of the differences between pairs of variables without taking into account the magnitude of the differences.

Significance of the interaction effect A test of the significance of the interaction between two or more independent variables.

Significance of the main effect of each factor A test of the significance of the main effect for each individual factor.

Significance of the overall effect A test that some differences exist between some of the treatment groups.

Simple random sampling (SRS) A probability sampling technique in which each element has a known and equal probability of selection. Every element is selected independently of every other element, and the sample is drawn by a random procedure from a sampling frame.

Simulated test market A quasi-test market in which respondents are preselected; they are then interviewed and observed on their purchases and attitudes towards the product.

Single cross-sectional design A cross-sectional design in which one sample of respondents is drawn from the target population and information is obtained from this sample once.

Single linkage A linkage method based on minimum distance or the nearest neighbour rule.

Skewness A characteristic of a distribution that assesses its symmetry about the mean.

Snowball sampling A non-probability sampling technique in which an initial group of respondents is selected randomly. Subsequent respondents are selected based on the referrals or information provided by the initial respondents. By obtaining referrals from referrals, this process may be carried out in waves.

Social desirability The tendency of respondents to give answers that may not be accurate but may be desirable from a social standpoint.

Solomon four-group design An experimental design that explicitly controls for interactive testing effects, in addition to controlling for all the other extraneous variables.

Special-purpose databases Databases that contain information of a specific nature, e.g. data on a specialised industry.

Specific components of the problem The second part of the marketing research problem definition that focuses on the key aspects of the problem and provides clear guidelines on how to proceed further.

Split-half reliability A form of internal consistency reliability in which the items constituting the scale are divided into two halves and the resulting half scores are correlated.

Standard deviation The square root of the variance.

Standard error The standard deviation of the sampling distribution of the mean or proportion.

Standard test market A test market in which the product is sold through regular distribution channels. For example, no special considerations are given to products simply because they are being test marketed.

Standardisation The process of correcting data to reduce them to the same scale by subtracting the sample mean and dividing by the standard deviation.

Standardised services Companies that use standardised procedures to provide marketing research to various clients.

Stapel scale A scale for measuring attitudes that consists of a single adjective in the middle of an even-numbered range of values.

Static group A pre-experimental design in which there are two groups: the experimental group (EG), which is exposed to the treatment, and the control group (CG). Measurements on both groups are made only after the treatment, and test units are not assigned at random.

Statistical control A method of controlling extraneous variables by measuring the extraneous variables and adjusting for their effects through statistical methods.

Statistical designs Designs that allow for the statistical control and analysis of external variables.

Statistical inference The process of generalising the sample results to a target population.

Statistical regression An extraneous variable that occurs when test units with extreme scores move closer to the average score during the course of the experiment.

Stepwise discriminant analysis Discriminant analysis in which the predictors are entered sequentially based on their ability to discriminate between the groups.

Stepwise regression A regression procedure in which the predictor variables enter or leave the regression equation one at a time.

Story completion A projective technique in which participants are provided with part of a story and are required to give the conclusion in their own words.

Stratified sampling A probability sampling technique that uses a two-step process to partition the population into subsequent subpopulations, or strata. Elements are selected from each stratum by a random procedure.

Structural equation modelling (SEM) Collection of statistical techniques including factor analysis and multiple regression. It allows the researcher to examine relationships between several continuous or discrete independent variables and several continuous or discrete dependant variables. The independent and dependent variables can be latent or measured variables.

Structured data collection Use of a formal questionnaire that presents questions in a prearranged order.

Structured observation Observation where the researcher clearly defines the behaviours to be observed and the techniques by which they will be measured.

Structured questions Questions that pre-specify the set of response alternatives and the response format. A structured question could be multiple-choice, dichotomous or a scale.

Substitution A procedure that substitutes for non-respondents other elements from the sampling frame who are expected to respond.

Sugging The use of marketing research to deliberately disguise a sales effort.

Surrogate variables A subset of original variables selected for use in subsequent analysis.

Survey techniques Technniques based upon the use of structured questionnaires given to a sample of a population.

Surveys Interviews with a large number of people using a questionnaire.

Symmetric lambda The symmetric lambda does not make an assumption about which variable is dependent. It measures the overall improvement when prediction is done in both directions.

Syndicated services Companies that collect and sell common pools of data designed to serve information needs shared by a number of clients.

Syndicated sources (services) Information services offered by marketing research organisations that provide information from a common database to different firms that subscribe to their services.

Systematic error An error that affects the measurement in a constant way and represents stable factors that affect the observed score in the same way each time the measurement is made.

Systematic sampling A probability sampling technique in which the sample is chosen by selecting a random starting point and then picking every ith element in succession from the sampling frame.

t distribution A symmetrical bell-shaped distribution that is useful for sample testing ($n < 30$). It is similar to the normal distribution in appearance.

t statistic A statistic that assumes that the variable has a symmetric bell-shaped distribution, that the mean is known (or assumed to be known), and that the population variance is estimated from the sample.

t test A univariate hypothesis test using the t distribution, which is used when the standard deviation is unknown and the sample size is small.

Target population The collection of elements or objects that possess the information sought by the researcher and about which inferences are to be made.

tau b A test statistic that measures the association between two ordinal-level variables. It makes an adjustment for ties and is the most appropriate when the table of variables is square.

tau c A test statistic that measures the association between two ordinal-level variables. It makes an adjustment for ties and is most appropriate when the table of variables is not square but a rectangle.

Telescoping A psychological phenomenon that takes place when an individual telescopes or compresses time by remembering an event as occurring more recently than it actually occurred.

Territorial map A tool for assessing discriminant analysis results by plotting the group membership of each case on a graph.

Test market A carefully selected part of the marketplace particularly suitable for test marketing.

Test marketing An application of a controlled experiment done in limited, but carefully selected, test markets. It involves a replication of the planned national marketing programme for a product in test markets.

Test statistic A measure of how close the sample has come to the null hypothesis. It often follows a well-known distribution, such as the normal, t, or chi-square distribution.

Test units Individuals, organisations or other entities whose response to independent variables or treatments is being studied.

Testing effects Effects caused by the process of experimentation.

Test–retest reliability An approach for assessing reliability, in which respondents are administered identical sets of scale items at two different times, under as nearly equivalent conditions as possible.

Thematic maps Maps that solve marketing problems. They combine geography with demographic information and a company's sales data or other proprietary information and are generated by a computer.

Theoretical sampling Data gathering driven by concepts derived from evolving theory and based on the concept of 'making comparisons'.

Theory A conceptual scheme based on foundational statements, or axioms, that are assumed to be true.

Third-person technique A projective technique in which participants are presented with a verbal or visual situation and are asked to relate the beliefs and attitudes of a third person in that situation.

Time series design A quasi-experimental design that involves periodic measurements of the dependent variable for a group of test units. Then the treatment is administered by the researcher or occurs naturally. After the treatment, periodic measurements are continued to determine the treatment effect.

Topic guide A list of topics, questions and probes that are used by a moderator to help manage a focus group discussion.

Total error The variation between the true mean value in the population of the variable of interest and the observed mean value obtained in the marketing research project

Trace analysis An approach in which data collection is based on physical traces, or evidence, of past behaviour.

Transcripts 'Hard copies' of the questions and probes and the corresponding answers and responses in focus group or in-depth interviews.

Transitivity of preference An assumption made to convert paired comparison data with rank order data. It implies that if Brand A is preferred to Brand B, and Brand B is preferred to Brand C, then Brand A is preferred to Brand C.

Treatment In ANOVA, a particular combination of factor levels or categories.

Trend analysis A method of adjusting for non-response in which the researcher tries to discern a trend between early and late respondents. This trend is projected to non-respondents to estimate their characteristic of interest.

True experimental designs Experimental designs distinguished by the fact that the researcher can randomly assign test units to experimental groups and also randomly assign treatments to experimental groups.

True score model A mathematical model that provides a framework for understanding the accuracy of measurement.

Two-group discriminant analysis Discriminant analysis technique where the criterion variable has two categories.

Two-sample median test Non-parametric test statistic that determines whether two groups are drawn from populations with the same median. This test is not as powerful as the Mann–Whitney U test.

Two-tailed test A test of the null hypothesis where the alternative hypothesis is not expressed directionally.

Type I error An error that occurs when the sample results lead to the rejection of a null hypothesis that is in fact true. Also known as alpha error (α).

Type II error An error that occurs when the sample results lead to acceptance of a null hypothesis that is in fact false. Also known as beta error (β).

Univariate techniques Statistical techniques appropriate for analysing data when there is a single measurement of each element in the sample, or, if there are several measurements on each element, when each variable is analysed in isolation.

Unstructured observation Observation that involves a researcher monitoring all relevant phenomena, without specifying the details in advance.

Unstructured questions Open-ended questions that respondents answer in their own words.

Validation sample That part of the total sample used to check the results of the estimation sample.

Validity The extent to which a measurement represents characteristics that exist in the phenomenon under investigation.

Variable respecification The transformation of data to create new variables or the modification of existing variables so that they are more consistent with the objectives of the study.

Variance The mean squared deviation of all the values of the mean.

Variance method An agglomerative method of hierarchical clustering in which clusters are generated to minimise the within-cluster variance.

Varimax procedure An orthogonal method of factor rotation that minimises the number of variables with high loadings on a factor, thereby enhancing the interpretability of the factors.

Verbal models Analytical models that provide a written representation of the relationships between variables.

Verbal protocol A technique used to understand respondents' cognitive responses or thought processes by having them think aloud while completing a task or making a decision.

Viewing laboratory A room where a focus group may be conducted and simultaneously observed, usually by using a two-way mirror.

Voice pitch analysis Measurement of emotional reactions through changes in the respondent's voice.

Volume tracking data Scanner data that provide information on purchases by brand, size, price and flavour or formulation.

Ward's procedure A variance method in which the squared Euclidean distance to the cluster means is minimised.

Weighting A statistical procedure that attempts to account for non-response by assigning differential weights to the data depending on the response rates.

Wilcoxon matched-pairs signed-ranks test A non-parametric test that analyses the differences between the paired observations, taking into account the magnitude of the differences.

Word association A projective technique in which participants are presented with a list of words, one at a time. After each word, they are asked to give the first word that comes to mind.

z test A univariate hypothesis test using the standard normal distribution.

z value The number of standard errors a point is away from the mean.

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